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

SAMPLE IDENTIFICATION: TarN44A-N1
WELL NAME/DEPTH: Gulf et al. E. Tarsiut
N44A-70-00-136-00/2249.26 m

INDURATION: poor either when wet or immersed in water.
COLOUR: light brown with scattered dark grey grains.
SEDIMENTARY STRUCTURES: planar lamination is defined by carbonaceous films together with a higher clay/silt content.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 65

%gravel size: 0

%sand size: 40

%silt size: 15

%clay size: 10

Cement %: 10% pore-lining kaolinite, 1% carbonate, 1% quartz overgrowths, trace pyrite framboids.

Porosity %: 25 (a porosity of 23.3% and a permeability of 44.1 millidarcies was obtained for core plug 085, taken near the sample).

Modal Size: 0.20 mm.

Sorting: 16%/84% diameter ratio=
300 micrometres/ 50 micrometres = 6

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy fine sandstone.

COMPOSITION: 15% monocrystalline quartz grains, 3% polycrystalline quartz grains, 15% chert grains, 20% phylloid and siltstone clasts, 10% alkali feldspar, 2% clasts of microcrystalline carbonate, 3% coal clasts, 1% carbonaceous films, trace microcline, trace unaltered glauconite pellets, trace muscovite flakes (partly altered to chlorite), trace chlorite.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): kaolinite-cemented carbonaceous and glauconite-bearing muddy fine-grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 5% is moldic, 5% is within grains (especially the chert and phylloid clasts), and 15% is between grains. At least half of this porosity is of secondary origin.

The relatively low permeability is due to a relatively high silt and clay content (especially pore-lining kaolinite cement), poor sorting and high pseudomatrix content, formed by compaction of the very common ductile grains. Rhomb-shaped molds at grain margins and within grains provide clear evidence for the former presence of space-filling and partly grain-replacive carbonate. Honeycombed alkali feldspar grains are also present. The excellent evidence for major compaction after carbonate decementation is provided by grossly deformed ductile grains commonly squeezed into the rhomb-shaped grain boundaries of adjacent competent grains. The kaolinite lines secondary pores between grains and even fills some of the moldic pores, suggesting a relatively late origin. The same reasoning applies to the trace quantities of pyrite framboids.

THIN SECTION MODAL AND GRAIN SIZE ANALYSIS

Sample I.D.: Tarn44a-N1

	No of Points	Percentage of Components	Percentages of Detrital Components
Detrital Components			
Monocrystalline Quartz	73	24.33	30.29
Polycrystalline Quartz	28	9.33	11.62
Clear Chert	39	13.00	16.18
Black Chert	13	4.33	5.39
Alkali Feldspar	10	3.33	4.15
Plagioclase	1	0.33	0.41
Phylloid Clasts	59	19.67	24.48
Volcanic Clasts	0	0.00	0.00
Chlorite	3	1.00	1.24
Mica	3	1.00	1.24
Siltstone Clasts	1	0.33	0.41
Coal	4	1.33	1.66
Unidentified (too small)	2	0.67	0.83
Other Clasts	5	1.67	2.07
Cements			
Kaolinite	1	0.33	
Carbonate	2	0.67	
Other	1	0.33	
Porosity			
Intergranular/ Moldic	49	16.33	

Intragranular	6	2.0

Plucked Grains=8

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: TarN44A-N1

Class Interval (phi)	No. Freq of Max Apparent Grain Dimension	Percentage Frequency	Cumulative Percentage Frequency
1.5 to 1.0	10	5.0	5.0
2.0 to 1.5	47	23.5	28.5
2.5 to 2.0	59	29.5	58.0
3.0 to 2.5	36	18.0	76.0
3.5 to 3.0	23	11.5	87.5
4.0 to 3.5	8	4.0	91.5
4.5 to 4.0	5	2.5	94.0
5.0 to 4.5	4	2.0	96.0
5.5 to 5.0	2	1.0	97.0
6.0 to 5.5	2	1.0	98.0
6.5 to 6.0	2	1.0	99.0
7.0 to 6.5	1	0.5	99.5
7.5 to 7.0	1	0.5	100.0

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

Sample I.D.: TarN44A-N1

Percentiles	Phi Values	Micrometres
1	-	-
5	1.50	354

16	1.81	285
25	1.96	257
50	2.38	192 (fine sand size)
75	2.98	127
84	3.32	100
95	4.74	37

$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 0.76$$

Verbal Sorting Scale= moderately sorted

Total Number of Grains Measured=200

Note: Moderate sorting was determined by thin section grain size analysis whereas a qualitative estimate indicated poor sorting. Different value estimates of the 84th percentile explains the discrepancy. More monocrystalline and polycrystalline quartz grains and fewer alkali feldspar grains were determined by thin section modal analysis than was estimated qualitatively. In addition, more kaolinite cement was observed on a sample fracture surface than in thin section. Further, total porosity by modal analysis (18.33%) is less than the porosimeter value for a nearby sample (23.3%).

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

SAMPLE IDENTIFICATION: TarN44A-N2
WELL NAME/DEPTH: Gulf et al. East Tarsiut N44A-70-00-136-00/2252.36 m

INDURATION: poor either when dry or immersed in water.
COLOUR: medium brown with dark grey grains.
SEDIMENTARY STRUCTURES: vague planar lamination defined by coaly films.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 70

%gravel size: 0

%sand size: 45

%silt size: 15

%clay size: 10?

Cement %: 5% kaolinite, trace quartz overgrowths.

Porosity %: 25 (a porosity of 24.0 and a permeability of 14.8 millidarcies was obtained for core plug 0B13, taken near the sample).

Modal Size: 0.13 mm.

Sorting: 16%/84% diameter ratio=
300 micrometres/ 30 micrometres = 10

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy fine sandstone.

COMPOSITION: 20% monocrystalline quartz grains, 2% polycrystalline quartz grains, 15% phylloid and siltstone clasts, 5% clasts of microcrystalline carbonate, 2% muscovite flakes (in part altered to chlorite), trace grains of sparry carbonate, 1% chlorite flakes, 1% alkali feldspar grains, 15% coaly films (50 micrometres thick and laterally continuous for several centimetres), trace reddish-brown translucent resinous material. The remainder is unidentified clay and silt-sized material.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): Kaolinite-cemented coal-bearing muddy fine-grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 3% is moldic, 5% is within grains and 14% is between grains. The intragranular porosity occurs mainly as leached phylloid and (to a lesser extent) chert clasts. The

corroded grain margins (including rhomb-shaped molds) provide ample evidence for the former presence of carbonate cement. Dissolution of this carbonate produced high secondary porosity. Most of this secondary intergranular porosity was reduced, however by mechanical compaction because of the relatively low proportion of competent grains. The low permeability is related to the poor sorting, small pore throats because of squeezed grain contacts, high silt and clay content and a relatively high proportion of pore-lining kaolinite cement. The kaolinite cement lines the secondary pores which suggests that it formed relatively late diagenetically.

Fluorescent lime green concentrate was added to the epoxy which could account in part for the relatively high degree of grain plucking and fracturing. Prior to final lapping, the surface of the section was impregnated with clear cyanoacrylate, which helped to prevent further plucking during polishing.

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

SAMPLE IDENTIFICATION: TarN44A-N3
WELL NAME/DEPTH: Gulf et al. East Tarsiut
N44A-70-00-136-00/2254.15 m

INDURATION: poor, either dry or immersed in water.
COLOUR: medium brown with dark grey grains.
SEDIMENTARY STRUCTURES: massive, possibly with some soft sediment deformation.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 68

%gravel size: 0

%sand size: 59

%silt size: 5

%clay size: 4?

Cement %: 5% pore-lining kaolinite (some of which is large in size and vermicular), 1% quartz overgrowths, 1% pore-lining pyrite framboids.

Porosity %: 25 (a porosity of 21.5% and a permeability of 2.79 millidarcies was obtained for core plug OB19, taken near the sample). Given the large pore throats that are easily seen with a binocular microscope, the permeability seems to be much too low. The lithology of the sample described and of the core plug must have been different.

Modal Size: 0.15 mm.

Sorting: 16%/84% diameter ratio=
250 micrometres/ 70 micrometres = 3.6

Verbal Sorting Scale: moderately sorted.

GRAIN SIZE NAME: muddy fine sandstone.

COMPOSITION: 15% monocrystalline quartz grains, 3% polycrystalline quartz grains, 15% chert clasts, 20% phylloid and siltstone clasts, 3% grains of microcrystalline carbonate, 1% muscovite flakes (in part altered to clays and chlorite), 1% alkali feldspar grains (some of which are honeycombed), 5% clasts and films of coal, trace grains of microcline, plagioclase, sparry carbonate, glauconite(?), and high birefringent/high relief grains. The remainder is unidentified silt and clay-sized material.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): Kaolinite/pyrite-cemented coal-bearing muddy fine-

grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 5% is moldic, 5% is within grains and 15% is between grains. The intragranular porosity occurs mainly in the chert and phylloid clasts though there are traces in monocrystalline quartz grains as well. These grains are characterized by rhomb-shaped carbonate dissolution molds. The intergranular porosity consists of elongate and oversized pores, commonly accompanied by rhomb-shaped corrosion molds along grain margins. Over half of the present porosity (especially the intergranular porosity) is estimated to be secondary in origin, formed by dissolution of carbonate (both as cement and as partial grain replacement). Honeycombed alkali feldspar grains and floating grains provide further contributions to secondary porosity. In spite of the presently high intergranular porosity, the porosity after removal of carbonate must have been much higher because many of the ductile grains have been forced against the corrosion molds (many of which are rhombic) of adjacent competent grains. Given these relations, the introduction of carbonate must have been soon after deposition. Kaolinite cement (commonly large vermicular booklets up to 80 micrometres wide) line and in rare cases fill pores of secondary origin, suggesting that it formed relatively late diagenetically. Pyrite as framboids also lines secondary pores and is therefore similarly a late diagenetic mineral.

THIN SECTION MODAL AND GRAIN SIZE ANALYSIS

Sample I.D.: Tarn44a-N3

	No of Points	Percentage of Components	Percentages of Detrital Components
Detrital Components			
Monocrystalline Quartz	65	21.67	27.66
Polycrystalline Quartz	13	4.33	5.53
Clear Chert	36	12.0	15.32
Black Chert	8	2.67	3.40
Alkali Feldspar	19	6.33	8.09
Plagioclase	0	0.00	0.00
Phylloid Clasts	68	22.67	28.94
Volcanic Clasts	0	0.00	0.00
Chlorite	2	0.67	0.85
Mica	4	1.33	1.70
Siltstone Clasts	4	1.33	1.70
Coal	3	1.00	1.28
Unidentified (too small)	6	2.00	2.55
Other Clasts	7	2.33	2.98
Cements			
Kaolinite	0	0.00	
Carbonate	0	0.00	
Other	3	1.00	
Porosity			
Intergranular/ Moldic	55	18.33	

Intragranular	7	2.33

Plucked Grains=1

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: TarN44A-N3

Class Interval (phi)	No. Freq of Max Apparent Grain Dimen-sion	Percentage Frequency	Cumulative Percentage Frequency
1.5 to 1.0	2	1.0	1.0
2.0 to 1.5	17	8.5	9.5
2.5 to 2.0	55	27.5	37.0
3.0 to 2.5	56	28.0	65.0
3.5 to 3.0	29	14.5	79.5
4.0 to 3.5	18	9.0	88.5
4.5 to 4.0	13	6.5	95.0
5.0 to 4.5	6	3.0	98.0
5.5 to 5.0	2	1.0	99.0
6.0 to 5.5	1	0.5	99.5
6.5 to 6.0	1	0.5	100.0

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

Sample I.D.: TarN44A-N3

Percentiles	Phi Values	Micrometres
1	1.50	354
5	1.83	281
16	2.17	222
25	2.32	200

50	2.73	151 (fine sand size)
75	3.33	99
84	3.71	76
95	4.50	44

$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 0.77$$

Verbal Sorting Scale= moderately sorted

Total Number of Grains Measured= 200

Note: Qualitative and quantitative grain size estimates are in good agreement. A higher proportion of alkali feldspar was determined by thin section modal analysis than was estimated qualitatvely. Pore-lining Kaolinite cement, seen easily in a sample fracture surface, however, was not detected from thin section analysis.

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

SAMPLE IDENTIFICATION: TarN44A-N4
WELL NAME/DEPTH: Gulf et al. E. Tarsiut
N44A-70-00-136-00/2257.80 m

INDURATION: poor either when dry or immersed in water.
COLOUR: light brown with dark grey grains.
SEDIMENTARY STRUCTURES: planar lamination is defined by slightly more silty and coaly intervals.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 70

%gravel size: 0

%sand size: 45

%silt size: 15

%clay size: 10

Cement %: 5% pore-lining kaolinite, trace pyrite framboids.

Porosity %: 25 (a porosity of 20.9% and a permeability of 20 microdarcies was measured for core plug OB29, taken near the sample).

Modal Size: 0.12 mm.

Sorting: 16%/84% diameter ratio=
250 micrometres/ 16 micrometres = 15.6

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone.

COMPOSITION: 20% monocrystalline quartz grains, 3% polycrystalline quartz grains, 15% chert grains, 20% phylloid and siltstone clasts, 1% muscovite flakes, 3% clasts of microspar-sized carbonate, 2% coal as films and grains, 2% alkali feldspar, 1% clasts of sparry carbonate (some are rounded single crystals), trace unaltered but sequeezed glauconite pellets, trace microcline grains (some partly altered to clays), trace chlorite flakes, trace high birefringent/high relief heavy minerals. The remainder is unidentified silt and clay-sized material.

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

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approxmately as follows; 5% is moldic, 5% is within grains, and 15% is between grains. Elongate and oversized intergranular pores

of secondary origin are accompanied by rhomb-shaped molds at grain boundaries, indicating that secondary porosity was formed by the dissolution of carbonate. However, less secondary porosity was developed in the muddy/coaly laminae. Floating grains and honeycombed alkali feldspar grains are common and provide further evidence for the extensive development of secondary porosity. The kaolinite and pyrite framboids line these secondary pores suggesting that they were formed relatively late. Compaction after secondary porosity development was considerable because of the high proportion of ductile grains. Many of these have been compactionally forced to fill the elongate and oversized pores. The combined effects of poor sorting, very fine grain size of the sandstone, high silt and clay content (including kaolinite cement) and compaction after secondary porosity development explains the low permeability (20 microdarcies) of the rock. The difference in the amount of secondary porosity between the muddy/coaly laminae and the sandier laminae is large and suggests that a threshold permeability is prerequisite to the extensive development of secondary porosity.

The thin section is of inferior quality because of grain plucking/fracturing, caused by a high mud content and because the impregnating epoxy was diluted with fluorescent lime green concentrate.

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

SAMPLE IDENTIFICATION: TarN44A-N5
WELL NAME/DEPTH: Gulf et al. East Tarsiut
N44A-70-00-136-00/2260.63 m.

INDURATION: very poor either dry or immersed in water.
COLOUR: medium brown with dark grey grains.
SEDIMENTARY STRUCTURES: vague planar laminae are defined by concentrations of coal.

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

%gravel size: 0

%sand size: 58

%silt size: 5

%clay size: 3?

Cement %: 3% pore-lining and to a lesser extent pore-filling kaolinite, 1% quartz overgrowths, trace pyrite framboids.

Porosity %: 30 (a porosity of 24.9% and a permeability of 20.6 millidarcies was obtained from core plug 0833, taken near the sample.

Modal Size: 0.2 mm.

Sorting: 16%/84% diameter ratio=
300 micrometres/ 80 micrometres = 3.8

Verbal Sorting Scale: moderately sorted.

GRAIN SIZE NAME: muddy fine sandstone.

COMPOSITION: 15% monocrystalline quartz grains, 3% polycrystalline quartz grains, 15% chert clasts, 15% phylloid and siltstone clasts, 3% alkali feldspar grains (partly altered to clays), 10% films and grains of coal, trace altered glauconite(?), trace 0.75 mm-sized translucent yellow amber(?), trace plagioclase (partly altered to clays). The remainder is unidentified silt and clay-sized material.

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

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 3% is moldic, 5% is within grains and 22% is between grains. Oversized and elongate molds as well as rhomb-shaped molds within grains and at grain margins provide

evidence for substantial (at least 15%) secondary porosity development through carbonate dissolution. Floating grains, honeycombed alkali feldspar and leached chert, polycrystalline quartz, and phylloid clasts are the main contributors to intragranular porosity. In some of the polycrystalline quartz grains, porosity has been developed between the quartz subgrains. Rhomb-shaped dissolution molds are common in the chert and phylloid clasts. Pores of secondary origin (possibly including grain molds) are lined and in some cases filled with Kaolinite. Similarly, pyrite framboids line intergranular pores and in addition, occur in intragranular pores. Compaction after secondary porosiy development was substantial as indicated by ductile grains that have been squeezed into the rhomb-shaped molds of adjacent more competent grains. Although other factors such as Kaolinite cementation may be important, compaction after secondary porosity development may be the main reason for the relatively low permeability (20.6 millidarcies).

The sample was very poorly indurated and the outer part of the section comprises loose grains that fell off the sample. Only the central portion is representative of the rock.

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

SAMPLE IDENTIFICATION: TarN44A-N6
WELL NAME/DEPTH: Gulf et al. East Tarsiut N44A-70-00-136-00/2272.18 m

INDURATION: poor when dry, very poor immersed in water (partly disaggregates by itself after a few minutes).
COLOUR: light brown.
SEDIMENTARY STRUCTURES: massive mudstone (bioturbation?) comprises about 20-30% of the thin section.

GRAIN SIZE/COMPOSITION (VOLUMETRIC ESTIMATES):
Terrigenous Constituent %: 72

%gravel size: 0

%sand size: 40

%silt size: 17

%clay size: 15

Cement %: 5? kaolinite, 2% sparry carbonate cement, trace quartz overgrowths, 1% pyrite framboids.

Porosity %: 20 (a porosity of 18.8% and a permeability of 2.93 millidarcies was determined for core plug 0844, taken near the sample).

Modal Size: 0.08 mm.

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

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME (ignoring the mudstone): muddy very fine sandstone.

COMPOSITION: 20% monocrystalline quartz grains, 3% polycrystalline quartz grains, 10% chert clasts, 20% phylloid and siltstone clasts, 2% muscovite flakes, 3% clasts of microcrystalline carbonate grains, 1% alkali feldspar grains, 3% coal films and grains, trace chlorite flakes. The remainder is unidentified silt and clay-sized material.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): (ignoring the mudstone): kaolinite/carbonate/pyrite cemented coaly and muddy very fine grained litharenite.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 3% is moldic, 5% is within grains and 12% is between grains. At least half of the total porosity is

secondary, as indicated by elongate and oversized pores with associated rhomb-shaped partial molds at grain boundaries and complete molds in chert and phylloid grains. Carbonate dissolution was undoubtedly the mechanism of secondary porosity development because relict sparry carbonate remains, some obviously replacing grain margins. The secondary porosity was greatly reduced by compaction after carbonate dissolution, as evidenced by corroded competent grains floating in a pseudomatrix of squeezed ductile grains as well as in original matrix. Many ductile phylloid and siltstone clasts have been compactionally forced against competent grains along the margins of which are rhomb-shaped indentations. The vermicular kaolinite and framboidal pyrite cements line secondary pores and were therefore formed relatively late. The poor permeability (about 3 millidarcies) is related to a combination of very fine grain size with a large clay and silt proportion, very poor sorting, extreme mechanical compaction (especially of ductile grains), and a high cement proportion.

The thin sections are of good quality, with surface relief of only about 2 micrometres between hard and soft grains and a good polish. The epoxy was not diluted with lime green concentrate which could explain the superior quality of the thin section. A minor problem was encountered during staining of one of the sections with the fluorescent lime green concentrate. Overheating during curing is indicated by discolouration of the epoxy to a pink colour. The stain was not absorbed by the epoxy in these areas.

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

SAMPLE IDENTIFICATION: TarP45-N1
WELL NAME/DEPTH: Gulf et al. West Tarsiut P-45-70-00-136-15/2474.90 m

INDURATION: poor when dry, disaggregates immediately when immersed in water.
COLOUR: light brown.
SEDIMENTARY STRUCTURES: vague planar lamination. Fractures occur at about a 45 degree angle to the lamination.

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

%gravel size: 0

%sand size: 30

%silt size: 30

%clay size: 20

Cement %: 5%(?) kaolinite, 1% sparry calcite (as cement and also replacing grain margins), trace pyrite framboids.

Porosity %: 15

Modal Size: 0.060 mm.

Sorting: 16%/84% diameter ratio=
100 micrometres/ 3? micrometres = 33

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: 20% monocrystalline quartz grains, 1% polycrystalline quartz grains, 5% chert grains, 20% phylloid clasts, 2% alkali feldspar grains, 10% muscovite flakes (in part altered to chlorite and clays), 2% chlorite flakes, 1% coal clasts, trace unaltered glauconite pellets, trace plagioclase grains. Unidentified silt and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): Kaolinite/carbonate-cemented glauconite and coal-bearing sandy (litharenitic) mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: Unaltered glauconite pellets provide good evidence for a marine orign, despite the presence of coal clasts. The porosity distribution is approximately as follows; 1% is moldic, at least 3% is within grains and about 3% occurs along fractures (at about 45 degrees to lamination). The

small particle size makes it difficult to assess the importance of secondary porosity. Although intergranular porosity is slightly higher immediately adjacent to the fractures, it is not known whether these fractures were formed by drying of the core. Extreme mechanical compaction is apparent from the high proportion of pseudomatrix, formed by the squeezing of ductile grains between more competent grains. The combined effects of very poor sorting, a mudstone lithology, extreme mechanical compaction and pore-lining kaolinite suggests tht the permaeability must be very low.

The thin section is of good quality although excessive grain plucking during preparation required surface impregnation with clear cyanoacrylate prior to final thinning.

THIN SECTION MODAL AND GRAIN SIZE ANALYSIS

Sample I.D.: TarP45-N1

	No of Points	Percentage of Components	Percentages of Detrital Components
Detrital Components			
Monocrystalline Quartz	94	31.33	35.34
Polycrystalline Quartz	5	1.67	1.88
Clear Chert	22	7.33	8.27
Black Chert	4	1.33	1.50
Alkali Feldspar	23	7.67	8.65
Plagioclase	0	0.00	0.00
Phylloid Clasts	75	25.00	28.20
Volcanic Clasts	0	0.00	0.00
Chlorite	5	1.67	1.88
Mica	18	6.00	6.77
Siltstone Clasts	1	0.33	0.38
Coal	2	0.67	0.75
Unidentified (too small)	13	4.33	4.89
Other Clasts	4	1.33	1.50
Cements			
Kaolinite	0	0.00	
Carbonate	1	0.33	
Other	2	0.67	
Porosity			
Intergranular/ Moldic	31	10.33	

Intragranular	0	0.00

Plucked Grains=12

Total number of points counted minus plucked grains= 300

GRAIN SIZE ANALYSIS

Sample I.D.: TarP45-N1

Class Interval (phi)	No. Freq of Max Apparent Grain Dimen-sion	Percentage Frequency	Cumulative Percentage Frequency
1.5 to 1.0	1	0.5	0.5
2.0 to 1.5	0	0.0	0.5
2.5 to 2.0	3	1.5	2.0
3.0 to 2.5	5	2.5	4.5
3.5 to 3.0	14	7.0	11.5
4.0 to 3.5	29	14.5	26.0
4.5 to 4.0	33	16.5	42.5
5.0 to 4.5	26	13.0	55.5
5.5 to 5.0	38	19.0	74.5
6.0 to 5.5	25	12.5	87.0
6.5 to 6.0	15	7.5	94.5
7.0 to 6.5	4	2.0	96.5
7.5 to 7.0	4	2.0	98.5
8.0 to 7.5	2	1.0	99.5
8.5 to 8.0	1	0.5	100.0

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

Sample I.D.: TarP45-N1

Percentiles	Phi Values	Micrometres
1	2.25	210
5	3.06	120
16	3.69	77
25	3.97	64
50	4.79	36 (coarse silt-size)
75	5.52	22
84	5.87	17
95	6.61	10

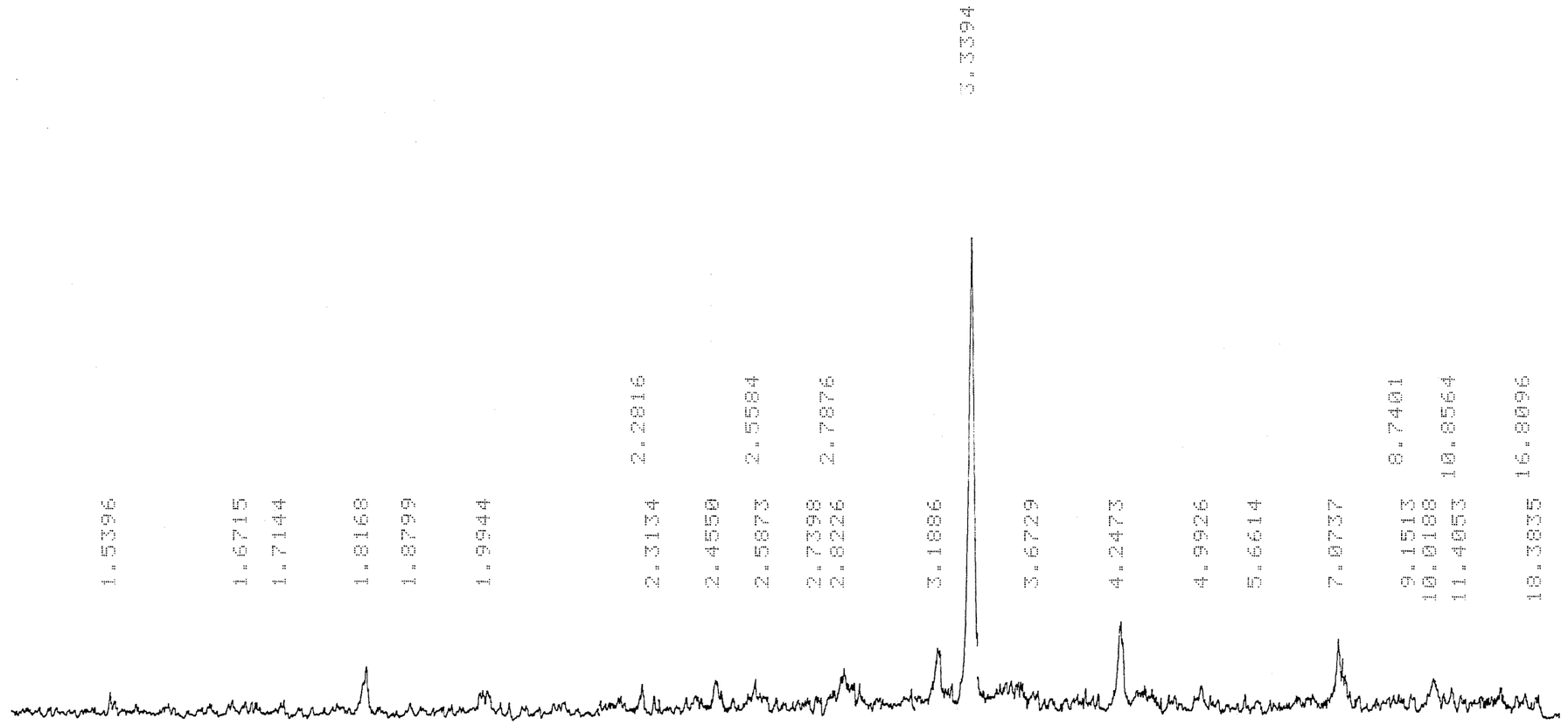
$$\text{Graphic Sorting (Inman)} = \frac{\text{Phi(84)} - \text{Phi(16)}}{2} = 1.09$$

Verbal Sorting Scale= poorly sorted

Total Number of Grains Measured= 200

Note: Less clay is indicated from thin section grain size analysis than by qualitative estimation based on examination of the thin section and a sample fracture surface. This explains the poor as opposed to very poor sorting value obtained by thin section grain size analysis. Clay-sized material is difficult to identify in thin section and may be mistaken for squeezed clay-rich phylloid clasts, especially in a sample fracture suface. Thin section modal analysis suggests a higher proportion of monocrystalline quartz and alkali feldspar grains than was estimated qualitatively. In addition, kaolinite cement was not detected in thin section though 5% is estimated in a sample fracture surface.

X-RAY DIFFRACTION ANALYSIS
SAMPLE IDENTIFICATION: TARP45-N1
WELL NAME: GULF EI AL. WEST TARSIUT P-45-70-00-136-15
SAMPLE DEPTH: 2474.90 METRES
NOTE: 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: TarP45-N2
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2476.00 m.

INDURATION: poor when dry, disaggregates immediately when immersed in water.
COLOUR: medium brown.
SEDIMENTARY STRUCTURES: massive.

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

%gravel size: 0

%sand size: 53

%silt size: 20

%clay size: 12

Cement %: trace sparry carbonate.

Porosity %: 15

Modal Size: 0.070 mm.

Sorting: 16%/84% diameter ratio=
200 micrometres/ 25 micrometres = 8

Verbal Sorting Scale: poorly sorted.

GRAIN SIZE NAME: muddy very fine sandstone.

COMPOSITION: 25% monocrystalline quartz, 3% polycrystalline quartz, 3% chert, 20% phylloid and siltstone clasts, 2% muscovite flakes, 1% alkali feldspar, 5% coal clasts and traces of coaly films, trace plagioclase grains, trace microcline, trace unaltered glauconite pellets. Unidentified clay- and silt-sized material comprises the remainder.

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

PETROGENESIS/ADDITIONAL INFORMATION: Rare unaltered glauconite pellets are good evidence for a marine origin, in spite of the presence of coal clasts. Porosity is distributed approximately as follows; 1% is moldic, 3% is within grains and 11% is between grains. The small grain size precludes detailed analysis of textural relations. Extreme mechanical compaction, however, is well shown by the large quantity of pseudomatrix, formed by squeezing of ductile grains between more competent grains. The

permeability must be very low (probably less than a millidarcy), owing to the poor sorting, very fine grain size (with a large silt and clay component) and extreme mechanical compaction.

The thin sections are of moderate quality though surface impregnation with clear cyanoacrylate was required prior to final thinning of the sections.

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

SAMPLE IDENTIFICATION: TarP45-N3
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2477.20 m

INDURATION: moderate when dry, disaggregates by itself 2 minutes after immersion in water.
COLOUR: medium brown.
SEDIMENTARY STRUCTURES: massive.

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

%gravel size: 0

%sand size: 30

%silt size: 30

%clay size: 25

Cement %: kaolinite?, trace framboidal pyrite, trace sparry carbonate.

Porosity %: 15

Modal Size: 0.04 mm.

Sorting: 16%/84% diameter ratio=
100 micrometres/ 3? micrometres = 33

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: 30% monocrystalline quartz, 3% chert, 10% muscovite (in part altered to chlorite and clays), 20% phylloid clasts, 1% alkali feldspar, 3% grains and films of coal/carbonaceous material, trace altered(?) glauconite or chlorite. Unidentified clay and silt-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): micaceous/carbonaceous sandy (litharenitic) mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: The porosity distribution is approximately as follows; 1% is moldic and most of the remaining 14% or so is intergranular. Evidence for secondary porosity includes a few leached grains. Textural relations are difficult to observe because of the small particle size. Mechanical compaction, however was of major importance, as shown by the high pseudomatrix content formed by squeezing of ductile phylloid and muscovite grains between the more competent grains. The

permeability must be very low (probably much less than a millidarcy) because of the very poor sorting, the small particle size and the extreme mechanical compaction.

Grain plucking was a problem because the epoxy only impregnated the outer millimetre or so of the sample. The problem was minimized to some extent by impregnating the surface of the sample with clear cyanoacrylate prior to final thinning.

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

SAMPLE IDENTIFICATION: TarP45-N4
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2477.90 m.

INDURATION: moderate when dry, disaggregates a few minutes after immersion in water.
COLOUR: dark brown.
SEDIMENTARY STRUCTURES: minor vague sandier lens-shaped laminae occur in the thin section.

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

%gravel size: 0

%sand size: 30

%silt size: 25

%clay size: 25

Cement %: Kaolinite(?), trace (ppm) framboidal pyrite.

Porosity %: 20

Modal Size: 0.06 mm.

Sorting: 16%/84% diameter ratio=
125 micrometres/ 3? micrometres = 41

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: 25% monocrystalline quartz grains, 2% polycrystalline quartz grains, 5% chert grains, 5% muscovite flakes (in part altered to chlorite and clays), 15% phylloid and siltstone clasts (now largely pseudomatrix), 2% chlorite flakes, 3% grains and trace films of coal. The remainder is unidentified silt- and clay-sized material. Organic matter content is probably quite high, judging by the dark brown colour.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): coal- and mica-bearing sandy (litharenitic) mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: Mechanical compaction was the main diagenetic process, though there are traces of secondary porosity, mainly as molds and leached grains. Although the porosity is estimated at 20%, the permeability must be very low (probably much less than a millidarcy) because of the very poor sorting, fine particle size, and mechanical compaction.

One of the thin sections is of good quality while the other is poor. To minimize excessive grain plucking, the surface of the thin section was re-impregnated with clear cyanoacrylate prior to final thinning. Staining of epoxy with the fluorescent lime green stain was not carried out because of the fine grain size and the excessive grain plucking.

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

SAMPLE IDENTIFICATION: TarP45-N5
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2478.60 m.

INDURATION: moderate when dry, disaggregates by itself 5 minutes after immesion in water.
COLOUR: light brown.
SEDIMENTARY STRUCTURES: planar laminated.

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

%gravel size: 0

%sand size: 20

%silt size: 35

%clay size: 30

Cement %: trace pyrite framboids, trace (ppm) sparry carbonate (in part replaces grain margins).

Porosity %: 15

Modal Size: 0.03 mm.

Sorting: 16%/84% diameter ratio=
125 micrometres/ 2? micrometres = 62

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: 15% monocrystalline quartz grains, 1% polycrystalline quartz grains, 3% chert clasts, 15% phylloid clasts (now partly pseudomatrix), 1% alkali feldspar, 15% muscovite flakes (in part altered to chlorite and clays), 3% coal grains. Unidentified silt and clay-sized material comprises the remainder.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): micaceous and coal-bearing sandy (litharenitic) mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: Mechanical compaction was the most important diagenetic event though the small particle size precludes detailed analysis in thin sections of ordinary thickness. Secondary porosity appears to have been of minor importance.

The epoxy only penetrated 0.5 mm into the sample, which explains why only one of the thin sections is of good quality. To

minimize grain plucking, the surface of the thin sections were impregnated with clear cyanoacrylate prior to final thinning. The fluorescent lime green stain for epoxy was not used because the stain would be absorbed by clay and silt-sized material.

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

SAMPLE IDENTIFICATION: TarP45-N6
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2479.70 m

INDURATION: moderate when dry, disaggregates by itself a few minutes after immersion in water.
COLOUR: dark brown.
SEDIMENTARY STRUCTURS: vague planar lamination is defined by slight grain size variations.

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

%gravel size: 0

%sand size: 30

%silt size: 30

%clay size: 25 (though some of this may be pseudomatrix)

Cement %: trace pyrite framboids.

Porosity %: 15

Modal Size: 0.03 mm.

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

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME: sandy mudstone.

COMPOSITION: 25% monocrystalline quartz grains, 1% polycrystalline quartz grains, 3% chert clasts, at least 20% pseudomatrix of ductile phylloid clasts, 2% muscovite flakes, 1% alkali feldspar grains, 10% coal grains and carbonaceous flakes (up to 2 mm wide), trace pyrite, high organic matter content.

ROCK NAME (cements, miscellaneous transported constituents, clan designation): organic-rich coaly sandy (litharenitic) mudstone.

PETROGENESIS/ADDITIONAL INFORMATION: Quiet water conditions are indicated by the thin subhorizontal carbonaceous flakes. The major diagenetic event was mechanical compaction, resulting in the production of pseudomatrix from ductile grains. The small particle size makes detailed petrographic analysis difficult, but it appears that secondary porosity development was negligible. The sample has a reasonable amount of porosity but the permeability must be negligible, given the poor sorting, small particle size and degree of compaction.

One of the sections is of good quality and is assumed to have been impregnated with epoxy. To minimize grain plucking the surfaces of both sections were impregnated with clear cyanoacrylate prior to final thinning. The epoxy stain was not used.

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

SAMPLE IDENTIFICATION: TarP45-N7
WELL NAME/DEPTH: Gulf et al. West Tarsiut
P-45-70-00-136-15/2480.30 m.

INDURATION: moderate when dry, disaggregates by itself a few minutes after being immersed in water.
COLOUR: dark brown.
SEDIMENTARY STRUCTURES: vaguely laminated with some sandy bioturbated areas. One 5 mm-thick lamina contains no sand-size fraction.

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

%gravel size: 0

%sand size: 45

%silt size: 24

%clay size: 15

Cement %: 1% calcite (in part replacing grain margins), trace quartz overgrowths and pyrite framboids.

Porosity %: 15

Modal Size: 0.07 mm.

Sorting: 16%/84% diameter ratio=
250 micrometres/ 4 micrometres = 62

Verbal Sorting Scale: very poorly sorted.

GRAIN SIZE NAME (of the main lithology): muddy very fine sandstone.

COMPOSITION (of the main lithology): 40% monocrystalline quartz grains, 2% polycrystalline quartz grains, 10% chert clasts, 20% phylloid and siltstone clasts (much of which is transformed to pseudomatrix), 2% alkali feldspar, 5% muscovite flakes (in part altered to chlorite, carbonate, and clays, 5% coal grains and flakes, trace unaltered glauconite pellets, trace plagioclase (partly altered to clays, trace high birefringent/high relief mineral. The remainder is unidentified clay- and silt-sized material.

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

PETROGENESIS/ADDITIONAL INFORMATION: A marine origin is suggested

by the unaltered glauconite pellets, in spite of the abundant grains and flakes of coal. Elongate and oversized pores, as well as floating grains are common in the sandy bioturbated areas. Leached intragranular pores in phylloid clasts and moldic pores, are also present, though rare in these bioturbated mud-poor parts of the sample. Rhombic molds at grain margins and rare remnant sparry calcite replacing grain margins leave little doubt that the secondary porosity in the bioturbated areas was formed by the dissolution of sparry calcite. Elsewhere in the sample where clay and silt is common, there is also evidence for secondary porosity as rhomb-shaped molds in chert grains, molds and isolated oversized pores but these are rare. The difference in abundance in secondary porosity is undoubtedly related to permeability differences between the mud-rich and mud-poor lithologies. Mechanical compaction was the most important diagentic process in the muddy sandstone lithology which comprises most of the sample.

Grain plucking was reduced by impregnating the surface of the sections with clear cyanoacrylate prior to final thinning. The calcite was etched several micrometres and was stained a bright red. The fluorescent lime green epoxy stain was not used because of the high percentage of clays and the problem of grain plucking.