Petrography of University of Washington dredge samples from the central Chukchi Sea

by Jeremy B. Platt

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Introduction

Twenty thin sections of rocks dredged from the central Chukchi Sea have been examined petrographically and compared with some onshore rocks in northern Alaska. Of these, 16 are sandstones, three are highly $CaCO_3$-rich silts and carbonate rocks, and one is an olivine-magnetite-rich basalt. Eight of the sandstones have been point-counted in an effort to determine compositional trends. Sample numbers, lithologies, and locations are summarized in Table 1, and locations are shown in Figure 1. Dr. Joe S. Creager of the University of Washington kindly provided the dredge samples and thin sections for study.

The hand specimens of the sandstones are nearly all slablike, indicating parting parallel to probable bedding. Parallel lamination is visible in addition in many of the samples. Ripple cross-laminations were found in one very fine-grained sandstone. Thus bedding, either internal or external, is present in all sandstones. These features are summarized in Table 2. Negative results of staining for potassium feldspar are presented in the Appendix.

Not enough samples have been obtained to delineate distinctive assemblages within the sandstones with confidence; however, the degree of compaction of the sandstones is a characteristic which seems to provide an initial framework for their classification. All the sandstones are highly indurated, yet some show more severe pressolution than others. On this basis, 10 of the sandstones fall into a "highly compacted" group, 4 into a "less-compacted" group, and 2 cannot be assigned to either group with assurance. The features of the sandstones will be discussed according to these tentative groupings. These groupings, the ranges of grain sizes of the sandstones (fine and very fine grained sizes predominate), and the degrees of sorting are summarized in Table 3.

All of the less compacted sandstones, all of the calcareous rocks and the basalt are from Station 65. For a summary of the most likely onshore correlatives to the less compacted sandstones, see page 11. A discussion of the regional geology and tectonic significance of these samples is presented in Grantz and others (1975).

Highly Compacted Sandstones

Most of the framework clasts within the sandstones of this group are very closely packed, such that any grain is in intimate contact with other grains along its full perimeter. The matrix, or fine recrystallized phyllosilicate mesostasis, has been squeezed so thoroughly that it is either absent or locally present as thin interstitial films. Widespread moderate to severe pressolution is characteristic and is evidenced in detail by embayed, planar, curved, and rare sutured grain boundaries. Both quartz and feldspar clasts are affected. Collectively an interlocking fabric is achieved. Plastic lithic fragments (e.g., silts and some tectonites) have been squeezed to conform to adjoining resistant grain boundaries. However, deformation of the majority of framework grains themselves does not appear to be very significant. Many quartz grains show minor strain-induced wavy extinction, which frequently emanates from point contacts, but polygonization of quartz grains is rare. Feldspars, where affected, may exhibit slight bending or splitting; and micas are crimped.

The combined effects of compaction, pressolution, deformation, recrystallization, and possibly sedimentation have produced a mild to pronounced preferred orientation of the clasts in many of the highly compacted sandstones. Flattening rather than shearing appears to be the cause. Where developed, this fabric in thin section is subparallel to bedding. The fabric is summarized in Table 2.

Variations in average grain size and relative sorting have been noted in these sandstones. Generally the coarser grained sandstones are the better sorted. Yet it is significant that the degree of compaction is independent of these differences, rather than being a function of either grain size or sorting. A tabulation of relative grain size and sorting is given in Table 3.

A common matrix constituent of all the sandstones (highly and less compacted groups alike) in addition to phyllosilicates and fine silt-sized resistates is amorphous to finely granular material. Two distinct types, occasionally referred to as "muck", are commonly present in the same rock. One is a very dark reddish-brown subtranslucent to opaque amorphous material which occupies intergranular spaces, cleavages and fractures as wispy stringers, lacy nets, and occasionally clots. This material may be organic-carbonaceous or it may represent a type of iron oxide, possibly hydrous. The other type of material is amber or light to dark brown and finely granular. It forms more massive clots, intergranular fillings and replacements. It resembles iron-stained leucoxene or carbonate, and it occasionally develops rhombohedral shapes. Possibly both types have been acquired since residence on the sea floor, although the dark amorphous type appears to be a more integral part of the rock and such an origin for it is doubtful.

In the highly compacted sandstones the amorphous material ranges from a few to approximately 15 percent of the entire rock. While it commonly has the habit of matrix, it can be difficult to discern from pseudomatrix (squeezed lithics) where it forms clots. $CaCO_3$ is present in minor amounts in nearly all the highly compacted sandstones. It is clear and occurs as granular to small rhomboid interstitial, and less frequently intragranular, crystals.

Point counts of selected highly compacted sandstones show a somewhat restricted range of composition. Quartz content varies from 70 to 80 percent of the framework clasts, feldspar 14 to 18 percent, and lithics 6 to 13 percent. The matrix content, as a percent of the entire rock, varies from 14 to 25 percent; and the combined matrix plus "muck" content varies from 17 to 29 percent. Matrix includes both phyllosilicate and silt-sized quartz, feldspar, and other clasts too small to identify positively. All feldspars are albitic plagioclase, based on optical properties. And lithics include sedimentary argillaceous and siltstone grains (some of which are siliceous), schistose metamorphic grains and mica (chiefly muscovite, lesser chlorite, minor biotite), igneous (chiefly plutonic) fragments, and other miscellaneous rock fragments. Quartz includes monomineralic and polycrystalline grains and minor chalcedony and chert. Chert is invariably present in only minor amounts. These data are summarized in Table 4 and plotted in Figure 2.

Less Compacted Sandstones

Four sandstones have been tentatively assigned to this group whose characteristics differ more in degree than in kind from the highly compacted group. Although lesser compaction is apparent among the sandstones of this group, any of the features of the highly compacted group may locally be present. Of chief importance is the general absence of flush grain contacts. The interstitial spaces are occupied by phyllosilicate matrix and/or "muck" of the types described above. Some subjectivity is involved in assigning sandstones to this group, and not all the sandstones exhibit the same degree of compaction. Sample P-65-9, for example, is much more highly compacted than B-65-10. But even in sample B-65-10, the least sorted, least compacted sandstone of all the dredge samples, the grains are quite closely packed--to the extent that they do not have a "floating" appearance--and the sandstone is well indurated.

The less compacted sandstones are all poorly sorted and of variable grain size. Preferred orientation is developed to varying degrees. These features are summarized in Tables 2 and 3.

The "muck" content of all but one of these sandstones is so high that it obscures clear observation of the grain boundaries. For this reason, these sandstones may appear to be less compacted than they really are. On the other hand, a relatively open framework may be necessary to allow prodigious accumulation of "muck". The "muck" content as a percent of the total rock ranges from 12 to 20 percent, while that in the highly compacted group ranges from 3 to 14 percent. Matrix varies from 20 to 36 percent; and the combined muck plus matrix content ranges from 40 to 48 percent--a reflection of the poor sorting. Clear carbonate is sparse or absent, although it locally forms large veinlike replacement crystals in sample B-65-10. Minor biaxialty of the carbonate phase indicates aragonite may be present.

Point counts of 3 of the 4 compacted sandstones reveal a broader range of composition than in the highly compacted group. The groups do not overlap. Quartz content as a percent of the framework clasts varies from 53 to 62 percent, feldspar 24 to 33 percent, and lithics from 8 to 21 percent. These data are summarized in Table 4 and Figure 2.

Unassigned Sandstone Samples

Samples P-65-7 and B-61-5 have not been assigned to either of the above categories since it is not clear to which groups they belong. P-65-7 is rather poorly sorted, of variable grain size, and has a mild fabric. It contains over 32 percent "muck", which surrounds all grains and prohibits observation of intergranular boundaries. The "muck" appears to be predominantly of the amber, finely granular variety. Its compositional affinities appear to lie with the less compacted group.

Sample B-61-5 is very poorly sorted, of variable grain size, and has a hint of preferred orientation. It is the only sandstone with large (up to 0.5 mm long) shale chips. Its compaction is variable, being locally similar to that of both major groups. Its composition shows affinities with the more highly compacted group.

Possible Onshore Correlatives of Dredged Sandstone Samples

Petrographic descriptions obtained from the literature and several thin sections of onshore sandstones have been studied in order to determine which onshore formations, if any, may be analogous to the dredge-haul sandstones. Unfortunately data on the onshore sandstone samples is almost as meager as for those offshore, and the comparisons that follow are tentative.* The following works have been consulted: in the western Brooks Range on the southwest side of Cape Lisburne, Campbell (1967), and to the northeast in the Utukok-Corwin region, Chapman and Sable (1960); north of the central Brooks Range in the Killik-Itkillik region, Patton and Tailleur (1964), and slightly to the north of that in the Chandler River region, Detterman, Bickel and Gryc (1963); and south of the central Brooks Range in the Hughes area, Patton and Miller (1966).

Thin sections from sandstones of the pre-Mississippian Iviagik Group of Martin (1970, p. 3609) at and south of Cape Dyer show that this argillite-graywacke sequence is probably an unlikely correlative of the dredged sandstones. This is because sandstones in the Iviagik Group, which are moderately

*Available modes are plotted in Figures 3, 4 and 5.

sheared and bear much chlorite and white mica, are more severely metamorphosed than the dredged sandstones. Since the Iviagik sandstones have compositional affinities with the less compacted group of dredge samples (Fig. 3), any correlation between them would require a change in metamorphic grade offshore. Such a possibility cannot be ruled out. The state of compaction of the Iviagik sandstones is not readily comparable with the dredge samples because of the very abundant matrix in the former.

A thin section of quartzitic sandstone from the coal-bearing sequence of Mississippian age that overlies the Iviagik Group near Kapaloak Creek and Cape Dyer (Tailleur, 1965) shows these sandstones to be very dissimilar to the dredged sandstones on account of their apparent lack of any feldspar and their relatively high chert content (Fig. 3). However, the rock is quite highly compacted.

No modes are available for sandstones from an unnamed mudstone-sandstone-limestone sequence of Mississippian age noted by Campbell (1967) in the Cape Thompson area of the Lisburne Peninsula.

The Mississippian Lisburne Group, predominantly a limestone sequence, does not appear to contain any sandstones in either the Cape Thompson o Killik-Itkillik regions. However, very minor amounts of sandstone have been observed just north of Cape Dyer among the shales, siltstones, argillaceous and cherty limestones, and limestones that characterize the lower third of the Nasorak Formation in that area (Armstrong and others, 1971). No modes are available.

The Siksikpuk Formation of probable Permian age is predominantly a shale-siltstone sequence in the Killik-Itkillik region but contains very minor amounts of very fine grained sandstone in the Cape Thompson region. While no modes are available, it is doubtful that either the Siksikpuk Formation or the Nasorak Formation provided the dredged sandstones unless the proportions of sandstone considerably increase offshore in the Chukchi Sea. Similarly, the Triassic Shublik Formation, which consists mostly of dark shales, chert, and limestone in both the Cape Thompson and Killik-Itkillik regions, is probably not the source of the dredged samples.

No modes are available for an unnamed siltstone-shale unit with minor very fine grained sandstone beds noted in the Utukok-Corwin region. The rocks are said to be "identical with those which overlie Triassic rocks near Cape Lisburne..." (Chapman and Sable, 1960).

Sandstones from the undated post-Upper Triassic pre-Early Cretaceous Ogotoruk and overlying Telavirak Formations from the southwest side of the Lisburne Peninsula have compositional affinities with the less compacted group of dredged sandstones (Fig. 4). In addition to appearing similarly compacted, they are poorly sorted invariably contain albitic feldspar, and are of similar grain size. These formations appear capable of providing material analogous to the less compacted group of dredged sandstones.

The same conclusion applies to the overlying Kisimilok Formation, another sandstone-mudstone sequence, of Early Cretaceous (possibly Berriasian and Valanginian) age. A trace of potash feldspar and minor detrital calcite was noted (Campbell, 1967).

Of similar age in the Killik-Itkillik region are the sandstones, siltstones, and shales of the Okpikruak and Tiglukpuk Formations of

Berriasian and Valanginian ages, respectively (Patton and Tailleur, 1964; Jones and Grantz, 1964). Comparison to the dredge samples based on the available petrographic descriptions is difficult. The quartz content in the Okpikruak Formation may be somewhat low, relative to the dredge samples, but the feldspar, chiefly albite, appears to be present in similar amounts. Detrital calcite in the Tiglukpuk Formation may be somewhat high, but the quartz content may be of the proper order of magnitude. Plagioclase, of unspecified composition, is the chief feldspar. The fine to very fine grained sizes of the sandstones in both formations are similar to those of the dredge samples. It is premature to exclude these Lower Cretaceous rocks from comparison with the dredged samples.

Late Early Cretaceous (early Albian) shales, siltstones, sandstones, and conglomerates of the Fortress Mountain Formation have been described from the Utukok-Corwin, Killik-Itkillik, and Cape Thompson regions. At the latter locality the sequence is designated Fortress Mountain(?) Formation. Little similarity exists between the dredged sandstones and these sandstones from the Killik-Itkillik region, where the quartz and feldspar contents are quite low and the chert content quite high; but these sandstones from the Cape Thompson region contain more quartz and less chert, as well as more albitic feldspar. But the quartz content is still somewhat low relative to the dredge samples, and there may be low but significant amounts of detrital calcite. Thus the Fortress Mountain Formation in the Killik-Itkillik region can probably be excluded from comparison with the dredge sandstones, while that in the Cape Thompson region cannot be excluded from available data. No modes are available for these sandstones in the Utukok-Corwin region. Here, and in the other regions, the ranges of grain sizes are similar to (or broader than) those of the dredge sandstones.

Partly of the same age as the Fortress Mountain Formation, but probably ranging into the middle Albian, are the shales, siltstones, and minor sandstones of the Torok Formation. In none of the regions studied does Torok sandstone bear any resemblance to the dredge samples. In the Killik-Itkillik and Utukok-Corwin regions the Torok sandstone contains abundant chert; and in the Utukok-Corwin and Chandler River regions its plagioclase is much too calcic. Volcanic rock fragments and/or detrital calcite are also generally too abundant.

Also unlikely onshore correlatives are the late Lower Cretaceous to early Upper Cretaceous rocks of the Nanushuk Group. These are represented in the Utukok-Corwin region by the marine middle and upper(?) Albian Kukpowruk Formation, in which sandstones ha e variable compositions but generally somewhat high chert and detrital .alcite contents, and by the Albian and Cenomanian nonmarine Corwin Formation, in which sandstones also have variable compositions but generally somewhat high chert, possible volcanic and calcite fragments, and possibly somewhat low quartz contents, relative to the dredged sandstones. In both formations the feldspar content may be relatively very low.

In the Killik-Itkillik and Chandler River regions, the basal member of the Nanushuk Group is the middle Albian Tuktu Formation, which contains very low feldspar contents relative to the dredge samples, and variable to significant amounts of chert and detrital calcite. Probable increased chert and negligible feldspar contents characterize the possibly middle Albian to late Cenomanian sandstones of the Killik tongue of the Chandler Formation.

No petrographic description was available for the partly equivalent Grandstand Formation of the Chandler River region.

In the Chandler River region, the late Cenomanian Ninuluk Formation contains, relative to the dredge samples, low quartz and feldspar, and high chert and detrital calcite. Microcline was present.

High chert, detrital calcite, and potash feldspar contents also characterize the post-early Late Cenomanian nonmarine Niakogon tongue of the Chandler Formation, also in the Chandler River region.

Thus none of the sandstones of the Nanushuk Group appear to resemble the dredged sandstones.

Unconformably overlying the Nanushuk Group is the Colville Group, best represented in the Chandler River region but also present in the Utukok-Corwin region. In the Chandler River region, the Colville Group is divided into the basal Seabee Formation (lower Shale Wall and upper Ayiyak members), and the overlying Prince Creek and largely equivalent Schrader Bluff Formations.

The Prince Creek Formation is divided into the Tuluvak and Kogosukruk tongues; the Shrader Bluff Formation is divided into the Rogers Creek, Barrow Trail, and Sentinel Hill members--the first two members being equivalent in age to the Tuluvak tongue and the last to the Kogosukruk tongue. Most of these formations are bentonitic, tuffaceous, and coal bearing. Sandstones from the Ayiyak member and Tuluvak tongue are, relative to the dredge samples, high in chert, low in feldspar, and moderately high in biotite and detrital calcite. Rocks of the Kogosukruk tongue are poorly consolidated.

It appears to be safe to conclude that sandstones of the Colville Group do not resemble the dredged sandstones.

Modal analyses are available for 5 graywackes of probable Albian age from the Hughes Quadrangle which lies south of the central Brooks Range (Fig. 5; Patton and Miller, 1966). These rocks are considerably different from the dredged sandstones in that they contain more lithic and felsic grains and much less quartz. Chert, in addition, may be a substantial component of the quartz fraction.

In sum, the most likely onshore correlatives to the dredged samples appear to be the post-upper Triassic to Early Cretaceous Ogotoruk, Telavirak, and Kisimilok Formations of the Cape Thompson area. The Pre-Mississippian Iviagik Group and the Early Cretaceous Okpikruak and Tiglukpuk Formations of the Killik-Itkillik region and Fortress Mountain(?) Formation in the Cape Thompson region are less likely. Furthermore, whatever similarities have been found refer to the less compacted group of dredge samples, and no correlatives have been indicated for the more quartz-rich sandstones of the highly compacted group.

It should be emphasized that these comparisons, while making best use of available data, are necessarily tentative in nature because sampling and description of onshore rocks are incomplete and, furthermore, onshore formations could change in character within the distance of 150 or more km to the dredge sites. However, additional support for the conclusions comes from the fact that the great bulk of rocks in the dredge hauls are sandstones. It is likely that the sandstones originate in dominantly graywacke or graywacke-siltstone sequences, such as those that they resemble petrographically, rather than from sandstones in the coal-bearing or the dominantly limestone-chert-shale sequences that underlie large tracts in the Lisburne Peninsula and western Brooks Range.

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Appendix

Results of Staining for Potash Feldspar

Polished slabs from the following 10 samples have been stained for potassium with sodium cobaltinitrate solution after etching in hydrofluoric acid. No grains of potassium feldspar were found in any of the slabs, thus confirming the optical observations.

B61-1

B61-2

B61-3

P61-6

B62-2

B62-3

B65-1

P65-4

P65-9

B65-10

Table 1

Dredge Sites and Lithologies

sample	lithology
B-61-1	ss-compacted
B-61-2	ss-compacted
B-61-3	ss-compacted
B-61-4	ss compacted
B-61-5	ss-unassigned
B-61-6	ss-compacted
B-62-1	ss-compacted
B-62-2	ss-compacted
B-62-3	ss-compacted
B-65-1	ss-compacted
B-65-2	ss-compacted
B-65-3	basalt (plagioclase ~ labradorite)
P-65-4	ss-less compacted
P-65-5	silty calcareous nodule(?), limestone(?)
P-65-6	calcareous nodule(?), limestone(?)
P-65-7	ss-unassigned
P-65-8	ss-less compacted
P-65-9	ss-less compacted
P- or B-65-10	ss-less compacted
65-11	calcareous siltstone

locations			depth
Station 61	69°54.0' N.	168°40.0' W.	40 m
Station 62	69°59.5' N.	168°58.0' W.	36 m
Station 65	69°03.0' N.	169°46.5' W.	38 m

Table 2

Summary of Bedding Features

number	shape	lamination	fabric**
Highly compacted group:			
B-61-1	slab, 30-45 mm thick	none apparent	1
B-61-2	slab, 15-20 mm thick	none apparent	1
B-61-3	irregular	clear parallel, 1.5-4 mm	2
*B-61-4	slab, veined or fractured	faint parallel, in thin section only, 1-~4 mm	2
*B-61-6	slab	faint parallel, 3-6 mm	2
B-62-1	massive, sub-cubic	clear ripple cross-beds	4
B-62-2	slab, 15-20 mm thick	none apparent	3
B-62-3	slab	faint parallel, 5 mm+	4
*B-65-1	irregular	faint parallel in t.s. only, 1.5-6 mm	3
B-65-2	slab	clear parallel, <1-5 mm	2
Unassigned:			
*B-61-5	irregular	partial alignment of shale chips	4
*B-65-7	slab, 15 mm thick	none apparent	2-3
Less compacted group:			
*P-65-4	slab, ~10 mm thick	none apparent	2-3
P-65-8	slab, ~15 mm thick	none apparent	2
*P-65-9	slab, part of sample is missing	none apparent	1
*B-65-10	irregular slab	faint parallel, 4 mm+	2-3

*point-counted

**1-pronounced; 2-mild; 3-poor; 4-very faint

Table 3

Grain-Size Measurements

Highly compacted group:

better sorted:

B61-1	F-V.F.
B61-2	F-V.F.
B61-3	F-V.F.
P61-6	F-V.F.
B62-2	F-V.F.
B62-3	F-V.F.

more poorly sorted:

B65-1	V.F-(silt)
B61-4	V.F-silt
B62-1	F-V.F-silt
B65-2	V.F-silt

Less compacted group:

all poorly sorted:

P65-9	F-V.F-silt
P65-8	(F)-V.F-silt
P65-4	(F)-V.F-silt
B65-10	(M)-F-V.F-silt

Unassigned:

all poorly sorted:

P65-7	F-V.F-(silt)
B61-5	(F)-V.F-silt

SCALE: Medium (M) 0.50-0.25 mm; Fine (F) 0.25-0.125 mm; Very Fine (V.F.) 0.125-0.062 mm; silt $<$0.062 mm. Parentheses indicate minor abundances. All sandstones contain a matrix of fine silt-to clay-sized particles. A "silt" or "(silt)" designation here refers to such material if present in significant amounts.

Table 4

Summary of Point Counts

sample	mode (Q-F-L)	matrix and muck as % of rock	# counts	# times
Highly compacted group:				
B-61-4	80Q 14F 6L	(25 mx, 4 muck)	300	1
P-61-6	72 15 13	(14 mx, 3 muck)	400	1
B-65-1	71 18 11	(15 mx, 14 muck)	350	1
Unassigned:				
B-61-5	76 16 8	(28 mx, 14 muck)	300	2
P-65-7	60 18 22	(11 mx, 32 muck)	400	1
Less compacted group:				
P-65-4	53 26 21	(24 mx, 18 muck)	400	2
P-65-9	62 24 14	(20 mx, 20 muck)	400	1
B-65-10	59 33 8	(36 mx, 12 muck)	450	1
Iviagik Gp. (Pre-Mississippian):				
73 AGZ 27A	60 22 18	(50 mx, 2 muck)	400	2
Mississippian strata near Kapaloak Creek				
73 AGZ 25	95 0 5	(13 mx, 0 muck)	300	2
Hughes area (Albian): From the literature				
	35 42 23	(31 mx, 0 calcite)		
	12 55 33	(36 mx, 5 calcite-detrital or not?)		
	12 48 40	(30 mx, 11 calcite- ")		
	35 35 30	(34 mx, 4 calcite- ").		
	11 53 36	(31 mx, 0 calcite)		
Cape Thompson area: From the literature				
Ogotoruk Fm. (Jura-Cretaceous?)				
58 ACr-lss	67Q 21F 12L	(28 mx)		
58 AKd-c-195	55Q 28F 17L	(33 mx + secondary calcite)		
59 ACr-31-33	40Q 33F 27L	(42 mx)		
Telavirak Fm. (Jura-Cretaceous?)				
58 ACr-3 3/4	56Q 25F 19L	(32 mx)		
58 ACr-4	51Q 26F 23L	(36 mx + secondary calcite)		
Kisimilok Fm. (Early Cretaceous)				
60ACr 51	52 26 22	(25 mx)		
60 ACr-49f	46 34 20	(38 mx + calcite cement(?))		
Fortress Mtn.(?) Fm.				
60 ACr-58-I	45 35 20	(35 mx + calcite cement(?))		

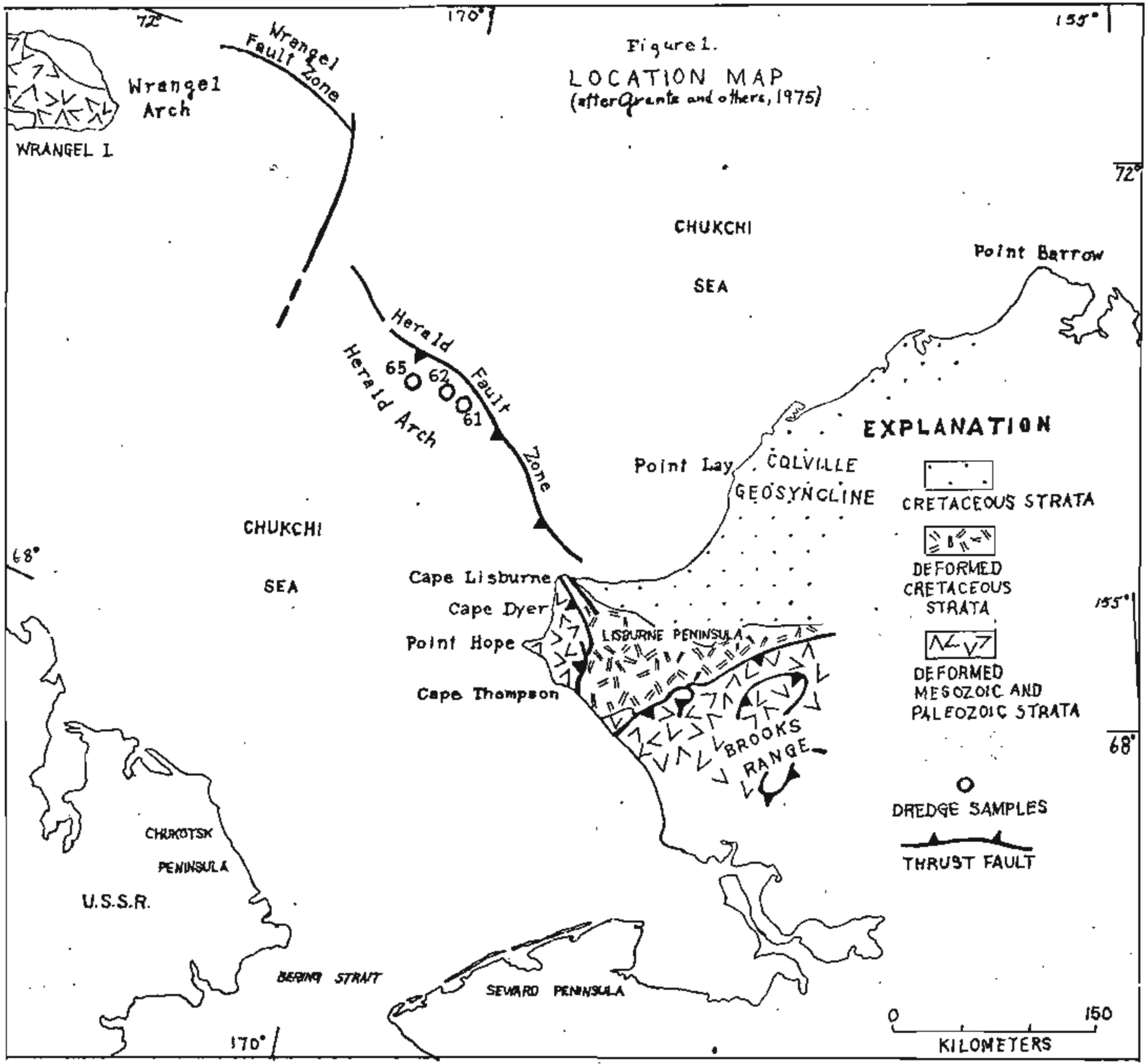


Figure 1.
LOCATION MAP
(after Grantz and others, 1975)
72°
170°
155°
72°
68°
155°
68°
170°
Wrangel Fault Zone
Wrangel Arch
WRANGEL I.
CHUKCHI
SEA
Point Barrow
Herald Fault Zone
Herald Arch
65
62
61
Point Lay
COLVILLE
GEOSYNCLINE
CHUKCHI
SEA
Cape Lisburne
Cape Dyer
Point Hope
Cape Thompson
LISBURNE PENINSULA
BROOKS
RANGE
CHUKOTSK
PENINSULA
U.S.S.R.
BERING STRAIT
SEWARD PENINSULA
EXPLANATION
CRETACEOUS STRATA
DEFORMED
CRETACEOUS
STRATA
DEFORMED
MESOZOIC AND
PALEOZOIC STRATA
DREDGE SAMPLES
THRUST FAULT
0
150
KILOMETERS

Figure 3.

Comparison with Onshore Rocks

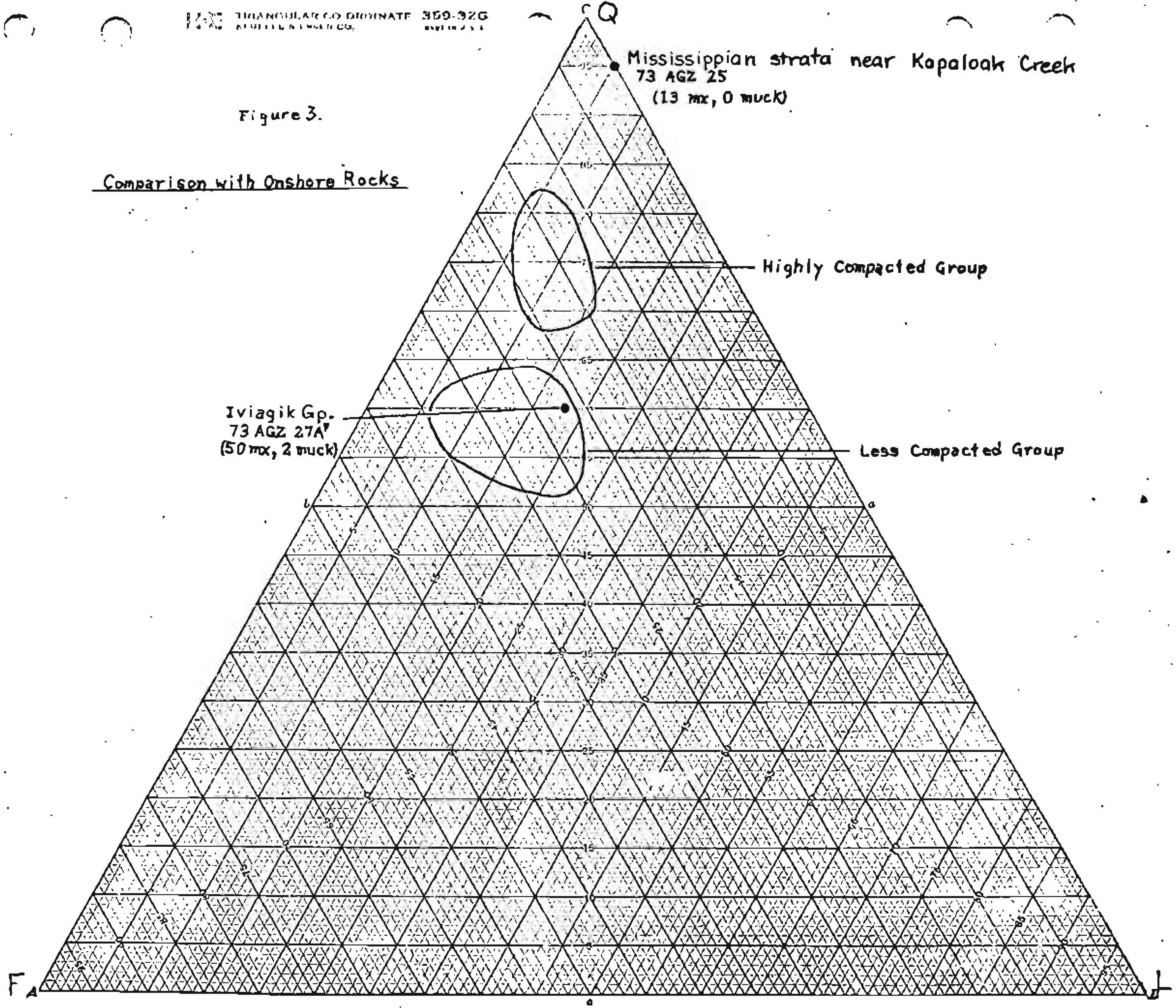


Figure 4.

Comparison with Onshore Rocks

Cape Thompson area
(Campbell, 1967)

Fortress Mtn. (?) Fm. FM •

Kisimilok Fm. K •

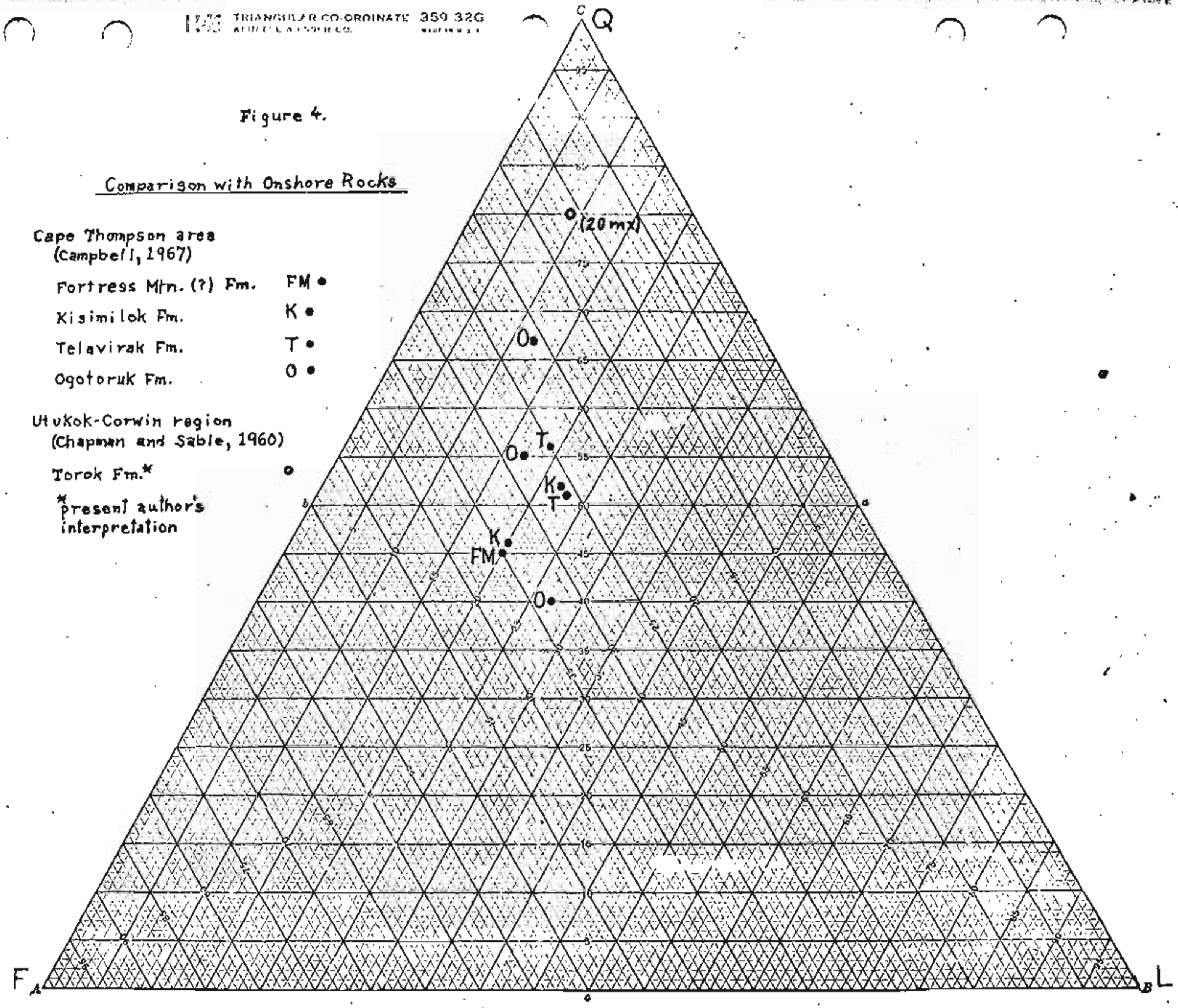
Telavirak Fm. T •

Ogotoruk Fm. O •

Utukok-Corwin region
(Chapman and Sable, 1960)

Torok Fm.* o

*present author's interpretation



TRIANGULAR CO-ORDINATE 359-32G

Figure 5.

Comparison with Onshore Rocks

Hughes Quadrangle
(Patton and Miller, 1966)

Albian graywackes •
from graywacke + mudstone unit
with matrix as % of total rock

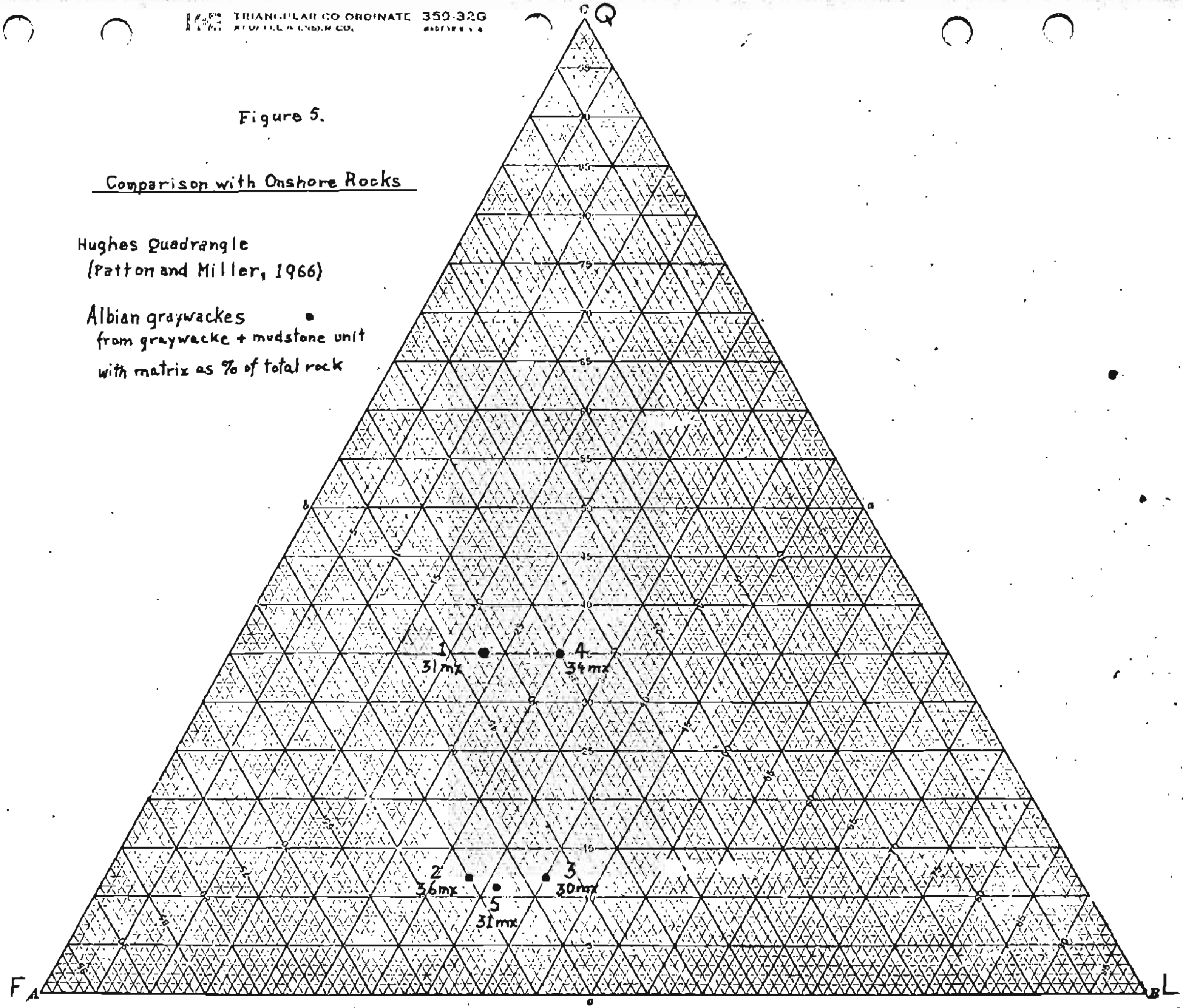
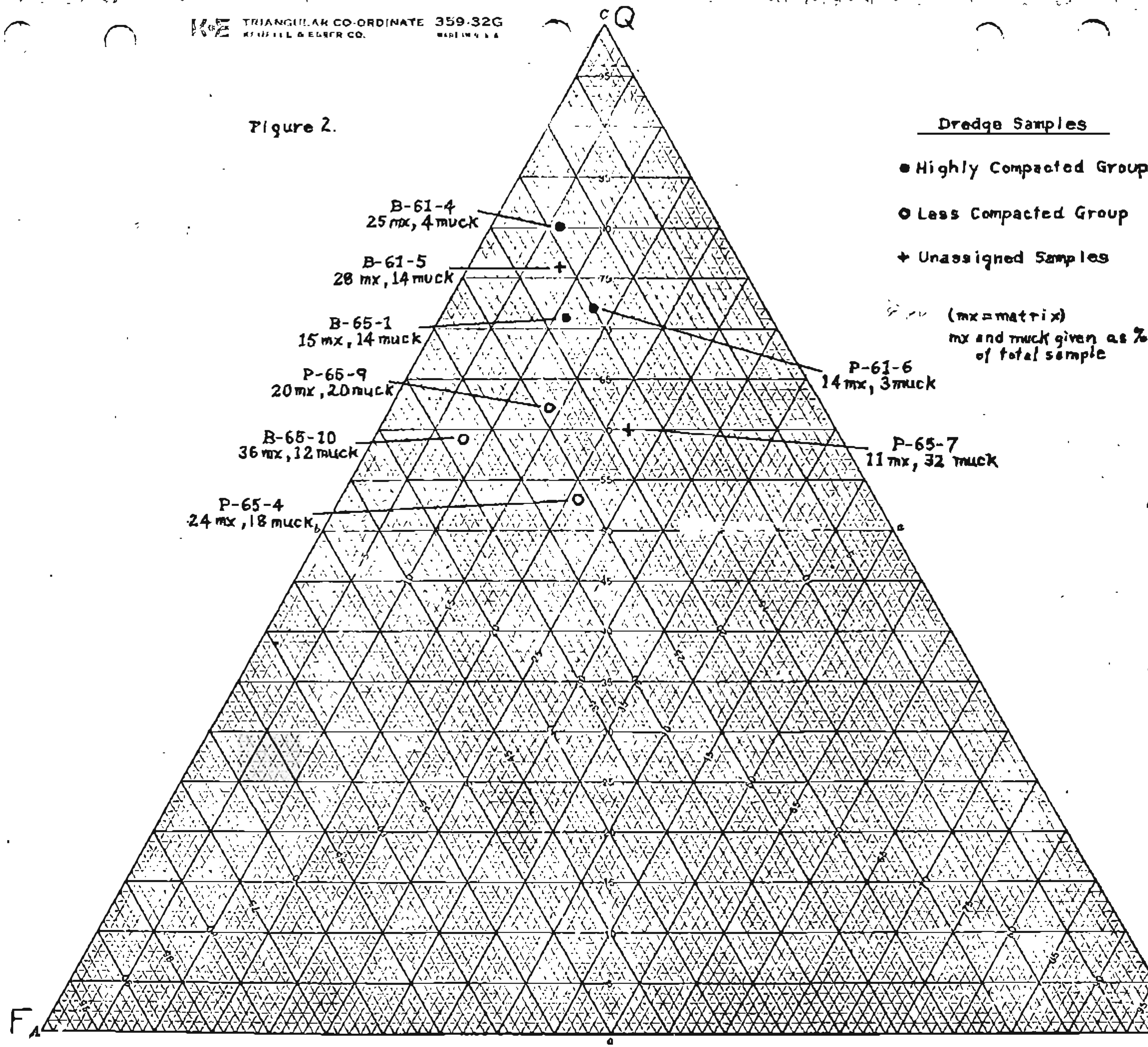


Figure 2.



K&E TRIANGULAR CO-ORDINATE 359-32G
KEUFFEL & ESSER CO.
Q
F
L
Dredge Samples
● Highly Compacted Group
○ Less Compacted Group
+ Unassigned Samples
(mx = matrix)
mx and muck given as % of total sample
B-61-4
25 mx, 4 muck
B-61-5
28 mx, 14 muck
B-65-1
15 mx, 14 muck
P-65-9
20 mx, 20 muck
B-65-10
36 mx, 12 muck
P-65-4
24 mx, 18 muck
P-61-6
14 mx, 3 muck
P-65-7
11 mx, 32 muck