PRELIMINARY RESULTS OF MINERALOGY AND PETROLOGY OF THE HIGH FLUVIAL I INTERVAL (DEPTH 4840-4960 ft) DRILL CORE MWX-1

by

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MULTI-WELL EXPERIMENT PROGRAM

This report is preliminary and has not been edited or reviewed for conformity with Bendix Field Engineering, Department of Energy, Sandia National Laboratories, or U.S. Geological Survey Standards

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TABLE OF CONTENTS

INTRODUCTION

Sandia National Laboratories is conducting and directing the Multi-Well Experiment (MWX) core analysis program as part of the Western Gas Sands Project for the Department of Energy's Unconventional Gas Sands Program. Sandia National Laboratories will carry out sample selection, sample distribution, prioritization of analyses, distribution of data, and coordination of interagency analyses. The U.S.G.S., along with Sandia, will provide interpretation of analytical results. A sedimentological model of the Mesaverde Group at the Multi-Well site will be published by J.C. Lorenze (Sandia).

The Petrology Laboratory of Bendix Field Engineering Corporation is providing routine mineralogic and petrologic analyses of MWX core samples and interpretations, as detailed in this report. These are preliminary results to be used primarily for characterization of the general mineralogy and textures of an interval so that variations in mineralogic trends can be delineated. This report is the seventh of fifteen which will present the results of petrologic analyses of the fifteen intervals to be submitted from drill holes MWX-1 and 2. Included here are mineralogic and petrologic data from the High Fluvial I Interval of drill hole MWX-1.

PROCEDURES

SAMPLE PREPARATION

Twenty-seven samples were submitted from the High Fluvial I Interval which extends from hole depths of 4840 ft to 4960 ft (drill hole MWX-1). The samples were received December 17, 1982 and consisted entirely of end-chips of core plugs which were used for routine core analysis. Thin section preparation, thin section analyses, clay mineral analyses, other X-ray diffraction analyses and scanning electron microscopy/energy dispersive spectrometry (SEM/EDS) were done as described for the Coastal Interval, MWX-1.

RESULTS

LITHOLOGY

The general rock types of the High Fluvial I Interval are very similar to those of the previous intervals. The overall texture and mineralogy of these samples are similar to those of the Fracture Zone Interval. This is not surprising because both are fluvial sands.

The sandstones are generally moderately sorted although most of the finer-grained sands are well sorted and the coarsest sands more poorly sorted. The average grain size of the detrital framework ranges from very fine sand-sized to medium sand-sized. Some detrital grains up to very coarse sand-sized are common in the samples near the bottom of the interval. The sandstones are well compacted with concavo-convex and sutured grain contacts. Cementation is mostly by quartz overgrowths and pressure solution. Carbonate cement is much less extensive in these samples than in those from previously studied intervals.

Although the general rock types are very similar throughout the interval, subtle changes in texture and mineralogy are fairly frequent. Some notable trends include an increase in grain size and lithic content toward the bottom of the interval. Other changes in lithology are discussed below. Changes in mineralogy and porosity will be discussed in more detail in their separate sections.

4842.8-4879.3 ft zone

Detrital grains are fine sand-sized. This zone is generally more feldspar-rich than the lower zones. The top sample (4842.8 ft) contains extensive clay matrix and is poorly sorted (Photo 1). Calcite veins cut through the next two samples (4844.6 and 4846.8 ft) (Photo 2) which also contain more calcite cement and a corresponding decrease in clay matrix. The rest of the samples in this zone are more uniform in texture. They contain less matrix than the top sample and are slightly coarser-grained.

4881.6-4902.5 ft zone

The upper sample in this zone is somewhat bimodal with distinct horizons containing silt-sized or fine sand-sized detritus. This sample is probably a transition between the fine sand-sized sandstones in the zone above and the siltstone in the next lower sample (4898.5 ft). Bedding in this siltstone grades from very fine sand- to silt-sized. The bottom sample in this zone is slightly coarser-grained than the siltstone.

4904.5-4913.8 ft zone

This zone is characterized by a gradual increase in grain size from very fine sand to fine sand (top to bottom).

4917.5 ft zone

This sandstone is much coarser-grained (medium sand-sized) and less well sorted than in the above zone.

4920.5 ft zone

This sample displays a graded bedding between silt-sized and very fine sand-sized. It is also very feldspar-rich and contains substantial clay matrix.

4928.6 to 4949.8 ft zone

This zone is characterized by a general increase in grain size from fine sand to medium sand-sized (top to bottom). These sandstones are also more

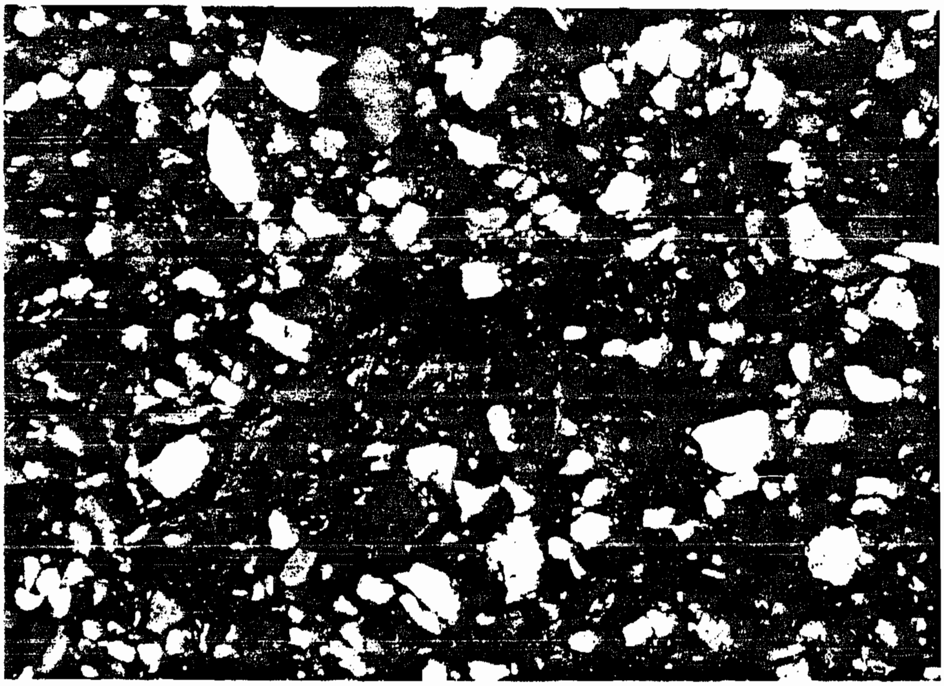

Photo 1. Poorly sorted sandstone with abundant matrix. 4242.8 ft, 40x, crossed polarizers.

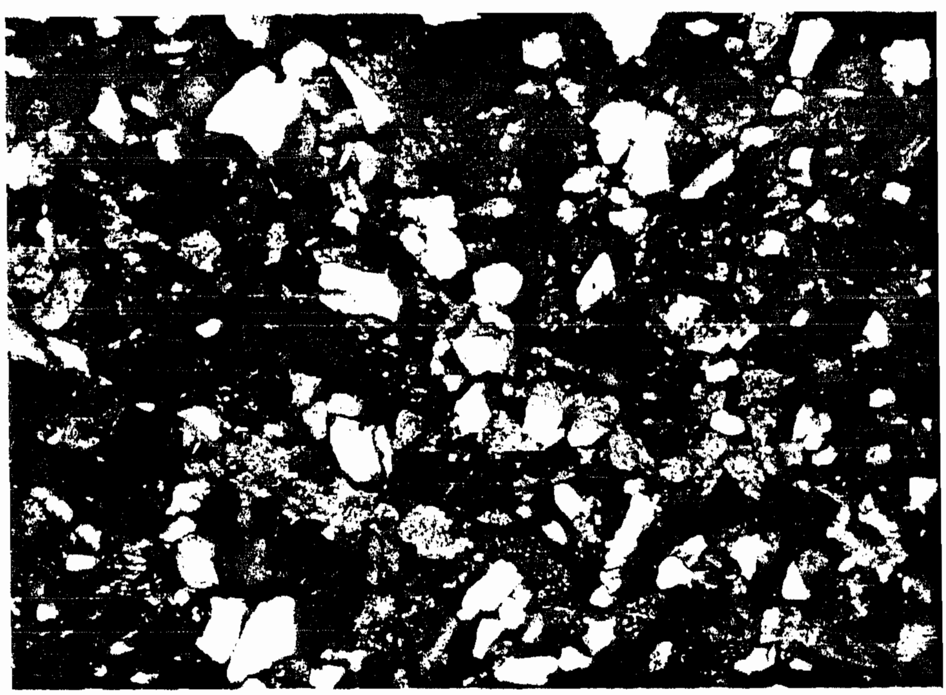

Photo 2. Calcite veins cutting through sandstone 4844.5 ft, 40x, crossed polarizers.

poorly sorted than in the other zones, especially toward the bottom where the grain size is coarsest. The bottom sample of the zone contains significantly more calcite cement than any of the other sandstones.

<u>4951.2 ft zone</u>

The bottom sample in the interval is a mudstone containing a wide size range of detritus floating in clay.

<u>MINERALOGY</u>

As mentioned previously, the overall detrital mineralogy is very similar to other intervals, but a few significant differences are evident. The detrital framework consists of quartz, feldspar, lithics, and chert. Muscovite, biotite, and opaques are minor constituents. Accessory minerals include zircon, tourmaline, apatite, garnet, and rutile/anatase? Carbonaceous material is rare. Characteristics of the detrital mineralogy are outlined below.

<u>Quartz</u> - Mostly monocrystalline, but more polycrystalline varieties than in previously studied intervals, especially in the coarser-grained samples. Rutilated grains are common.

<u>Feldspars</u> - Plagioclase is the predominant feldspar mineral, but K-feldspar (microcline) is more abundant than in any of the previous intervals. Alteration of the plagioclase varies from nil to extensive and is generally clay and/or sericite. K-feldspar alteration to clay is slight. Albitization of feldspars is common, but is predepositional.

<u>Lithics</u> - The most common lithics are plutonic (granitic), sedimentary and volcanic rock fragments. A few metamorphic (schist) fragments are present. Plutonic rock fragments are much more abundant than in the previously studied intervals and are the predominant lithics

found in this interval. In general, the coarser-grained lithics are plutonic and the finer-grained lithics are sedimentary and volcanic. This is especially true in the lower one-third of the interval. Volcanic rock fragments are also more abundant in this interval. There is a distinct lack of the detrital carbonate (dolomite) which is prevalent in the Coastal, Paludal and blanket sand Intervals.

Chert - Chert is fairly clear. None of the very cloudy chert with rhombohedral dolomite inclusions, which were common in the Coastal, Paludal, and blanket sand Intervals, were observed.

Accessory Minerals - Accessory minerals are very fine sand- to silt-sized and fairly well rounded. They are generally scattered, but in the middle one-third of the interval are commonly found in placer-like lenses (Photo 3) and along bedding planes.

Other detrital constituents include carbonaceous debris and mudstone clasts several times larger than the detrital framework. These constituents are sparse and found only in a few samples. Organic material is associated with the mudstone fragments and is probably derived from them (Photo 4).

Authigenic minerals include calcite, secondary quartz overgrowths and clay minerals. Clay mineralogy will be discussed separately. Secondary quartz overgrowths are common on detrital quartz in all the samples. As mentioned previously, calcite cement is not as extensive as in previous intervals and rarely exceeds two or three percent of the mode. The calcite is generally patchy, but in the samples containing calcite veins some poikilotopic areas are present. Much of the calcite is twinned (throughout the interval), but not to the extent as in previously studied intervals. Dolomitization of calcite is very slight.

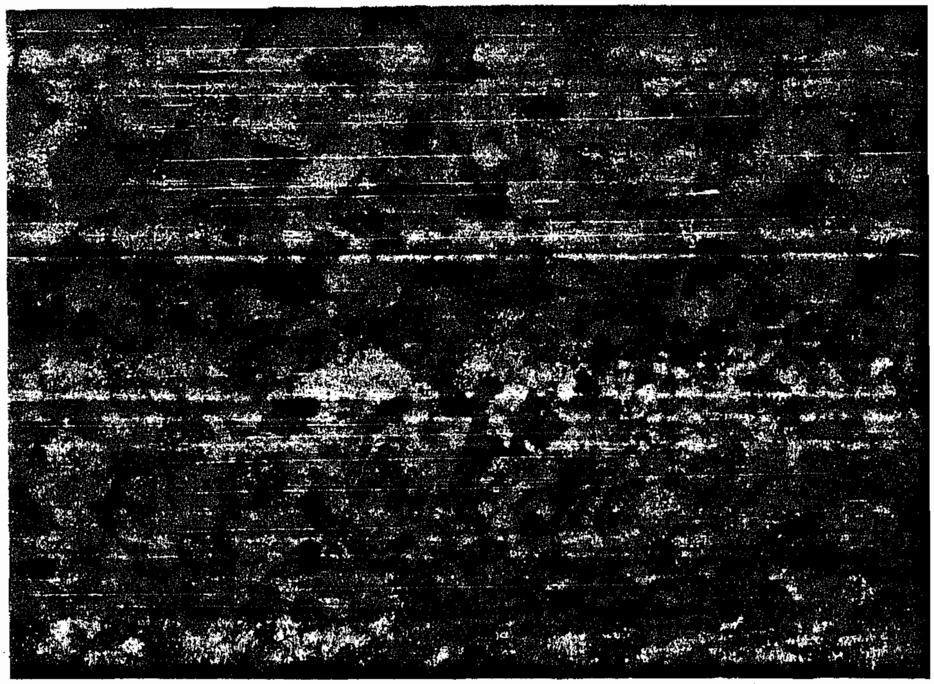

Photo 3. Concentration of heavy minerals in a placer. 4904.5 ft, 40x, plane polarized light.

Photo 4. Organic material being squeezed out of a squashed mudstone clast. 4853.1 ft, 40x, plane polarized light.

CLAY MINERALOGY

Clay minerals occurring in the High Fluvial I Interval include illite, illite/montmorillonite mixed-layer clay, kaolinite, and chlorite. A chlorite/ montmorillonite mixed-layer clay may also be present.

The presence of the chlorite/montmorillonite has not been confirmed as X-ray diffraction analyses have been inconclusive. A small 32 Å (2.75°2Θ) reflection occurs on X-ray diffraction (XRD) patterns of glycolated clays in some of the samplès, which would indicate a 1:1 regular interstratification of chlorite and montmorillonite expanded after glycolation. However, a 28 Å (2.15°2Θ) reflection should be present on patterns of air-dried clays. The presence of this peak has not been confirmed (Chart 1). This may indicate that the chlorite/montmorillonite is very poorly crystalline and/or occurs in insufficient quantity (less than 5 percent of the clay fraction) for detection by X-ray diffraction.

The illite/montmorillonite appears to contain more interstratified montmorillonite than in that found in previously studied intervals. XRD patterns of air-dried clay show a peak at 10.8 Å (8.2°2Θ) as opposed to a 10.4 Å (8.45°2Θ) reflection for illite and illite/montmorillonite in the previously studied intervals. Upon glycolation a pronounced step to 12.6 Å (7.8°2Θ) occurs as opposed to an 11.0 Å (8.0°2Θ) step in previous intervals. Also the illite peak at 10.0 Å (8.75°2Θ) (after glycolation) is of lower intensity when compared with XRD patterns from the other intervals (Chart 1). This would indicate that there is up to twice as much interstratified montmorillonite as in the previously studied intervals.

Illite (illite and illite/montmorillonite always occur together and will be referred to as illite) occurs in intergranular pore space and dissolution pores. When filling pores caused by dissolution of feldspars it

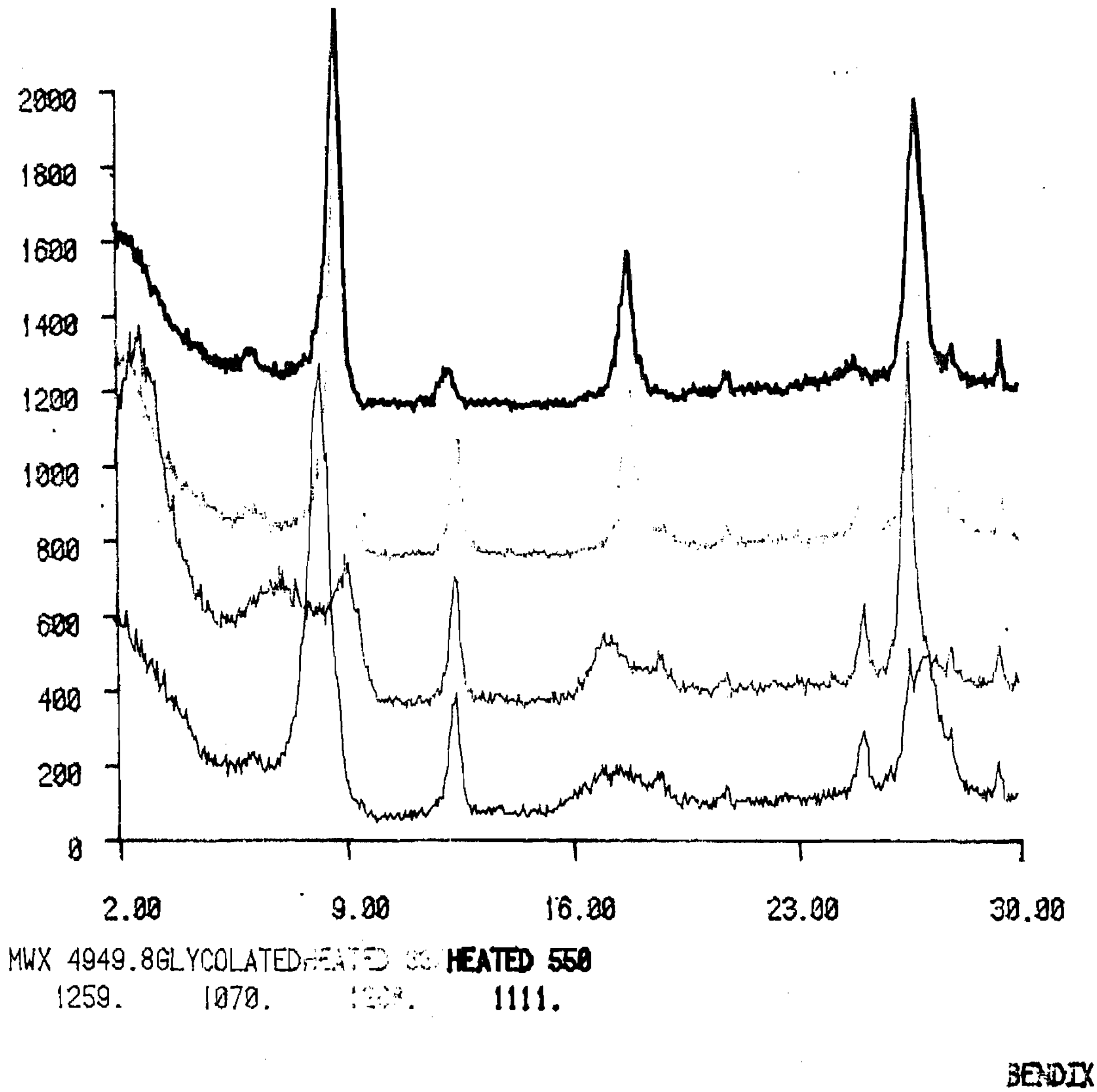

Chart 1. X-ray diffraction patterns of (bottom to top) air-dried clay, glycolated clay, clay heated to 330°C and clay heated to 550°C. Note the distinct 32 Å (2.75°2Θ) peak and the pronounced shoulder at 12.6 Å (7.8°2Θ) on the glycolated patterns.

always occurs in patches of randomly oriented flakes. When filling intergranular pore space in samples above 4934.5 ft it also occurs as patches of randomly oriented flakes. At 4934.5 ft the illite conforms to the shape of the detrital grains and the clay flakes are aligned parallel to grain surfaces. Below 4934.5 ft the illite often occurs as thin flakes oriented perpendicular to, and coating grain surfaces (Photo 5). SEM/EDS analysis as well as XRD analyses confirm this clay to be illite.

Kaolinite generally occurs in kaolinized feldspars and sometimes in intergranular pore space. Chlorite occurs as intergranular patches and as alteration of biotite and volcanic rock fragments containing mafics.

Illite is the predominant clay mineral in most of the interval, but kaolonite is dominant in a few samples. Chlorite is a minor constituent. A comparison of the clay minerals is presented in Table I. This table provides a general comparison of XRD peak heights without consideration to differences in crystallinity.

POROSITY

Compaction, quartz overgrowths, and clay minerals have effectively reduced all the primary pore space in these sandstones. In many areas the detrital framework is totally fused. Therefore, almost all the pore space is secondary, caused by dissolution of feldspars (Photo 6), lithics, and calcite cement (Photo 7). Above 4935.5 ft nearly all the pore space is filled with clay and open pore space is rare. Below 4935.5 ft open pore space is more common (up to 4 percent), but these pores are lined with the illite which occurs as grain cotaing perpendicular to grain surfaces. Primary pore space is also more common in these lower samples. In general, the point counted porosity values appear lower in the High Fluvial I Interval than in most of the previously studied intervals.

Photo 5. Authigenic clay coating grains and forming perpendicular to grain surface. 4937.6 ft, 400x, crossed polarizers.

TABLE I

COMPARISON OF CLAY MINERALS
HIGH FLUVIAL I INTERVAL MWX-1

Depth[1]	Illite and Illite/Montmorillonite	Kaolinite	Chlorite	Chlorite/ Montmorillonite?
4842.8	Dom	Min	tr	tr
4844.6	Mod	Dom	Min	tr
4846.8	Dom	Min	tr	-
4849.5	Dom	Dom	Min	-
4879.3	Subd	Dom	Min	-
4881.6	Mod	Dom	Min	-
4898.5	Dom	Mod	tr	tr
4902.5	Dom	Min	tr	tr
4904.5	Dom	Mod	tr	-
4913.8	Dom	Mod	tr	-
4917.5	Mod	Dom	tr	-
4920.5	Mod	Dom	tr-Min	-
4928.6	Min	Dom	Min	-
4931.5	Dom	Dom	Min	-
4934.5	Dom	Mod	Min	-
4935.5	Dom	Min	tr	tr
4947.4	Dom	Mod	tr	tr
4949.8	Dom	Mod	tr	tr
4951.2	Dom	Mod	Min	-

Dom = Dominant (strongest peak)
Subd = Subdominant (peak nearly as strong as dominant peak)
Mod = Moderate (peak approximately 1/2 as strong as dominant peak)
Min = Minor (peak approximately 1/3 as strong as dominant peak)
tr = trace (very small peak)

[1]Only samples which had clay mineral analyses done are listed.

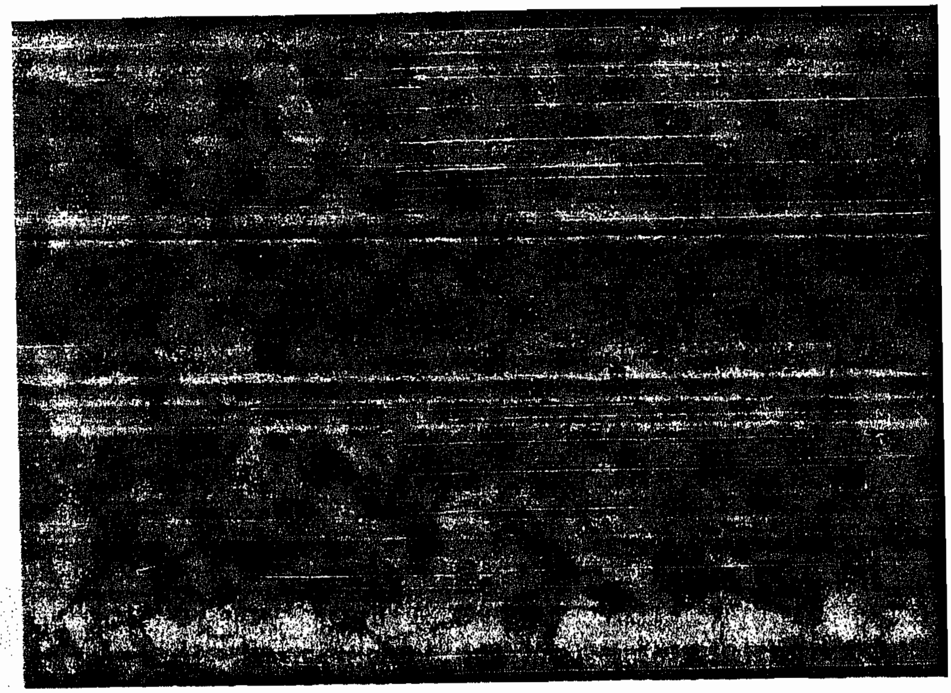

Photo 6. Secondary porosity formed by dissolution of a feldspar grain. 4851.8 ft, 64x, plane polarized light.

Photo 7. Secondary porosity formed by dissolution of calcite which has previously replaced a feldspar grain. 4846.8 ft, 160x, plane polarized light.

DIAGENESIS

The diagenetic sequence interpreted for the High Fluvial I Interval is very similar to the sequence interpreted for the previously studied intervals. Some minor differences are apparent and some diagenetic processes are difficult to place. The diagenetic sequence is as follows (early to late):

- Early authigenic clay?
- Compaction
- Feldspar alteration
- Formation of chlorite
- Quartz overgrowths
- Calcite cement
- Secondary porosity
- Authigenic clay

Many of these processes occurred contemporaneously and continued throughout the remainder of the sequence.

It should be noted that the early calcite cement which was interpreted in the previously studied intervals is not present in this sequence. There is no evidence for the early calcite stage in this interval. These sandstones are very well compacted, especially above 4934.5 ft, and an early calcite stage would have kept the framework more open during compaction.

The authigenic clay which is oriented perpendicular to grain surfaces in samples below 4934.5 ft is interpreted as occurring early in the sequence, but some arguments can be made for it being a late diagenetic process. Evidence for the clay occurring early is as follows:

- Clay coats most grains, including along contacts, inhibiting compaction and preserving primary pore space (Photo 8)
- Quartz overgrowths do not occur on grains coated with clay
- Lines pores prior to calcite fillings (Photo 9)
- Forms remnant grain boundaries of dissolved grains (Photo 10)

Evidence that this may be a later diagenetic process is as follows:

- This clay texture appears to be too fragile to have withstood all the later diagenetic processes.
- In a few areas it was observed lining dissolution cavities in calcite.

Evidence for the clay being an early process appears to outweigh the evidence for a late process. Evidence for the position of the other diagenetic processes is as presented in the previous reports.

SUMMARY

The sandstones in the High Fluvial I Interval are similar in most aspects as those in previously studied intervals. The major differences are an increase in grain size and feldspar content, and a decrease in carbonate cement.

Reduction in pore space due to compaction and quartz overgrowths appear to be more of a factor limiting porosity and permeability in this interval than in the previously studied intervals. Pore space is mostly secondary and is nearly all clay-filled. This clay filling is the primary factor limiting the permeability.

Photo 8. Authigenic clay coating all grain surfaces including along grain contacts. 4937.6 ft, 160x, crossed polarizers.

Photo 9. Calcite filling pore space previously lined with authigenic clay. 4949.8 ft, 400x, crossed polarizers.

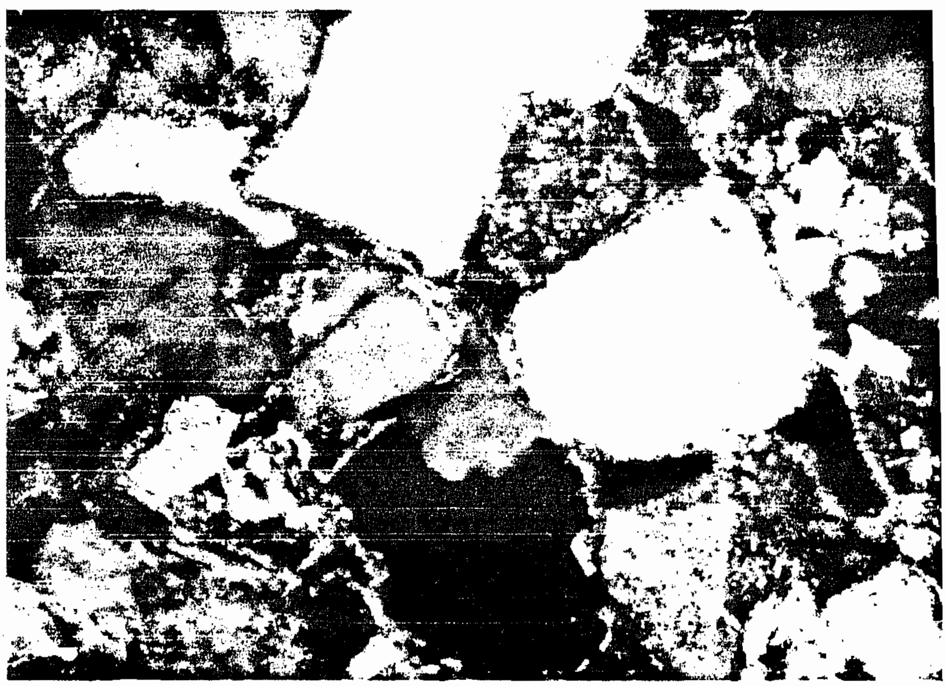

Photo 10. Authigenic clay forming remnant grain boundaries in secondary pore space. 4937.6 ft, 160x, crossed polarizers.

APPENDIX A

SUMMARY OF RESULTS
HIGH FLUVIAL I INTERVAL, MWX-1

DEPTH (ft)	ROCK NAME*	GR. SIZE (mm)	% PORE SPACE	% CALCITE	SORTING	CLAY ANALYSES (BY XRD)
4842.8	Arkose	0.14	tr	tr	P	X
4844.6	Lith. Arenite	0.13	13	3**	W	X
4846.8	Arkose	0.15	6	10**	M-W	X
4849.5	Arkose	0.16	9	1	M-W	X
4851.8	Lith. Arenite	0.16	12	1	M	-
4853.1	Feld. Lith.	0.17	8	2	M	-
4879.3	Feld. Lith.	0.17	14	1	M-W	X
4881.6	Litharenite	0.08	9	4	M	X
4898.5	Siltstone	Silt	tr	tr	VW	X
4902.4	Sublitharenite	0.08	10	-	W	X
4904.5	Sublitharenite	0.10	7	tr	W	X
4906.5	Subarkose	0.12	12	tr	M-W	-
4911.5	Feld. Lith.	0.15	11	1	M-W	-
4912.5	Lith. Arenite	0.14	10	1	M-W	-
4913.8	Feld. Lith.	0.16	13	-	M-W	X
4917.5	Lith. Arenite	0.28	12	1	M	X
4920.5	Arkose	0.07	3	2	W	X
4928.6	Feld. Lith.	0.17	4	3	M	X
4931.5	Feld. Lith.	0.11	15	1	M	X
4934.5	Feld. Lith.	0.27	12	1	M	X
4935.5	Feld. Lith.	0.16	12	3	M	X
4937.6	Feld. Lith.	0.27	15	2	M	-
4942.4	Feld. Lith.	0.21	13	tr	M	-
4944.3	Feld. Lith.	0.23	12	2	M	-
4947.4	Feld. Lith.	0.27	17	2	M-P	X
4949.8	Calc. Feld. Lith.	0.38	7	16	M-P	X
4951.2	Mudstone	Clay	tr	tr	P	X

* Classification from Folk, R.L., 1980, Petrology of Sedimentary Rocks (2d ed.): Sustin, Texas, Hemphill Publishing Company, 184 p.

** These samples also contain vein calcite.

APPENDIX B

PRIORITY INTERVALS AND THE TENTATIVE DATES OF COMPLETION (IN ORDER OF PRIORITY) FOR MINERALOGY AND PETROLOGY ANALYSES

(Revised 12-1-82)

Priority	Depth	Well	Interval	Tentative Completion Date
1	6435–6580	MWX-1	Coastal	07-02-82
2	7817–7900	MWX-1	Cozzette	07-20-82
3	7832–8141	MWX-2	Corcoran & Cozzette	08-31-82
4	5690–5870	MWX-1	Fracture Zone	10-18-82
5	7080–7390	MWX-2	Paludal	12-22-82
6	6400–6580	MWX-2	Coastal	01-22-83
7	4840–4960	MWX-1	High Fluvial I	02-26-83
8	4180–4400	MWX-1	Top	03-26-83
9	5690–5870	MWX-2	Fracture Zone	04-23-83
10	4490–4830	MWX-1	High Fluvial II	06-04-83
11	4690–5300	MWX-1	Mid Fluvial I	07-16-83
12	5300–5690	MWX-1	Mid Fluvial II	09-03-83
13	5870–6345	MWX-1	Low Fluvial	10-22-83
14	6580–6830	MWX-1	Bottom Fluvial	11-24-83
15	4880–4950	MWX-2	High Fluvial I	12-31-83

APPENDIX C

PETROGRAPHIC DATA SHEETS
HIGH FLUVIAL I INTERVAL
MWX-1

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4842.8
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: Feburary 3, 1983

Rock Type: Arkose
Mean Grain Size (mm): 0.14
Grain Size Range (mm): Clay to 0.48

% Pore Space: Tr
Sorting (est.): Poor
Angularity (est.): A to SR

GENERAL DESCRIPTION: This sample consists of sand sized detritus floating in a clay/silt matrix. Grain contacts are common. Primary pore space is non-existent and secondary pore space is slight. Sub-parallel fractures or microfaults filled with limonitic clay.

COMPOSITION	%	COMMENTS
Quartz	45	
K-Feldspar	5	
Plagioclase	10	
Chert	2	
Lithics	3	
Authigenic Minerals		
Silica O. gr.	1	
Calcite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Tourmaline	tr	
Unknown	tr	Fe clay?
Voids w/Clay	tr	
Clay Minerals	34	Non-impregnated matrix
Kaolinite (XRD)	Min	Authigenic patches
Illite (XRD)	Dom	With illite/montmorillonite
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Chlorite/montmorillonite (1:1), Poorly crystalline or poorly ordered

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4844.6
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: February 4, 1983

Rock Type: Lithic Arenite
Mean Grain Size (mm): 0.13
Grain Size Range (mm): 0.04 to 0.48

% Pore Space: 13
Sorting (est.): Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Detrital mineralogy is very similar to the previous sample; contains less matrix and is more tightly compacted; elongate grains show sub-parallel alignment; a calcite vein cuts across the sample; secondary moldic porosity is better developed in this sample than the previous sample and more of the clay matrix impregnated.

COMPOSITION	%	COMMENTS
Quartz	43	
K-Feldspar	1	
Plagioclase	15	
Chert	2	
Lithics	7	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	3	
Dolomite	tr	
Vein Calcite	3	Patchy cement
Muscovite	1	
Biotite	tr	
Opaques	tr	
Voids w/o Clay	tr	
Voids w/Clay	13	
Clay Minerals	10	Clay matrix
Kaolinite (XRD)	Dom	
Illite (XRD)	Mod	With mixed-layer illite/montmorillonite
Chlorite (XRD)	Min	Fill some intergranular pore space
Mixed Layer (XRD)	tr	Mixed-layer chlorite/montmorillonite (1:1) poorly crystallized or poorly ordered

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4846.8 | Petrologist: M. O. Eatough
INTERVAL: High Fluvial I | Date: February 4, 1983

Rock Type: Arkose | % Pore Space: 6
Mean Grain Size (mm): 0.15 | Sorting (est.): Moderate to Well
Grain Size Range (mm): 0.04 to 0.48 | Angularity (est.): A to SR

GENERAL DESCRIPTION: Detrital mineralogy is similar to previous samples; fairly extensive patchy calcite cement supports most detrital grains, but point contacts are extremely common. Broad (1.8 mm) calcite vein cuts across sample. Porosity is almost all secondary from dissolution of cement and detrital grains.

COMPOSITION	%	COMMENTS
Quartz	39	
K-Feldspar	tr	
Plagioclase	13	
Chert	1	
Lithics	6	
Authigenic Minerals		
Silica O. gr.	1	
Calcite	10	Patchy cement; poikilotopic in some areas around vein
Dolomite	tr	
Vein Calcite	6	Broad vein 1.8 mm
Muscovite	tr	
Biotite	tr	Chloritized
Opaques	tr	Some detrital; iron oxides? fill pockets in intergranular space
Accessory Minerals		
Zircon	tr	
Garnet	tr	
Voids w/o Clay	tr	
Voids w/Clay	6	
Clay Minerals	1	Non-impregnated clay
Kaolinite (XRD)	Min	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4849.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: February 25, 1983

Rock Type: Arkose
Mean Grain Size (mm): 0.16
Grain Size Range (mm): 0.06 to 0.66

% Pore Space: 9
Sorting (est.): Moderate to Well
Angularity (est.): A to R

GENERAL DESCRIPTION: Detrital mineralogy similar to previous samples; sparse calcite cement; porosity is mostly secondary intragranular moldic porosity; few microfractures with clay filling.

COMPOSITION	%	COMMENTS
Quartz	40	More polycrystalline grains than in previous intervals
K-Feldspar	2	
Plagioclase	24	
Chert	2	
Lithics	12	Few mudstone clasts slightly larger than other detritus
Authigenic Minerals		
Silica O. gr.	3	
Calcite	1	
Dolomite	tr	
Muscovite	1	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Garnet	tr	
Voids w/o Clay	tr	
Voids w/Clay	9	
Clay Minerals	5	Non-impregnated clay matrix
Kaolinite (XRD)	Dom	
Illite (XRD)	Dom	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4851.8
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: February 25, 1983

Rock Type: Lithic Arenite
Mean Grain Size (mm): 0.16
Grain Size Range (mm): 0.04 to 0.60

% Pore Space: 12
Sorting (est.): Moderate
Angularity (est.): A to R

GENERAL DESCRIPTION: Very similar to sample at 4849.5 ft.

COMPOSITION	%	COMMENTS
Quartz	51	
K-Feldspar	2	
Plagioclase	12	
Chert	2	
Lithics	12	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	1	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Garnet	tr	
Apatite	tr	
Voids w/o Clay	1	
Voids w/Clay	11	
Clay Minerals	6	
Kaolinite (Assumed)	Dom	
Illite (Assumed)	Dom	
Chlorite (Assumed)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4853.1
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: Febraury 25, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.17
Grain Size Range (mm): 0.04 to 0.54

% Pore Space: 8
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous two samples. Small fractures filled with opaques.

COMPOSITION	%	COMMENTS
Quartz	46	
K-Feldspar	3	
Plagioclase	9	
Chert	2	
Lithics	15	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	2	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	Chloritized
Opaques	tr	Could be carbonaceous material; some large patches
Accessory Minerals		
Rutile/Anatase	tr	Aggregates in mudstone clast(?)
Garnet	tr	
Zircon	tr	
Other	tr	Mudstone clasts several times larger than detritus
Voids w/o Clay	tr	
Voids w/Clay	8	
Clay Minerals	11	1% chlorite
Kaolinite (Assumed)	Dom	
Illite (Assumed)	Dom	
Chlorite (Assumed)	Min	(Optically 1%)

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4879.3
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: February 28, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.17
Grain Size Range (mm): 0.04 to 0.51

% Pore Space: 14
Sorting (est.): Moderate to Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous sample.

COMPOSITION	%	COMMENTS
Quartz	43	
K-Feldspar	4	
Plagioclase	10	
Chert	3	
Lithics	14	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	1	
Muscovite	tr	
Biotite	tr	
Opaques	tr	Organic? in stringers
Accessory Minerals		
Garnet	tr	
Apatite	tr	
Zircon	tr	
Voids w/o Clay	1	
Voids w/Clay	13	
Clay Minerals	8	
Kaolinite (XRD)	Dom	
Illite(XRD)	Subd	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4881.6
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: February 28, 1983

Rock Type: Litharenite
Mean Grain Size (mm): 0.08
Grain Size Range (mm): Silt to 0.30

% Pore Space: 9
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: This sample appears to be somewhat bi-modal with distinct horizons of fine sand sized detritus, and horizons with silt sized detritus. Heavy minerals are concentrated in the finer grained horizons. Extensive matrix appears to be formed from the breakdown of lithics and feldspars.

COMPOSITION	%	COMMENTS
Quartz	41	
K-Feldspar	2	
Plagioclase	2	
Chert	2	
Lithics	12	
Authigenic Minerals		
Silica O. gr	tr	
Calcite	4	
Biotite	tr	
Opaques	tr	Concentrated in finer horizons
Accessory Minerals		Concentrated in finer horizons
Zircon	tr	
Tourmaline	tr	
Apatite	tr	
Voids w/Clay	9	
Clay Minerals	27	
Kaolinite (XRD)	Dom	
Illite (XRD)	Mod	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4898.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: February 28, 1983

Rock Type: Siltstone
Mean Grain Size (mm): Silt
Grain Size Range: Clay to 0.12

% Pore Space: tr
Sorting (est.): Very Well
Angularity (est.): A to R

GENERAL DESCRIPTION: Silt detritus in a clay matrix. Bedding is somewhat graded with some beds being very fine sand sized. Detrital mineralogy is similar to other samples; feldspars are more extensively atlered. Clay-filled microfractures cut across the bedding.

COMPOSITION	%	COMMENTS
Clay Minerals		
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Chlorite/montmorillonite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4902.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 1, 1983

Rock Type: Sublitharenite
Mean Grain Size (mm): 0.08
Grain Size Range: Silt to 0.18

% Pore Space: 10
Sorting (est.): Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Slightly coarser grained than the siltstone of the previous sample. Compacted with clay and organic lenses squashed along bedding planes. Porosity is mostly microporosity in clays, but some secondary intragranular moldic porosity is evident.

COMPOSITION	%	COMMENTS
Quartz	52	
K-Feldspar	tr	
Plagioclase	7	
Chert	1	
Lithics	6	
Authigenic Minerals		
Silica O. gr.	3	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Other	3	Ferruginous (brown) clay
Voids w/o Clay	tr	
Voids w/Clay	10	
Clay Minerals	17	Matrix
Kaolinite (XRD)	Min	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Chlorite/montmorillonite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4904.5
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: March 1, 1983

Rock Type: Sublitharenite
Mean Grain Size (mm): 0.10
Grain Size Range (mm): 0.04 to 0.30

% Pore Space: 7
Sorting (est.): Well
Angularity (est.): A to R

GENERAL DESCRIPTION: Bedding is defined by vague horizons of heavy minerals, i.e., zircons, opaques, rutile(?).

COMPOSITION	%	COMMENTS
Quartz	52	
K-Feldspar	2	
Plagioclase	4	
Chert	2	
Lithics	5	Mainly clay clasts
Authigenic Minerals		
Silica O. gr.	1	
Calcite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	Concentrated along certain horizons
Rutile(?)	tr	
Mud/Clay Lens or Clast	20	Muddy lens or very coarse clast in thin section (Organics are concentrated at margin)
Voids w/o Clay	1	
Voids w/Clay	6	
Clay Minerals	8	
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4906.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 1, 1983

Rock Type: Subarkose
Mean Grain Size (mm): 0.12
Grain Size Range (mm): 0.04 to 0.54

% Pore Space: 12
Sorting (est.): Moderate to Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous sample; fractures and some intergranular pore space filled with opaques (organic? or iron oxides?). Some heavies concentrated in a placer-type lens.

COMPOSITION	%	COMMENTS
Quartz	61	
K-feldspar	1	
Plagioclase	6	
Chert	1	
Lithics	5	
Authigenic Minerals		
Silica O. gr.	6	
Calcite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Rutile	tr	
Voids w/o Clay	tr	
Voids w/Clay	12	
Clay Minerals	3	
Kaolinite (Assumed)	Mod	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4911.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 1, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.15
Grain Size Range (mm): 0.04 to 0.57

% Pore Space: 11
Sorting (est.): Moderate to Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Detrital mineralogy very similar to other samples; well compacted with sutured grain contacts. Many areas totally fused; pore space is mostly secondary intragranular moldic porosity.

COMPOSITION	%	COMMENTS
Quartz	55	
K-Feldspar	2	
Plagioclase	5	
Chert	4	
Lithics	12	
Authigenic Minerals		
Silica O. gr.	5	
Calcite	1	
Dolomite	tr	
Muscovite	2	
Biotite	tr	Altering to chlorite
Opaques	tr	
Accessory Minerals		
Zircon		
Apatite		
Voids w/o Clay	tr	
Voids w/Clay	11	
Clay Minerals	3	
Kaolinite (Assumed)	Mod	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	Also as altered biotite flakes

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4912.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 1, 1983

Rock Type: Lithic Arenite
Mean Grain Size (mm): 0.14
Grain Size Range (mm): 0.04 to 0.54

% Pore Space: 10
Sorting (est.): Moderate to Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous sample.

COMPOSITION	%	COMMENTS
Quartz	53	
K-Feldspar	2	
Plagioclase	13	
Chert	3	
Lithics	10	
Authigenic Minerals		
Silica O. gr.	6	
Calcite	1	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Apatite	tr	
Voids w/o Clay	tr	
Voids w/Clay	10	
Clay Minerals	2	
Kaolinite (Assumed)	Mod	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4913.8
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 2, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.16
Grain Size Range (mm): 0.14 to 0.51

% Pore Space: 13
Sorting (est.): Moderate to Well
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous sample.

COMPOSITION	%	COMMENTS
Quartz	48	
K-Feldspar	2	
Plagioclase	6	
Chert	3	
Lithics	22	
Authigenic Minerals		
Silica O. gr.	3	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	1	
Voids w/Clay	12	
Clay Minerals	3	
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4917.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 2, 1983

Rock Type: Lithic Arenite
Mean Grain Size (mm): 0.28
Grain Size Range (mm): 0.10 to 1.10

% Pore Space: 12
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: Very similar to previous samples except that grain size is increased substantially. Largest rock fragments are plutonic and sedimentary and volcanic fragments are generally finer grained than the average grain size.

COMPOSITION	%	COMMENTS
Quartz	55	
K-Feldspar	3	
Plagioclase	8	
Chert	2	
Lithics	10	
Authigenic Minerals		
Silica O. gr.	7	
Calcite	1	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	1	
Voids w/Clay	11	
Clay Minerals	2	
Kaolinite (XRD)	Dom	
Illite (XRD)	Mod	
Chlorite (XRD)	tr	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4920.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 2, 1983

Rock Type: Arkose
Mean Grain Size (mm): 0.07
Grain Size Range: Silt to 0.21

% Pore Space: 3
Sorting (est.): Well
Angularity (est.): A to R

GENERAL DESCRIPTION: This sample is very similar to the siltstone at 4898.5 ft. with graded bedding between silt sized and very fine sand.

COMPOSITION	%	COMMENTS
Quartz	40	
K-Feldspar	5	
Plagioclase	16	
Chert	1	
Lithics	8	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	2	
Dolomite	tr	
Muscovite	1	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/Clay	3	
Clay Minerals	22	As matrix
Kaolinite (XRD)	Dom	
Illite (XRD)	Mod	
Chlorite (XRD)	tr-Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4928.6
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: March 2, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.17
Grain Size Range (mm): 0.04 to 0.48

% Pore Space: 4
Sorting (est.): Moderate
Angularity (est.): A to R

GENERAL DESCRIPTION: Abundant totally fused areas with sutured grain contacts; few glauconite-looking pellets.

COMPOSITION	%	COMMENTS
Quartz	57	
K-Feldspar	4	
Plagioclase	9	
Chert	9	
Lithics	11	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	3	
Dolomite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Tourmaline	tr	
Unknown	tr	Glauconite pellets?
Voids w/o Clay	tr	
Voids w/Clay	4	
Clay Minerals	1	
Kaolinite (XRD)	Dom	
Illite (XRD)	Min	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4931.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 2, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.11
Grain Size Range (mm): 0.04 to 0.54

% Pore Space: 15
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: Elongate grains parallel to bedding. Detrital mineralogy similar to other samples; porosity is mostly microporosity in the matrix.

COMPOSITION	%	COMMENTS
Quartz	40	
K-Feldspar	4	
Plagioclase	11	
Chert	3	
Lithics	20	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	1	
Dolomite	tr	
Muscovite	tr	
Biotite	1	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	tr	
Voids w/Clay	15	
Clay Minerals	3	
Kaolinite (XRD)	Dom	
Illite (XRD)	Dom	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4934.5
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: March 2, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.27
Grain Size Range (mm): 0.04 to 0.75

% Pore Space: 12
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: Authigenic clay which fills intergranular pore space and coats detritus is different in appearance than the clay which fills pore space caused by total grain dissolution. This clay also conforms to the shape of the detrital grains.

COMPOSITION	%	COMMENTS
Quartz	47	
K-Feldspar	4	
Plagioclase	4	
Chert	11	
Lithics	11	Many plutonic
Authigenic Minerals		
Silica O. gr.	1	
Calcite	1	Generally occurs as feldspar replacement
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Garnet	tr	
Voids w/Clay	12	
Clay Minerals	9	
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	Min	

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4935.5
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 2, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.16
Grain Size Range (mm): 0.04 to 0.72

% Pore Space: 12
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: Intergranular clays coat detrital grains and are aligned perpendicular to grain surface; these clays only partially fill pore space and usually occur in primary pore space.

COMPOSITION	%	COMMENTS
Quartz	46	
K-Feldspar	2	
Plagioclase	8	
Chert	5	
Lithics	20	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	3	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	3	
Voids w/Clay	9	
Clay Minerals	2	
Kaolinite (XRD)	Min	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Chlorite/montmorillonite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4937.6
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 3, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.27
Grain Size Range (mm): 0.04 to 0.75

% Pore Space: 15
Sorting (est.): Moderate
Angularity (est.): A to R

GENERAL DESCRIPTION: Average grain size is coarser than previous sample (could be due to poor sorting) but is very similar.

COMPOSITION	%	COMMENTS
Quartz	48	
K-Feldspar	2	
Plagioclase	8	
Chert	3	
Lithics	17	
Authigenic Minerals		
Silica O. gr.	1	
Calcite	2	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Other	tr	Pockets of clay (could be large claystone clasts)
Voids w/o Clay	4	
Voids w/Clay	11	
Clay Minerals	3	
Kaolinite (Assumed)	Min	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	
Mixed Layer (Assumed)	tr	Illite/chlorite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4942.4
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 3, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.21
Grain Size Range (mm): 0.04 to 0.51

% Pore Space: 13
Sorting (est.): Moderate
Angularity (est.): A to SR

GENERAL DESCRIPTION: This sample is very similar to the previous sample except that there is very little primary pore space with clay coatings perpendicular to grain surfaces. Porosity is mostly secondary intragranular moldic porosity.

COMPOSITION	%	COMMENTS
Quartz	54	
K-Feldspar	3	
Plagioclase	10	
Chert	3	
Lithics	14	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	tr	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	tr	
Voids w/Clay	13	
Clay Minerals	1	
Kaolinite (Assumed)	Min	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	
Mixed Layer (Assumed)	tr	Illite/chlorite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: 'MWX-4944.3
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: March 3, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.23
Grain Size Range (mm): 0.04 to 0.51

% Pore Space: 12
Sorting (est.): Moderate
Angularity (est.): A to R

GENERAL DESCRIPTION: Nearly identical to previous sample; fabric appears to be slightly more open.

COMPOSITION	%	COMMENTS
Quartz	54	
K-Feldspar	2	
Plagioclase	8	
Chert	6	And chalcedony
Lithics	14	Good plutonic rock fragments
Authigenic Minerals		
Silica O. gr.	1	
Calcite	2	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	Bleached and altered to chlorite
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Tourmaline	tr	
Voids w/o Clay	1	
Voids w/Clay	11	
Clay Minerals	1	
Kaolinite (Assumed)	Min	
Illite (Assumed)	Dom	
Chlorite (Assumed)	tr	
Mixed Layer (Assumed)	tr	Illite/chlorite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4947.4
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 3, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.27
Grain Size Range (mm): 0.06 to 0.66

% Pore Space: 17
Sorting (est.): Moderate to Poor
Angularity (est.): A to R

GENERAL DESCRIPTION: Slightly coarser grained than the previous sample, but otherwise very similar. Clay minerals which coat detrital grains and occur perpendicular to grain surfaces reappear in this sample.

COMPOSITION	%	COMMENTS
Quartz	50	
K-Feldspar	1	
Plagioclase	8	
Chert	5	
Lithics	14	
Authigenic Minerals		
Silica O. gr.	2	
Calcite	2	
Dolomite	tr	
Muscovite	tr	
Biotite	tr	
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Tourmaline	tr	
Voids w/o Clay	2	
Voids w/Clay	15	
Clay Minerals	tr	
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Chlorite/montmorillonite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4949.8
INTERVAL: High Fluvial I

Petrologist: M. O. Eatough
Date: March 3, 1983

Rock Type: Feldspathic Litharenite
Mean Grain Size (mm): 0.38
Grain Size Range (mm): 0.06 to 1.1

% Pore Space: 7
Sorting (est.): Moderate to Poor
Angularity (est.): A to R

GENERAL DESCRIPTION: Detrital mineralogy similar to other samples. Extensive carbonate cement. Clay forming perpendicular to grain surfaces also fill dissolution cavities in calcite.

COMPOSITION	%	COMMENTS
Quartz	49	
K-Feldspar	1	
Plagioclase	7	
Chert	5	
Lithics	11	
Authigenic Minerals		
Silica O. gr.	3	
Calcite	16	Patchy and sometimes poikilotopic
Dolomite	tr	
Muscovite	tr	
Biotite	tr	Altering to clay and chlorite
Opaques	tr	
Accessory Minerals		
Zircon	tr	
Voids w/o Clay	1	
Voids w/Clay	6	
Clay Minerals	1	
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	tr	
Mixed Layer (XRD)	tr	Illite/chlorite (1:1)?

MULTI-WELL PETROGRAPHIC ANALYSIS

SAMPLE NO: MWX-4951.2
INTERVAL: High Fluvial I

Petrologist: M. L. Dixon
Date: March 3, 1983

Rock Type: Mudstone

% Pore Space: tr

GENERAL DESCRIPTION: This is generally a mudstone with detrital quartz, plagioclase, K-feldspar, biotite/chlorite, muscovite, lithics, opaques, zircon, tourmaline, and garnet occurring as angular floating grains and grains with point and long contacts. The detrital grains range in size from clay to approximately 0.064 mm (very fine sand). The matrix (20 to 40%) consists largely of clay and micas. Sparse carbonate grains are scattered throughout the sample.

COMPOSITION	%	COMMENTS
Clay Minerals		
Kaolinite (XRD)	Mod	
Illite (XRD)	Dom	
Chlorite (XRD)	Min	