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August 17, 1983
IMP - 83 - 132

Mr. G.E. Hicks
Field Exploration and Development
Phillips Petroleum Co. Norway
P.O. Box 220

4056 TANANGER

SIDE WALL CORES

Dear Mr. Hicks,

Re: Cod 7/11-7 Jurassic Sandstone.

Please find enclosed laboratory report T12-A090-83 detailing results of test performed on core samples from the above well.

Stimulation recommendations for this formation will be based on this report, our experience in the area and local operational considerations.

I hope that the information contained within this report will assist you in your well planning and that you will not hestiate to call should you require further information.

Yours sincerely,

I. McPherson

cc: F.W. Mannes
P.C. Jennings
S.K. Karnes

CHEMICAL RESEARCH AND DEVELOPMENT DEPARTMENT

HALLIBURTON SERVICES
DUNCAN, OKLAHOMA

LABORATORY REPORT

No. T12-A090-83

To: Mr. Ian McPherson
Halliburton Overseas Limited
4056 Tananger, Norway

Date: August 5, 1983

We give below results of our examination of 3 cores.

Submitted by: for Phillips Petroleum Company, Norway

Marked: Well: Cod 7/11 A-6
Location: North Sea
Formation: Jurassic Sandstone
Depth: 14,927; 14,931.5; and 14,942 ft
Received: 7-19-83

PURPOSE

This report contains the results of the requested analyses.

RECOMMENDATIONS

VERSAGEL HT would be a suitable fluid to use for fracturing the Cod 7-11 A-6. At this depth, a delayed crosslink, as experienced with CL-18, will reduce friction going down the tubing, and lower pump hydraulic horsepower. Proper selection of the base gel weight will depend on your pumping time. With 350°F BHT, I suggest a major portion of the job be run with VERSAGEL HT 1700 with 5% methanol and 20 lbs GEL-STA per 1000 gallons (no HT breaker during this stage), then complete the final stage with VERSAGEL HT 1600. The idea should be to try and obtain a uniform gel break after completing the job. This procedure is used domestically quite often. Another idea is to use a large pad (which you will probably need due to fluid loss at 4 md) of HYGEL-566 to cool the formation. The base fluid for VERSAGEL should be 2% KCl, 2 1/2 lbs HYG-3, and 10 lbs K-34 per 1000 gallons. CLA-STA II can be used at 1 gallon per 1000 in the pre-pad stage.

Fracture flow capacity testing indicates that 20/40 mesh INTERPROP™ develops flow capacity comparable to SUPER PROP® even at 10,000 psi closure pressure. INTERPROPS are 13% lighter so are easier to suspend. A few trial runs of the Prop computer program should give you a good idea of the transport and settling characteristics to expect.

DATA

Core Description

Three samples were received; core plugs from 14,927 and 14,942 ft depth, and a 5 1/2 inch section of 4 inch diameter core from 14,931.5 ft. All three are visually alike: medium grained, micaceous, oily, brown quartz sandstones. They are massive, lacking any sedimentary structures.

Qualitative X-ray Diffraction and Acid Solubility Analyses

Purpose: To identify the types and relative quantities of minerals in the formation sample.

Procedure: A pulverized 1 gram sample is placed in an x-ray beam and rotated through an arc. The x-ray beam is diffracted by the sample and the diffraction patterns are recorded.

Results: The diffraction patterns are used to identify the types of minerals present and their relative quantities. The relative quantities for the submitted samples are as follows:

Sample No.	1	2	3
Depth (Feet)	14,927	14,931.5	14,942
HCl Solubility %*	2.8	2.8	10.6
HF Solubility %**	33.7	36.3	46.9
Iron Content %***	0.4	0.3	1.0
Quartz	50-65%	50-65%	40-50%
Feldspar	15-20%	25-30%	20-30%
Calcite	0.5-2%	0.5-2%	0.5-2%
Dolomite	2-5%	2-5%	5-10%
Illite	2-5%	2-5%	5-10%
Mixed Layer Clay	2-5%	5-10%	5-10%
Chlorite	2-5%	0.5-2%	2-5%
Pyrite	2-5%	0.5-2%	0.5-2%

* 1 gram of sample is added to 0.5N HCl. After reaction, the excess acid is titrated with 0.2N NaOH. The results are calculated and reported as calcium carbonate. (Note: a pure dolomite will be reported as 108%.)

** This is solubility by actual weight loss after reaction with an excess amount of 3% HF-12% HCl at 150°F for 30 minutes.
MUD ACID

*** 1 gram of sample is added to concentrated HCl. After reaction, the dissolved iron is titrated with Potassium Dichromate and reported as % by weight.

DATA (Cont'd)

Permeability and Porosity Analyses

Purpose: To measure the permeability and porosity of a porous media.

Procedure: A test plug 1 inch in diameter by 1.187 inches long is obtained from the submitted core sample so that the longitudinal axis of the plug is normal to the depth. The plug is then oven dried and allowed to cool to room temperature.

Permeability is determined by placing the plug securely in a Hassler Sleeve of the Permeameter. Dry air is then flowed through the plug. Measurements of flow rate and pressure drop across the plug are then obtained.

Porosity is determined by placing the plug securely in a Hassler Sleeve of the Porosimeter. The system is purged with helium gas. The meter has a known storage volume in which the helium gas is allowed to reach equilibrium and a reference point is set on the gauge and a reading taken. The valve to the plug chamber is opened allowing the helium gas to expand into all the void spaces of the plug. A gauge reading is taken in cubic centimeters. The plug is removed and a nonporous plug is placed in the holder and the gas volume is measured in the same manner as with the sample plug. The difference in the volumes is the pore volume of the test plug. The bulk volume is calculated from measuring the plug with calipers.

Results: Permeability is calculated by the following:

$$K = \frac{CQL}{0.7845\ (D)(D)}$$

K is permeability in millidarcys (md)
C is the value reading taken from the charts on the Permeameter
Q is the flow rate in cubic centimeters per second (cc/sec)
L is the plug's longitudinal length in centimeters (cm)
D is the diameter of the plug in centimeters (cm)

Porosity is calculated by the following:

$$P = \frac{P.V.}{B.V.} \times 100$$

P is the effective porosity expressed in percent (%)
P.V. is the pore volume measured in cubic centimeters (cc)
B.V. is the bulk volume measured in cubic centimeters (cc)

Sample No.	Depth (feet)	Porosity (%)	Air Permeability (md)
1	14,927	16.37	5.59
3	14,942	13.06	0.45

DATA (Cont'd)

Rock Properties

Purpose: To measure the elastic deformation and strength of rock materials.

Procedure: A 15/16 inch diameter by 2 inch plug is drilled horizontally from a core and placed in the test load cell. An axial stress is applied to the plug and the resulting deformation is measured by displacement transducers. Two transducers are mounted to detect axial strain and one transducer to detect lateral strain. The axial stress is applied to the test plug until full scale (120,000 pounds) is reached or failure occurs.

Results: This data is recorded as Young's Modulus, which is the ratio of stress to strain for values of stress not exceeding the elastic limit of the test plug. Poisson's Ratio is the ratio of lateral strain to axial strain within the elastic limit of the test plug.

Sample No.	Depth (feet)	Young's Modulus (psi)	Poisson's Ratio
1	14,927	1.8E6	0.27
3	14,942	1.8E6	0.32

Immersion Test

Purpose: To observe the effect of various base fluids on core chips from selected representative cores.

Procedure: Freshly broken chips from cores are immersed in test fluids; one chip per fluid in a 30 ml beaker. The samples are then placed in a vacuum for one hour. After that time, an observation is made to evaluate the effect of the fluid on the core chip.

Results: Released fines from a core chip may indicate formation sensitivity to the test fluid.

Effects of immersion under vacuum at 180°F (test temp.) for one hour in the following:

Sample No.	Depth (feet)	Sea Water	Fresh Water	2% KCl	2% KCl*	7½% MCA	6% HF	Kero-sene
2	14,931.5	N	N	V	N	N	N	N

N = No fines released.
V = Very small amount fines.
S = Small amount fines.
M = Moderate amount fines.
L = Large amount fines.
P = Partially disintegrated.
CD = Completely disintegrated.
GR = Gelatinous residue formed.
PD = Partially dissolved.
C = Completely dissolved.

* 0.5 gallon CLA-STA II compound per 1000 gallons.

DATA (Cont'd)

Fluid Loss Tests

Purpose: To describe the leakoff properties of a particular fluid on a formation rock sample.

Procedure: The sides of a test plug (15/16 inches in diameter by 1 inch in length) taken horizontally from a core are sealed with an epoxy so that the test fluid flows linearly through the test plug. A 1000 psi differential pressure is applied to the test fluid. The fluid volume through the test plug is recorded as a function of time for 36 minutes as per API Test procedures.

Results: The results of these timed volume readings are plotted as a function of volume versus the square root of time. The slope of the line obtained when the data is plotted on regular graph paper will give the C_w values and spurt volume.

Sample No.	Depth (feet)	Perm. Gas (md)	Gelled Fluid	Cw (feet/ sq. rt. min)	Spurt Loss (gal./ sq. foot)
2A	14931.5	4.10	VERSAGEL HT 1600	0.00287	0.0

Gelled Fluids Description

VERSAGEL HT 1600:
60.0 lbs WG-11
10.0 lbs K-34
2.5 lbs HYG-3
2.5 lbs SP Breaker
1.8 gal CL-18
All per 1000 gal 2% KCl water

DATA (Cont'd)

Regained Permeability Tests (N_2 Gas)

Sample No.	Depth (feet)	Test Pressure (psig)
2A	14,931.5	150
2B	14,931.5	150

Purpose: To measure the effect of fluids on the permeability of samples.

Procedure: The core test plugs (15/16 inches in diameter by 1 inch in length) are oven dried and the sides are sealed with epoxy to insure linear flow through the test plugs. Initial nitrogen permeability measurements are then obtained in one direction. The core plugs are then saturated and a measured volume of fluid is flowed through the core plug in the opposite direction. Fluid flow temperature was 180°F. Some of the plugs are then subjected to a standard 36-minute fluid loss test on gelled fluids at 180°F and a test pressure of 1000 psig. The plugs remained in the gelled fluids for 24 hours at 180°F to obtain a gel break prior to regained nitrogen flow. Regained permeability measurements are obtained in the original direction. Gas flow measurements are at 73°F.

Results: The data are reported as a percent of the initial permeability recovered.

No.	Sample (md)	Saturation Gelled Fluid*
2A	2% KCl	
2B	2% KCl	VERSAGEL HT 1600

* Fluid descriptions are under the Fluid Loss Tests section.

Sample No.	Time (hrs)	%
2A	24	17
2B	24	96

DATA (Cont'd)

Fracture Flow Capacity

Purpose: To measure the conductivity of a created proppant pack under closure pressure.

Procedure: The core sample is cut into wafers, with a set of two wafers used to make a test. The test is conducted with one set of wafers with a proppant pack between. A perforated stem is placed down through a hole in the middle of the wafer set. Air is flowed through the stem, out of the perforations and radially through the proppant pack. The upstream pressure is measured and compared to the known downstream pressure to obtain a differential pressure. Pressure readings are made under various closure pressures.

Results: The data is presented as liquid conductivity in units of md-ft.

Core Depth: 14,931.5 ft

Proppant Type: (1) 20/40 SUPER PROP®
(2) 20/40 INTERPROP™

Proppant Concentration (lb/sq ft)	Closure Pressure (psi)	Fracture Flow Capacity (md-ft) Prop No. 1	Prop No. 2
1.0	5,000	1522	1847
	7,000	1364	1446
	9,000	1065	1032
	10,000	962	836
2.0	5,000	2865	4242
	7,000	2557	3242
	9,000	1992	2269
	10,000	1848	1831

DATA (Cont'd)

Scanning Electron Microscope (SEM) Examination

and Petrographic Analysis

For SEM:

Purpose: To provide a greatly magnified view of a core sample. Minerals present in the sample can be identified and their location observed.

Procedure: A core chip with a freshly broken surface is required for this examination. The sample is coated with a gold palladium alloy and placed in the vacuum chamber of the SEM. The core chip is viewed at a high magnification and a photomicrograph is taken. An associated energy dispersive x-ray (EDX) is used to help identify the mineral content of the sample.

Results: The framework grains can be identified and their size approximated. The location of the clay minerals within the sample can be observed. The SEM can produce, in effect, a pseudo three dimensional view of formation pore spaces. The area of the sample viewed is very small and may not clearly characterize the entire formation.

For Petrographic:

Purpose: To describe the framework grains, the matrix or the cementing material, and the pore spaces.

Procedure: Core chips are glued to glass slides and then ground to a thin section through which light can be transmitted. The slide is placed under a microscope and viewed using polarized light at high magnification.

Results: The result of this examination is descriptive and systematic classification of the rock and materials present in the sample. This analysis is a visual observation, thus is somewhat subjective.

DATA (Cont'd)

Scanning Electron Microscope (SEM) Examination

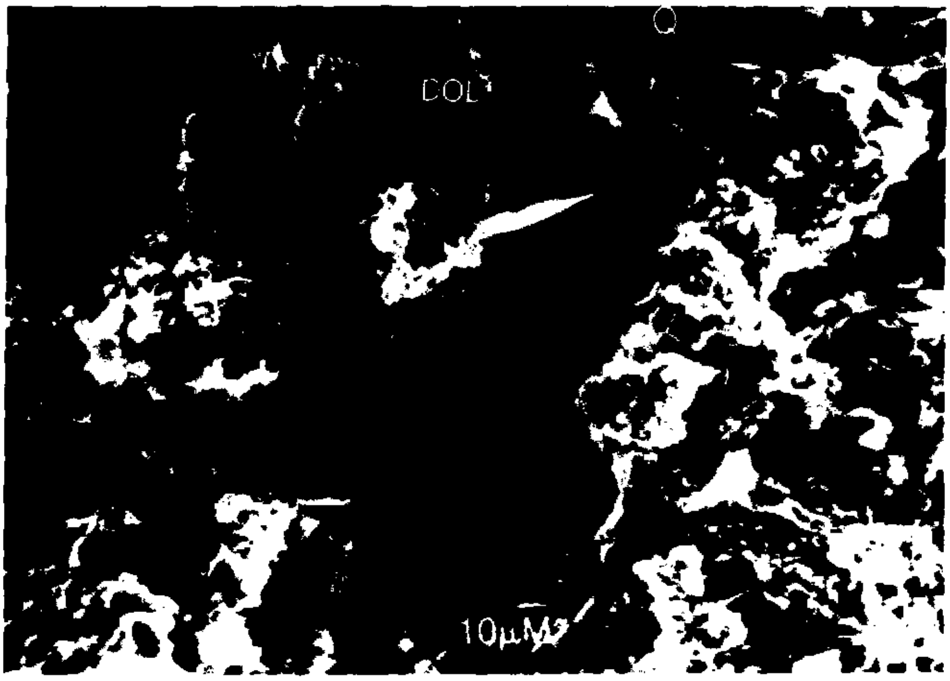


Figure No. 1; Negative: 21821-1713; Sample No. 1; Depth: 14,927 feet; Magnification 1000X.

A framework of fine to very fine quartz grains covered with mixed layer (ML) clay, secondary quartz (∂ and Q) and debris. Scattered dolomite (DOL) crystals observed. Fair to good apparent porosity.

Petrographic

PEBBLY SANDSTONE - Framework of poorly sorted, subangular to round, pebbly to fine sand size grains of quartz, feldspar, with mica and rock fragments. Intergrain pores coated with mixture of illite, mixed layer and chlorite clays. Fair to good visible porosity.

DATA (Cont'd)

Scanning Electron Microscope (SEM) Examination (Cont'd)

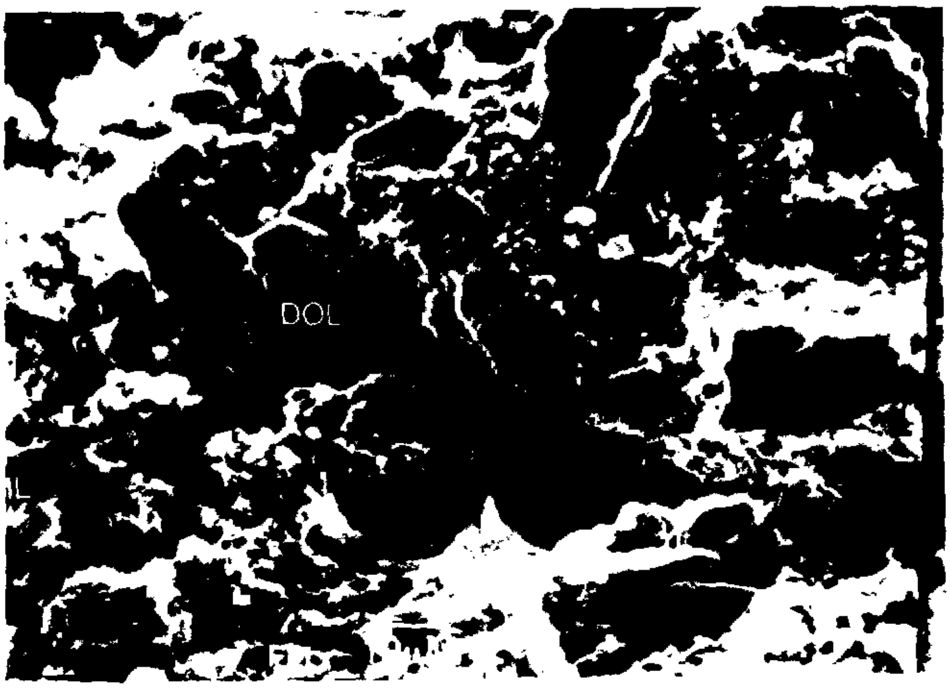


Figure No. 2; Negative No. 21821-1712; Sample No. 2; Depth: 14,931.5 ft; Magnification 1000X.

This sample has a framework of very fine quartz and feldspar (FEL) sand grains covered with mixed layer clay and quartz debris. Scattered dolomite crystals. Fair apparent porosity.

Petrographic

CALCAREOUS SANDSTONE - Framework of poor to moderately sorted, medium to fine quartz and feldspar grains with mica and rock fragments. Intergrain pores are lined by illite and mixed layer clays, and contain dolomite crystals. Poor visible porosity.

DATA (Cont'd)

Scanning Electron Microscope (SEM) Examination (Cont'd)

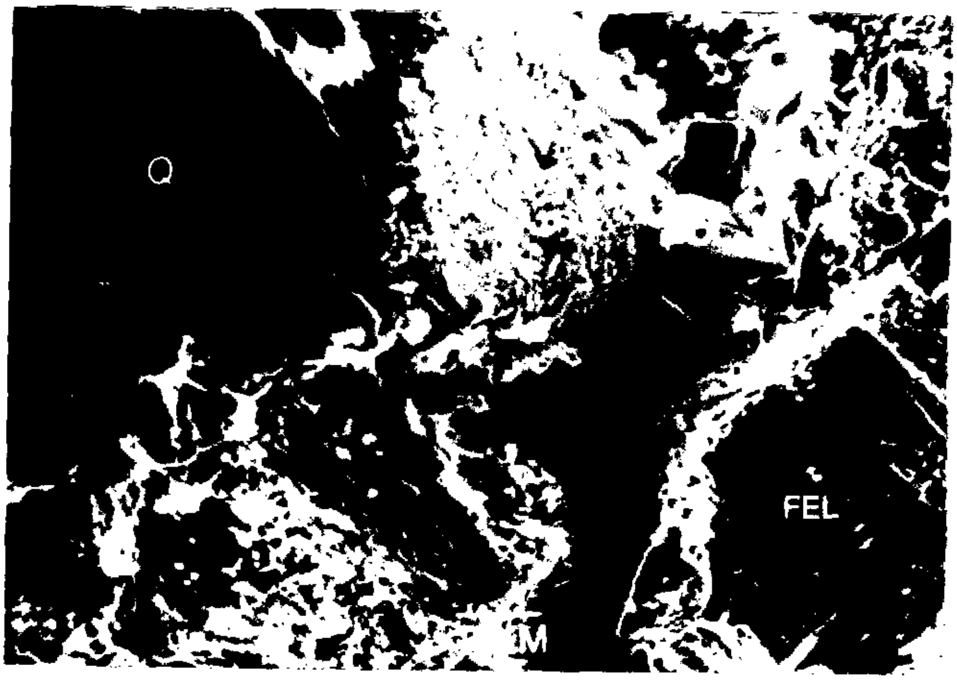


Figure No. 3; Negative No. 21821-1714; Sample No. 3; Depth: 14,942 ft; Magnification 1000X.

A framework of fine to very fine quartz and feldspar sand grains. Small amounts of mixed layer clay and dolomite crystals cover the grains. Fair apparent porosity.

REMARKS

The data in this report were telexed to Mr. McPherson on August 1, 1983.

CORE SAMPLE DISPOSITION

The core samples will be held in storage for 60 days following mailing of the report. At the end of this time, we will select representative core pieces for storage in the Core Library and discard the remainder unless we are requested to ship the cores to another location.

The selected core pieces will be in the Core Library for two years and will be considered the property of the customer. These core pieces will not be released without the permission of the customer, the originating Halliburton Engineer, or a Stimulation Technical Support Section Supervisor. After two years, the selected core pieces will be kept for another eight years, during this time the pieces may be used for a variety of projects.

DATA BOOK REFERENCES

The data presented in this report are recorded in Stimulation Technical Support Book No. 5177, pages 52, 54; Stimulation Technical Support Book No. 5192, page 59; Stimulation Technical Support Book No. 5211, pages 18-25; Stimulation Engineering Research Book No. 5154, page 68; Analytical Book No. 5202, page 45; Analytical Book No. 5207, pages 21, 24; Analytical Book No. 5199, page 34; Analytical Book No. 5130, page 21; and Analytical Book No. 5218, page 6.

cc: Mr. F. M. Blakeslee
Mr. R. D. Padgham
Mr. P. C. Jennings
Mr. F. W. Mannes
Mr. S. K. Karnes
Mr. R. M. Lasater
Mr. A. B. Waters
Dr. L. E. Harris

Respectfully submitted,

Laboratory Analyst Phelps-Brinegar-Blanton-Loghry-Graham
Meadows-Anderson-Simon-Stewart-Halterman

HALLIBURTON SERVICES

By Martin Halterman

jd

Martin Halterman

TOP TRIASSIC

EUROPEAN REGION TECHNICAL CENTRE

REPORT No CS-83-48

PARTIAL ROCK ANALYSIS

CLIENT- PHILLIPS, NORWAY
DATE - 15.8.83
D.S. CONTACT - R. COOPER

AUTHOR(S)	MANAGER- C. KEARY
C. SIM	

CONTENTS

1. INFORMATION REQUESTED

Solubility in 15% HCL and 12-3 mud acid and scanning electron microscope study.

2. SAMPLES TESTED

Five sidewall rock samples were received in the lab. from depths of 15,010 ft, 15,168 ft, 15,340 ft, 15,686 ft and 15,703 ft from COD 7/11-7.

They were labelled for analysis purposes A,B,C,D and E respectively.

All chemicals used came from laboratory stock.

3. Chemical Characteristics

ACID SOLUBILITY

1. Hydrochloric Acid Solubility Tests

i) Procedure

One gram of pulverised formation was placed in 100 mls of 15% hydrochloric acid for one hour at 150°F. The solution was then filtered, then weighed. The amount of hydrochloric acid soluble material was calculated and reported as a percentage by weight.

ii) Results

Sample	Percent Solubility in 15% Hydrochloric Acid
A	9.0
B	8.0
C	9.0
D	7.0
E	13.0

2. Mud Acid (12% Hydrochloric, 3% Hydrofluoric Acid) Tests

i) Procedure

One gram of pulverised formation was placed in 15% hydrochloric acid for one hour at 150°F to remove any carbonates from the sample. This was done since calcium or magnesium fluoride precipitation could occur when hydrofluoric acid reacts with carbonate material.

The hydrochloric acid was then poured off and 100 mls of mud acid was added. After one hour at 150°F the solution was filtered and the residue dried and weighed.

3. Chemical Characteristics (contd)

The amount of mud acid soluble material was calculated and reported as a percent by weight.

ii) Results

Sample No.	Percent Solubility in 12-3 Mud Acid
A	45.0
B	47.0
C	54.0
D	56.0
E	62.0

4. PETROGRAPHIC STUDY

The samples were all silty sandstones with the primary grains predominantly composed of quartz, with minor amounts of K-feldspar and mica. There were also clay coatings on some of the samples composed of chlorite and illite.

Pore space appeared to be very limited which suggests that permeability would be very low, although these properties could not be measured due to the nature of the samples received.

S.E.M. Observations

Core A Magnification x 160

Tightly packed quartz, K-feldspar and mica primary grains make up this sample.

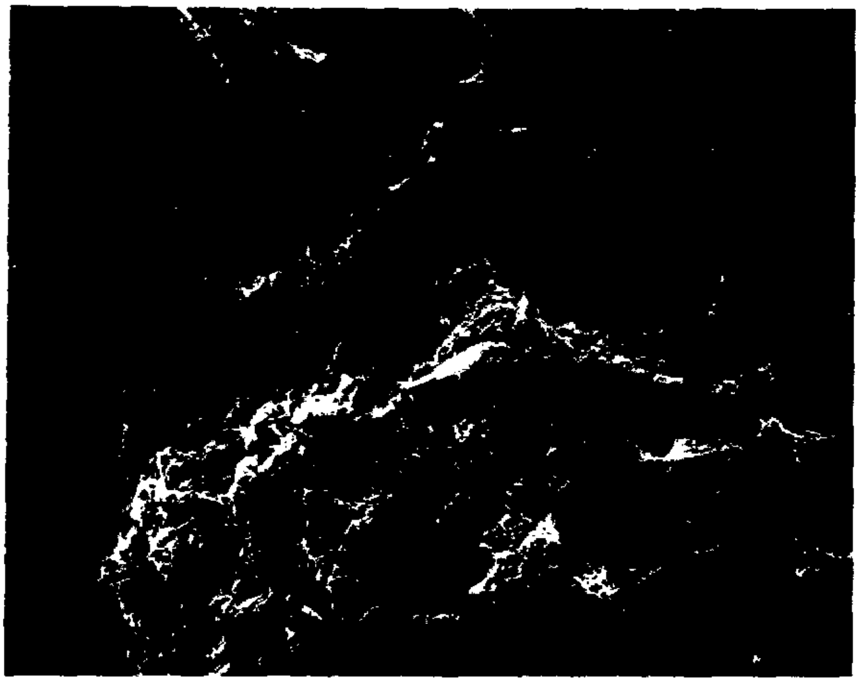
Photo 1

S.E.M. Observations (contd)

Core A Magnification x 1250

Platy mica grains

S.E.M. Observations (contd)



Core B Magnification x 160

Quartz and K-feldspar form the bulk of the primary grains of this sample, with chlorite and illite clay coatings.

Photo 3

S.E.M. Observations (contd)

Core B Magnification x 640

The clay mineral chlorite

S.E.M. Observations (contd)

Core C Magnification x 160

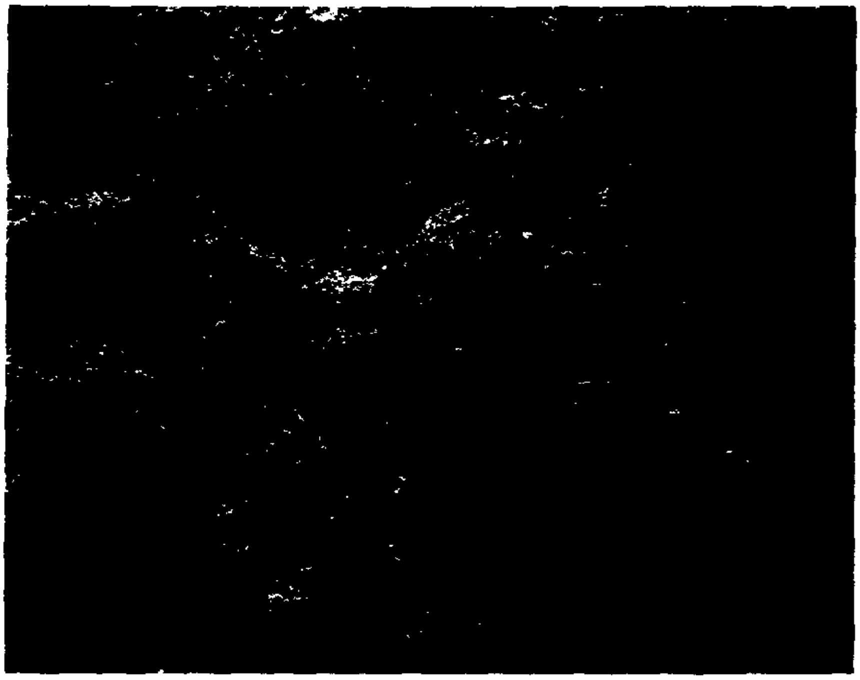
Quartz, K-feldspar and mica primary grains with chlorite and illite coatings.

S.E.M. Observations (contd)

Core C Magnification x 1250

Chlorite

S.E.M. Observations (contd)



Core D Magnification x 160

Photo 7

S.E.M. Observations (contd)

Core D Magnification x 640

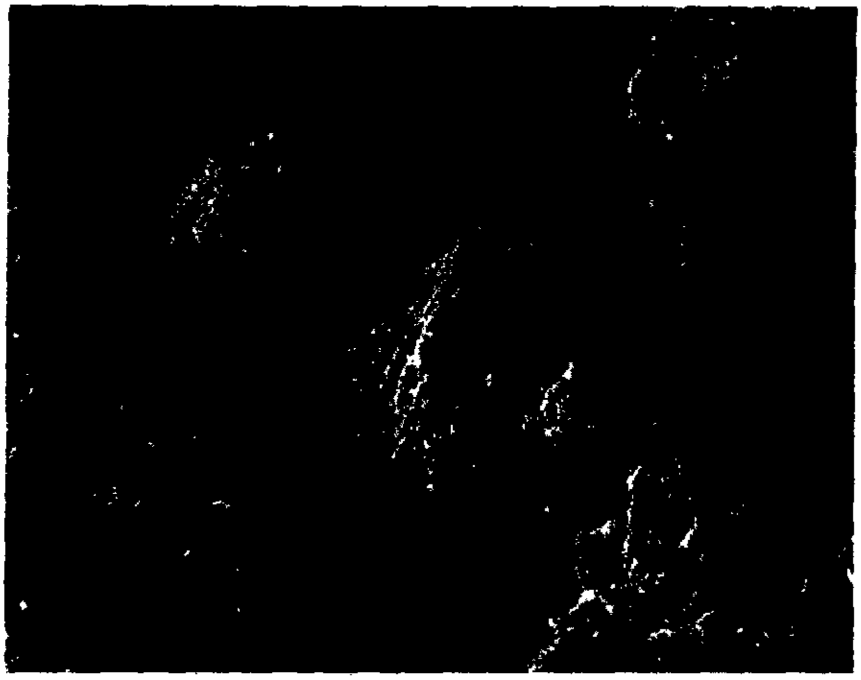
Photos 7 and 8 show the dominantly quartz primary grains with silt coatings.

Photo 8

S.E.M. Observations (contd)

Core E Magnification x 160

S.E.M. Observations (contd)



Core E Magnification x 640

Photos 9 and 10 show that sample E is very similar in form to sample D with quartz grains coated by silt.

Photo 10

DOLOMITE SECTION

EUROPEAN REGION TECHNICAL CENTRE

REPORT No CS-83-43

PARTIAL ROCK ANALYSIS

CLIENT- PHILLIPS
DATE- 28 July 1983
D.S. CONTACT- R COOPER

AUTHOR(S)

COLIN SIM

MANAGER- C. KEARY

INFORMATION REQUESTED

Solubility in 15X and mud acid and scanning electron microscope examination with EDAX analysis.

SAMPLES TESTED

Three small samples of rock debris were received in the lab, labelled:-

A	-	COD 7/11-7	15,926 ft Calc siltstone
B	-	COD 7/11-7	15,958 ft Dolomite
C	-	COD 7/11-7	15,967 ft Calc claystone

All chemicals used came from laboratory stock.

SUMMARY OF RESULTS

Sample A was found to be 12.0% soluble in 15X and 50.0% soluble in RMA.

Sample B was found to be 37.0% soluble in 15X and 80.0% soluble in RMA.

Sample C was found to be 11.0% soluble in 15X and 56.0% soluble in RMA.

Due to the poor quality and small size of the samples, it was not possible to perform detailed mineralogical analysis, but the labels already designated to the samples are fairly accurate, ie, A was a calcareous siltstone with a high clay content; B was either a dolomite or limestone (since the Mg content was fairly low); and C was a calcareous claystone consisting of mixed clays.

ACID SOLUBILITY

1 Hydrochloric Acid Solubility Tests

i) Procedure

One gram of pulverised formation was placed in 100 mls of 15% hydrochloric acid for one hour at 150°F. The solution was then filtered, then weighed. The amount of hydrochloric acid soluble material was calculated and reported as a percentage by weight.

ii) Results

SAMPLE	PERCENT SOLUBILITY IN 15% HYDROCHLORIC ACID
A	12.0
B	37.0
C	11.0

2 Mud Acid (12% Hydrochloric, 3% Hydroflouric Acid) Tests

i) Procedure

One gram of pulverised formation was placed in 15% hydrochloric acid for one hour at 150°F to remove any carbonates from the sample. This was done since calcium or magnesium fluoride precipitation could occur when hydrofluoric acid reacts with carbonate material.

The hydrochloric acid was then poured off and 100 mls of mud acid was added. After one hour at 150°F the solution was filtered and the residue dried and weighed.

ACID SOLUBILITY (Continued)

The amount of mud acid soluble material was calculated and reported as a percent by weight.

ii) Results

SAMPLE NUMBER	PERCENT SOLUBILITY IN 12-3 MUD ACID
A	50.0
B	80.0
C	56.0

S.E.M. STUDY

All samples were found to consist of quartz and calcite grains with a high percentage of mixed clays, differing only in the relative proportions of the constituents.

A had the highest proportion of quartz with fairly low carbonates and a high mixed clay content.

B had a high percentage of carbonates, mainly Ca, with some Mg; low quartz content and fairly high clay content.

C consisted almost entirely of clays with minor amounts of quartz and carbonates.

EDAX analysis showed all samples to contain the following elements;-
Si, Al, Na, Mg, K, Ca, Fe, Ba and Cl.

At the time of analysis no information was available on the drilling mud composition and consequently it was not possible to determine if any of these elements arose from mud damage.

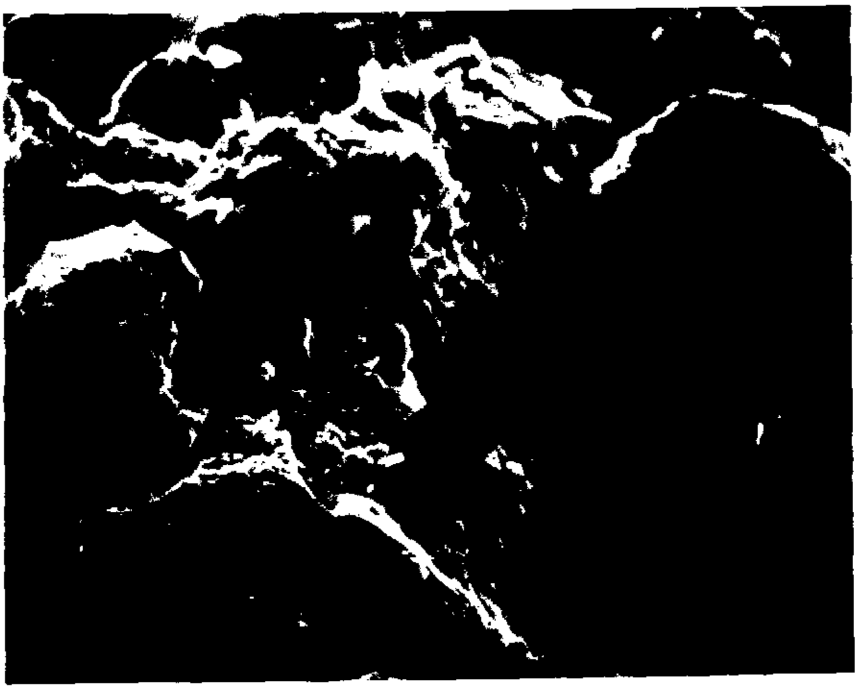
S.E.M. OBSERVATIONS

Sample A Magnification x 160

Quartz grains interspersed with Ca and Mg carbonate grains, coated with mixed clays.

Photo 1

S.E.M. OBSERVATIONS (Continued)



Sample A Magnification x 1250

Clay coatings on the primary grains.

S.E.M. OBSERVATIONS (Continued)

Sample B Magnification x 160

Primary carbonate grains with a high interstitial clay content.

Photo 3

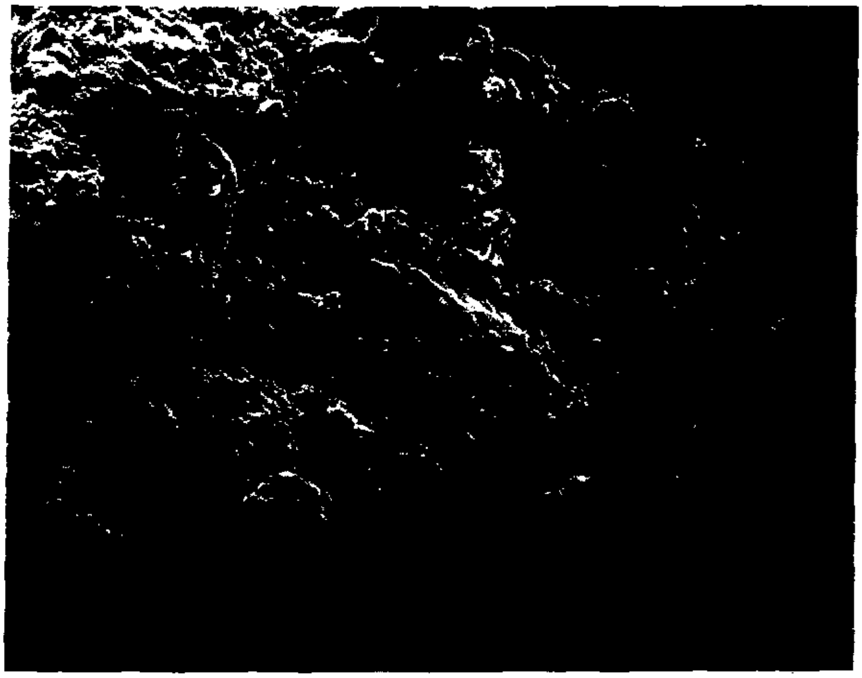
S.E.M. OBSERVATIONS (Continued)

Sample B Magnification x 1250

Clay coatings on the primary grains.

Photo 4

S.E.M. STUDY



Sample C Magnification x 160

Little granular texture is evident with the sample consisting almost entirely of clays.

Photo 5

S.E.M. OBSERVATIONS (Continued)

Sample C Magnification x 1250

Occasional silt-sized quartz grains in the clay matrix.

Photo 6

7/11-A6

file 7/11 A-6

EUROPEAN REGION TECHNICAL CENTRE

REPORT No CS-83-38

CORE ANALYSIS

CLIENT- PHILLIPS, NORWAY
DATE - 14 July 1983
D.S. CONTACT- R COOPER

AUTHOR(S)

COLIN SIM

MANAGER- C. KEARY

CONTENTS

1 INFORMATION REQUESTED

Core analysis to include permeability, porosity, acid solubility, iron content, water sensitivity, acid response, hardness and Scanning Electron Microscope study with EDAX analysis.

2 SAMPLES TESTED

Three core samples were received in the laboratory from the following depths:-

A - 14,928 ft
B - 14,941 ft
C - 14,948 ft

All chemicals used came from laboratory stock.

3 SUMMARY OF RESULTS

The following table summarises the results given in this report.

	CORE		
	A	B	C
Porosity	13.37%	12.63%	5.40%
Permeability	3.40 mD	4.77 mD	-*
Hardness	Medium Hard	Medium Hard	Medium Hard
15x Solubility	8.0%	13.0%	4.0%
RMA Solubility	35.0%	33.0%	41.0%
Iron Content	1130 ppm	4510 ppm	1570 ppm
Fresh Water Sensitivity	Not sensitive		
Sea Water Sensitivity	Not sensitive		
Acid Response	Permeability increased from 4.12 mD to 32.06 mD		
Mineralogy	>99% Quartz + Illite	>95% Quartz + calcite + illite	>99% Quartz + illite

* Permeability below the range of the permeameter.

4 PHYSICAL PROPERTIES

POROSITY

i) Procedure

The effective porosity was found by subtracting the absolute volume from the bulk volume of the sample. Clean, dry cores were used, the bulk volume was determined using a mercury pycnometer and the absolute volume by an air compression pycnometer.

ii) Results

SAMPLE	Effective Porosity (%)
A	13.37
B	12.63
C	5.40

PERMEABILITY

i) Procedure

Clean, dry one inch diameter core plugs were placed in the permeameter, where nitrogen was flowed through them. The permeabilities were then determined from pressure and gas flow rate measurements using Darcy's Law.

ii) Results

SAMPLE	NITROGEN PERMEABILITY (md)
A	3.40
B	4.77
C	-*

* Below range of permeameter

PHYSICAL PROPERTIES (Continued)

FORMATION HARDNESS

i) Procedure

These tests were carried out by penetrating a water wet section of core with a 1/16 inch diameter spherical tip. DOWELL uses an arbitrary scale on which hardness is inversely proportional to the depth of penetration. The reported values are an average of a number of readings.

ii) Results

SAMPLE	HARDNESS	MODULUS OF ELASTICITY	POISSONS RATIO
A	Medium Hard	6.5×10^6 psi	0.22
B	Medium Hard	6.5×10^6 psi	0.22
C	Medium Hard	6.5×10^6 psi	0.22

5 CHEMICAL PROPERTIES

ACID SOLUBILITY

1 HYDROCHLORIC ACID SOLUBILITY TESTS

i) Procedure

One gram of pulverised formation was placed in 100 mls of 15% hydrochloric acid for one hour at 150°F. The solution was then filtered, then weighed. The amount of hydrochloric acid soluble material was calculated and reported as a percentage by weight.

ii) Results

SAMPLE	PERCENT SOLUBILITY IN 15% HYDROCHLORIC ACID
A	8.0
B	13.0
C	4.0

2 MUD ACID (12% HYDROCHLORIC, 3% HYDROFLUORIC ACID) TESTS

i) Procedure

One gram of pulverised formation was placed in 15% hydrochloric acid for one hour at 150°F to remove any carbonates from the sample. This was done since calcium or magnesium fluoride precipitation could occur when hydrofluoric acid reacts with carbonate material.

The hydrochloric acid was then poured off and 100 mls of mud acid was added. After one hour at 150°F the solution was filtered and the residue dried and weighed.

5 CHEMICAL PROPERTIES (Continued)

The amount of mud acid soluble material was calculated and reported as a percent by weight.

ii) Results

SAMPLE NUMBER	PERCENT SOLUBILITY IN 12-3 MUD ACID
A	35.0
B	33.0
C	41.0

IRON CONTENT

i) Procedure

The total iron content of the samples were measured using a Perkin-Elmer atomic absorption spectrometer calibrated with standard solutions of known concentration. One gram of pulverised formation was immersed in 100 mls of 15% hydrochloric acid for one hour at 150°F. The solution was then filtered to remove undissolved solids and then aspirated into the spectrophotometer, where the iron content was directly displayed.

ii) Results

SAMPLE NUMBER	IRON CONTENT
A	1130 ppm
B	4510 ppm
C	1570 ppm

5 CHEMICAL PROPERTIES (Continued)

ACID RESPONSE TESTS (ARC III)

i) Procedure

One inch diameter cylindrical core plugs were placed in the Hassler sleeve holder of the flow test apparatus, a confinement pressure was then applied to the outside of the sleeve to eliminate fluid flow along the core-sleeve interphase.

The tests were run at a chosen temperature during which the core permeability was monitored using measurements of differential pressure and the volume of fluid passed through the core.

The initial permeability to an inert fluid (sea water) was first measured; after treating fluids had been passed through the core this measurement was repeated to assess the success of the acid treatment.

The treatment carried out on the core consisted of a 15x pre-flush & 12-3 Mud Acid main stage.

ii) Results

Core B

Test Temperature = 80°F

FLUID	STABILIZED PERMEABILITY
Sea Water	4.12 mD
15x (216mls)	3.83 mD
12-3 Mud Acid (440 mls)	30.90 mD
Sea Water	32.06 mD

This represents an increase in permeability to sea water of almost 8 fold.

PETROGRAPHIC DESCRIPTION

The cores were all found to be medium grained sandstone, consisting in all cases, of over 95% quartz.

Core A consisted of over 99% quartz with the primary grains being cemented by secondary quartz and the only other mineral detected was illite.

Illite typically occurs as a fibrous coating on the host grains. This structure gives a very large surface area and therefore the presence of illite can cause the formation to hold large amounts of bound water in the micropores. The introduction of fresh water into an illite - rich formation can also cause a certain amount of swelling of the illite which leads to a reduction in permeability.

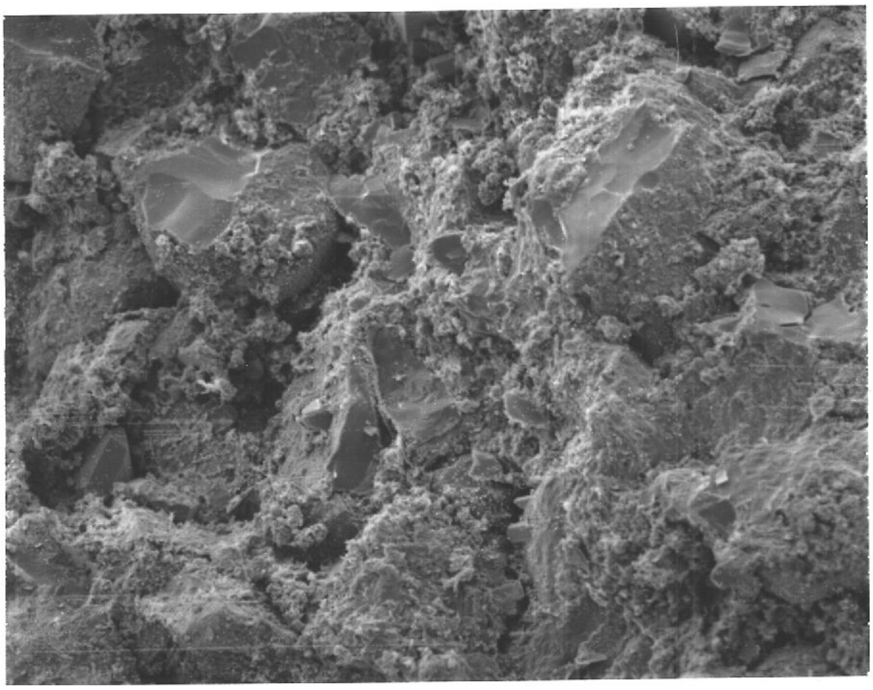
However, in the sensitivity testing carried out in the lab, no detrimental effects on permeability were noted, when flowing fresh or sea water through the cores, so in this case, the effects of illite are minimal.

Core B was very similar to core A, except that a small amount of calcite was present.

This explains the higher solubility of this core in 15x.

Core C was similar to core A in that it consisted of over 99% quartz plus illite, but the degree of cementing by secondary quartz was much greater with very little pore space remaining, resulting in very low permeability.

S.E.M. OBSERVATIONS

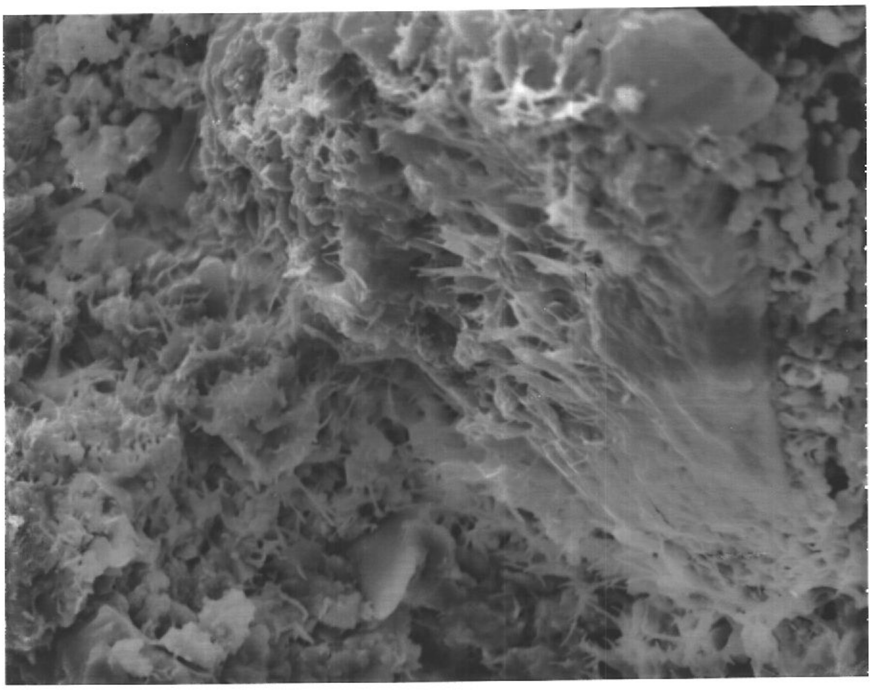


Core A Magnification x 160

The primary quartz grains with secondary quartz cement and illite coatings.

Photo 1

S.E.M. OBSERVATIONS (Continued)

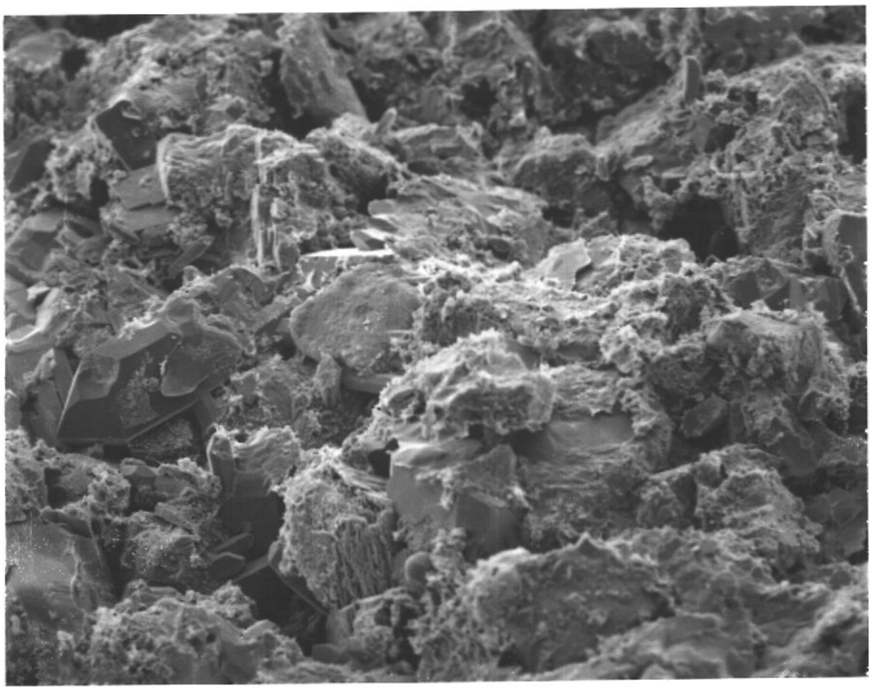


Core A Magnification x 1250

Fibrous illite coating a primary grain.

Photo 2

S.E.M. OBSERVATIONS (Continued)

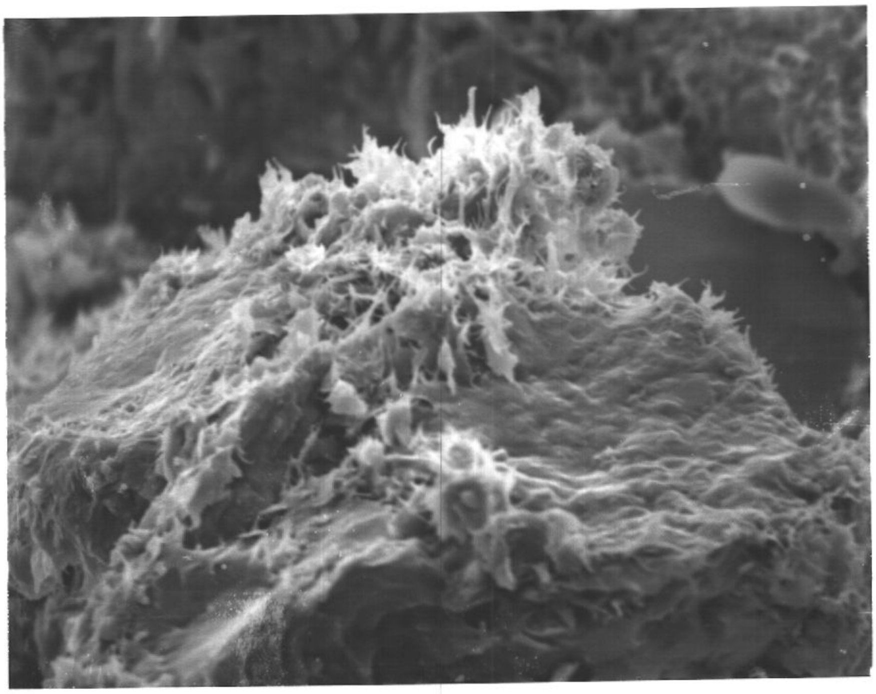


Core B Magnification x 160

Very similar to core A in morphology except that this core contains a small amount of secondary calcite.

Photo 3

S.E.M. OBSERVATIONS (Continued)

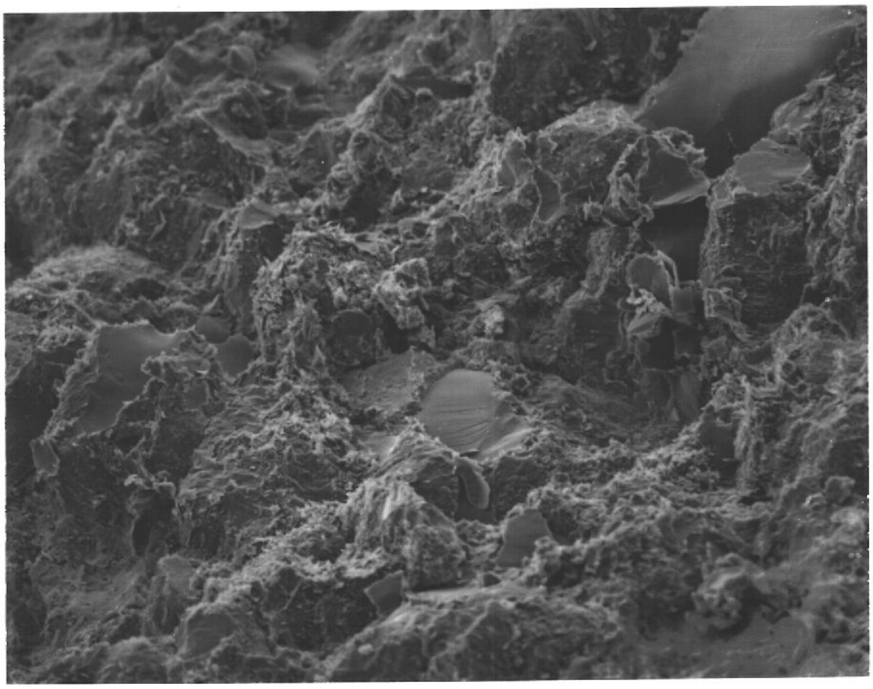


Core B Magnification x 1250

Illite

Photo 4

S.E.M. OBSERVATIONS (Continued)

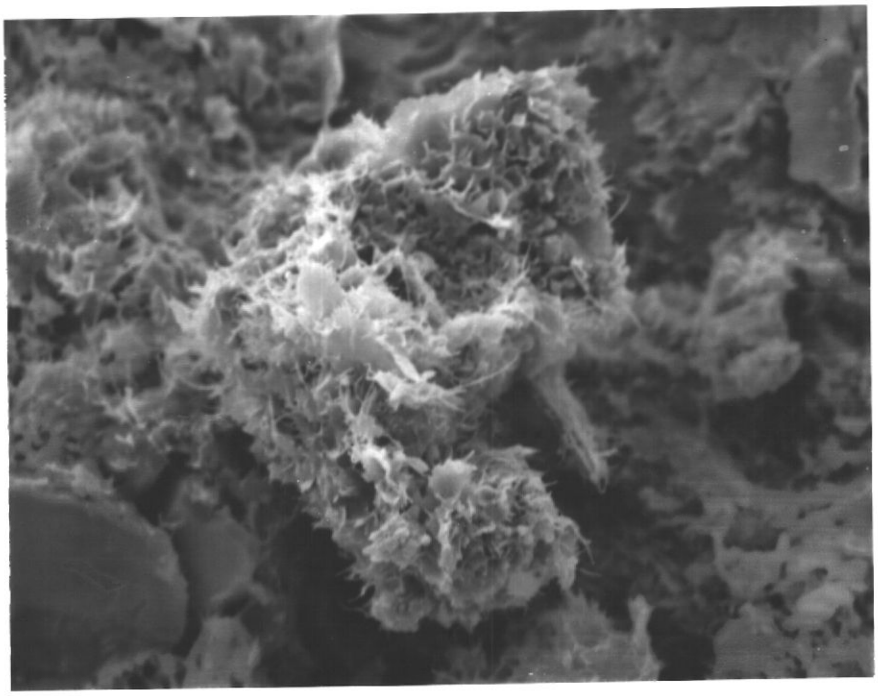


Core C Magnification x 160

The original pore spaces in this core have been almost completely filled by secondary minerals resulting in very low permeability.

Photo 5

S.E.M. OBSERVATIONS (Continued)



Core C Magnification x 1250

Coatings of illite are common in this core as in the others.