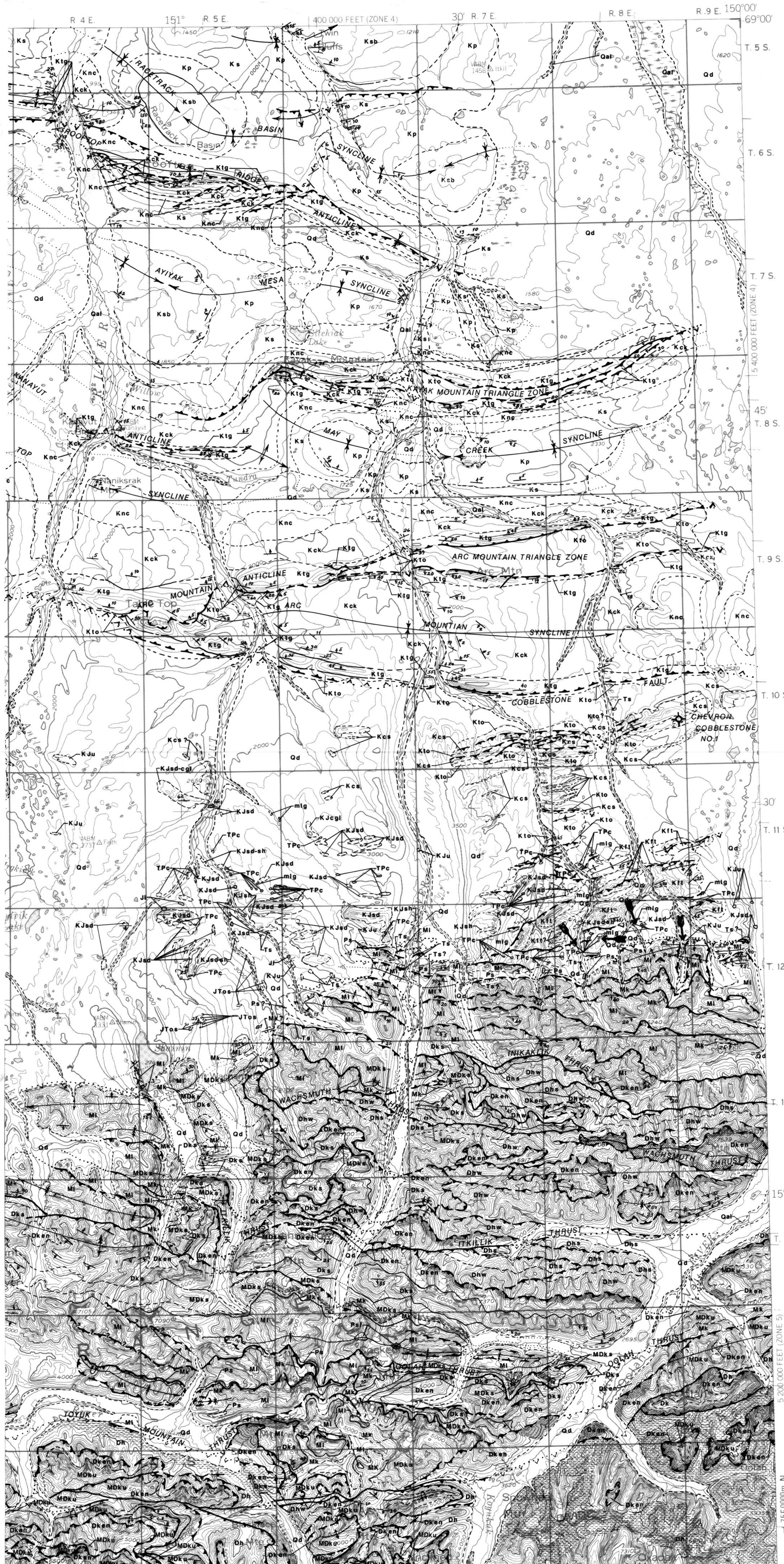
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 88-42
SHEET 2 OF 2



SCALE 1:125 000

2 0 2 4 6 8 10 MILES

2 0 2 4 6 8 10 KILOMETERS

200 foot contour interval

GEOLOGY FROM:

Published Sources: Bowsher and Dutro, 1957; Brosgé and others, 1960 and 1979; Detterman and others, 1963; Kelley, 1984a and b; and Patton and Tailleur; 1964.

Field Investigations: J.S. Kelley, A.K. Armstrong, J.R. Bergquist, W.H. Nelson, C.G. Mull, and D.M. Peterson, 1982; J.S. Kelley, W.P. Brosgé, D. Bohn, W.H. Nelson, and G.D. Stricker, 1983; J.S. Kelley, M.W. Reynolds, J.T. Dutro, Jr., W.H. Nelson, B. Csejtey, Jr., and D. Bohn, 1984; J.S. Kelley, G.D. Stricker, S.W. Nelson, B. Csjetey, Jr, and D. Bohn, 1985; and J.S. Kelley, S.M. Karl, D. Bohn, and G.A. Lancaster, 1986.

EAST HALF
PRELIMINARY GEOLOGIC MAP OF THE CHANDLER LAKE QUADRANGLE, ALASKA

BY J.S. KELLEY 1988

DESCRIPTION OF MAP UNITS

INTRODUCTION

This is a preliminary compilation of geologic mapping in the Chandler Lake quadrangle. Recently completed geologic field investigations in the Chandler Lake quadrangle are for the purpose of making a hydrocarbon and mineral resource assessment of the quadrangle as part of the Alaska Mineral Resource Assessment Program (AMRAP). An AMRAP folio for the Chandler Lake quadrangle, however, will not be available in time to contribute to an oil and gas assessment required by statute.

This map is an interim product to provide new information for an oil and gas assessment of the Central Arctic Management Area (CAMA) required by Section 1001 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. ANILCA requires oil and gas assessment of all Federal lands lying north of 68° N latitude exclusive of the National Petroleum Reserve-Alaska, the Arctic National Wildlife Refuge, and submerged land on the Outer Continental Shelf.

The principal emphasis of this map is to provide a basis for determining the structural framework of the Chandler Lake quadrangle. Reconnaissance mapping showing the distribution of major rock types is available for most of the quadrangle but, detailed mapping is only available for small and widely scattered parts of the quadrangle prior to the present study. Structural framework is imperative to an oil and gas assessment, especially so in a fold and thrust belt where source, trap, reservoir, seal, and timing are interrelated to a great degree through structural geology.

The map incorporates new mapping and interpreted published mapping. New mapping includes a transect of unpublished 1:63,360 geologic mapping generalized to 1:125,000 along the eastern boundary of the quadrangle. The transect provides an understanding of structural style in the quadrangle and a basis for incorporating published geologic mapping at varying scales, with and without topographic bases, and differing detail and opinion, into a coherent geologic map. Map construction outside the transect relies heavily on air-photo interpretation to integrate the different sources of information. Scattered geological observations from spot checks, helicopter overflights, and foot traverses are part of the map compilation outside of the transect.

Two portions of the geologic map show structural and stratigraphic relations whereas an intervening part of the map is largely an outcrop map. Near-continuous outcrop south of the range front affords construction of a map showing distribution of structures and map units. Regional continuity and simple structural patterns underlying most of the area north of the escarpment including Hatbox Mountain, Tuktu Bluff, Gunsight Mountain, Banded Mountain, and Table Mountain affords construction of a map showing structural and stratigraphic relations north of the escarpment. Limited outcrop and structural complexity severely limit mapping between the escarpment and the range front; mapping in this area is mostly the outcrop distribution of rock-units. Mapping between the escarpment and the range front is from field observations annotated on air-photographs at 1:120,000 and transferred by inspection to a topographic base at 1:125,000.

Qal QUATERNARY ALLUVIUM (Hamilton, T.D., 1979) (Holocene)--Unconsolidated debris including boulders, gravel, sand, silt, clay and humic material. Primarily sediments in river channels, active floodplains, bogs and swamps. See Hamilton (1979) for detailed map and descriptions of Quaternary deposits.

Qd QUATERNARY DEPOSITS (Hamilton, T.D., 1979) (Quaternary)--Undifferentiated unconsolidated deposits, including glacial drift, outwash, and high-level terraces: boulders, gravel, sand, silt and clay. See Hamilton (1979) for detailed map and descriptions of Quaternary deposits.

Ksb SCHRADER BLUFF FORMATION (Detterman and others, 1963) (Upper Cretaceous)--Three members make up the Schrader Bluff Formation, in ascending order, the Rogers Creek, Barrow Trail, and Sentinel Hill Members. All three members occur in the Chandler Lake quadrangle but are not discriminated. Detterman and others (1963) report about 1800 feet (550 m) of Schrader Bluff Formation at Race Track Basin syncline.

Shale, claystone, sandstone, and bentonite. Medium- to light-gray bentonitic shale, clayey, fissile, and includes tuff beds. Medium-gray claystone; commonly well indurated, probably tuffaceous in part. Light-gray to light-brown sandstone; fine-grained, laminated, and micaceous. Medium- to light-grayish-green bentonite beds. Gray tuffaceous siltstone. Formation includes shell fragments and coalified wood debris.

Kp PRINCE CREEK FORMATION (Detterman and others, 1963) (Upper Cretaceous)--Only the Tuluvak Tongue of the Prince Creek Formation is recognized in the Chandler Lake quadrangle. Detterman and others (1963) report 575 feet (175 m) of Tuluvak Tongue at the type locality at Schrader Bluff about 15 miles (24 km) north of Race Track Basin. The Tuluvak Tongue appears to thicken radically because outcrop widths and dips in the northeastern Chandler Lake quadrangle suggest thicknesses approaching 2,000 feet (610 m). The character of the Prince Creek Formation changes from southwest to northeast.

Northeast Sandstone, siltstone, mudstone, coal, and tuff. Medium- to light-medium-gray, yellowish-gray, and brownish-gray sandstone; thin- to medium-bedded, fine-to coarse-grained, locally conglomeratic, tuffaceous in part, includes conglomerate composed mostly of small pebbles of black chert and white quartz and quartzite. Mudstone, siltstone, and shale; medium-gray to dark-gray, fissile in part, bentonitic in part. Includes plant fragments, tuff beds, coal, and ironstone nodules.

Southwest Conglomerate, sandstone, siltstone, and shale. Basal conglomerate up to 40 feet (10 m) thick composed of well rounded pebbles of white to light-gray quartz and orthoquartzite and medium-to dark-gray chert. Conglomerate has a sandstone matrix and prominent quartz cement that reflects light. Conglomerate produces prominent positive weathering topographic features such as cuestas and rimrock. Sandstone in upper part of the unit is prominently cross bedded and very poorly exposed.

Ks SEABEE FORMATION (Detterman and others, 1963) (Upper Cretaceous)--Includes the Shale Wall Member and overlying Ayiyak Member. Detterman and others (1963) report about 1,800 feet (550 m) of Shale Wall Member along the Nanushuk River at Rooftop Ridge. Detterman and others (1963) also report 360 feet (110 m) of Ayiyak Member in the type locality along the Ayiyak River and a generally persistent thickness distribution. Outcrop widths and dips suggest that the Seabee Formation is about 1,400 feet (425 m) thick and probably thins to the south, probably at the expense of the Shale Wall Member. Differences in reported thickness probably are related to structural complications in the tuffaceous and shaly Shale Wall Member.

Shale Wall Member Medium-gray shale; bentonitic, clayey, with bentonite beds, laminated siltstone interbeds, and limestone concretions. Includes dark-gray to black organic shale locally, clayey limestone concretions up to 8 feet (2.4 meters) across, and marine fossils. Also locally includes medium- to medium-light-gray fine- to very fine grained sandstone with interbeds of siltstone. Member is calcareous cemented in part.

Ayiyak Member Greenish-gray and olive-gray siltstone; typically shaly, and grades to mudstone. Brownish-gray and greenish-gray sandstone; thin- to medium-bedded, mostly fine-grained but locally coarse-grained and conglomeratic. Includes thin lenticular beds of conglomerate composed mostly of black chert and white quartz pebbles, impure limestone, calcareous concretions, shale, and ironstone concretions.

Knc NIAKOGON TONGUE OF THE CHANDLER FORMATION, AND NINULUK FORMATION (Detterman and others, 1963) (Upper-Cretaceous)--The Niakogan Tongue is principally nonmarine sandstone that interfingers with the laterally equivalent and principally marine sandstone of the Ninuluk Formation. The Ninuluk Formation crops out northeast of the Niakogon Tongue. The Ninuluk Formation comprises strata deposited in progressively deeper water to the northeast. Detterman and others (1963) report 1,160 feet (355 m) of Ninuluk Formation on the east fork of the upper Tuluga River. Outcrop widths and dips suggest that 1,160 feet (355 m) is a maximum value for the Niakogon Tongue and Ninuluk Formation; both units are locally absent either by erosion along an unconformity at the base of the Seabee Formation or abrupt depositional wedge out.

Niakogon Tongue Sandstone, siltstone, and mudstone. Light-olive-gray, greenish-gray, and medium-gray sandstone; light-gray-weathering with a "salt and pepper" appearance, also locally buff and yellowish-red weathering and strongly iron-oxide-stained, fine- to coarse-grained, thin-bedded to massive, well indurated, limonite cemented locally, includes ironstone concretions locally, and includes beds of granule conglomerate and conglomeratic sandstone. Granules in conglomerate and conglomeratic sandstone are mostly dark-gray chert and quartz. Siltstone and mudstone make up half of the tongue. Plastic grayish-green bentonite beds occur in the upper part of the tongue.

Ninuluk Formation Sandstone, siltstone, and shale. Greenish-gray to brownish-gray sandstone; thin-bedded to massive, laminated in part, cross-bedded, friable to moderately indurated, fine- to very fine grained and grades to siltstone, conglomeratic in part and includes beds and lenses of granule conglomerate comprising varicolored chert and white quartz. Sandstone includes ripple marks, carbonaceous debris, marine fossils, and thoroughly carbonate-cemented lenses grading to sandy and silty limestone. Sandstone beds become progressively finer grained, thinner bedded, more clayey and more commonly carbonate cemented in a northeasterly direction. Greenish-gray shaly siltstone and dark-bluish-gray clay shale; siltstone is hard and hackly weathering and both siltstone and shale are laminated. Formation includes soft shale with weathered surfaces that commonly have yellowish-gray or light-gray bloom. Siltstone and shale include ironstone concretions. Grayish-green plastic claystone, probably bentonite, occurs in shale.

Kck KILLIK TONGUE OF THE CHANDLER FORMATION (Detterman and others, 1963; Patton and Tailleur, 1964) (Lower Cretaceous)--Detterman and others (1963) report thicknesses of 2,570 and 2,840 feet (785 and 865 m) from measured sections in the Chandler Lake quadrangle where the Killik tongue is not interfingered with other map units. Mapped outcrop widths and dips suggest that the Killik tongue is about 2,600 feet (790 m) thick but thins dramatically to the northeast, possibly by truncation under an unconformity at the base of the Seabee Formation or possibly by facies transition into marine map units. Sandstone, conglomerate, siltstone, shale, and coal. Light-olive-gray, greenish-gray, and medium-gray sandstone and conglomerate; weathers light-gray with "salt and pepper" color patterns caused by dark gray chert and aphanitic rock fragments in contrast to very light gray weathering quartz, feldspar, and light-gray chert grains; medium-grained to fine-grained, and cross bedded. Conglomeratic sandstone and conglomerate beds comprise clasts of mostly chert and quartz. Conglomerate is framework supported. Coal beds up to 10 feet (3 m) thick occur in the upper part of the tongue and together with siltstone and shale are negative weathering and generally poorly exposed. Ironstone concretions are common in the coal-bearing part of the tongue. Sandstone and conglomerate are very prominent ledge-forming strata.

Ktg TUKTU FORMATION AND GRANDSTAND FORMATION (Detterman and others, 1963; Patton and Tailleur, 1964) (Lower Cretaceous)--Tuktu and Grandstand Formations constitute the basal sandstone of the Nanushuk Group. The basal sandstone is time-transgressive to the north; the age of the Grandstand Formation is equivalent to that of the Killik tongue of the Chandler Formation, which overlies the Tuktu Formation. The two formations are mapped as an undivided unit here although the Grandstand Formation is younger than the Tuktu Formation because: (1) both formations occupy the same stratigraphic position at the base of the Nanushuk Group, (2) the units are chronologic end members of a time-transgressive depositional unit, and (3) a widespread structural detachment occurs between the Tuktu/Grandstand Formations and underlying shale; the single map unit helps demonstrate the structural discontinuity and stratigraphic continuity.

Detterman and others (1963) report thickness of Tuktu Formation from measured sections to range from 940 to 1,030 feet (285 to 315 m). Detterman and others (1963) report 1,430 feet (435 m) of Grandstand Formation at the type section on the Anaktuvuk River. Outcrop widths and dips suggest that the Tuktu/Grandstand Formation attains thicknesses up to 1,500 feet (455 m). Grayish-green to greenish-gray sandstone; medium- to very fine grained, shaly in part, cross bedded in part, includes ripple marks locally, wood debris, marine fossils, few conglomerate beds, and bioturbations. Greenish-gray siltstone and mudstone makes up a small part of the formations. The formations are resistant weathering and together with the overlying nonmarine sandstone form prominent ridges.

Kf(t) FORTRESS MOUNTAIN FORMATION, (Patton and Tailleur, 1964) (Lower Cretaceous)--This unit includes 2 lithofacies: (1) nonmarine conglomerate and associated marine sandstone (Kf) which occurs west of the Anaktuvuk River, and (2) turbidite sandstone and conglomerate (Kft) east of the Anaktuvuk River. Patton and Tailleur (1964) report between 2,500 and 10,000 feet (760 and 3050 m) of Fortress Mountain Formation at Fortress and Castle Mountains. Outcrop widths and attitudes suggest that the Fortress Mountain Formation, as used in this map and west of the Anaktuvuk River, is probably between 700 and 2,000 feet (215 and 610 m) thick in the Castle Mountain and Fortress Mountain area and thins to the east. Sandstone and conglomerate east of the Anaktuvuk River is possibly about 1,000 feet (305 m) thick; structural complexity, however, greatly limits confidence in this estimate.

Fortress Mountain Formation in this map differs from previous reconnaissance mapping in the Chandler Lake quadrangle. Previous workers (Patton and Tailleur, 1964, p. 458) consider the stratigraphic relations between the Fortress Mountain and Torok Formations and Nanushuk Group uncertain, but state that the Fortress Mountain Formation is unlikely as young as middle Albian or equivalent to the Nanushuk Group. Other workers (Detterman and others, 1963, p. 230; Chapman and others, 1964; Gryc, 1956; Patton, 1956; Jones and Gryc, 1960, p. 151; Molenaar, 1981, p. 26; Molenaar and others, 1981, p. 3; Mull, 1979, p. 5; and Ahlbrandt and others, 1979, p. 14) describe the Fortress Mountain Formation as laterally equivalent to or below the Torok Formation, which underlies the Nanushuk Group. In this map, the term Fortress Mountain Formation applies to Lower Cretaceous sandstone and conglomerate that overlie the Torok Formation at least in part.

West of the Anaktuvuk River, the Fortress Mountain Formation comprises much nonmarine strata that occur in unimbricate shallow-dipping slab-like structural blocks that lie on complexly imbricated blocks of Mississippian to Lower Cretaceous strata, melange, and locally Torok Formation. Outcrops are mostly massive-weathering nonmarine conglomerate and sandstone but include locally marine sandstone. Most outcrops are erosional remnants of broad basin-shaped synclines comprising ridges underlain by beds of erosion-resistant conglomerate and sandstone arranged in a circular or ellipsoidal pattern and dipping toward a central point. The outcrops are remnants of more extensive structural sheets in probable fault contact, possibly a fault superimposed along a pre-existing unconformity, with underlying older rocks including graywacke, ribbon chert, mafic igneous rocks and melange. Outcrops of Torok Formation occur below the Fortress Mountain Formation on the north flank of Fortress Mountain and east of Fortress Mountain in T.10S., R.2W., U.M. Mudstone, and to a lesser degree sandstone, depositionally consanguinous with the Fortress Mountain Formation but structurally detached and intermixed with older underlying graywacke and mudstone is operationally mapped as KJsh or KJu. Fossils from marine sandstone interbeds within predominately nonmarine strata in the Fortress Mountain Formation are middle to late Albian (J.W. Miller, writen comm., 1983) and equivalent to the lower part of the Nanushuk Group and Torok Formation. The Fortress Mountain may also include fossils as old as Barremian; however, formation assignments of strata containing pre-Albian fossils are in doubt.

East of the Anaktuvuk River, the Fortress Mountain Formation contrasts in some respects to the Fortress Mountain Formation west of the Anaktuvuk River. Outcrops east of the Anaktuvuk River occur along upper Cobblestone and May Creeks where the strata are submarine gravity flow deposits rather than interbedded nonmarine and marine deposits as west of the river. Torok Formation is not recognized beneath the Fortress Mountain Formation along upper Cobblestone and May Creeks although Torok Formation lies adjacent to the Fortress Mountain Formation along May Creek. Along upper Cobblestone and May Creeks, the Fortress Mountain formation occurs in imbricate south-dipping slab-like blocks in contrast to the unimbricate blocks west of the Anaktuvuk River; on both sides of the Anaktuvuk River, however, the Fortress Mountain Formation lies in fault contact on complexly imbricated blocks of ribbon chert, mafic igneous rock, Mesozoic clastic rock, and melange. Occurrences on both sides of the Anaktuvuk River include wood debris and framework compositions rich in chert clasts.

Kf Nonmarine conglomerate and associated marine sandstone Principally light-greenish-gray-weathering greenish-gray pebble conglomerate; framework-supported, characteristically consists of beds up to about 4 feet (1.2m) thick and lenticular on outcrop scale and cross bedded, prominent pebble imbrication, includes rip-up clasts, scarce mud-cracks in thin discontinuous mudstone intervals, and plant debris ranging from small carbonized wood debris to coalified logs. Although most clasts are well rounded, clasts of sedimentary rock are typically elongate parallel to bedding. Clasts include greenish-gray, bright greenish-gray, gray, reddish-brown, and light-gray translucent varieties of chert, greenish-gray aphanitic, porphyritic vesicular, and nonvesicular mafic igneous rocks, light-gray to medium- light- gray limestone and dolomitic limestone, silicified argillite, organic shale, and granitic rocks. Conglomerate is interbedded with and grades abruptly to marine sandstone including fine- to coarse-grained thin-bedded to laminated sandstone with very prominent parting lineation and a flaggy weathering character. Sandstone includes scarce shell and wood debris. Sandstone is also locally cross bedded, bioturbated, ripple cross bedded and includes gravel lenses with abundant wood debris and marine mollusks.

Kft Turbidite sandstone and conglomerate Medium-greenish-gray sandstone; fine- to very coarse grained and granular, mostly fine- to medium-grained with very coarse grained sandy to granule conglomerate. Sandstone beds are up to 5 feet (1.5m) thick, but most beds are between 1 to 2 feet (0.3 to .6m) thick and thicker sandstone intervals are generally composed of amalgamated beds. Beds are massive, graded, laminated, and locally wispy cross bedded. Sole marks include flute casts and tool marks. Sandstone includes much carbonized wood debris some of which is up to 1 foot (0.3m) long. Most larger sand grains and granules are chert including light-gray, light-greenish-gray, dark-gray, and very light gray tripolitic chert. Sandstone is interbedded with siltstone and silty mudstone.

Kto TOROK FORMATION (Detterman and others, 1963) (Lower Cretaceous)--Detterman and others (1963) report 6,120 feet (1865m) of Torok Formation in the type section along Torok Creek north-northwest of Castle Mountain. The monotonous character, imbrication, incompetence, and incomplete exposure of this unit make estimates of thickness based on outcrop width and dip unreliable. Shale, mudstone, siltstone, and sandstone. Mostly bluish-gray, dark-greenish-gray, medium-dark-gray and dark-gray shale, mudstone, and clayey siltstone; fissile in part, mostly very thin bedded, includes siltstone and fine-grained sandstone partings and thin interbeds. Sandstone, medium-light-gray and greenish-gray, very fine to very coarse grained, silty and shaly, conglomeratic in part with granules of mostly chert, includes some lenses of granule conglomerate. Formation includes distinctive iron-stained and granule- to small-pebble-bearing shale, mudstone, and siltstone (xxx). Some outcrops of pebbly strata are deeply iron-stained with goethite coatings that give some beds a metallic appearance. Clasts in pebbly beds are scattered, well rounded, percussion-marked and mostly chert and mafic igneous rock. Iron-stained and pebbly units include ironstone lenses. Formation includes some thin beds which are tough, fissile, and carbonaceous shale.

Kcs COBBLESTONE SANDSTONE UNIT (Lower Cretaceous)--Cobblestone sandstone unit is a new and informal lithostratigraphic name proposed for Lower Cretaceous sandstone that occurs in the lower part of the Torok Formation. The unit comprises lenticular and discontinuous bodies of sandstone and conglomerate that occur in structurally complex and south-dipping imbricate fault blocks. Outcrops occur discontinuously in a trend that parallels and lies south of the Tuktu Escarpment.

Recognition of the Cobblestone sandstone unit refines previous stratigraphy. Previous workers (Patton and Tailleur, 1964, pl. 50) map strata herein assigned to the Cobblestone sandstone unit as Fortress Mountain Formation. Cobblestone sandstone unit discriminates exclusively marine strata that occurs in the lower part of the Torok Formation from nonmarine and marine strata of the Fortress Mountain Formation that overlie the Torok Formation and structurally complex rocks exclusive of the Torok Formation. The Cobblestone sandstone unit comprises submarine gravity flow deposits, mostly turbidites, that depositionally underlie dark-gray shale in the Torok Formation. In contrast, Fortress Mountain Formation at the type section (Patton and Tailleur, 1964) and other outcrops west of the Anaktuvuk River includes much nonmarine strata and overlies dark-gray shale of the Torok Formation. Fossils in the upper part of the Fortress Mountain Formation are middle and late Albian (J.W. Miller, 1983, written comm.) and age correlative to fossils in the Nanushuk Group which overlies the Torok Formation along the Tuktu Escarpment.

Map pattern suggests that sandstone bodies of the Cobblestone sandstone unit range up to 1,000 feet (305 m) thick and greater than 10 miles (16 km) in lateral continuity. Structural complexities too small to be shown at 1:125,000 and likely to produce repeated section suggest that the estimated thickness and lateral extent are at least maximum values.

--Sandstone, siltstone, mudstone, and conglomerate. Mostly yellowish-brown-weathering olive- to greenish-gray coarse- to very fine grained sandstone; very thin to massive-bedded, laminated in part, small-scale and wispy cross bedded in part, includes locally abundant carbonized small plant debris and carbonaceous films, includes flute marks, load casts, and tool marks. Sandstone comprises moderately sorted subangular to subrounded clasts of chert, quartz and rock fragments. Sandstone occurs in typically incomplete turbidite sequences. Sandstone beds are locally organized into thinning upward cycles consisting of amalgamated sandstone and gritty sandstone progressively overlain by thinner and fewer amalgamated sandstone beds interbedded with siltstone and mudstone. Yellowish-brown-weathering olive- to greenish-gray siltstone; is mostly thin-bedded to laminated, grades to very fine grained sandstone, and includes plant debris. Medium-dark-gray to medium-greenish-gray mudstone; mostly thin-bedded, very silty in part, very sandy in part, and locally includes sandstone partings. Conglomerate is framework-supported and consists mostly of well rounded clasts that range from granule to cobble size but are mostly pebble size; clasts are mostly chert, miscellaneous silicified aphanitic rock, mafic igneous rock, and carbonate rock.

COQUINOID LIMESTONE (Lower Cretaceous-Valanginian)--Brownish-gray and reddish-brown-weathering beds comprising bivalves, typically Buchia sublaevis, algae, and shell hash. Typically these beds are broken slabs in association with the Otuk Formation and probably in depositional contact with the Blankenship Member of the Otuk Formation in the Ekokpuk Creek area. The coquinoid limestone also occurs as slab-like blocks in highly sheared and disrupted Cretaceous and Upper Jurassic shale and sandstone. The coquinoid limestone occurs in presumable deposition relations with Otuk Formation on upper Ekokpuk Creek.

KJu, sh, sd, cgl CRETACEOUS AND UPPER JURASSIC STRATA UNDIVIDED--Patton and Tailleur 1964, p. 447) report between 1,800 (550 m) and possibly 2,200 feet (670 m) of Berriasian and Valanginian strata in the Cretaceous and Jurassic strata undivided unit. The total thickness of the Cretaceous and Jurassic strata undivided unit is unknown due to structural complexity, generally poor and discontinuous exposure, lack of reliable marker beds, and poor biostratigraphic control. This unit includes at least 4 facies: (1) sandstone (sd) and shale (sh), (2) conglomerate (cgl), (3) tuffaceous sandstone, and (4) volcaniclastic breccia. The 4 facies, with the possible exception of the conglomerate facies, are probably end members of a continuum of rock-types. The sandstone and shale facies (u) make up the bulk of unit and range from shale with subordinate turbidite sandstone to amalgamated turbidite sandstone with subordinate shale. The sandstone and shale facies includes the Okpikruak Formation of Patton and Tailleur (1964). The unit probably includes exposures of Lower Cretaceous strata that with better exposure and close examination would be assigned to the Cobblestone sandstone unit, Torok Formation, or Fortress Mountain Formation.

Sandstone and shale Light-olive-gray and greenish-gray sandstone; mostly medium- to fine-grained subangular to subrounded quartz, feldspar, chert, and greenish-gray rock fragments in a chloritic matrix. Grain boundaries are typically obscure in more matrix-rich sandstone. Graded bedding and incomplete turbidite sequences are common. Wood debris, prod marks, flute casts, and load casts are common. Conglomeratic in part with granules of mainly chert and aphanitic rock fragments. Includes medium-greenish-gray siltstone, mudstone, and shale.

Conglomerate Framework supported conglomerate that typically occurs as beds and lenses in association with turbidite sandstone; composed of well rounded to subangular granules and small pebbles of quartz, chert, and rock fragments. Chert includes greenish-gray, light-gray, and dark-gray varieties. Most rock fragments are greenish-gray to dark-gray, aphanitic, and silicified. Framework-supported conglomerate also typically occurs in isolated bodies, some of which appear to fill channels cut in sandstone and shale. Isolated bodies of the heterolithic conglomerate include subrounded to subangular pebbles of greenish-gray and various colored chert, and yellowish-gray-weathering silicified limestone or mudstone, and organic shale.

Tuffaceous sandstone Grayish-green tuffaceous sandstone; fine- to coarse-grained, most grain boundaries are indistinct, very chloritic, includes chloritized rock fragments, includes relict glass shard textures in thin section. Bedding ranges up to 1 foot (0.3m) thick and is commonly graded, also massive or obscure. Chlorite development and grain obliteration is especially prominent along broken and slickensided surfaces. Tuffaceous sandstone is interbedded with greenish-gray to olive-gray to medium-dark-gray siltstone and shale.

Volcaniclastic breccia Grayish-green breccia; mostly granule to pebble size clasts of greenish-gray rock fragments in grayish-green matrix, includes framework- and matrix-supported breccias. Volcanic rock fragments are mostly chloritized aphanitic rock fragments but some fragments include fine-grained plagioclase laths. Few fragments are vesicular and amygdaloidal. Scattered chert clasts occur locally in the breccias. The matrix is typically a dense felted mass of chlorite.

Ji MAFIC IGNEOUS ROCKS (Patton and Tailleur, 1964) (Jurassic)--Dark-greenish-gray, olive-gray, and light-olive-gray mafic igneous rocks; mostly fine-grained and equigranular, but also aphanitic, porphyritic, and coarse-grained. Porphyritic varieties include plagioclase laths in a grayish-green groundmass of chloritized mafic minerals, mostly pyroxene. Some varieties have diabase texture. Some are amygdaloidal and vesicular. Some are autoclastic, consisting of fine-grained to aphanitic clasts in a crystalline groundmass of similar apparent composition. Some are sills, although most are pod-like masses in structurally disturbed contact with their host rock. Undisturbed chilled margins are rare. S. W. Karl (oral comm., 1976) reports observing pillow structures on Tiglukpuk Creek.

Jto OTUK FORMATION (Mull and others, 1982) (Lower Jurassic and Triassic)--Bodnar (1984) reports thicknesses of incomplete, and possibly structurally complex sections, ranging from 119 m. (390 ft.) to 18 m. (60 ft.) thick in the Chandler Lake quadrangle. Based on correlation and projection of the measured sections (Bodnar, 1984, fig. 10), the thickness of the Otuk formation is about 415 ft. (125m.). The formation consists of 4 members; shale member, chert member, and limestone member, and the Blankenship Member in ascending order. The shale, chert, and limestone members are not discriminated in mapping and the Blankenship Member is not widely recognized.

Shale Member Dark-gray, grayish-black, and greenish-gray shale and mudstone; silty in part, fissile in part, soft and sooty in part, includes thin beds of dark-gray limestone that is locally phosphatic and dark-gray to black chert.

Chert Member Dark-gray to black chert, and silicified micritic limestone; typically rhythmically bedded and thin-bedded, laminated in part, wispy cross bedded in part, with interbeds and partings of dark-gray and commonly silty shale, and intervals up to 10 feet (3m) thick of black, soft, sooty shale. Halobia and Monotis are locally abundant.

Limestone Member Rhythmically interbedded yellowish-gray, light-brownish-gray, and tan-weathering dark-gray fine-grained and very impure limestone; thin-bedded with partings and interbeds of dark-gray and black shale. Includes very thin bedded intervals and partings of Monotis and Halobia coquina.

Blankenship Member Dark-gray to black shale; carbonaceous, includes brownish-gray-weathering pliable paper-like oil shale beds and thin chert interbeds.

Ts SHUBLIK FORMATION, (Patton and Tailleur, 1964) (Triassic)--The Shublik Formation is probably between 415 and 450 ft. (125m. and 135m.) thick. Biggest exposure of the Shublik Formation is along upper Cobblestone Creek, but structural complexity precludes accurate estimation of formation thickness. Shale and impure limestone, mostly dark- to very dark gray shale; soft, sooty, fissile in part with paper-like weathering character in part, locally includes spherical and ellipsoidal apatite concretions up to 1.5 inch (38mm) across, calcareous in part. Dark-gray limestone; also medium-dark-gray and brownish-gray, typically weathers in positive relief and lighter shades of gray than associated shale, includes locally abundant thin-shell bivalves including Halobia and Monotis. Unit locally includes ferrugenous-weathering shale and mudstone. Unit locally includes yellowish-gray-weathering silicified beds and grades to Otuk Formation.

JTos OTUK and SHUBLIK FORMATIONS UNDIFFERENTIATED (Jurassic(?) and Triassic)--Shale, limestone, and chert. Dark-gray to very dark-gray shale; soft, recessive-weathering, sooty in part, fissile in part, and locally very calcareous. Dark-gray limestone; also brownish-gray, very argillaceous and grades to calcareous shale, very thin bedded, and locally includes mud Pecten coquina. Yellowish-gray-weathering chert; grades to silicified limestone and mudstone, rhythmically bedded, and thin bedded. This unit is transitional between Shublik and Otuk Formations. Where well exposed the unit comprises much shale and limey shale, but includes yellowish-gray-weathering beds characteristic of the Otuk Formation.

TPc CHERT (Triassic and Permian)--Patton and Tailleur (1964, p. 439) report ribbon chert bodies as much as 300 feet (90 m) thick in the Chandler Lake quadrangle. Although structural complexity, poor and discontinuous outcrop, and general lack of stratigraphic control from outcrop to outcrop, limit confidence in estimating the thickness of Triassic and Permian chert, the chert appears to be as much as 500 feet (150 m) thick east of the Anaktuvuk River and appears in general to thin eastward towards the Cobblestone Creek area. Chert occurs as structural blocks that range from hand specimen-size clasts in melange to large blocks that probably include the original depositional thickness of the chert. Medium-light-gray, grayish-green, very light gray, and moderate-yellowish-green to grayish-green ribbon chert; very finely laminated in part, locally obscurely graded, evenly parallel bedded with beds ranging from 1 to 6 inches (2.5 to 15cm) thick with most beds between 2 to 2.5 inches (5 to 6cm) thick, radiolarians are locally abundant and especially conspicuous in light-greenish-gray chert, locally includes silicious shale partings and black-carbonaceous shale partings, locally deeply iron-stained on weathered surfaces, part of the Triassic cherts grade to the chert member of the Otuk Formation.

Ps SIKSIKPUK FORMATION (Patton and Tailleur, 1964) (Permian)--Siok (1985, pl. 7) reports 175 and 145 m. (575 and 475 ft.) of Siksikpuk Formation in two measured sections along the range front between Confusion and Firestone Creeks. The top of the Siksikpuk Formation is not exposed in either section but, outcrops of the overlying Otuk Formation occur near the top of the measured sections, especially close to 145 m (475 ft.) thick section. Three lithofacies occur in the Siksikpuk Formation. The three lithofacies are end members of a continuum obscured by thrust faulting, especially north-south facies transitions. Lithofacies 1 occurs along the range front between the western boundary of the map area and the Anaktuvuk River. Lithofacies 2 occurs east of the Nanushuk River along the range front. Lithofacies 3 occurs near the head of Ekokpuk Creek in the southwestern map area.

Lithofacies 1--Mostly mudstone and siltstone with smaller amounts of shale, and limestone. Variegated mudstone and siltstone; reddish-brown, grayish-red, light- to dark-greenish-gray, and medium-dark-gray to black, laminated in part, thin- to medium-bedded, calcareous in part and grades to very silty and shaly limestone, locally weathers reddish-orange, locally pyritic, includes barite veins and nodules, carbonate nodules, and includes reddish-orange claystone partings and thin interbeds. Medium-dark-gray to black limestone; very impure, very shaly and silty, and locally fossiliferous. Black to dark-gray shale; fissile, includes siltstone and mudstone partings, and sooty in part. Includes medium-dark-gray to black and greenish-gray to dark-greenish gray siliceous mudstone; wispy laminated and resistant weathering.

Lithofacies 2--Mostly shale and mudstone with smaller amounts of very impure limestone. Medium-gray to black and dark-greenish-gray shale and mudstone; fissile in part, silty in part, calcareous in part, includes fissile dark-gray to black shale that is commonly soft, includes sooty to silty mudstone in which bedding is obscure, includes prominent barite nodules with radiating crystal structure and barite veins. Limestone makes up a very small part of the section; very impure, mostly shaly, and occurs in thin nodularform beds and concretions. Some of the limestone beds are ferrugenous weathering. Siok (1985) reports Zoophycos on bedding surfaces near the base of the section.

Lithofacies 3--Siltstone and shale. Light-gray siltstone, also dark- to very dark gray, and some brownish-gray, hard siliceous, very uniform texture but with faint color laminations in part, conchoidal fracturing but blockly weathering, partly rhythmically bedded and thin- to medium-bedded, includes porcellaneous chert. Shale is dark-gray to black, soft, sooty in part, and poorly exposed. Barite concretions and vienlets up to three inches in greatest dimension are rare.

Psl SADLEROCHIT GROUP (Permian)--Slab-like bodies of Sadlerochit Group strata up to 50 feet (15 m) thick occur in imbricate fault blocks composed mostly of Lisburne Group carbonate strata east and adjacent to the head of the Nanushuk River. Siltstone, sandstone, and mudstone. Reddish-brown siltstone and mudstone; iron-oxide cemented and deeply iron-stained on weathered surfaces, also greenish-gray varieties without much iron-stain. Sandstone is very fine to fine-grained, ripple-scale cross bedded, and grades to siltstone. Includes coquina of brachiopods, bryozoans, and shell debris. Large Zoophycos are prominent. Only the basal part of the rock unit is present.

Ml ALAPAH and WACHSMUTH LIMESTONES of the LISBURNE GROUP (Bowsher and Dutro, 1957; Armstrong and Mamet, 1977 and 1978) (Mississippian)--Mostly light-brownish-gray packstones and wackestones composed of bioclastic framework clasts and interstitial lime mud; abundantly fossiliferous including brachiopods, foraminifera, echinoderms, corals, bryozoans, and gastropods. In most places, the clastic character of the limestone is apparent, but dolomitization obscures the grain fabric locally. Bedding ranges from thin to massive and locally includes cross bedding and cross lamination. Dark-gray shale, carbonaceous limestone, shaly limestone, and limy shale occur locally. Dark-gray to light-medium-gray chert occurs as nodules and nodularform beds. Ferruginous-weathering and especially fossiliferous beds occur near the base of the Wachsmuth Limestone. The Alapah and Wachsmuth Limestones are about 3,340 feet (1018 m.) thick (Bowsher and Dutro, 1957; Armstrong and Mamet, 1977; and Armstrong and Mamet, 1978) in aggregate throughout the quadrangle except in the Ekokpuk Creek area, southwest of confluence of Ekokpuk Creek and the John River, and between the John River and upper Inukpasugruk Creek where the Lisburne Group is hundreds of feet thick rather than thousands of feet thick.

The Alapah and Wachsmuth Limestones of the Lisburne Group include two facies suggested (Mull and others, 1982) to be part of the Kuna Formation. Both facies, a shale (Mlsh) and a chert facies (Mlch), are identified but not assigned to the Kuna Formation.

Mlsh SHALE FACIES OF THE ALAPAH LIMESTONE (Mississippian)--Very dark gray to medium-dark-gray argillaceous limestone, limy shale, and nodular-form chert. Includes locally abundant phosphatic nodules and/or ooids. Most of the limestone and limy shale is fine-grained, carbonaceous, thin bedded to laminated, locally platy weathering. Carbonaceous shale partings occur locally. Some outcrops have a sooty carbonaceous bloom on weathered surfaces. The facies grades to medium-gray bioclastic limestone and dolomitized limestone. Mull and others (1982) suggest that the shale facies in this map is likely the easternmost tongue of the black chert and shale facies of the Kuna Formation.

The shale facies are not herein assigned to the Kuna Formation because they lack lateral persistence, consistent stratigraphic position, and unique lithology. At least locally, two intervals, separated by up to 400 feet (120 m) of Alapah Limestone, identified herein as shaly facies (Mlsh) occur; the upper interval is transitional to the Siksikpuk formation and the lower interval is previously identified as the black chert and shale member of the Alapah Limestone (Patton and Tailleur, 1964, p. 419). Neither interval is persistent in thickness or extent. The lower interval, which is locally phosphate-bearing, does not have a locally persistent stratigraphic position probably due to intertonguing of locally subtle facies; Armstrong and Mamet, 1977 (pl. 40 and A1) and Patton and Tailleur (1964, p. 420, fig. 71) both measure sections along Skimo Creek, but only Patton and Tailleur (1964) report a black chert and shale interval within the resistant limestone of the Alapah Limestone.

Mlch CHERT FACIES OF ALAPAH AND WACHSMUTH LIMESTONES (Mississippian)--Very dark gray to black chert; dense, nearly opaque, mostly massive, conchoidal fracture, highly fractured, many white quartz vienlets, includes locally abundant medium-light-gray dolomitized micrite in oblate ellipsoidal lenses, includes layers of dark to very dark gray argillaceous siltstone and medium-gray limestone, includes faint wispy structures which may be relict bedding. It is a replacement of Alapah and Wachmuth Limestones undifferentiated.

The chert facies is not assigned herein to the Kuna Formation, because of contrasts in bedding characteristics and likely protolith between these strata and most of the strata assigned to the Kuna Formation. Prominent bedding, ranging from rhythmic to uneven, characterizes the Kuna Formation, whereas the chert facies along Ekokpuk Creek are massive. Protolith in replacement chert in much of the Kuna Formation is fine-grained clastic strata, possibly mudstone turbidites, whereas protolith in the chert facies in the Chandler Lake Quadrangle is platform carbonate strata.

Regional facies changes suggest that the chert facies in the Chandler Lake quadrangle are part of a regional transition from shelf carbonate on the northeast to chert and possibly to Kuna Formation on the southeast. The transition takes place across a linear zone that extends southeast from the range front in the Outwash Creek area west of the Chandler Lake quadrangle, through the Ekokpuk Creek area, and thence south of Doonerak Mountain, south of the Chandler Lake quadrangle. Northeast of the transition zone the Lisburne Group is anomalously thin. Transition from limestone to chert takes place by replacement of platform carbonate in the Outwash Creek area and the Ekokpuk Creek area. Bedded chert occurs on upper Otuk Creek, west of the Outwash Creek-rangefront area and southwest of the southeast-trending transition zone and could be the facies that lay southwest of the chert facies in the Chandler Lake quadrangle.

Mn NUKA FORMATION (Mississippian)--Sandstone and limestone. Light-gray to yellowish-gray sandstone; fine- to very coarse grained, mostly coarse- to very coarse grained, mostly subangular quartz and feldspar grains, most feldspar appears to be microcline, glauconite is locally abundant. Light- to light-medium-gray limestone; very coarse grained to fine-grained, composed mostly of crinoid debris, includes some micrite, thin bedded, and cross bedded. Outcrops are small, poor and typically rubbly. The outcrops occur near the confluence of Fortress Creek and Ayiyak Creek, north of Fortress Mountain. Thickness is unknown.

mrbl MARBLE--Marble, light-gray to light-yellowish-gray, coarsely crystalline but grades to medium-grained crystalline limestone, relict thin-bedding locally present, friable weathering, highly fractured, rubbly outcrops, some parts of the unit consist of friable-weathering mixtures of large single crystal calcite grains in a recrystallized finer-grained matrix-possibly recrystallized encrinite limestone. This unit may be part of the Nuka Formation of Mississippian age. Outcrops of marble occur adjacent to Natvakruak and Tiglukpuk Creeks in the 11 S. township tier.

mlg MELANGE--Includes blocks of Triassic and Permian ribbon chert, mafic igneous rocks, Cretaceous and Jurassic sandstone, coquinoid limestone, and probably marble in a thoroughly sheared and disrupted matrix of greenish-gray and olive-gray shale and mudstone. The matrix and sandstone blocks are indistinguishable from broken formation consisting of strata elsewhere assigned to Cretaceous and Upper Jurassic strata (KJu).

Mk KAYAK SHALE (Bowsher and Dutro, 1957; and Nilsen and Moore, 1984) (Mississippian)--Predominately shale with interbedded bioclastic limestone and finely crystalline limestone. Dark-gray to grayish-black shale; carbonaceous, generally micaceous and fissile, clayey to very silty, and soft to brittle. Shale is negative weathering in comparison to nonshale interbeds and overlying and underlying formations. Shale grades to mudstone and siltstone and includes thin quartz-rich and commonly bioturbated sandstone beds near the base of the formation. Bioclastic limestone beds are generally less than 6 ft. (2 m.) thick and composed of reddish- and yellowish-brown-weathering accumulations of megafossil hash including abundant crinoid parts together with smaller amounts of brachiopod, bryozoan, and coral debris. Argillaceous limestone consists of fine-grained crystalline limestone that is dark-gray to grayish-black, carbonaceous, and generally positive weathering. Reiser and others (1979) report beds of andesitic tuff and volcanic conglomerate in the Kayak Shale at the head of Inukpasugruk Creek. The formation is between about 270 and 870 feet (82-265 m.) thick. Where the formation is best exposed and least disturbed, it is about 560 feet (171 m.) thick.

MDKs STUVER MEMBER of the KANAYUT CONGLOMERATE (Bowsher and Dutro, 1957; Nilsen and Moore, 1984, Nilsen and others, 1980; Nilsen and others, 1981; Nilsen and Moore, 1982; and Porter, 1966) (Mississippian(?) and Upper Devonian)--Nilsen and Moore (1984, p. A60) report thicknesses from three measured sections in the Chandler Lake quadrangle; 217m (710 ft.) in the Shainin Lake area, 215m (705 ft.) near Chandler Lake, and 165m (540 ft.) west of the John River. They further report that the Stuver Member is generally thin along the northern margin of the mountains and thickens eastward into the adjacent Philip Smith quadrangle. Mapping indicates that the Stuver Member changes facies to the south and southwest and the resulting map unit, which includes the underlying Shainin Lake Member, is about 1,000 ft. (305 m) thick in the southeastern part of the quadrangle. Sandstone, siltstone, conglomerate and shale. Variously iron-stained sandstone; ranges from very fine grained to very coarse grained and conglomeratic, ranges from orthoquartzite to quartz-rich sandstone, consists of very light gray quartz, chert, and siliceous rock fragments. Sandstone beds range up to about 3 feet (1 m.) thick and typically occur as elements of fining upward cycles. Cross bedding is common in the sandstone. The Stuver member includes conglomerate consisting of granules and small pebbles of chert, quartz, and siliceous rocks typically in a matrix of quartz sandstone. Dark-gray to grayish-black shale and argillaceous siltstone; micaceous, very silty, sandy, and grades to silty sandstone. Most of the strata in the member are iron-stained to varying degrees. The Stuver Member contains Devonian and Early Mississippian(?) plant fossils. The Stuver Member locally includes at its top an unnamed Mississippian(?) grayish-black to dark-gray shale indicated by pattern on the map. The Mississippian(?) shale is carbonaceous, includes plant debris, local ironstones and partings of siltstone and very fine grained quartzose sandstone. Dark-gray, commonly carbonaceous, and shaly quartz sandstone beds occur as positive-weathering tabular bodies in the Mississippian(?) shale. The Mississippian(?) shale unit crops out along the belt of Stuver Member extending from NW 1/4 T.15S., R.7E. west across the Nanushuk River and the head of Alapah Creek to the Kanayut River. Other outcrops occur in S 1/2 T.13S., R.6E. between Erratic Creek and the Nanushuk River and T.15S., R.7E.

Dks SHAININ LAKE MEMBER of the KANAYUT CONGLOMERATE (Nilsen and Moore, 1984; Nilsen and others, 1980; Nilsen and others, 1981; Nilsen, 1981; Nilsen and Moore, 1982) (Upper Devonian)--Nilsen and Moore (1984, p. A49) report thickness from two complete measured sections in the Chandler Lake quadrangle, 526m (1,725 ft.) near Shainin Lake and 400m (1,300 ft.) on the John River. Furthermore, they report that the Shainin Lake Member thins to the east, west, and south. Mapping further suggests that the Shainin Lake Member thins and probably wedges out to the northeast. Maximum thickness from map information is about 1,800 ft. (550 m). The Shainin Lake Member changes facies to the south and southwest to a map unit, including the overlying Stuver Member, which is between 1,000 and 2,200 ft. (305 and 670 m) thick; facies transition takes place at least in part by wedge-out of the Shainin Lake Member. At least locally, southward thinning in the Shainin Lake Member is abrupt (Kelley, 1984b). Conglomerate and sandstone. Conglomerate makes up half of the Shainin Lake Member. The conglomerate is principally framework-supported and comprises generally well rounded pebbles and cobbles of mostly chert, quartz and quartzite. Matrix of the conglomerate consists of quartz- and chert-rich sandstone and granules. The conglomerate occurs in hard and resistant intervals up to 15 feet (4.5 m) thick. Conglomerate is typically silica-cemented although calcareous and iron-oxide cements are present. Sandstone is hard, resistant, cemented to varying degrees with silica, carbonate, and iron-oxide, and composed of moderately to poorly sorted quartz, chert, and silicified rock fragments. Sandstone beds are commonly cross bedded. The sandstone is moderately to poorly sorted, conglomeratic in part, and includes pebble trains. Much of the conglomerate and sandstone is organized into recognizable fining upward sequences. The Shainin Lake Member includes reddish-brown, greenish-gray, and dark-gray to grayish-black, silty, sandy shale, siltstone, and argillaceous sandstone in varying amounts. The positive-weathering Shainin Lake Member of the Kanayut Conglomerate contrasts sharply with the relatively recessive weathering overlying and underlying members of the Kanayut Conglomerate. The alternating recessive and resistive weathering character of the shale and sandstone making up members of the Kanayut Conglomerate overlying and underlying the Shainin Lake Member contrasts with the massive-weathering character of the Shainin Lake Member.

MDku UPPER PART of the KANAYUT CONGLOMERATE (Mississippian? and Devonian)--Based on map information, the upper part of the Kanayut Conglomerate probably ranges from 1,000 ft. to 2,200 ft. (305 to 670 m) thick. Sandstone, conglomerate, and shale. Light-brownish-gray, reddish-brown, and light-olive-gray sandstone; ironstained to varying degrees, cross bedded, very fine grained to very coarse grained, mostly coarse-grained, granular conglomeratic in part, composed mostly of chert, quartz, and silicic rock fragments. Conglomerate is framework supported and consists of mostly granules and small pebbles of chert, quartz, and siliceous rock fragments. Sandstone and conglomerate organized into fining upward sequences. Shale is dark-gray, carbonaceous locally, very silty, sandy, and iron-stained in part. The upper part of the Kanayut Conglomerate is characterized by iron-stained outcrops of differentially weathering sandstone-conglomerate intervals and shaly intervals. One or more massive weathering intervals consisting of amalgamated sandstone and conglomerate are present, but generally less than 200 feet (60m) thick and probably discontinuous.

Dken EAR PEAK MEMBER of the KANAYUT CONGLOMERATE and NOATAK SANDSTONE (Nilsen and Moore, 1984; Nilsen and others, 1980; Nilsen and others, 1981; Nilsen, 1981; and Nilsen and Moore, 1982 (Upper Devonian)--Nilsen and Moore (1984, p. A33 and A34) report 510m (1,673 ft.) at Ear Peak, 120m (395 ft.) near the John River and 260m (855 ft.) near Mount MacVicar. Map information suggests that the Ear Peak Member and Noatak Sandstone undifferentiated may be up to 2,500 ft. (760 m) thick. Outcrop width and dips suggest that the Ear Peak Member of the Kanayut Conglomerate and the Noatak Sandstone thin abruptly to the northeast.

Ear Peak Member Shale, mudstone, sandstone, and conglomerate. Shale is reddish-brown, grayish-green, brownish-gray, and grayish-black, typically very silty and micaceous and grades to siltstone. Sandstone is quartz-rich and includes orthoquartzites and quartz-rich sandstones with varying amounts of silica, carbonate, and iron-oxide cements. Sandstones are granule to pebble conglomeratic in part and grade to conglomerate. Cross bedding is common in sandstone beds. Cross bedding ranges from large scale to ripple laminae. Conglomerate is framework-supported with framework clasts consisting of granules, pebbles, and cobbles of quartz and chert. Sandstone consisting of principally quartz and chert make up the matrix in the conglomerates. The principal rock types of the Ear Peak Member typically are organized into fining upward cycles with conglomerate or massive sandstone at the base grading upward to finer-grained and cross bedded strata. At a distance, the recessive-weathering character of the Ear Peak Member relative to the overlying Shainin Lake Member of the Kanayut Conglomerate together with the greater degree of differential weathering between sandstone and conglomerate beds and shale beds within the Ear Peak Member help distinguish the Ear Peak Member from the Shainin Lake Member of the Kanayut Conglomerate.

Rock types in the Ear Peak Member vary across the map area. Sandstone is most abundant in the north and east parts of the outcrop area mostly north of the Toyuk Mountain thrust. Dark-gray shale is more abundant south of the Toyuk Mountain thrust fault than north of the thrust.

Noatak Sandstone (Upper Devonian) (indicated by pattern on map)--Sandstone and mudstone. Pinkish-gray, light-brownish-gray, light-gray calcareous-cemented sandstone; fine- to coarse-grained with scattered occurrences of granules and small pebbles of quartz and chert. Sandstone is laminated in part, ranges from thin- to thick-bedded, cross-bedded in part, locally includes load casts, marine fossils and scattered plant debris. Dark-gray and brownish-gray mudstone. Principal distinguishing characteristics of the Noatak Sandstone include: pinkish-gray weathering outcrops, continuous and tabular-weathering beds, moderate or good sorting, and carbonate cement.

The Noatak Sandstone changes character across the map area. In the Mount Thibodeaux area, the Noatak Sandstone is much iron-stained, granular conglomeratic with granules of quartz, chert, and ironstone, includes conglomerate beds and lenses, deeply iron-stained shale partings, prominent cross bedding, possible rain drop structures, possible paleosols, and marine fossils in deeply iron-stained lenses. The occurence of conglomerate, conglomeratic sandstone, and amount of sandstone in the formation and indication of nonmarine sedimentation decreases south and west of the Mount Thibodeaux area. The Noatak Sandstone discontinuously occurs in the map area. The Noatak Sandstone probably interfingers with the Hunk Fork Shale locally but, structural detachment and thrusting greatly obscure the interfingering relations.

Dkn KANAYUT CONGLOMERATE and NOATAK SANDSTONE (Nilsen and Moore, 1984; and Brosgé and others, 1979) (Upper Devonian)--The thickness of this map unit is very poorly constrained but likely around 2,500 ft. (760 m). Sandstone, shale, and conglomerate. Reddish-brown-weathering reddish-brown to brownish-gray sandstone; iron-stained, cemented with iron-oxide, silica, and carbonate, prominently cross bedded, thin to medium bedded, mostly fine-to coarse-grained, mostly moderately to poorly sorted, and includes granular conglomeratic intervals. Reddish-brown and dark-gray shale; very silty, sandy in part, carbonaceous in part, ferrugenous in part. Conglomerate; framework-supported, granule to pebble, and composed of chert, quartz, and silicic rock fragments. Stuver, Shainin Lake, and Ear Peak Members are obscure, if present. Dark-gray Mississippian(?) shale is not present, or unrecognized. Much of the formation appears transitional to the Noatak Sandstone, especially in the southwestern part of the map area.

Dhw WACKE MEMBER of the HUNT FORK SHALE (Brosgé and others, 1979) (Upper Devonian)--Outcrop widths and dip suggest that the wacke member is around 2,500 ft. (760 m) thick. The wacke member appears to thin to the northeast. Siltstone, mudstone, and sandstone. Greenish-gray brownish-gray olive-gray, and medium-dark-gray, siltstone and mudstone; typically brownish-gray and yellowish-brownish-gray, hackly weathering and many manganiferous films on weathered surfaces. Siltstone is very shaly and mudstone grades to siltstone. Light- to medium-olive-gray sandstone; fine-to medium-grained, conglomeratic locally, includes small pebbles and granules of chert, argillite, and ironstone, commonly limonitic, ferruginous-weathering in part, and fossiliferous locally. Fossils typically occur in conglomeratic lenses with plant debris. Sandstone occurs in beds up to 3 feet thick and ranges from wackes containing quartz, chert, mica, and aphanitic rock fragments to quartzites composed of quartz and chert. Load casts and bioturbation are locally common. The wacke member may locally interfinger with the overlying Noatak Sandstone but structural complexities obscure the possible gradational relations between the wacke member and Noatak Sandstone.

Dhs SHALE MEMBER of the HUNT FORK SHALE (Brosgé and others, 1979) (Upper Devonian)--Map information suggests that the shale member attains a maximum thickness of 2,000 ft. (610 m) and probably thins to the northeast. Mudstone, shale, and sandstone. Medium- to medium-dark-gray mudstone and shale, very silty, fissile, grades to siltstone and slate, interbedded with sandstone. Brownish-gray and greenish-gray sandstone, fine- to medium- grained, but mostly fine-grained, laminated, low-angle cross-bedded, wavy laminated in part, and includes ripple marks, load casts, and few rip-up clasts of dark-gray shale. Sandstones consist of generally well sorted grains of quartz, chert, argillite?, feldspar, and white mica. Sandstone/shale ratios range from 1:5 to 2:3. The unit is structurally thickened and locally involved in imbricate fault blocks. The shale member is probably low grade metamorphosed, because mudstone and shale commonly have a poorly developed axial plane cleavage in the cores of mesoscopic folds; micaceous sheen occurs on bedding and cleavage surfaces, and gradational relations to slate.

Dh HUNT FORK SHALE (Brosgé and others, 1979) (Devonian)--The thickness of this unit is unknown. Shale and sandstone. Medium-dark-gray and olive-gray shale; includes argillite with poorly developed cleavage, grades to slate, poorly developed phyllitic sheen on partings, and includes sandstone partings and interbeds. Grayish-green and greenish-gray sandstone; mostly fine- to medium-grained, micaceous, ripple cross stratified in part, and graded bedded in part. Much of the outcrop area in which the wacke and shale members are undiscriminated is underlain by shaly strata (indicated by pattern on map). Unresolved structural complication precludes determining whether the shale member thickens or there is a facies change to more shaly strata to the southwest and southeastern parts of the map area.

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