Intragranular	1	0.33

Plucked Grains: 3

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: Iss2061-N15

Class Interval (phi)	No. Freq of Max Apparent Grain Dimen-sion	Percentage Frequency	Cumulative Percentage Frequency
2.0 to 1.5	7	3.5	3.5
2.5 to 2.0	37	18.5	22.0
3.0 to 2.5	73	36.5	58.5
3.5 to 3.0	50	25.0	83.5
4.0 to 3.5	21	10.5	94.0
4.5 to 4.0	6	3.0	97.0
5.0 to 4.5	4	2.0	99.0
5.5 to 5.0	1	0.5	99.5
6.0 to 5.5	0	0.0	99.5
6.5 to 6.0	0	0.0	99.5
7.0 to 6.5	1	0.5	100.0

GRAPHIC GRAIN SIZE CUMULATIVE PERCENTILES IN PHI (MICROMETRE) UNITS OF SELECTED DETRITAL COMPONENTS

Sample I.D.: Iss2061-N15

Percentiles	Phi Values	Micrometres
1	-	-
5	2.08	237
16	2.39	191
25	2.55	171

50	2.89	135 (fine sand size)
75	3.32	100
84	3.54	86
95	4.13	57

$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 0.58$$

Verbal Sorting Scale= moderately sorted

Total Number of Grains Measured= 200

Note: Modal analysis indicated more monocrystalline quartz (35 rather than 25%) and less phylloid clasts (8.3 rather than 15%) than was estimated qualitatively. All porosity estimates, however are in close agreement.

SEMI-QUANTITATIVE ENERGY DISPERSIVE X-RAY ANALYSIS OF A CARBON COATED ARTIFICIAL SAMPLE FRACTURE SURFACE USING THE GEOL 820 SEM/TRACOR NORTHERN INSTRUMENT AT CANMET, EMR.

Matrix(?) particle, specimen Iss2061-N15 (Issungnak 2-O-61/3199.5 m) 18KV Time=50 secs 40 degs.

EL	NORM.	K-RATIO
NA-K	0.00147	+- 0.00012
MG-K	0.03029	+- 0.00046
AL-K	0.24062	+-0.00123
SI-K	0.43696	+-0.00159
K -K	0.01561	+-0.00035
CA-K	0.00000	+-0.00000
TI-K	0.00971	+-0.00033
FE-K	0.21700	+-0.00214
O -K	0.04831	+-0.00845

ZAF CORRECTION 18.00KV 40 DEGS

No. of Iterations 5

----	K	[Z]	[A]	[F]	[ZAF]	ATOM%	WT.%	
NA-K	0.001	1.006	2.038	0.990	2.032	0.25	0.20	*
MG-K	0.030	0.969	1.573	0.982	1.497	3.65	3.10	*
AL-K	0.240	1.012	1.381	0.980	1.371	23.58	22.57	
SI-K	0.436	0.980	1.580	0.999	1.549	46.61	46.26	*
K-K	0.015	1.027	1.183	0.995	1.210	0.93	1.29	
CA-K	0.000	0.997	1.133	0.991	1.120	0.00	0.00	G
TI-K	0.009	1.104	1.059	0.982	1.149	0.45	0.76	
FE-K	0.217	1.110	1.010	1.000	1.122	8.39	16.65	
O-K	0.048	0.941	2.945	0.999	2.771	16.14	9.16	*

* - High absorbance

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Iss2061-N16
WELL NAME/DEPTH: Esso Gulf et al. Issungnak
2-O-61-70-10-134-00/3202.20 m.

INDURATION: moderate either dry or wet.
COLOUR: light brown with dark grey carbonaceous films.
SEDIMENTARY STRUCTURES: planar and possibly low-angle cross lamination is defined by carbonaceous films and by variations in grain size.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 80

%gravel size: 0

%sand size: 40

%silt size: 26

%clay size: 15

Cement %: 3% kaolinite, 1% quartz overgrowths, 3% framboidal pyrite.

Porosity %: 14 (a porosity of 24.3% and a permeability of 190 millidarcies was obtained for core plug 206, taken near the sample).

Modal Size: 0.050 mm.

Sorting: 16%/84% diameter ratio=
100 micrometres/ 5? micrometres = 20

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: The following composition is for the sandy laminae. 20% monocrystalline quartz, 2% polycrystalline quartz, 3% chert, 25% phylloid clasts, 3% muscovite flakes, 3% coal clasts (with a high disseminated pyrite content), trace glauconite(?), tr translucent high-birefringence grains. The remainder is unidentified silt and clay-size material.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): kaolinite- and quartz-cemented interlaminated variously sandy mudstone (transitional to sandstone).

PETROGENESIS/ADDITIONAL INFORMATION: Secondary porosity, though well-developed in the sandier laminae is only poorly developed in the clay and silt-rich laminae. While elongate and oversized pores comprise most of this secondary porosity, moldic and

intragranular porosity is also important. The porosity in sandy laminae in which secondary porosity is important may range as high as 25% while muddy laminae appear to have a much lower porosity. The sand-sized grains in these muddy laminae appear to be corroded and it is possible that the process of secondary porosity operated in the finer grained material but that the proportion of competent grains was insufficient to prevent compaction. Trace amounts of sparry carbonate were observed replacing grain boundaries but most of the carbonate was removed by decementation as evidenced by the rhomb-shaped dissolution molds. Another common diagenetic process was the alteration of muscovite (as flakes and in quartz-muscovite schist) to chlorite. The amount of chlorite in phylloid clasts is high, but it is uncertain how much is diagenetic and how much is detrital phyllite or chlorite schist. Finally, the precipitation of kaolinite and framboidal pyrite were among the last in the diagenetic sequence of events because they line secondary pores. It should be noted that the small grain size makes petrographic analysis difficult. It could be that pseudomatrix as squeezed ductile grains is more important volumetrically than detrital clay content.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Iss2061-N17
WELL NAME/DEPTH: Esso Gulf et al. Issungnak 2-O-61-70-10-134-00/3312.41 m.

INDURATION: moderate either dry or immersed in water.
COLOUR: medium grey with dark grey grains.
SEDIMENTARY STRUCTURES: massive.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 64

%gravel size: 0

%sand size: 58

%silt size: 3

%clay size: 3?

Cement %: 5% kaolinite, 1% quartz overgrowths.

Porosity %: 30 (a porosity of 12.2% and a permeability of 0.28 millidarcies was measured for core plug b9 taken near the sample. This porosity is much too low and the lithology of the core plug must be different from that of the sample).

Modal Size: 0.15 mm.

Sorting: 16%/84% diameter ratio=
300 micrometres/ 90 micrometres = 3.3

Verbal Sorting Scale: moderately sorted.

GRAIN SIZE NAME: fine sandstone.

COMPOSITION: 25% ~~poly~~ mono crystalline quartz, 5% polycrystalline quartz, 15% chert, 3% muscovite flakes (partly altered to chlorite and carbonate), 15% phylloid and siltstone clasts, trace unaltered volcanic rock fragments, trace microcline, trace coal grains, trace glauconite(?) pellets.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): Kaolinite- and quartz-cemented fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: Visual estimation suggests about 5% moldic porosity, 5% intragranular porosity and 20% intergranular porosity. The moldic porosity is well defined by remnant clay rims, which outline original grain boundaries. The intragranular porosity occurs mainly in phylloid clasts and clear chert, where rhomb-shaped molds are common. Honeycombed alkali feldspar grains also are present but are volumetrically

insignificant. Of the 20% intergranular porosity at least 10% is of secondary origin as elongate and oversized pores. The large rhomb-shaped molds along grain margins testify to the former presence of carbonate cement. The quartz overgrowths and kaolinite line secondary pores, suggesting a relatively late origin, at least for some of the cement. Compaction after carbonate decementation was of minor importance because the oversized pores are preserved and only a few ductile grains have been compactionally forced into the rhomb-shaped dissolution molds of adjacent competent grains.

Staining of the epoxy with the fluorescent lime green concentrate was inefffective on the discoloured (overheated) pink epoxy. However, the polish is good and the amount of surface relief is minor.

THIN SECTION MODAL AND GRAIN SIZE ANALYSIS

Sample I.D.: Iss2061-N17

	No of Points	Percentage of Components	Percentages of Detrital Components
Detrital Components			
Monocrystalline Quartz	89	29.67	33.97
Polycrystalline Quartz	41	13.67	15.64
Clear Chert	67	22.33	25.57
Black Chert	16	5.33	6.11
Alkali Feldspar	12	4.00	4.58
Plagioclase	2	0.67	0.76
Phylloid Clasts	24	8.00	9.16
Volcanic Clasts	0	0.00	0.00
Chlorite	0	0.00	0.00
Mica	2	0.67	0.76
Siltstone Clasts	3	1.00	1.15
Coal	1	0.33	0.38
Unidentified (too small)	2	0.67	0.76
Other Clasts	2	0.67	0.76
Cements			
Kaolinite	0	0.00	
Carbonate	0	0.00	
Other	1	0.33	
Porosity			
Intergranular/ Moldic	37	12.33	

Intragranular	1	0.33

Plucked Grains=1

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: Iss2061-N17

Class Interval (phi)	No. Freq of Max Apparent Grain Dimension	Percentage Frequency	Cumulative Percentage Frequency
1.5 to 1.0	5	2.5	2.5
2.0 to 1.5	35	17.5	20.0
2.5 to 2.0	98	49.0	69.0
3.0 to 2.5	39	19.5	88.5
3.5 to 3.0	12	6.0	94.5
4.0 to 3.5	6	3.0	97.5
4.5 to 4.0	3	1.5	99.0
5.0 to 4.5	0	0.0	99.0
5.5 to 5.0	0	0.0	99.0
6.0 to 5.5	1	0.5	99.5
6.5 to 6.0	0	0.0	99.5
7.0 to 6.5	1	0.5	100.0

GRAPHIC GRAIN SIZE CUMULATIVE PERCENTILES IN PHI (MICROMETRE) UNITS OF SELECTED DETRITAL COMPONENTS

Sample I.D.: Iss2061-N17

Percentiles	Phi Values	Micrometres
1	-	-
5	1.63	323
16	1.93	262

25	2.07	238	
50	2.32	200	(fine sand-size)
75	2.62	163	
84	2.83	141	
95	3.57	84	

$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 0.45$$

Verbal Sorting Scale= well sorted

Total Number of Grains Measured=200

Note: Better sorting (well rather than moderate) was determined by thin section grain size analysis than by qualitative estimation. Compared with modal analysis, mono- and polycrystalline quartz grain proportions were underestimated qualitatively and the proportion of phylloid clasts was overestimated. The porosity estimate by modal analysis (12.67%) compares well with the porosimeter value (12.2%) but is well below the qualitative estimate (30%). On the other hand, Kaolinite cement, which is easily observed from a sample fracture surface, was not detected by thin section modal analysis.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: KadO07-1
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1489.1 m

INDURATION: very poor, either when dry or immersed in water (but does not disaggregate by itself).
COLOUR: light brown.
SEDIMENTARY STRUCTURES: planar lamination/parting is defined by coaly films.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 66

%gravel size: 0

%sand size: 41

%silt size: 15

%clay size: 10

Cement %: 2% kaolinite, 1% sparry carbonate, 1% quartz overgrowths, trace pyrite framboids.

Porosity %: 30 (a porosity of 27.9% and a permeability of 163 millidarcies was measured for core plug 4, taken near the sample).

Modal Size: 0.09 mm.

Sorting: 16%/84% diameter ratio=
150 micrometres/ 30 micrometres = 5

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy fine sandstone.

COMPOSITION: 25% monocrystalline quartz grains, 3% polycrystalline quartz grains, 10% chert clasts, 20% phylloid and siltstone clasts, 1% muscovite flakes (partly altered to carbonate, chlorite and clays), 2% alkali feldspar grains, 5% coaly films and grains, 1% clasts of translucent brown microcrystalline carbonate (siderite?), trace unaltered glauconite pellets, trace plagioclase grains (partly altered to clays). Unidentified clay- and silt-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): kaolinite/carbonate/quartz-cemented glauconite/coal-bearing muddy fine-grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of unaltered

glauconite pellets (assumed to be in place) indicates a marine origin, in spite of the coal content. The porosity distribution is approximately as follows; 3% is grain moldic, 2% (at least) is intragranular, and 25% is intergranular. Secondary porosity accounts for at least half of the total porosity, especially as oversized and elongate intergranular pores. Intragranular porosity includes leached phylloid clasts and honeycombed alkali feldspar grains. The permeability is quite high (163 millidarcies), in spite of the poor sorting because pore throats were enlarged during secondary porosity development. If one ignores secondary porosity, mechanical compaction and to a lesser extent pressure solution were important porosity reducing processes, as evidenced by squeezed ductile grains and the high proportion of planar sutured contacts between quartzose grains. Textural relations, which include elongate pores developed around squeezed grains suggests that the secondary porosity was formed after burial of several hundred metres. Relict sparry carbonate cement and rhomb-shaped partial molds at grain margins suggest the former presence of carbonate cement. It follows that the carbonate cement was not introduced until after burial of several hundred metres. The secondary porosity is well preserved, suggesting that most of the mechanical and chemical compaction took place prior to its development. The pyrite framboids were formed relatively late diagenetically because they occur in secondary pores, including the intragranular pores between the lamellae of deformed muscovite flakes.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-2
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1490.5 m.

INDURATION: moderate when dry, a small chip disaggregates by itself in about 5 minutes.
COLOUR: light brown.
SEDIMENTARY STRUCTURES: vague planar lamination.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 75

%gravel size: 0

%sand size: 40

%silt size: 20

%clay size: 15

Cement %: 1% sparry carbonate, trace pyrite framboids.

Porosity %: 25 (a porosity of 22.5% and a permeability of 11.4 millidarcies was measured for core plug 5, taken near the sample).
Modal Size: 0.07 mm.

Sorting: 16%/84% diameter ratio=
150 micrometres/ 3? micrometres = 50

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone.

COMPOSITION: 25% monocrystalline quartz grains, 3% polycrystalline quartz grains, 3% chert clasts, 1% alkali feldspar grains, 20% phylloid and siltstone clasts, 2% muscovite flakes (in part altered to chlorite, carbonate and clays), 1% chlorite flakes, 5% coal clasts, trace unaltered glauconite pellets. Unidentified clay- and silt-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): carbonate/pyrite-cemented coaly and glauconite-bearing muddy very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of unaltered glauconite pellets indicates a marine origin, assuming that the pellets are in situ. Mechanical compaction was the most important diagenetic pocess, resulting in considerable reduction in porosity and permeability. Ductile phylloid grains, which are common, were squeezed between more competent grains, resulting in

a marked increase in pseudomatrix content. Pressure solution and quartz cementation, on the other hand, were comparatively unimportant processes. The reduction in porosity was in part compensated for by the development of secondary porosity in some of the laminae, mainly as elongate and oversized pores. The relict sparry carbonate cement, which partly replaces grain extremities lends support to the process of dissolution of carbonate-replaced material as the means of secondary porosity formation. Many of the secondary pores are lined with framboidal pyrite, indicating a relatively late diagenetic origin for this mineral. The porosity distribution is approximately as follows; 1% is moldic, 2% (at least) is intragranular, and 22% is intergranular. The small particle size makes estimation difficult, but at least a third of the total porosity is of secondary origin, especially as elongate and oversized pores.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: KadO07-4
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1495.75 m

INDURATION: poor when dry, a small chip immersed in water disaggregates by itself in 30 minutes.
COLOUR: light brown.
SEDIMENTARY STRUCTURES: vague planar lamination/parting, moderately bioturbated, minor subvertical fractures.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 73

%gravel size: 0

%sand size: 38

%silt size: 20

%clay size: 15

Cement %: 1% kaolinite(?), trace pyrite framboids, 1% sparry carbonate.

Porosity %: 25 (a porosity of 21.2% and a permeability of 9.99 millidarcies was measured for core plug 7, taken near the sample).

Modal Size: 0.09 mm.

Sorting: 16%/84% diameter ratio=
200 micrometres/ 5? micrometres = 40

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone.

COMPOSITION: 15% monocrystalline quartz grains, 3% polycrystalline quartz grains, 5% chert clasts, 5% alkali feldspar grains, 10% muscovite flakes (in part altered to chlorite and clays), 20% phylloid and siltstone clasts, 5% coal grains and flakes, 1% chlorite (in part altered to clays), 2% clasts of microcrystalline carbonate, trace grains of microcline (partly altered to clays), trace unaltered glauconite pellets, trace volcanic rock fragments. Unidentified silt- and clay- sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): carbonate-cemented coaly glauconite-bearing muddy very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of glauconite

pellets, some of which are compactionally deformed suggests a marine origin, assuming they are in situ. Moderate bioturbation is suggested by mottling (subvertical mud-rich and mud-poor zones) and coal flakes that dip at all angles. The porosity distribution is approximately as follows; 1% is along subvertical fractures, 2% is moldic, 2% (at least) is intragranular and 20% is intergranular. Grains with secondary intragranular porosity include chert, phylloid/siltstone, chlorite (flakes), and alkali feldspar. The total intragranular porosity may be as high as 5% if one assumes that the 20% phylloid clasts have a porosity of 15%. Secondary porosity, mainly as elongate and oversized pores is especially well-developed in the mud-poor bioturbated areas. In the muddy parts unaffected by bioturbation, mechanical compaction has almost eliminated intergranular porosity, because the ductile grains are squeezed between more competent grains. This may also explain the low measured permeability of about 10 millidarcies. Secondary porosity accounts for at least half of the total porosity and is believed to have formed by the dissolution of once much more common carbonate as cement and grain replacement. The evidence includes abundant rhomb-shaped molds along grain margins that are associated with elongate and oversized pores. Most of the mechanical compaction occurred prior to secondary porosity development, as shown for example, by grain molds the boundaries of which are deformed ductile grains.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-6
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1509.80 m.

INDURATION: very poor, either when wet or dry.
COLOUR: medium brown.
SEDIMENTARY STRUCTURES: very vague planar lamination/parting is defined by slight vertical variations in grain size and concentration of coal grains.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 73

%gravel size: 0

%sand size: 48

%silt size: 20

%clay size: 5?

Cement %: 2% pore-lining kaolinite, trace quartz overgrowths, trace framboidal pyrite.

Porosity %: 25 (a porosity of 23.9% and a permeability of 28.3 millidarcies was measured for core plug 14, taken near the sample).

Modal Size: 0.10 mm.

Sorting: 16%/84% diameter ratio=
200 micrometres/ 30 micrometres = 6.6

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: silty very fine sandstone.

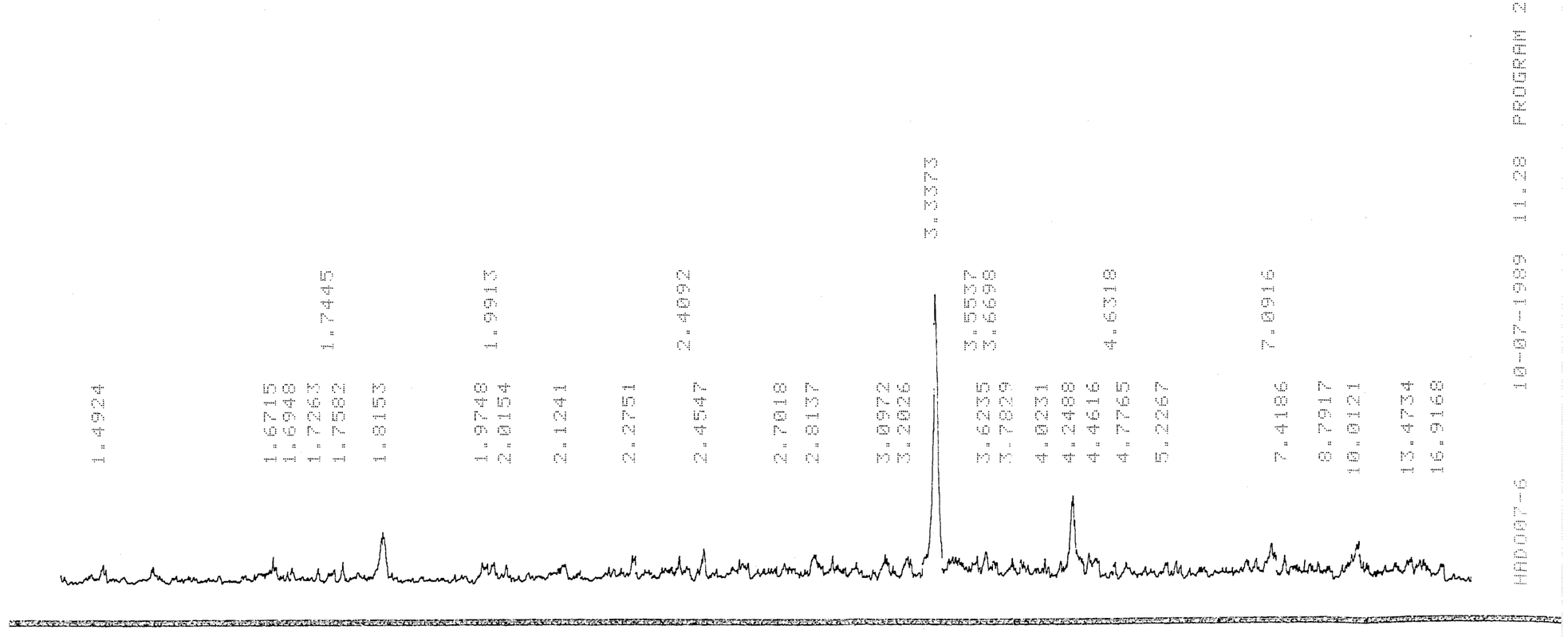
COMPOSITION: 20% monocrystalline quartz grains, 3% polycrystalline quartz grains, 10% chert clasts, 2% alkali feldspar grains, 25% phylloid and siltstone clasts (a large proportion of which have been deformed between more competetnt grains), 1% muscovite flakes (partly altered to carbonate, chlorite and clays), 1% chlorite flakes, 3% coal grains, 1% clasts of microcrystalline carbonate (especially concentrated in the coalier laminae), trace grains of volcanic rock fragments, trace sparry carbonate grains, trace plagioclase grains (partly altered to clays), trace altered(?) glauconite pellets, trace microcline. Unidentified mud-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): kaolinite-cemented coal/glauconite-bearing silty very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of glauconite pellets suggests a marine origin, in spite of the coal content. There are good examples of subvertical fractures and one case of a normal fault with an apparent vertical displacement of 1 mm. A mud-rich zone about 0.25 mm thick occurs along this fault. The porosity distribution is approximately as follows; 3% is moldic, 2% is secondary intragranular and 20% is intergranular. The secondary intragranular porosity occurs in phylloid clasts, polycrystalline quartz grains, chert clasts and alkali feldspar grains. Assuming that the phylloid clasts (which comprise about a quarter of the grains by volume) have a 15% porosity, the total intragranular porosity would be as high as 6%. At least half of the total porosity is secondary, and is most obvious as enhanced intergranular porosity, mainly as oversized and elongate pores. The low clay content may be a result of removal during secondary porosity formation. The evidence of squeezed ductile grains and preserved secondary porosity suggests that most of the mechanical compaction occurred before secondary porosity was formed. Some of the secondary pores (including intragranular secondary pores) are lined or filled with pyrite, which suggests a relatively late diagenetic origin for this mineral.

The surface of the section was impregnated with cyanoacrylate prior to final lapping because of excessive grain plucking.

X-RAY DIFFRACTION ANALYSIS
SAMPLE IDENTIFICATION: KAD007-6
WELL NAME: ESSO HOME ET AL. KADLUK O-07-69-50-136-00
SAMPLE DEPTH: 1509.80 METRES
NOTE: CHLORITE, MUSCOVITE AND/OR ILLITE, FELDSPAR(?) AND QUARTZ ARE PRESENT



HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-7
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1517.15 m

INDURATION: all material was used to make the thin section.
COLOUR: interlaminate light and dark brown.
SEDIMENTARY STRUCTURES: well-defined planar laminae are defined by concentrations of subhorizontal coal flakes. Other structures include rare cross-lamination, minor bioturbation or soft sediment deformation and minor subvertical fractures.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 84

%gravel size: 0

%sand size: 34

%silt size: 35

%clay size: 15?

Cement %: 1% sparry dolomite, trace pyrite framboids.

Porosity %: 15

Modal Size: 0.05 mm.

Sorting: 16%/84% diameter ratio=
180 micrometres/ 5? micrometres = 36

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy siltstone.

COMPOSITION: Note: there are differences in grain size and composition between laminae but these are ignored in this general description). 25% monocrystalline quartz grains, 2% polycrystalline quartz grains, 3% chert grains, 1% alkali feldspar grains, 15% phylloid and siltstone clasts, 5% muscovite flakes, 1% clasts of brown microcrystalline carbonate (especially common in the coaly laminae), 1% chlorite flakes, 10% coal, mainly as flakes and to a lesser extent grains), 1%(?) disseminated submicroscopic organic matter in the coaly laminae, trace unaltered glauconite pellets, trace microcline. Unidentified mud-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): sparry dolomite-cemented coaly glauconite-bearing sandy (litharenitic) siltstone.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of glauconite

pellets (assumed to be in situ) suggests that in spite of the coal flake content, the sample is of marine origin. Minor cross-lamination as well as grain size and compositional differences between laminae suggests fluctuating depositional conditions. Laminae rich in coal and mud-sized material alternate with mud-poor laminae characterised by well-developed secondary porosity. Mechanical compaction was the most important diagenetic process, resulting in the deformation of ductile phylloid, siltstone, muscovite, coal and microcrystalline dolostone grains between more competent grains. The porosity distribution of the sample as a whole is approximately as follows; 1% is grain moldic, 1% (at least) is secondary intragranular and 13% is intergranular. However, assuming that the phylloid clasts themselves have an average invisible intragranular porosity of 15%, then the total intragranular porosity may be as high as 3%. At least a third of the total porosity is of secondary origin, especially as elongate and oversized intergranular pores in the mud/coal-poor sandier laminae.

Grain plucking was a problem because of the relatively high content of mud-sized material. Although clear cyanoacrylate was used to re-impregnate the surface of the thin section prior to final lapping, the thin section developed excessive surface relief between quartzose and clay-rich grains. In addition, a small amount of aluminum oxide polishing powder remains in the depressions.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-8
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1518.15 m.

INDURATION: poor when dry, a small chip disaggregates by itself within 2 minutes after immersion in water.
COLOUR: medium grey
SEDIMENTARY STRUCTURES: planar lamination/parting, minor bioturbation. Subvertical fractures.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 85

%gravel size: 0

%sand size: 8 (variable vertically)

%silt size: 45

%clay size: 32

Cement %: trace pyrite framboids.

Porosity %: 15

Modal Size: 0.015 mm.

Sorting: 16%/84% diameter ratio=
60 micrometres/ 3? micrometres = 20

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: mudstone with minor sandstone laminae.

COMPOSITION: (of the mudstone): 20% monocrystalline quartz grains, 10% muscovite, 15% phylloid and siltstone clasts, 4% coal grains and 1% coal flakes, 1% clasts of microcrystalline carbonate, trace chlorite flakes. Unidentified silt- and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): coal-bearing litharenitic mudstone with minor sandstone laminae.

PETROGENESIS/ADDITIONAL INFORMATION: Subvertical fractures terminate in many cases at bedding plane fractures. The fracturing occurred before secondary porosity development because the secondary porosity is highest near the fractures. This texture also shows that the fractures are not an artifact of drying of the core during storage. One of the subvertical fractures in sandstone was observed to pass through a mica flake some of the lamellae of which were dissolved during secondary

porosity development. The lamellae are thinner at and adjacent to where the subvertical fracture transects the subhorizontal mica flake. Although secondary porosity is well developed in the small amount of sandstone, it was not observed in the mudstone, although this would be difficult to see in any event because of the small particle size.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-13
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1754.30 m.
INDURATION: very poor, either when dry or immersed in water.
COLOUR: light brown with dark grey grains.
SEDIMENTARY STRUCTURES: massive.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 66

%gravel size: 0

%sand size: 61

%silt size: 3

%clay size: 2?

Cement %: 1% pore-lining kaolinite, 3% dolomite (in part replaces grains), trace quartz overgrowths, trace pyrite framboids.

Porosity %: 35 (a porosity of 30.7% and a permeability of 2390 millidarcies was measured for core plug C25, taken near the sample).

Modal Size: 0.23 mm.

Sorting: 16%/84% diameter ratio=
300 micrometres/ 160 micrometres = 1.87

Verbal Sorting Scale: well sorted.

GRAIN SIZE NAME: fine sandstone.

COMPOSITION: 20% monocrystalline quartz grains, 3% polycrystalline quartz grains, 20% chert clasts (a high proportion of which contain pyrite and/or magnetite), 3% alkali feldspar, trace muscovite flakes, trace volcanic rock fragments, 10% phylloid and siltstone clasts, trace chlorite, trace amber, 1% plagioclase (in part altered to clays), trace microcline, trace coal clasts. Unidentified sand, silt and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): dolospar-cemented fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 5% is moldic, 2% is intragranular and 28% is intergranular. The intragranular porosity occurs mainly as leached chert and phylloid clasts. Pores and pore throats are enlarged, suggesting high permeability. This is supported by a measured permeability of 2390 millidarcies, obtained from a core

plug taken near the sample. Compaction is evidenced by squeezed ductile grains though contacts between quartzose grains suggests insignificant pressure solution. The relict dolospar cement, dolospar molds in chert grains, as well as relict partial rhomb-shaped molds at grain grain margins suggests that secondary porosity was formed by the dissolution of carbonate-replaced material, mainly of grain margins. Remnant dolospar also replaces entire grains, which lends credibility to the high (5%) moldic porosity estimate. At least half of the porosity is of secondary origin. It may well be that much of the original matrix (assuming it was once present) was replaced by carbonate that was subsequently dissolved.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: KadO07-15
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1760.40 m
INDURATION: poor when dry, a small chip disaggregates by itself within a minute after immersion in water.
COLOUR: light brownish grey with dark grey grains.
SEDIMENTARY STRUCTURES: massive.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 66

%gravel size: 0

%sand size: 47

%silt size: 15

%clay size: 4?

Cement %: 2% pore-lining kaolinite, 1% quartz overgrowths, trace pyrite framboids, 1% carbonate.

Porosity %: 30 (a porosity of 27.0% and a permeability of 196 millidarcies was measured for core plug 28, taken near the sample).

Modal Size: 0.12 mm.

Sorting: 16%/84% diameter ratio=
250 micrometres/ 50 micrometres = 5.0

Verbal Sorting Scale: poorly sorted

GRAIN SIZE NAME: silty very fine sandstone.

COMPOSITION: 10% monocrystalline quartz grains, 2% polycrystalline quartz grains, 10% chert clasts, 3% alkali feldspar grains, 20% phylloid (mainly mudstone and shale) clasts, 1% muscovite flakes (altered in part to chlorite or carbonate), 1% chlorite flakes, trace coal grains, trace clasts of microcrystalline carbonate, trace apatite(?), one unaltered glauconite pellet.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): Kaolinite/quartz/carbonate-cemented glauconite-bearing silty very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: Rare unaltered glauconite pellets suggest a marine origin, assuming they are in situ. The porosity distribution is approximately as follows; 5% (at least) is moldic, 3% (at least) is secondary intragranular and 22% is intergranular. The secondary intragranular porosity occurs manly

in phylloid, chert, polycrystalline quartz, muscovite and alkali feldspar grains. Leaching has occurred along the fractures of compactionally-fractured grains, suggesting that at least some of the leaching occurred after considerable burial. Intergranular porosity is enhanced with a high proportion of elongate pores, some even between squeezed ductile grains and adjacent competent grains. At least half of the total porosity is of secondary origin, which may explain the surprisingly high permeability, given the small grain size and poor sorting. Mechanical compaction resulted in squeezing of a high proportion of ductile phylloid clasts but the fracturing of only a few grains. Pressure solution was of relatively minor importance.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-18
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/1765.70 m.

INDURATION: poor when dry, a small chip disaggregates by tself in 2 minutes after immersion in water.
COLOUR: light brown muddy sandstone interlaminated with minor medium grey mudstone.
SEDIMENTARY STRUCTURES: planar lamination is defined by concentrations of coaly films and grains in medium grey laminae and by minor mudstone interlaminated with sandy mudstone.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent % (of the muddy sandstone): 73

%gravel size: 0

%sand size: 40

%silt size: 18

%clay size: 15

Cement %: 2% dolospar, trace pyrite framboids, trace kaolinite.

Porosity %: 25 (a porosity of 18.5% and a permeability of 56.8 millidarcies was measured for core plug 41, taken near the sample).

Modal Size: 0.08 mm.

Sorting: 16%/84% diameter ratio=
130 micrometres/ 5? micrometres = 26

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone interlaminated with minor (10%) coaly mudstone. Note that a fracture surface examined in incident light gives the impression that the sample is a sandy mudstone, because of the high proportion of pseudomatrix. Thin section study, however, reveals a high proportion of squeezed phylloid grains and shows that the rock is in fact a muddy sandstone.

COMPOSITION: 25% monocrystalline quartz grains, 2% polycrystalline quartz grains, 10% chert clasts, 1% muscovite flakes (in part altered to chlorite), 20% phylloid clasts, 1% alkali feldspar grains, 2% coal films and minor coal grains, 1% brown microcrystalline carbonate clasts (siderite), trace unaltered (but squeezed) glauconite, trace amber grains, trace chlorite flakes, trace plagioclase grains, trace microcline grains, trace high relief/high birefringent minerals.

Unidentified silt- and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): dolospar-cemented coaly glauconite-bearing muddy very fine grained litharenite with minor mudstone (10%) laminae.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of unaltered glauconite pellets suggests a marine origin, in spite of the coal content. The porosity distribution is approximately as follows; 2% (at least) is grain moldic, 4% (at least) is intragranular and 19% is intergranular. The intragranular porosity occurs mainly n the chert and phylloid clasts where rhomb-shaped molds indicate the dissolution of former carbonate. Honeycombed alkali feldspar grains are rare. Mechanical compaction was the most important porosity and permeability reducing mechanism, as shown by the squeezing of abundant ductile grains between the more competent grains. Pressure solution was relatively insignificant as a porosity reducing process. The reduction in porosity due to mechanical compaction, however, has been more than compensated for by the development of secondary porosity, which accounts for at least half of the total porosity. Oversized and elongate pores accompanied by enlarged pore throats are common and explain the permeability of about 57 millidarcies. Remnant dolomite cement and the common rhomb-shaped partial molds at grain boundaries suggests that most of the secondary porosity was formed by the dissolution of carbonate both as cement and as grain replacement. The pyrite framboids occupy the elongate and oversized intergranular pores and are therefore relatively late diagenetic. Grain plucking was a problem especially in the mudstone laminae. The surface of the thin section was impregnated with clear cyanoacrylate prior to final thinning which minimized the problem during polishing.

HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-23
WELL NAME/DEPTH: Esso Home et al. Kadluk
O-07-69-50-136-00/2398.75 m

INDURATION: moderate when dry, disaggregates by itself 24 hours after immersion in water.
COLOUR: light brown.
SEDIMENTARY STRUCTURES: planar lamination is defined by coaly films.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 71

%gravel size: 0

%sand size: 38

%silt size: 20

%clay size: 13?

Cement %: 2% spar-sized dolomite cement (including partial grain replacements), 2%(?) pore-lining kaolinite, 1% quartz overgrowths.

Porosity %: 24 (a porosity of 19.0% and a permeability of 12.2 millidarcies was measured for core plug 48, taken near the sample).

Modal Size: 0.08 mm.

Sorting: 16%/84% diameter ratio=
130 micrometres/ 15 micrometres = 8.6

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone.

COMPOSITION: 25% monocrystalline quartz grains, 2% polycrystalline quartz grains, 10% chert clasts, 15% phylloid and siltstone clasts, 3% alkali feldspar grains, 3% coaly films and 1% coal grains, 1% clasts of microcrystalline carbonate, 1% muscovite flakes (partly altered to chlorite), trace plagioclase grains, trace volcanic rock fragments (with feldspar laths) replaced by carbonate, trace chlorite flakes, trace unaltered and altered glauconite pellets. Unidentified silt and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): dolomite/kaolinite-cemented coal/glauconite-bearing muddy very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The presence of unaltered but presumably in situ glauconite pellets suggests a marine origin, in spite of the coal content. The porosity distribution is approximately as follows; 3% is grain moldic, at least 2% is intragranular (secondary) and 19% is intergranular. The secondary intragranular porosity is best developed in phylloid and chert clasts and to a lesser extent in alkali feldspar grains. Assuming that the phylloid clasts also have a primary porosity of 15%, and since these grains comprise about 15% of the rock, the total intragranular porosity may be as high as 4%. The intergranular porosity is mainly of secondary origin, and occurs as oversized and to a lesser extent elongate pores. The partial rhomb-shaped molds associated with these secondary pores again suggests that the porosity was greatly enhanced by the dissolution of carbonate-replaced material. Both mechanical and chemical compaction (pressure solution) were important porosity-reducing processes. Pressure solution is evidenced by a high proportion of planar sutured quartzose grain contacts. The result of these processes has been a rock with relatively large but commonly isolated pores. The high mud content, poor sorting and very fine grain size in addition to the porosity distribution explains the relatively low permeability (12.2 millidarcies).

THIN SECTION MODAL AND GRAIN SIZE ANALYSIS

Sample I.D.: KadO07-23

	No of Points	Percentage of Components	Percentages of Detrital Components
Detrital Components			
Monocrystalline Quartz	87	29.00	33.72
Polycrystalline Quartz	6	2.00	2.33
Clear Chert	45	15.00	17.44
Black Chert	11	3.67	4.26
Alkali Feldspar	14	4.67	5.43
Plagioclase	0	0.00	0.00
Phylloid Clasts	48	16.00	18.60
Volcanic Clasts	0	0.00	0.00
Chlorite	8	2.67	3.10
Mica	11	3.67	4.26
Siltstone Clasts	4	1.33	1.55
Coal	13	4.33	5.04
Unidentified (too small)	2	0.67	0.78
Other Clasts	9	3.00	3.49
Cements			
Kaolinite	0	0.00	
Carbonate	3	1.00	
Other	9	3.00	
Porosity			
Intergranular/ Moldic	28	9.33	

Intragranular 2 0.67

Plucked Grains=13

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: Kad007-23

Class Interval (phi)	No. Freq of Max Apparent Grain Dimension	Percentage Frequency	Cumulative Percentage Frequency
1.5 to 1.0	3	1.5	1.5
2.0 to 1.5	0	0.0	1.5
2.5 to 2.0	11	5.5	7.0
3.0 to 2.5	30	15.0	22.0
3.5 to 3.0	50	25.0	47.0
4.0 to 3.5	32	16.0	63.0
4.5 to 4.0	22	11.0	74.0
5.0 to 4.5	22	11.0	85.0
5.5 to 5.0	13	6.5	91.5
6.0 to 5.5	6	3.0	94.5
6.5 to 6.0	4	2.0	96.5
7.0 to 6.5	2	1.0	97.5
7.5 to 7.0	1	0.5	98.0
8.0 to 7.5	2	1.0	99.0
8.5 to 8.0	1	0.5	99.5
9.0 to 8.5	1	0.5	100.0

GRAPHIC GRAIN SIZE CUMULATIVE PERCENTILES IN PHI (MICROMETRE) UNITS OF SELECTED DETRITAL COMPONENTS

Sample I.D.: Kad007-23

Percentiles	Phi Values	Micrometres
1	-	-
5	2.38	192
16	2.84	140
25	3.06	120
50	3.59	83 (very fine sand size)
75	4.56	42
84	4.95	32
95	6.11	14

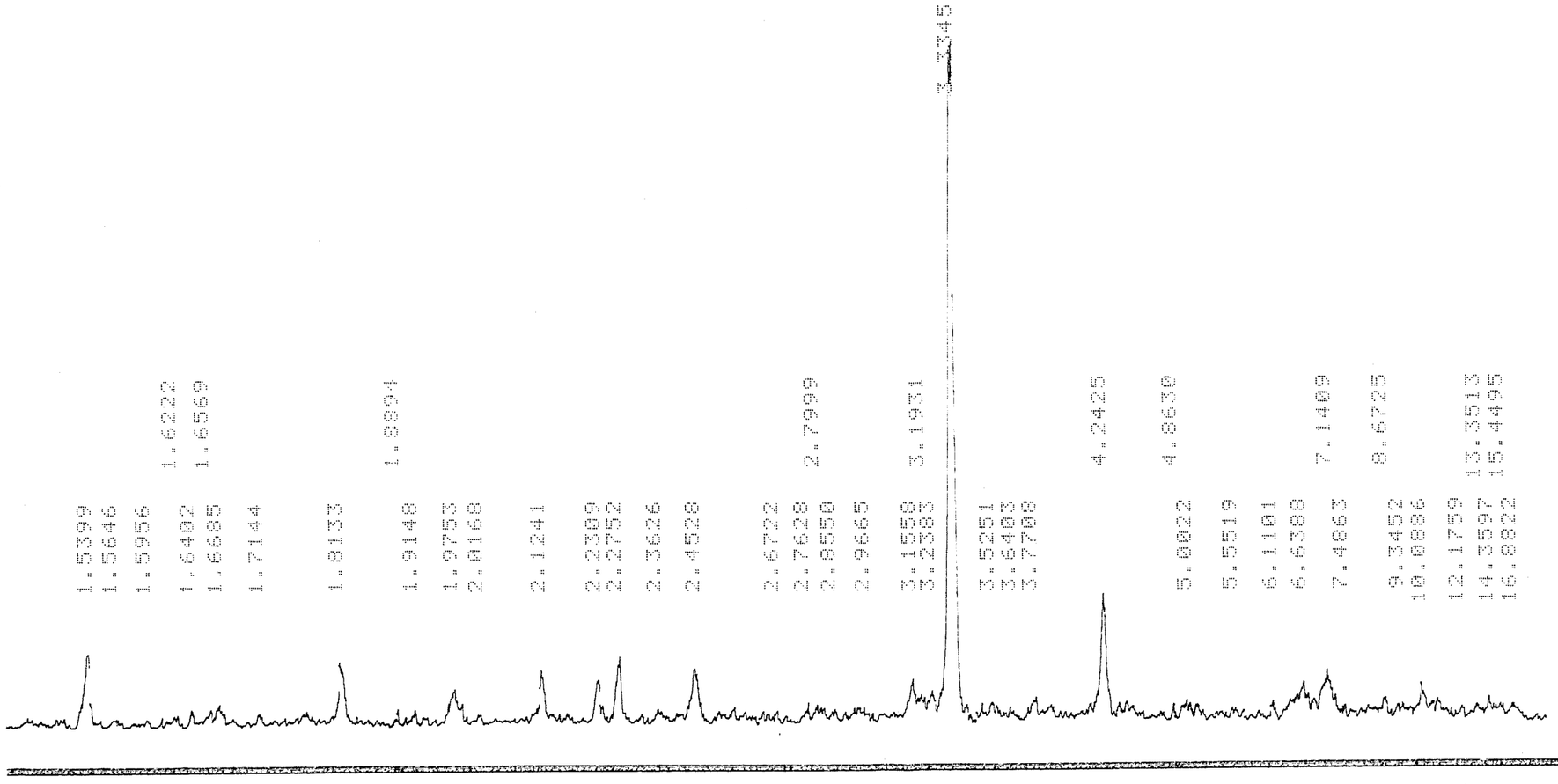
$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 1.06$$

Verbal Sorting Scale= poorly sorted

Total Number of Grains Measured= 200

Note: More silt but much less clay was determined by thin section grain size analysis than by qualitative estimation. The section was of poor quality, however, perhaps because clays were removed during preparation. Otherwise, the grain size estimates are similar. More chert (18.7 compared to 10%) and mica (3.67 rather than 1%) was determined by modal analysis than by visual estimation. The thin section porosity estimate (10%) is much less than that of the qualitative estimate (24%) and the porosimeter value of a nearby sample (19.0%).

X-RAY DIFFRACTION ANALYSIS
SAMPLE IDENTIFICATION: KAD007-23
WELL NAME: ESSO HOME EI AL. KADLUK O-07-69-50-136-00
SAMPLE DEPTH: 2398.75 METRES
NOTE: CHLORITE AND/OR KAOLINITE, MUSCOVITE AND/OR ILLITE, ALKALI FELDSPAR AND QUARTZ ARE PRESENT.



HAND SPECIMEN/THIN SECTION MICROSCOPE DESCRIPTION: MACKENZIE DELTA-BEAUFORT SEA SUBSURFACE CONVENTIONAL DRILL CORE SAMPLES.

SAMPLE IDENTIFICATION: Kad007-25
WELL NAME/DEPTH: Esso Home et al. Kadluk O-07-69-50-136-00/2401.50 m

INDURATION: moderate when dry, a small chip disaggregates by itself in about 5 minutes after immersion in water.
COLOUR: medium grey in incident light, brown in transmitted light.
SEDIMENTARY STRUCTURES: hackly parting.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 84

%gravel size: 0

%sand size: 5

%silt size: 49

%clay size: 30

Cement %: 1% spar-sized carbonate.

Porosity %: 15 (a porosity of 14.9% and a permeability of 1.09 millidarcies was measured for core plug 52, taken near the sample).

Modal Size: 0.02 mm (medium silt-size).

Sorting: 16%/84% diameter ratio=
40 micrometres/ 3? micrometres = 13.3

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: mudstone.

COMPOSITION: 25% monocrystalline quartz grains, trace polycrystalline quartz grains, 2% chert clasts, 15% muscovite flakes (partly altered to chlorite or clays), 10% (at least) phylloid clasts (difficult to estimate because many are pseudomatrix), 2% coal grains, 1% coal films. A minor amount of clay-sized organic matter is also suggested by the brown colour in transmitted light. Unidentified clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): carbonate-cemented quartzose and micaceous coal-bearing mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: Subvertical fractures meet parting along lamination, resulting in the hackly parting. The small particle size precludes detailed textural analysis.

Mechanical compaction, however, is apparent from muscovite flakes deformed between the more competent grains. Many of these muscovite flakes have been altered to chlorite or clays and because these flakes are relatively abundant, these diagenetic changes are significant.

Grain plucking was a problem during thin section preparation. It was minimized by impregnating the surface of the section with clear cyanoacrylate prior to final thinning. Staining was not carried out because of the fine particle size and because of the poor quality of the section.