Public Data File 86-86 C

PRELIMINARY BEDROCK GEOLOGIC MAP OF PART OF THE DEMARCATION POINT A-3 AND A-4 QUADRANGLES, BATHTUB RIDGE, NORTHEASTERN ALASKA

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September, 1986

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This public data file contains preliminary information on the bedrock geology and structure of the west end of Bathtub Ridge in the northeastern Brooks Range, Alaska. Data was collected during the 1986 field season in partial fulfillment for a Master of Science degree (for W. Camber) funded by the Alaska Division of Geological and Geophysical Surveys as part of the Eastern North Slope Appraisal Project (ENSAP). Public data File 86-86 C is a preliminary report on the bedrock geology of part of the Demarcation Point A-3 and A-4 (1:63,360) quadrangles.

INTRODUCTION

Bathtub Ridge syncline, located in the Northeastern Brooks Range (Fig. 1.) is a regional syncline of Triassic through Lower Cretaceous strata bounded on the south by folded thrust sheets and on the north by a series of thrusted anticlines and synclines. The bedrock geology of the west end of Bathtub Ridge (lat 69 05' 30" N to long142 18" W) was mapped during the 1986 field season by W. Camber, C.G. Mull and J.B. King. Nine stratigraphic sections were measured, Figure 3 is an index map showing the locations of the measured sections in the Demarcation Point A-3 and A-4 quadrangles. This report contains information concerning the outcrop distribution and lithology of: the Lisburne Group (undifferentiated); Ivishak Formation (undifferentiated); Shublik Formation; Kingak Shale; clay shale, Kemik Sandstone, pebble shale and siltstone members of the Kongakut Formation; and the Bathtub Graywacke.

DESCRIPTION OF MAP UNITS

Bathtub Graywacke (Lower Cretaceous)

The Bathtub Graywacke is a sequence of graywacke sandstone with siltstone and shale interbeds. At Bathtub Ridge it is resistant, incomplete (approximately 760 m exposed) and appears to be conformably gradational with the underlying siltstone member of the Kongakut Formation. Detterman and others (1975) believe the contact to be a disconformity based on their inference that the Bathtub Graywacke is the initial deposit from a southern (Brookian) provenance. The overall depositional pattern of the Bathtub Graywacke is cyclic with units of siltstone and shale near the base, grading upward to rhythmic units of sandstone and shale with conglomerates and shale at the top.

The Bathtub graywacke is interpreted to be a prograding turbidite sequence on the basis of rhythmic sandstone and shale intervals, graded bedding and flute and load casts and an overall coarsening and thickening upward sequence. Sandstone and shale beds < 50 cm thick are laterally extensive on outcrop scale (50 m) and do not pinch out. They probably represent facies C of Mutti and Ricci Lucci (1972) and are interpreted to be the product of deposition by classical turbidites. Sandstone units 0.5 to 10 m thick are massive and commonly amalgamated. These beds are interpreted to be the product of grain flows in high velocity turbidity currents probably deposited as sheet flood lobes. Interbedded shales are thin (< 20 cm) and predominantly shale units up to 5 m thick represent deposition of thin bedded turbidites between lobes due to lobe switching. The

Bathtub Graywacke can be divided into cycles of three different orders of magnitude. The first order is an overall thickening and coarsening upward cycle approximately 750 m thick interpreted to be a prograding sequence of turbidites. The second order is also thickening and coarsening upward cycles tens of m thick, these cycles can be subdivided into third order of magnitude cycles which consist of thickening and coarsening upward, thinning and fining upward or randomly ordered sequences 1 to 5 m thick. The provenance of the Bathtub Graywacke is interpreted from preliminary petrographic modal analysis of three thin-sections. This analysis showed that the Bathtub Graywacke plots in the recycled orogen field, (Dickinson, 1979) indicating that the provenance of these rocks was to the south in the Brooks Range orogenic belt. Directional sedimentary features such as flute casts support this hypothesis. Detterman and others (1975) reported greater thickness in southern exposures indicating transport of sediment from south to north. The age of the Bathtub Graywacke is not known directly from fossils but is inferred from stratigraphic relationships to be Albian (Detterman and others, 1975).

Kb Bathtub Graywacke

Rhythmically interbedded sandstone and shale, medium gray silty to conglomeratic sandstone, composed of quartz, chert, mica and volcanic, sedimentary and metamorphic rock fragments, massive beds, occasionally ripple crossbedded at the top, Bouma Tb-Te and rarely Ta-Te, weathers tan with slight Fe-red staining, quartz veins, fractures blocky, conchoidal, beds 2 cm to 8 m, sharp bottoms, graded tops, dark gray to black, silty and clay shale interbeds, 1 to 30 cm thick. Interpreted to be a prograding sequence of turbidites.

Kongakut Formation

The Kongakut Formation (Detterman and others, 1975) is a Lower Cretaceous sequence of shale and siltstone. The formation is divided into four members : the clay shale member, Kemik Sandstone Member, pebble shale member, and the siltstone member. The siltstone member was mapped at Bathtub Ridge but the other members were regrouped into mapable units described below. In this study, the Kongakut Formation was divided into different mapable units (Fig.2): the manganiferous transitional shale, the manganiferous shale, and the black shale probably correspond to the pebble shale defined by Detterman and others (1975). The marker bed (see map symbols) maps the outcrops of coquinoid limestone, and the sandstone and siltstone that probably correspond to the Kemik Sandstone Member. The black clay shale probably corresponds to the clay shale member or the Kingak Shale defined by Leffingwell (1919). Map units were designated somewhat arbitrarily due to the gradational nature of the contacts. The entire sequence from the clay shale to the Bathtub Graywacke appears to be gradational. It is approximately 1050 m thick and is interpreted to be Lower Cretaceous in age (Detterman and others, 1972)

Ks Siltstone member

Rhythmically interbedded siltstone and shale, medium gray lithic siltstone, ripple crossbedded, slight Fe red weathering, beds .5 to 4 cm thick, sharp bases, tops grade into dark gray shale interbeds, .2 to 3 cm thick, some amalgamation, grades into overlying and underlying units, less resistant, 300 m thick. Interpreted to represent thin

bedded, laterally extensive turbidites, Mutti and Ricci Lucci facies D , Bouma sequences Td-Te.

Kmnt Manganiferous transition shale (pebble shale member)

Dark gray and black shale and silty shale, fissile, platy, weathers dark gray with little Fe red stain, rare silicified beds, grades upward into interbedded shale and siltstone, slight blue black weathering character at base of unit, non-resistant saddle former, 200 m thick. Interpreted to represent a transition from deep water shale to distal turbidite deposition. Silt component increases upsection.

Kmn Manganiferous shale (pebble shale member)

Dark gray to black shale, fissile, platy, blocky, weathers red and blue black, silicified ovoid concretions 4 to 30 cm in diameter and silicified beds .2 to 5 cm thick, very resistant, forms prominant outcrops, 350 m thick. Interpreted to represent deep water deposition, manganiferous content represented by blue black stain and occasional botryoidal nodules.

Kcs Black shale (pebble shale member)

Dark gray to black silty clay shale, weathers to flat thin plates or pencils, beds .2 to 3 cm thick, sharp bases, imperceptibly graded tops, occasional sand grains near bases of beds, interbeds of black clay shale, Fe-silicic ovoid concretions common in isolated sections up to 4 m thick, Fe-red and Mn-blue black weathering character increases up section, 60 m thick.

Silty sandstone, medium gray, very fine grained, plane laminated or ripple crossbedded, 6 beds, 6 to 15 cm thick, sharp bases graded tops, interbeds of black clay shale. Interpreted as turbidites, Mutti and Ricci Lucci facies C, bouma sequences Tc-Te.

Sandstone, light gray, fine grained, quartsose, massive, 1.5 m thick bed, sharp base sharp top. Interpreted to be a turbidite, corresponds to the Kemik Sandstone Member of the Kongakut Formation.

Coquinoid limestone, light brown, crushed and packed shells (Buchia ?), weathers tan brown, 12 beds, 4 to 6 cm thick, interbeds of black clay shale. Valanginian marker bed.

Kingak Shale (Jurassic)

The Kingak Shale was named and described by Leffingwell (1919). It is a soft black clay shale. The Kingak Shale is not well exposed at Bathtub Ridge . The Kingak Shale is correlated with the clay shale member of the Kongakut Formation on the basis of Valanginian fosils and stratigraphic position (Detterman and others, 1975). The Kingak Shale is 150 m thick and is interpreted to be an offshore shelf or deep marine deposit. The upper contact is a thrust fault with Triassic (Ivishak) and older strata thrust over Kingak. The lower contact is not exposed.

KJk Black clay shale (Kingak Shale)

Dark gray to black, sooty, soft clay shale weathers to flat, thin plates .5 cm thick, contains Pentacrinus (?), siliceous concretions contain pelecepods and ammonites.

Shublik Formation (Middle and Upper Triassic)

The Shublik Formation is poorly exposed at Bathtub Ridge. Limestone interpreted to be Triassic in age is thin and poorly exposed but fossils were collected. An erosional unconformity was noted at the top of the limestone and the Karen Creek formation and Kingak Shale appear to be missing. The siltstone containing black phosphatic nodules, that is associated with the Shublik, was noted at two locations but its relationship to the limestone was obscure. The exteremely limited nature of the outcrop strongly suggests that the contact is erosional. The base of the Shublik is not well exposed but appears to be a disconformity represented by an abrupt change in lithology as well as an abrupt change in structural deformation. The Shublik Formation was divided into two units at Bathtub Ridge: the Shublik limestone and Shublik sandstone correlate with the limestone and dolomite member and the siltstone member respectively.

T sl Limestone (Shublik ?)

Light gray silty, contains brachiopods (Rhinconelids ?, Halobia?, Monotis ?, Spirifer ?), weathers red-tan, dip slope former but poorly exposed.

T ss Camp sandstone (Shublik ?)

Medium gray, medium grained, quartzose, cherty and limonitic, massive, bioturbated, indistinct beds 6 cm to 1 m thick, occasional silty interbeds 3 cm thick, resistant. Black phosphatic nodules .5 to 3 cm in diameter found in poorly exposed sandstone outcrop. Zoophycus was noted on a dip slope forming bedding surface.

Ivishak Formation (Lower Triassic)

The Ivishak Formation (Keller and others,1961) is the uppermost formation in the Sadlerochit Group (Detterman and others,1975). The contact between the Ivishak and the overlying Shublik is probably an unconformity. Fossils from the top of the Ivishak and the bottom of the Shublik indicate there was some erosion of the Ivishak prior to deposition of the Shublik (Detterman and others, 1975) The Ivishak Formation is divided into three members, at Bathtub Ridge only one lithology is represented and the members were not differentiated. The Ivishak sandstone is a silty quartzose sand that is tightly folded, measurement of the stratigraphic thickness was not attempted. The provenance of the Ivishak Formation was to the north. It is Triassic in age and is interpreted to represent a near shore shelf to shallow marine environment of deposition. The Ivishak Formation is the main hydrocarbon reservoir at Prudhoe Bay.

T I Ivishak Formation

Medium gray, medium grained, contains quartz, chert, and limonite, massive, hard, resistant, siltstone and silty sandstone.

Tan gray, very fine grained, contains quartz, chert, mica and limonite, bioturbated, isoclinally folded, non-resistant siltstone and silty sandstone. Interpreted to be a shelf deposit.

Echooka Formation (Upper Permian)

The Echooka Formation (Keller and others, 1961) is well exposed in the Bathtub Ridge syncline. The upper part of the section contains a calcareous sandstone and limestone underlain by chert which was considered to be secondary in origin (Detterman and others 1975). This section probably corresponds to the Joe Creek Member and is a resistant, prominent ridge former. The lower part of the section contains a calcareous siltstone that contains glauconite and weathers a characteristic yellow green. It contains fossils (brachiopods, bryozoans, corals and gastropods) and probably corresponds to the Ikiakpaurak Member of the Echooka Formation. This unit was deposited in a shelf environment and is Permian in age. The Echooka in the Bathtub Ridge area is 67 m thick.

Pe Echooka Formation

Medium gray calcareous sandstone and limestone, beds 10 to 40 cm thick, resistant.

Dark gray to black chert, massive beds 10 to 50 cm thick, resistant.

Dark gray calcareous, glauconitic siltstone, weathers yellow green, bioturbated beds, 10 to 60 cm thick, contains brachiopods and bryozoans.

Lisburne Group (Pennsylvanian-Mississippian)

The Lisburne Formation was named by Schrader (1902). Bowsher and Dutro (1957) later renamed this unit the Lisburne Group. This unit is well exposed near Bathtub Ridge where it is folded and faulted. No attempt was made to differentiate members or to measure stratigraphic thickness in this study. The Lisburne is a resistant white to gray limestone unit of Mississippian age (Armstrong and others, 1970) deposited in a variety of shallow marine to supratidal environments (Armstrong and Mamet, 1975, 1977, 1978)

PMl Lisburne Group (undifferentiated)

Light gray to white limestone, abundantly fossiliferous, contains crinoids, braciopods and bryozoans, thin to massively bedded, resistant.

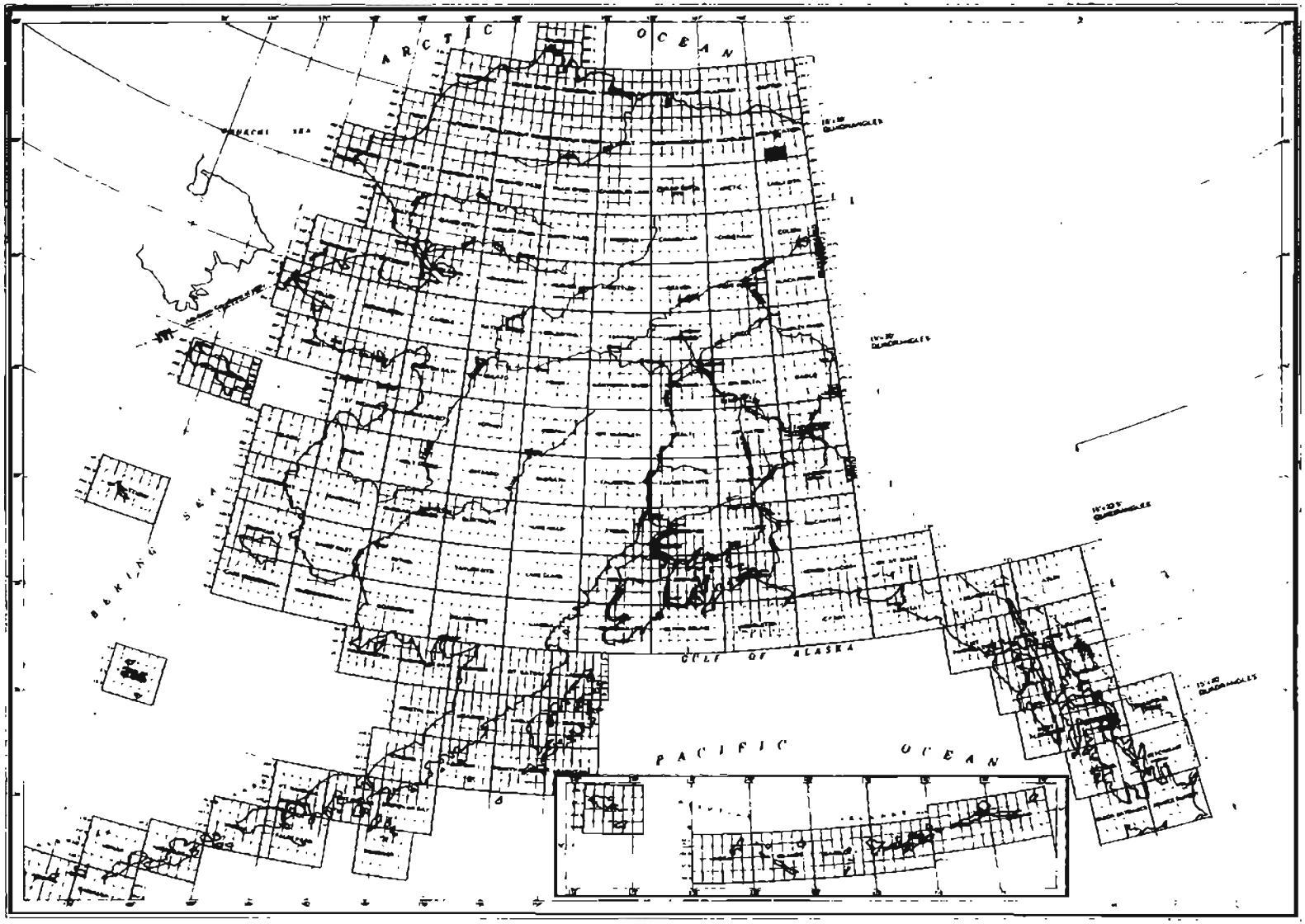

FIGURE 1. Demarcation Point A-3 and A-4 Quadrangle locations.

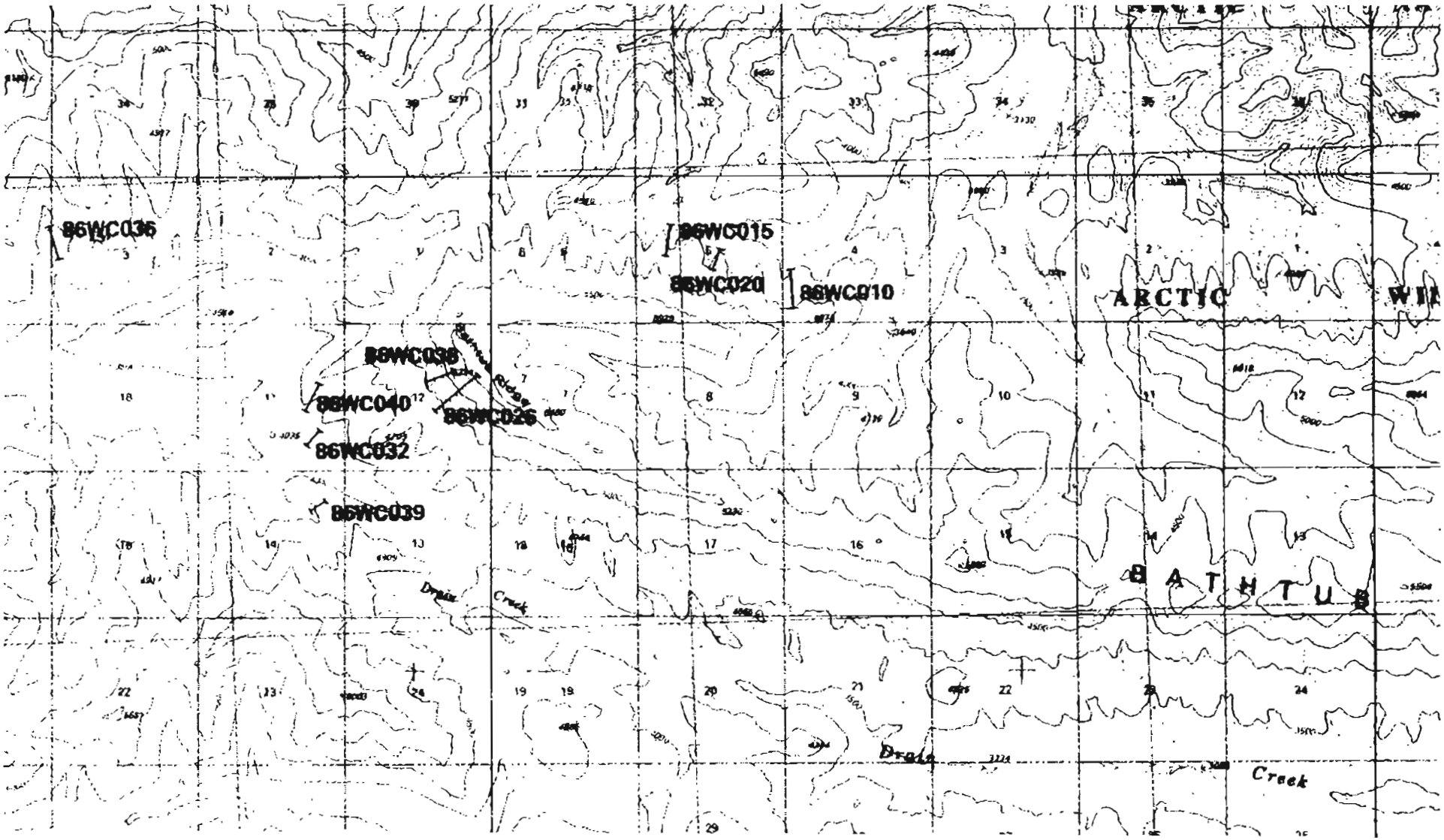

FIGURE 2. Locations of measured sections.

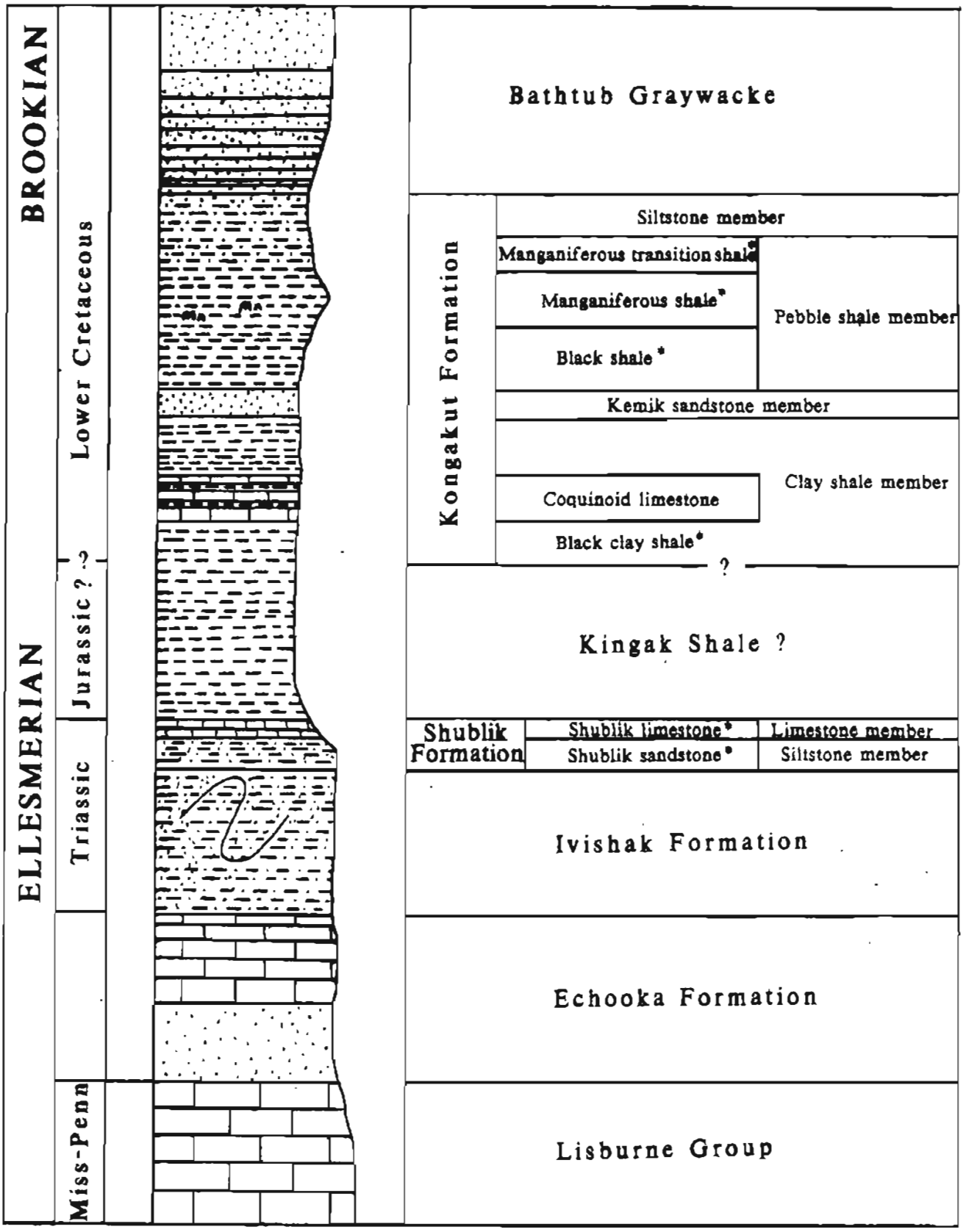

FIGURE 3. Generalized stratigraphic column showing the correlation between terms units used in this report* and units defined by Detterman and others (1975).