SPECIAL CORE ANALYSIS STUDY

for

SANDIA NATIONAL LABORATORIES

MULTI-WELL EXPERIMENTS NO. 1 & 3
RULISON FIELD
GARFIELD COUNTY, COLORADO

7501 STEMMONS FREEWAY, BOX 47547, DALLAS, TEXAS 75247 • 214/631-8270

CORE LABORATORIES, INC.

November 16, 1983

Reply To:
10703 E. BETHANY DRIVE
AURORA, COLORADO 80014

Sandia National Laboratories
Division 4753
P. O. Box 5800
Albuquerque, New Mexico 87185

Attention: Mr. Allan R. Sattler

Subject:

Special Core Analysis Study
Multi-Well Experiment No. 1 & 3
Rulison Field
Mesa Verde Formation
Paludal Zone, Upper Coastal Zone
Garfield County, Colorado
Document Number: 61-4863
File Number: SCAL 203-830070

Gentlemen:

On September 9, 1982 Mr. Allan R. Sattler requested Core Laboratories to perform Special Core Analysis studies on core material submitted from the subject well. Reported are the final report results on this test:

1) Klinkenberg Permeability Measurements at Overburden Pressure.

One inch diameter core plugs were obtained from a previous conventional core analysis study and utilized in the aforementioned testing sequence. Sample selection for Special Core Analysis testing was approved previous to the study between Mr. Sattler and a Core Laboratories representative.

Additional testing is in progress on this well under a separate project number, as well as additional work on another adjacent well (Multi-Well Experiment No. 2).

Each core plug obtained for this study was extracted of hydrocarbons using cool toluene and leached of salt using cool methyl alcohol in a centrifuge solvent reflux apparatus. Upon completion of cleaning, the core plug samples were dried in a humidity oven at 40-50% relative humidity and 140-150°F. Permeability to air and Boyle's Law porosity values were obtained on the dried core plugs. This routine data is presented in conjunction with the Klinkenberg data on Pages 5 and 6 of this report. A lithologic description and sample identification section is presented on Pages 1 through 4.

1) Klinkenberg Permeability Measurements at Overburden Pressure:

The Klinkenberg (gas slippage corrected) permeability, Pages 5 through 8 were measured for each sample at 1000, 2000 and 3000 psi effective overburden pressure by the non-steady state method. Core samples from two zones are represented, with thirty one samples from the Multi-Well Experiment No. 3 (Paludal Zone) and the remaining samples from the Upper Coastal Zone of the Multi-Well Experiment No. 1. Four intervals were designated for testing with visual fractures evident in the core plugs. All four core samples crumbled during the cleaning phases. Alternate samples were obtained and utilized for the permeability measurements.

Many sample intervals within the Paludal Zone are laminated by carboneous lamina. It is possible that these lamina influence the permeability values within this zone.

A bibliographical reference for the apparatus and procedure used in this study may be gleened from:

Freeman, D. and Bush, D., Low Permeability Laboratory Measurements by Non-Steady State and Conventional Methods, SPE Technical Paper 10075.

It has been a pleasure working with Sandia National Laboratories on this study. Should you have any questions pertaining to these test results or if we can be of further assistance, please contact me at 751-9334.

Very truly yours,

CORE LABORATORIES, Inc.

Mercer L. Brugler

Mercer L. Brugler
Laboratory Supervisor

MLB:ss
cc Distribution List

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

COMPANY SANDIA NATIONAL LABORATORIES WELL MULTI-WELL EXPERIMENT NO. 3

FORMATION MESA VERDE-PALUDAL ZONE FIELD RULISON

COUNTY, STATE GARFIELD, COLORADO

Sample Identification	Depth, feet	Lithological Description
109	6878.2-78.4	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl calc,sh lam,mic,s&p
113	6894.5-94.7	Sst,sil,gry,vfgr,wl srtd,wl consol,v shly,lam,mic
116	7081.3-81.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,sh lam,mic
117	7083.1-83.3	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl calc,carb lam,mic,s&p
118	7084.3-84.5	Sst,sil,ltgry,fgr,wl srtd,wl consol,carb lam,mic,s&p
119	7086.0-86.3	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl slty,carb lam
121	7088.8-88.9	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl slty,carb lam
122	7090.4-90.6	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl slty,carb lam,mic
124	7093.0-93.2	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,sh lam,tr mic
125	7094.6-94.8	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,sh lam,tr mic
126	7096.7-96.9	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,sh lam,tr mic
127	7098.3-98.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,carb lam,mic
128	7099.6-99.8	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,carb lam,mic
129	7101.3-01.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,sl calc,carb lam,mic
131	7104.1-04.3	Sst,sil,gry,fgr,wl srtd,wl consol,abd carb lam,tr mic
132	7120.2-20.4	Sltst,sil,dkgry,wl consol,pyr,mic

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

COMPANY SANDIA NATIONAL LABORATORIES WELL MULTI-WELL EXPERIMENT NO. 3

FORMATION MESA VERDE-PALUDAL ZONE FIELD RULISON

COUNTY, STATE GARFIELD, COLORADO

Sample Identification	Depth, feet	Lithological Description
133	7122.5-22.7	Sst,sil,gry,vfgr,wl srtd,wl consol,v shly
135	7124.8-24.9	Sst,sil,gry,vf-fgr,prly srtd,wl consol, v shly,carb
136	7126.4-26.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,abd carb lam,x-bdg
137	7127.8-28.0	Sst,sil,ltgry,vfgr,wl srtd,wl consol,abd carb lam,tr pyr
138	7129.5-29.6	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl mic
139	7130.7-30.9	Sst,sil,ltgry,vfgr,wl srtd,wl consol,mic, pyr
140	7132.5-32.7	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl slty
141	7133.9-34.0	Sst,sil,ltgry,fgr,wl srtd,wl consol
142	7135.3-35.4	Sst,sil,ltgry,fgr,wl srtd,wl consol
143	7136.7-36.8	Sst,sil,ltgry,fgr,wl srtd,wl consol
145	7138.5-38.8	Sst,sil,ltgry,fgr,wl srtd,wl consol,mic
146	7143.3-43.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol, abd carb lam,x-bdg
147	7145.0-45.2	Sst,sil,ltgry,vfgr,wl srtd,wl consol, abd carb lam,mic
148	7146.3-46.5	Sst,sil,gry,fgr,wl srtd,wl consol,s&p
149	7148.8-49.1	Sst,sil,gry,vfgr,wl srtd,wl consol,abd sh lam,frac w/carb inf
150	7150.5-50.8	Sst,sil,gry,vfgr,wl srtd,wl consol,abd carb lam,mic
151	7152.4-52.6	Sst,sil,gry,vfgr,wl srtd,wl consol,sh lam,frac

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

COMPANY SANDIA NATIONAL LABORATORIES WELL MULTI-WELL EXPERIMENT NO. 1

FORMATION MESA VERDE-UPPER COASTAL ZONE FIELD RULISON

COUNTY, STATE GARFIELD, COLORADO

Sample Identification	Depth, feet	Lithological Description
338	5145.5	Sst,sil,gry,vfgr,wl srtd,wl consol,shly, mic,sl carb
339	5146.5	Sst,calc,ltgry,f-medgr,prly srtd,wl consol, mic,pyr,s&p
341	5149.5	Sst,sil,ltgry,f-crsgr,prly srtd.w; consol, sl slty,sl mic
342	5151.5	Sst,sil,ltgry,f-crsgr,prly srtd,wl consol, sl slty,mic carb
343	5153.5	Sst,sil,ltgry,f-crsgr,prly srtd,wl consol, sl slty,mic
346	5166.5	Sltst,dkgry,wl consol,shly,mic
349	5180.5	Sltst,dkgry,wl consol,shly,mic,frac
350	5181.9	Sltst,dkgry,wl consol,shly,mic,frac
463	5379.8	Sltst,gry,shly,wl consol,mic,pyr,frac
697	5806.5	Sst,sil,ltgry,fgr,wl srtd,wl consol,mic frac w/carb inf
739	5870.4	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl calc,mic,s&p
770	5960.5	Sst,calc,gry,fgr,wl srtd,wl consol,mic
772	5962.4	Sst,sil,gry,fgr,wl srtd,wl consol,calc,mic
774	5964.5	Sst,sil,gry,fgr,wl srtd,wl consol,calc,mic, s&p
776	5966.5	Sst,sil,gry,fgr,wl srtd,wl consol,calc,mic, s&p
778	5968.3	Sst,sil,gry,fgr,wl srtd,wl consol,shly,w/frac calc,s&p

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

IDENTIFICATION AND LITHOLOGICAL DESCRIPTION OF SAMPLES

COMPANY SANDIA NATIONAL LABORATORIES WELL MULTI-WELL EXPERIMENT NO. 1

FORMATION MESA VERDE-UPPER COASTAL ZONE FIELD RULISON

COUNTY, STATE GARFIELD, COLORADO

Sample Identification	Depth, feet	Lithological Description
780	5970.5	Sst,sil,gry,fgr,wl srtd,wl consol,calc, mic,s&p
782	5972.6	Sst,sil,ltgry,fgr,wl srtd,wl consol,sl calc,mic,s&p
783	5973.5	Sst,sil,gry,fgr,wl srtd,wl consol,mic, s&p
786	5979.6	Sst,sil,ltgry,vfgr,wl srtd,wl consol,frac
787	5980.5	Sltst,sil,dkgry,wl consol,frac w/carb inf
788	5981.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,frac, s&p
790	5983.1	Sst,sil,ltgry,vfgr,wl srtd,wl consol,mic, s&p
792	5985.5	Sst,sil,ltgry,vfgr,wl srtd,wl consol,mic, s&p
811	6069.3	Sst,sil,ltgry,vfgr,wl srtd,wl consol,mic, s&p
813	6071.1	Sst,sil,ltgry,vf-fgr,mod srtd,wl consol, mic,s&p
815	6073.7	Sst,sil,ltgry,vf-fgr,mod srtd,wl consol, mic,s&p
817	6079.7	Sst,sil,ltgry,fgr,wl srtd,wl consol,mic, s&p
818	6081.7	Sltst,sil,dkgry,wl consol,sl calc,frac

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

File 203-830070

Company SANDIA NATIONAL LABORATORIES Formation MESA VERDE-PALUDAL ZONE

Well MULTI-WELL EXPERIMENT NO. 3 County GARFIELD

Field RULISON State COLORADO

SUMMARY OF ROUTINE PERMEABILITY, POROSITY & KLINKENBERG PERMEABILITY AS A FUNCTION OF OVERBURDEN PRESSURE

Sample Identification	Depth, feet	Effective Overburden Pressure, Psi: Permeability to Air Millidarcys	Porosity Percent	Klinkenberg Permeability Millidarcys: 1000	2000	3000
109	6878.2-78.4	0.05	5.8	0.0046	0.0036	0.0035
113	6894.5-94.7	0.03	3.5	0.0029	0.0016	0.0008
116	7081.3-81.5	0.03	3.8	0.0020	0.0006	0.0001
117	7083.1-83.3	0.08	8.3	0.0118	0.0065	0.0046
118	7084.3-84.5	0.22	10.0	0.0203	0.0086	0.0063
119	7086.0-86.3	0.30	11.1	0.0419	0.0186	0.0150
121	7088.8-88.9	0.08	10.0	0.0101	0.0062	0.0051
122	7090.4-90.6	0.13	11.2	0.0161	0.0130	0.0096
124	7093.0-93.2	0.08	8.9	0.0062	0.0051	0.0037
125	7094.6-94.8	0.13	10.8	0.0182	0.0144	0.0083
126	7096.7-96.9	0.11	10.9	0.0165	0.0117	0.0080
127	7098.3-98.5	0.13	10.0	0.0107	0.0080	0.0057
128	7099.6-99.8	0.15	10.0	0.0201	0.0089	0.0060
129	7101.3-01.5	0.12	9.8	0.0104	0.0053	0.0048
131	7104.1-04.3	0.14	7.6	0.0072	0.0038	0.0014
132	7120.2-20.4	0.05	1.9	0.0018	0.0003	0.0001
133	7122.5-22.7	0.03	4.0	0.0009	0.0003	0.0002
135	7124.8-24.9	0.05	6.4	0.0017	0.0006	0.0003
136	7126.4-26.5	0.10	7.1	0.0056	0.0021	0.0010
137	7127.8-28.0	0.14	10.6	0.0154	0.0066	0.0063
138	7129.5-29.6	0.12	10.9	0.0133	0.0124	0.0091
139	7130.7-30.9	0.13	11.6	0.0166	0.0152	0.0136
140	7132.5-32.7	0.10	11.4	0.0147	0.0128	0.0088
141	7133.9-34.0	0.17	12.4	0.0323	0.0252	0.0218
142	7135.3-35.4	0.15	11.5	0.0259	0.0189	0.0163
143	7136.7-36.8	0.10	10.9	0.0140	0.0131	0.0115
145	7138.5-38.8	0.10	10.8	0.0139	0.0123	0.0094
146	7143.3-43.5	0.13	6.5	0.0053	0.0029	0.0011
147	7145.0-45.2	0.06	6.1	0.0023	0.0005	0.0003
148	7146.3-36.5	0.06	7.0	0.0031	0.0018	0.0010
149	7148.8-49.1	0.07	5.6	0.0041	0.0011	0.0009
150	7150.5-50.8	0.06	6.4	0.0032	0.0028	0.0010
151	7152.4-52.6	0.08	4.6	0.0021	0.0004	0.0002

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.

File 203-830070

Company SANDIA NATIONAL LABORATORIES Formation MESA VERDE-UPPER COASTAL ZONE

Well MULTI-WELL EXPERIMENT NO. 1 County GARFIELD

Field RULISON State COLORADO

SUMMARY OF ROUTINE PERMEABILITY, POROSITY & KLINKENBERG PERMEABILITY AS A FUNCTION OF OVERBURDEN PRESSURE

				Effective Overburden Pressure, Psi	1000	2000	3000
Sample Identification	Depth, feet	Permeability to Air Millidarcys	Porosity Percent	Klinkenberg Permeability Millidarcys			
338	5145.5	0.04	5.5		0.0040	0.0027	0.0015
339	5146.5	0.02	1.7		0.0001	<0.0001	<0.0001
341	5149.5	0.15	11.1		0.0252	0.0180	0.0124
342	5151.5	0.24	11.5		0.0540	0.0279	0.0194
343	5153.5	0.55	11.9		0.1938	0.1338	0.0999
346	5166.5	0.02	2.3		0.0028	0.0011	0.0009
349	5180.5	0.01	0.9		<0.0001	<0.0001	<0.0001
350	5181.9	0.02	0.6		<0.0001	<0.0001	<0.0001
463	5379.8	0.02	0.07		<0.0001	<0.0001	<0.0001
697	5806.5	0.02	4.1		0.0036	0.0018	0.0015
739	5870.4	0.03	4.2		0.0036	0.0019	0.0018
783	5973.5	0.03	3.5		0.0029	0.0017	0.0010
770	5960.5	0.02	3.1		0.0025	0.0021	0.0012
772	5962.4	0.03	4.6		0.0021	0.0010	0.0004
774	5964.5	0.04	4.7		0.0028	0.0021	0.0008
776	5966.5	0.05	6.1		0.0030	0.0009	0.0008
778	5968.3	0.07	6.5		0.0033	0.0022	0.0016
780	5970.5	0.05	5.8		0.0039	0.0019	0.0008
782	5972.6	0.04	5.9		0.0040	0.0019	0.0009
786	5979.6	0.30	4.1		0.0029	0.0009	0.0004
787	5980.5	0.03	5.4		0.0040	0.0030	0.0028
788	5981.5	0.05	5.5		0.0042	0.0032	0.0029
790	5983.1	0.07	6.8		0.0039	0.0019	0.0012
792	5985.5	0.06	7.2		0.0031	0.0018	0.0010
811	6069.3	0.05	8.1		0.0056	0.0046	0.0036
813	6071.7	0.06	9.0		0.0100	0.0062	0.0058
815	6073.7	0.12	9.9		0.0198	0.0162	0.0146
817	6079.7	0.13	6.8		0.0094	0.0064	0.0061
818	6081.7	0.10	3.6		0.0025	0.0011	0.0006

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgement of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations as to the productivity, proper operation, or profitableness of any oil, gas or other mineral well or sand in connection with which such report is used or relied upon.