UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY DATA FOR MADISON LIMESTONE TEST WELL 3, NW¼SE¼ SEC. 35, T. 2 N., R. 27 E., YELLOWSTONE COUNTY, MONTANA

By R. K. Blankennagel, L. W. Howells, W. R. Miller, and C. V. Hansen

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Open-File Report 79-745

Study of Madison aquifer in cooperation with
Montana Bureau of Mines and Geology
Montana Department of Natural Resources and Conservation
North Dakota State Water Commission
South Dakota Division of Geological Survey
Wyoming State Engineer

This report has not been edited or reviewed for conformity with Geological Survey stratigraphic nomenclature.

Denver, Colorado

June 1979

ILLUSTRATIONS

(Plates are in pocket)

TABLES

CONVERSION FACTORS

In this report, figures for measures are given only in inch-pound units.[1] Factors for converting inch-pound units to metric units are shown in the following table:

Inch-pound	Multiply by	Metric
in (inch)	25.4	mm (millimeter)
ft (foot)	0.305	m (meter)
ft^3 (cubic foot)	0.02832	m^3 (cubic meter)
mi^2 (square mile)	2.59	km^2 (square kilometer)
gal (gallon)	3.785	L (liter)
gal/min (gallon per minute)	0.0631	L/s (liter per second)
gal/min/ft (gallon per minute per foot)	0.207	(L/s)/m (liter per second per meter)
lb (pound)	0.4536	kg (kilogram)
lb/in^2 (pound per square inch)	6.8948	kPa (kilopascal)
md (millidarcy)	0.000987	μm^2 (square micrometer)

[1]Temperature is reported in degrees Celsius. To convert to degrees Fahrenheit use: Temperature °F = 1.8 temperature °C + 32.

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Abstract

This report provides preliminary data for Madison Limestone test well 3 including test-well history, geology of the test well, hydrologic testing, and geochemistry. It also discusses the preliminary results and future testing.

The test well was drilled as part of the study to determine the water-resource potential of the Madison Limestone and associated rocks to meet future water needs in a 188,000-square-mile region that includes the coal-rich area of the Northern Great Plains. Drilling and testing were designed to yield a maximum of stratigraphic, structural, geophysical, and hydrologic information.

Madison Limestone test well 3 was drilled in the NW¼SE¼ sec. 35, T. 2 N., R. 27 E., Yellowstone County, Montana, to a depth of 7,175 feet below land surface. It is cased with 13-3/8-inch diameter casing from land surface to 979 feet, with 9-5/8-inch diameter casing from 810 to 4,298 feet, and with 7-inch diameter casing from 4,115 to 5,942 feet.

Before running the 7-inch casing, two cement plugs were set in the 8-3/4-inch open hole. One is from the bottom of the well to 6,935 feet below land surface, and the other is from 6,235 to 6,135 feet.

The 7-inch casing presently is perforated at two water-bearing zones in the Madison Limestone--one between 4,378 and 4,358 feet and the other between 4,342 and 4,322 feet. The top of a cement plug inside the casing, the result of earlier cement squeeze jobs through lower perforations to seal off intervals yielding mineralized water, is at 4,985 feet.

Twenty cores were taken from selected intervals totaling 594.8 feet; 520.3 feet of core was recovered. The cores were slabbed and plugged, and selected parts were tested for density, porosity, and vertical and horizontal permeability. Thin sections are being prepared for detailed examination.

Twelve conventional drill-stem tests were made in the open hole. Eleven of these give clues to pressure heads of the water in the intervals tested. Water flowed at land surface during nine of the tests. Flow from the packer-isolated intervals ranged from 13 to 115 gallons per minute; back pressures while flowing ranged from 0 to 65 pounds per square inch. The sum of the flows from all producing intervals tested was about 560 gallons per minute. The calculated average production rate for all producing intervals was about 1,000 gallons per minute. The sum of the flows and calculated production

total are less than the potential production of the well due to the effect of restrictions within the test tool and possible formation damage.

Pressure gradients for intervals tested in the well were anomalously high, ranging from 0.502 to 0.548 pounds per square inch per foot. Potentiometric-surface elevations in Paleozoic rocks, based on extrapolated pressure data ranged from 4,000 to 4,150 feet above sea level (about 975 to 1,125 feet above land surface).

Freshwater (less than 1,000 milligrams per liter dissolved solids) was not found in any of the intervals tested in the well. Dissolved-solids concentrations ranged from 2,660 to 19,800 milligrams per liter.

Although there are some bridges in the 13-3/8-inch and 9-5/8-inch casing, caused by sloughing of cement after the drilling fluid was removed from the well, the well is flowing more than 40 gallons per minute from the two perforated intervals. Completion of the well, including removing of the sloughing cement and bridges, perforating additional water-bearing zones, and testing, will be done in July or August 1979.

Introduction

Madison Limestone test well 3 is the third well drilled as part of a study to evaluate the Madison Limestone and associated rocks as potential sources for water supplies in the Northern Great Plains. This report provides the preliminary data for the test well including test-well history, geology of the test well, hydrologic testing, and geochemistry, and discusses the preliminary results and future plans.

The impending development of the coal reserves in the Fort Union coal region of the Northern Great Plains and the attendant water requirements necessary for such development will place a heavy demand on the region's available water resources. Streamflow is poorly distributed in time and space, and throughout much of the area it is already fully appropriated. The diversion of surface water to coal mining and other industrial uses would deprive present users of their water supply. Aquifers in the Paleozoic rocks, which underlie most of the region, may supply, at least on a temporary basis, a significant percentage of the water required for the development. One such source of water supply is the Madison aquifer, which includes the Madison Limestone and associated rocks.

In 1975 the U.S. Geological Survey, in cooperation with the Old West Regional Commission, prepared a plan of study (U.S. Geological Survey, 1975) for evaluating the water-supply potential of the Madison Limestone and associated rocks. That report not only presents a plan of study for the Madison, but also gives references relating to the regional geology and hydrology, cites the current geohydrologic studies being made by Federal and State agencies and by private companies, and summarizes the available data and the deficiencies of these data.

During the 1976 fiscal year, the U.S. Geological Survey, in cooperation with the States of Montana, North Dakota, South Dakota, and Wyoming, began a study to determine the water-resource potential of the Madison Limestone and associated rocks to meet the future water needs in a 188,000-mi^2 region that includes the coal-rich area of the Northern Great Plains, and to evaluate these rocks (the Madison aquifer) as a source of water for industrial, agricultural, public, and domestic supplies. The study area includes eastern Montana, western North and South Dakota, a small part of Nebraska, and northeastern Wyoming (fig. 1). The area of greatest interest, however, is the Powder River Basin of Montana and Wyoming, and the area surrounding the Black Hills in Wyoming, Montana, the Dakotas, and Nebraska.

Within the scope of available funds and manpower, the objectives and approach are those outlined in the plan-of-study report. The objectives include determining:

1. The quantity of water that may be available from the Madison aquifer.

2. The chemical and physical properties of the water.

3. The effects of existing developments on the potentiometric head, storage, recharge and discharge, springs, streamflow, and the pattern of ground-water flow.

4. The probable hydrologic effects of proposed withdrawals of water for large-scale developments at selected rates and locations.

5. The locations for wells and the type of construction and development of deep wells that would obtain optimum yields.

Many oil tests have been drilled to the Madison aquifer in the study area. Most did not completely penetrate the aquifer, but were drilled to develop oil fields or were exploration tests on known geologic structures. Few data from these tests were collected for hydrologic purposes, but the information is useful in defining the geologic framework and some of the aquifer characteristics such as water quality, temperature, porosity, and potentiometric head.

To obtain better subsurface hydrologic and geologic information, it was recognized that test wells would have to be drilled. Drilling and testing were designed to yield a maximum of stratigraphic, structural, geophysical, and hydrologic information. Stratigraphic and structural information, obtained from drill cuttings, cores, and geophysical logs, is critical for reconstructing the paleogeologic history of the region as well as defining the present structural and sedimentary framework. Careful analysis of cuttings and cores, and correlation with geophysical log characteristics will have transfer value to data obtained from oil-well tests and surface geophysical surveys.

Hydrologic tests were designed to yield pressure data and subsurface water samples from discrete intervals. These data are used to determine the thick Ordovician Red River or Devonian section would be present, (2) the Precambrian contact would be 6,000 to 7,000 ft below land surface, and (3) good porosity and permeability would be present to provide high water yields. The constraints, which caused the drill site to be located near the margin of the most favorable area, were the availability of Federal or State land on which to drill, and an adequate supply of water for drilling.

Madison test well 3 is in the NW¼SE¼ sec. 35, T. 2 N., R. 27 E., Yellowstone County, Mont. (figs. 1, 2, and 3). It is about 15 mi northeast of Billings, and about 1½ mi from Huntley.

The well was spudded in alluvium on Aug. 15, 1978, and bottomed 48 ft below the top of Precambrian gneiss rocks at 7,175 ft below land surface on Nov. 16, 1978. It is cased with 13-3/8-in diameter casing from land surface to 979 ft, with 9-5/8-in diameter casing from 810 to 4,298 ft, and with 7-in diameter casing from 4,115 to 5,942 ft.

Before running the 7-in casing, two cement plugs were set in the 8-3/4-in open hole to isolate Cambrian rocks that contained saline water. One plug is from the bottom of the well to 6,935 ft below land surface, and the other plug is from 6,235 to 6,135 ft.

The 7-in casing presently is perforated at two water-bearing zones in the Madison Limestone--one between 4,378 and 4,358 ft and the other between 4,342 and 4,322 ft. The top of a cement plug inside the casing, the result of earlier cement squeeze jobs through lower perforations to seal off intervals yielding mineralized water, is at 4,985 ft. The well is so constructed that additional water-bearing zones can be perforated and additional hydrologic tests and geophysical logs and surveys can be run at a later date (figs. 4 and 5).

Twelve drill-stem tests, using inflatable single and straddle packers, were run; 11 yielded data on formation pressures and 9 provided information on quality of the water in the intervals tested. Water from the two intervals perforated in the 7-in casing has a head greater than 450 lb/in^2 at land surface.

Twenty cores were taken from selected intervals totaling 594.8 ft; 520.3 ft of core was recovered. The cores were slabbed and plugged, and selected parts were tested for density, porosity, and vertical and horizontal permeability. Thin sections are being prepared for detailed examination.

Geophysical logs were obtained in three overlapping sections of the well. The logs include dual-induction laterolog, sidewall neutron porosity, borehole compensated sonic, compensated formation density, caliper, and temperature. Additional geophysical logs, although not in overlapping sections, include 3-dimensional velocity, fracture identification, and variable density.

Many individuals from the U.S. Geological Survey, other Federal agencies, State agencies, and industry contributed to the planning and operations at the

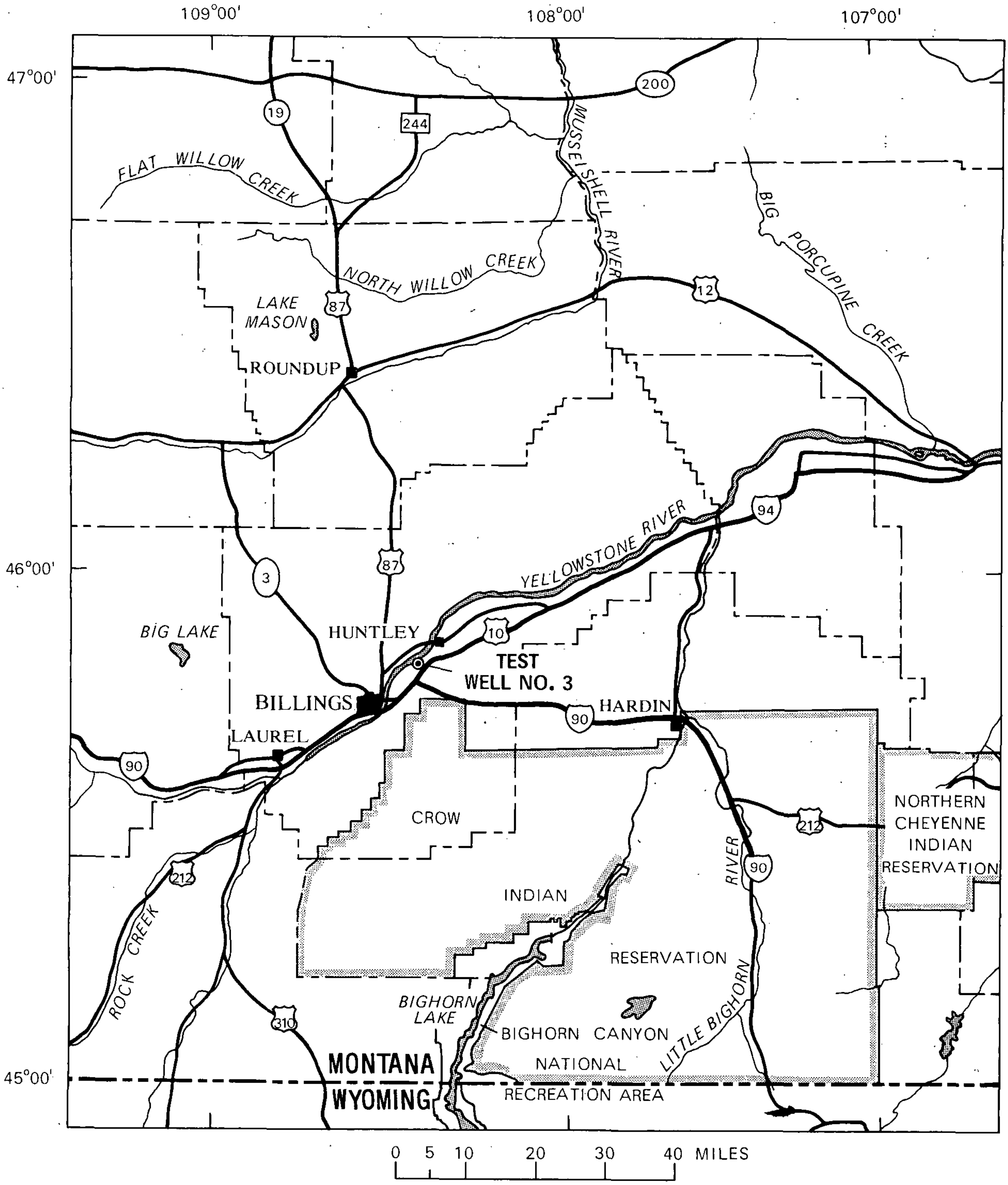


Figure 2.--Location of Madison Limestone test well 3 near Billings, Montana.

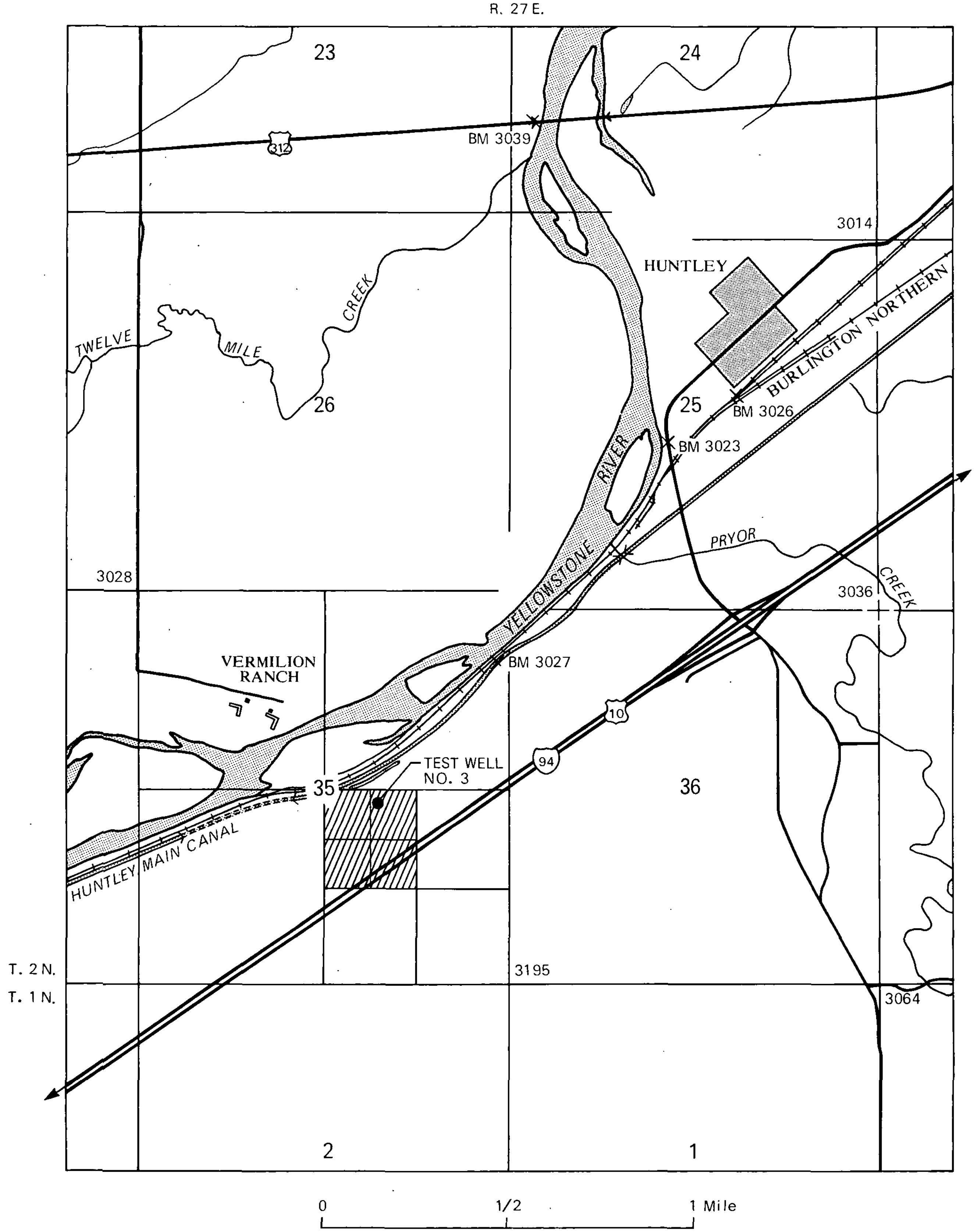


Figure 3.--Location of drill site for Madison Limestone test well 3.

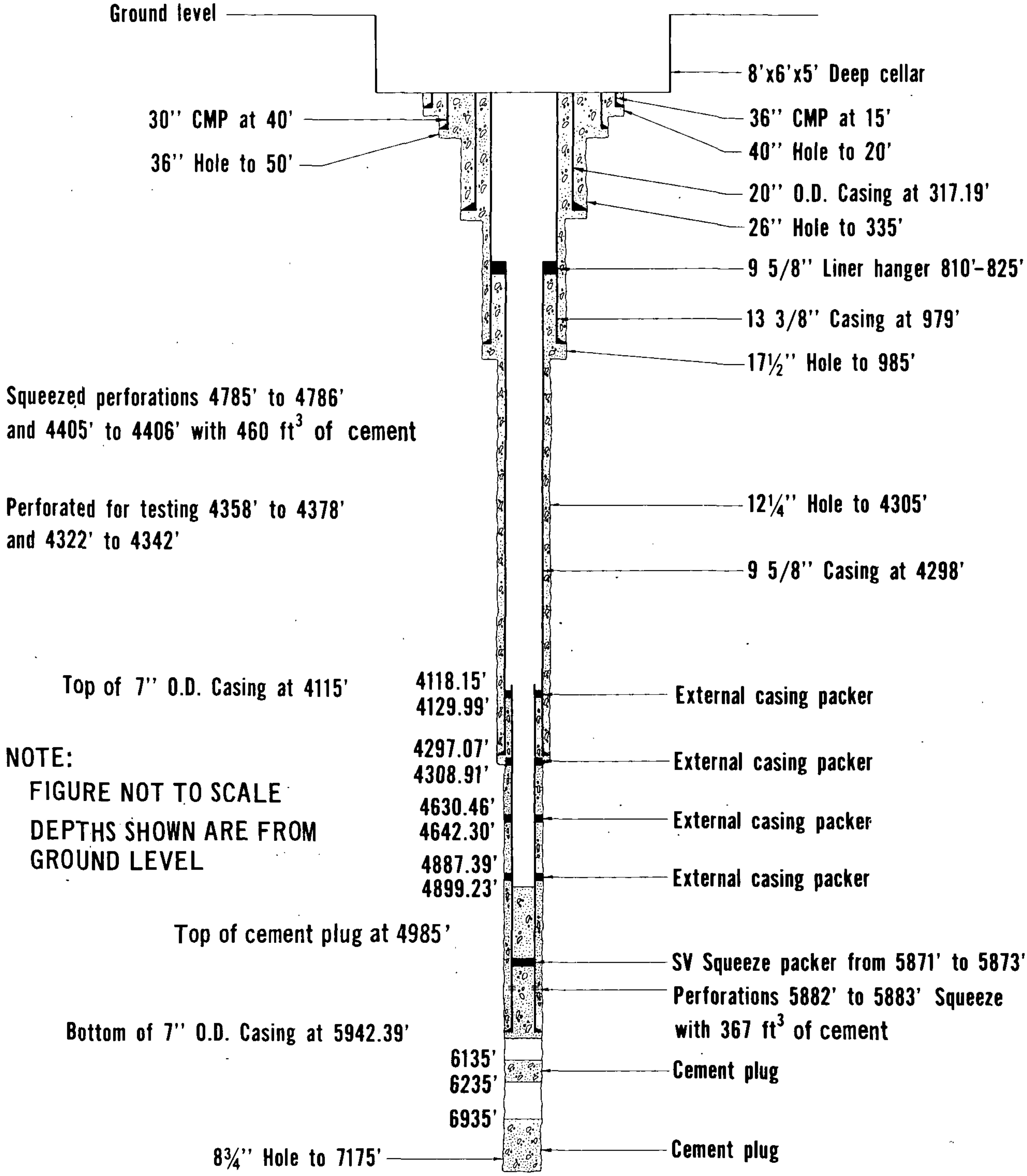


Figure 4.--Construction of Madison Limestone test well 3 (12/19/78).

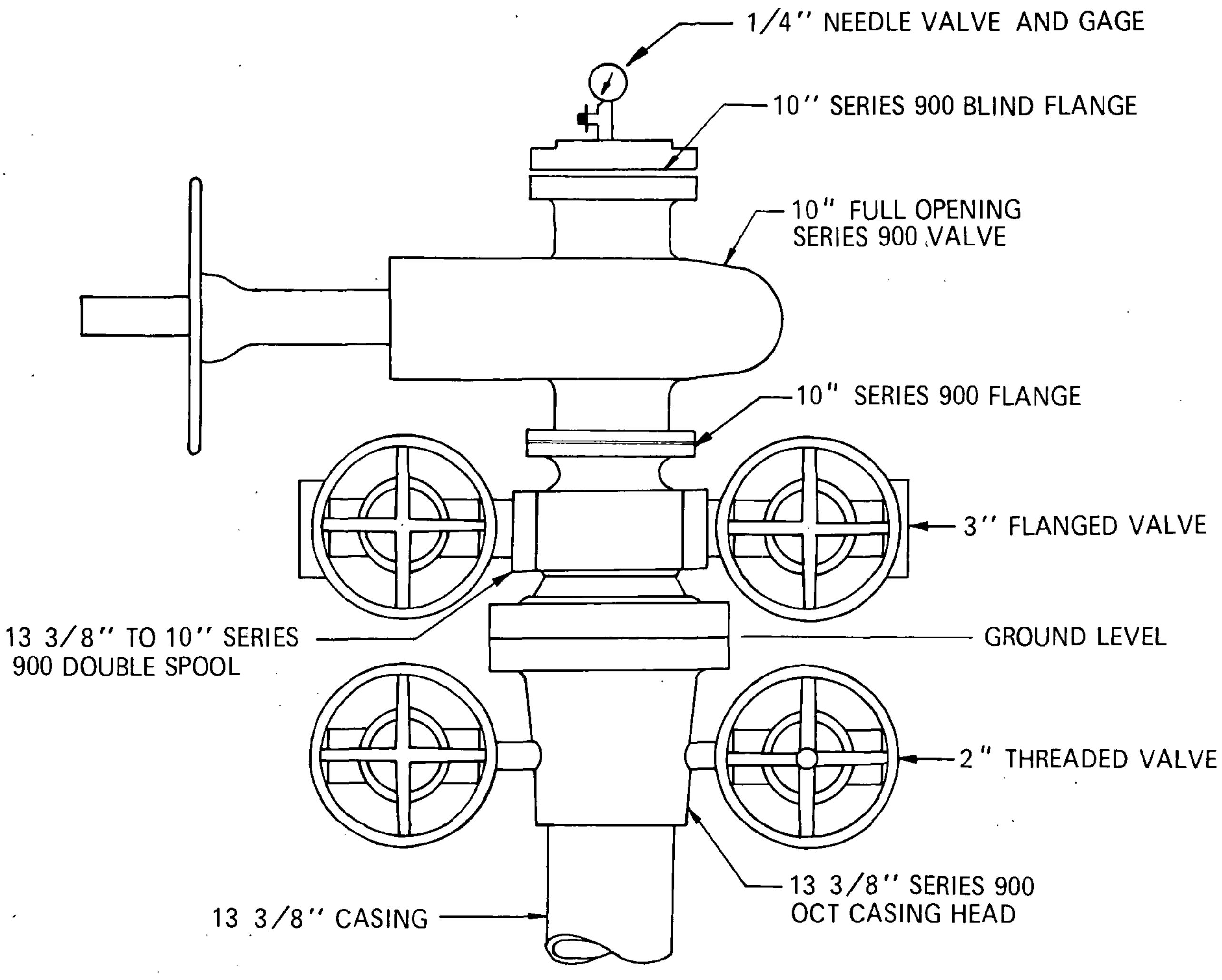


Figure 5.--Well head equipment of Madison Limestone test well 3 (12/19/78).

test well. No attempt will be made to list all the U.S. Geological Survey personnel involved in the operation; however, special recognition must be given to Donald L. Brown, James A. Peterson, Thad W. Custis, Lawrence M. MacCary, John F. Busby, Dave W. Litke, Joe A. Moreland, Rickard D. Hutchinson, Les R. Murray, Steven A. Strausz, Douglas R. Winter, Louis J. Hamilton, Wendell L. Bradford, William J. Head, Darwin L. Rahder, and Edward R. Banta for their contributions in the site selection, logistics, and drilling, coring, and testing operations. Roger W. Lee prepared the geochemistry section included in this report.

Fenix and Scisson, Inc., Tulsa, Okla., prime contractor for the Department of Energy, Nevada Operations Office, Las Vegas, Nev., assisted with the preparation of the drilling specifications and provided a project engineer, William M. Garms, at the drill site. Fenix and Scisson also prepared the well history included in this report.

Molen Drilling Co., Inc., Billings, Mont., was awarded the contract for drilling the test hole, and for providing and coordinating all associated services, equipment, and materials. Irvin Kranzler and John R. Warne, consulting geologists, Billings, Mont., were employed by the drilling contractor. They assisted with selection of cored intervals and identified formation tops. Their descriptions of cuttings and cores, a lithologic log (pl. 1), and the mud and chemical record are included in this report. Continental Laboratories were employed by the drilling contractor to supply a hydrocarbon well log (pl. 2). Geophysical logging was done by Schlumberger Well Services; Birdwell Division, Seismograph Service Corp.; Dresser Atlas; and McCullough. A composite dual-induction laterolog is included in this report (pl. 3). Coring was done by Christensen Diamond Products, U.S.A. Packer tests were run by Lynes, Inc., and interpretations are by Roger L. Hoeger. Analyses for density, porosity, and vertical and horizontal permeability of selected parts of cores were by Core Laboratories, Inc., Denver, Colo. Other companies, too numerous to mention, were involved in the drilling, fishing, casing, cementing, perforating, and other operations.

Test-well history

The following historical data on the test well including time breakdown, hole history, hole deviation surveys, bit record, and log index sheet were photocopied from the Fenix and Scisson report provided to the U.S. Geological Survey at the completion of drilling, coring, and preliminary logging and testing of Madison Limestone test well 3. The mud and chemical record is from Irvin Kranzler and John R. Warne's report.

FENIX & SCISSON, INC.

HOLE HISTORY DATA

DATE: 1-30-79

HOLE NO.: Madison #3	W. O. NO.:	I. D. NO.:
USER: USGS	TYPE HOLE: Exploratory/Hydrologic	
LOCATION Montana	COUNTY: Yellowstone	AREA:
SURFACE COORDINATES: NW, SE, Sec. 35, T2N, R27E		
GROUND ELEVATION: 3024.3'	PAD ELEVATION:	TOP CASING ELEVATION:
RIG ON LOCATION:	SPUDDED: 8-15-78	COMPLETED: 12-19-78
CIRCULATING MEDIA: Mud		
MAIN RIG & CONTRACTOR		NO. OF COMPRESSORS & CAPACITY:

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I.D.	WT./FT.	WALL	GRADE	CPL'G.	FROM	TO	CU. FT. CMT.
* 5'	20'	40"	36"			CMP		5'	15'	
* 20'	50'	36"	30"			CMP		5'	40'	118
50'	335'	26"	19.124"	94.00#		H-40	Butress	5'	317'	885
335'	985'	17-1/2"	12.615"	54.50#		K-55	ST&C	0'	979'	1062
985'	4305'	12-1/4"	8.921"	36.00#		S-80	ST&C	810'	4298'	2584'
4305'	7175'	8-3/4"	6.366"	23.00#		K-55	ST&C	4115'	5942'	* *

TOTAL DEPTH: 7175'GL	AVERAGE MANDREL DEPTH:	FROM REFERENCE ELEVATION @
JUNK & PLUGS LEFT IN HOLE:		
SURVEYS PAGE: 9	CORING PAGE:	CU. FT. CMT. TOTAL IN PLUGS, ETC:
LOGGING DATA: Page 12		
BOTTOM HOLE COORDINATES:		REFERENCE:

RIGS USED *(Site Prep Rigs *)*

RIG NO.	NAME	TYPE	CLASS	DAYS OPERATING	SECURED W CREW	SECURED W/O CREW	TOTAL DAYS ON LOC.
4	Molen Drilling Co.	National 50A		125.10	1.06	-	126.16

REMARKS: * *Site Prep Items* 8' x 6' x 5' deep cellar.

* * Squeezed perforations 5882' to 5883' with 367 ft^3 and 4785' to 4786', 4405' to 4406' with 460 ft^3.

<u>NOTE</u>: Depths shown on this page are from ground level 15.5' below kelly busing elevation.

PREPARED BY:

TIME BREAKDOWN ON NEXT PAGE

MADISON #3
TIME BREAKDOWN

SITE PREPARATION

DRILLING OPERATION TIME (DOT)		OTHER SCHEDULED TIME (OST)		OPERATIONAL DELAY TIME (ODT)	
DRILL		MOVE		RIG REPAIRS	
TRIPS		RUN CASING		W. O. DRILLING SUPPLIES	
SURVEYS		CEMENT CASING		CLEAN OUT FILL	
				SECURED WITH CREWS	
SITE DOT ____ DAYS		SITE OST ____ DAYS		SITE ODT ____	

TOTAL SITE PREP TIME ____ DAYS | REMARKS:

MAIN HOLE CONSTRUCTION

DRILLING OPERATION TIME (DOT)		OTHER SCHEDULED TIME (OST)		OPERATIONAL DELAY TIME (ODT)	
DRILL	29.92	MOBILIZATION & DEMOBILIZATION		RIG REPAIRS	1.14
TRIPS	9.97	CORE	13.04	W. O. EQUIPMENT	0.79
DRESS DRILLING ASSEMBLY		LOG	6.73	FISH	0.58
SINGLE SHOT DEV. SURVEYS	1.80	CASED HOLE DIR. SURVEYS		CLEAN OUT FILL	
OPEN HOLE DIRECTION SURVEYS		UNLOAD CASED HOLE		UNLOAD WATER INFLOW	
Open Hole	19.48	RUN MANDREL		REAM CROOKED HOLE	
		HYDROLOGICAL TESTS	13.50	PLUG BACK	0.33
		Circulate Samples	1.30	DRILL OUT PLUGS	
MAIN HOLE DOT 49.17 DAYS		Perforate for Hydro Test	0.77	SECURED WITH CREWS	1.06
				Wash & Ream	2.17
				W.O. Cementers	0.38
				Cement & Test 7" casing	15.01
				Thaw Out rig	0.08
				W.O. Loggers	0.49
				Stuck Drill Pipe	0.78
				Mix & Condition Mud	3.24
		MAIN HOLE OST 35.34 DAYS		MAIN HOLE ODT 26.05 DAYS	

CASING OPERATION TIME (COT)		
RUN	20" CASING	0.31
RUN	* CASING	
CEMENT	20" CASING	0.99
CEMENT	** CASING	
DRILL OUT SHOE		1.08
MAIN HOLE COT 5.60 DAYS		

TOTAL MAIN HOLE CONST. TIME 126.16 DAYS | REMARKS:

TOTAL ELAPSED TIME

TOTAL SITE PREP TIME		DAYS
TOTAL MAIN HOLE CONST. TIME	126.16	DAYS
SEC. W/O CREW SITE PREP		DAYS
SEC. W/O CREW MAIN HOLE CONST.		DAYS
TOTAL SUSPENDED (NO RIG)		DAYS
TOTAL ELAPSED TIME	126.16	DAYS

REMARKS:
* Run 13-3/8" casing 0.71 Days
Run 9-5/8" casing 0.35 Days
Run 7" casing 0.44 Days
** Cement 13-3/8" casing 1.08 Days
Cement 9-5/8" casing 0.64 Days

MADISON #3
HOLE HISTORY

An 8' x 6' x 5' deep cellar was dug and lined with 2" x 12" boards. 36" CMP was set at 15' and the annulus was backfilled with dirt. 30" CMP was set at 40' and the annulus cemented with 118 ft^3 of class "G" cement with 2% calcium chloride.

All depths reported are from kelly bushing elevation (KB) 15.5' above ground level (GL) unless otherwise noted.

8-15-78	Moved in Molen Drilling Company rig #4 and rigged up. Spudded hole at 1900 hours. Drilled 8-3/4" hole from 55' to 241' using mud.
8-16-78	Drilled 8-3/4" hole from 241' to 350'. Opened 8-3/4" hole to 12-1/4" from 55' to 350' and opened to 17-1/2" from 54' to 257'.
8-17-78	Opened 12-1/4" hole to 17-1/2" from 257' to 350'. Opened 17-1/2" hole to 26" from 54' to 273'.
8-18-78	Opened 17-1/2" hole to 26" from 273' to 350'. Rigged up and ran 8 joints (336.19') of 20" O.D., 94#, H-40 buttress thread casing to 317' (GL) with a guide shoe on bottom and a baffle plate on top of the bottom joint. Centralizers were placed at 100', 200' and 300' all at ground level measurements. Cemented annulus using Halliburton with 885 ft^3 of class "G" cement with 2% $CaCl_2$. Cement in place 1630 hours.
8-19-78	Waited on cement to 0200 hours. Cut off casing and installed blow out equipment. Drilled out cement from 292' to 326'. Tested blow out equipment to 1000 psi for 15 minutes. Drilled out cement, shoe and cleaned out to 350'. Drilled 8-3/4" hole from 350' to 450'.
8-20-78	Drilled 8-3/4" hole from 540' to 1000'. Circulated samples.
8-21-78	Conditioned hole for logging and pulled out of hole. Ran Schlumberger logs. Opened 8-3/4" hole to 12-1/4" from 350' to 540'.
8-22-78	Opened 8-3/4" hole to 12-1/4" from 540' to 748'.
8-23-78	Opened 8-3/4" hole to 12-1/4" from 748' to 1000'. Reamed out cement from 304' to 350' and opened 12-1/4" hole to 17-1/2" from 350' to 497'.
8-24-78	Opened 12-1/4" hole to 17-1/2" from 497' to 816'.
8-25-78	Opened 12-1/4" hole to 17-1/2" from 816' to 900'. Lost 12-1/4" pilot bit in the hole at 877', fished for and recovered same.
8-26-78	Opened 12-1/4" hole to 17-1/2" from 900' to 1000'. Ran Schlumberger caliper log. Started running 13-3/8" O.D., 54.50#, K-55, ST&C casing.
8-27-78	Completed running casing to 979' (GL) with a guide shoe on bottom, a float collar at 938' (GL) and centralizers at 969', 479 and 279' (GL). Cemented annulus using Halliburton with 1062 ft^3 of class "G" cement with 2% calcium chloride. Cement in place at 0430 hours. Waited on cement to 1630 hours. Cut off casing and installed 13-3/8" series 900 casinghead.

8-28-78	Connected blow out equipment and tested to 1000 psi for 15 minutes. Ran 12-1/4" bit in the hole and drilled out cement to above the guide shoe. Tested blow out equipment and casing to 1000 psi for 15 minutes. Drilled out shoe and cleaned out to 1000'. Made trip for bit and drilled 8-3/4" bit from 1000' to 1139'.
8-29-78	Drilled 8-3/4" hole from 1139' to 1426'.
8-30-78	Drilled 8-3/4" hole from 1426' to 1650'.
8-31-78	Drilled 8-3/4" hole from 1650' to 1900'.
9-1-78	Drilled 8-3/4" hole from 1900' to 2150'. Made trip for bit at 2142' and washed and reamed 30' to bottom.
9-2-78	Drilled 8-3/4" hole from 2150' to 2270'. Made up 8-3/4" x 4" core bit and washed and reamed 60' to bottom. Cut core #1 from 2270' to 2300', recovered 24.5'.
9-3-78	Drilled 8-3/4" hole from 2300' to 2493'.
9-4-78	Drilled 8-3/4" hole from 2493' to 2710'. Made trip for bit at 2510' and washed and reamed 100' to bottom.
9-5-78	Drilled 8-3/4" hole from 2710' to 2995'.
9-6-78	Drilled 8-3/4" hole from 2995' to 3184'. Conditioned hole for coring.
9-7-78	Washed and reamed 90' to bottom. Cut 8-3/4" core #2 from 3184' to 3214', recovered 29'. Washed and reamed 30' to bottom and drilled 8-3/4" hole from 3214' to 3330'.
9-8-78	Drilled 8-3/4" hole from 3330' to 3380'. Washed and reamed 60' to bottom and cut 8-3/4" core #3 from 3380' to 3410', recovered 24'.
9-9-78	Washed and reamed 30' to bottom and drilled 8-3/4" hole from 3410' to 3595'. Made trip for bit at 3491' and washed and reamed 40' to bottom.
9-10-78	Drilled 8-3/4" hole from 3595' to 3701'. Washed 30' to bottom and cut 8-3/4" core #4 from 3701' to 3721'.
9-11-78	Completed core #4 from 3721' to 3737', recovered 36'. Drilled 8-3/4" hole from 3737' to 3896'.
9-12-78	Drilled 8-3/4" hole from 3896' to 4099'.
9-13-78	Drilled 8-3/4" hole from 4099' to 4135'. Washed and reamed 30' to bottom and cut 8-3/4" core #5 from 4135' to 4163'.

10-23-78	Completed core #13 from 4852' to 4878', recovered 30'. Ran 8-3/4" bit in the hole, washed 30' to bottom and drilled from 4878' to 4940'.
10-24-78	Drilled 8-3/4" hole from 4940' to 5052'.
10-25-78	Drilled 8-3/4" hole from 5052' to 5177'.
10-26-78	Drilled 8-3/4" hole from 5177' to 5285'. Cut core #14 from 5285' to 5315'.
10-27-78	Completed core #14 from 5315' to 5345', recovered 60'. Drilled 8-3/4" hole from 5345' to 5360'.
10-28-78	Drilled 8-3/4" hole from 5360' to 5375'. Cut core #15 from 5375' to 5420'.
10-29-78	Completed core #15 from 5420' to 5423', recovered 48'. Drilled 8-3/4" hole from 5423' to 5481'.
10-30-78	Drilled 8-3/4" hole from 5481' to 5598'.
10-31-78	Drilled 8-3/4" hole from 5598' to 5658'. Washed 30' to bottom and cut core #16 from 5658' to 5683.7'.
11-1-78	Recovered 25.7' on core #16. Cut core #17 from 5683.7' to 5698.4', recovered 14.7'. Drilled 8-3/4" hole from 5698.4' to 5765'.
11-2-78	Drilled 8-3/4" hole from 5765' to 5830'. Lost circulation at 5814'. Mixed mud and lost circulation materials. Washed 30' to bottom and cut core #18 from 5830' to 5836'.
11-3-78	Completed core #18 from 5836' to 5861', recovered 31'. Drilled 8-3/4" hole from 5861' to 5944'. Lost 15 to 25 barrels of mud.
11-4-78	Drilled 8-3/4" hole from 5944' to 6077'. Mixed mud and lost circulation materials.
11-5-78	Drilled 8-3/4" hole from 6077' to 6214'.
11-6-78	Drilled 8-3/4" hole from 6214' to 6311'.
11-7-78	Drilled 8-3/4" hole from 6311' to 6412'.
11-8-78	Drilled 8-3/4" hole from 6412' to 6525'.
11-9-78	Drilled 8-3/4" hole from 6525' to 6652'.
11-10-78	Drilled 8-3/4" hole from 6652' to 6774'.
11-11-78	Drilled 8-3/4" hole from 6774' to 6887'.
11-12-78	Drilled 8-3/4" hole from 6887' to 7015'.
11-13-78	Drilled 8-3/4" hole from 7015' to 7072'.

11-14-78	Made depth correction and cut core #19 from 7071' to 7095.4', recovered 24.4'.
11-15-78	Drilled 8-3/4" hole from 7095.4' to 7174'. Losing fluid from 7106' to 7151', mixed mud and lost circulation materials.
11-16-78	Ran 8-3/4" core assembly in the hole, stuck drill pipe. Worked free, washed and reamed to bottom. Cut core #20 from 7174' to 7190'.
11-17-78	Recovered 16' on core #20. Ran Schlumberger logs.
11-18-78	Continued logging.
11-19-78	Continued logging.
11-20-78	Completed Schlumberger logs. Made trip with 8-3/4" bit and conditioned mud for testing.
11-21-78	Made up test tool and set packer at 6984' to test zone from 6984' to bottom at 7190'. Ran hydrological test #4 from 0300 hours to 1330 hours. Displaced fluid in drill pipe with mud.
11-22-78	Made up straddle packer test tool and set from 6550' to 6635'. Ran hydrological test #5 from 1500 hours to 2300 hours.
11-23-78	Respaced packers and set from 5748' to 5940'. Ran hydrological test #6 from 1130 hours to 2000 hours. Displaced fluid in drill pipe with mud.
11-24-78	Respaced packers and set from 5608' to 5743'. Ran hydrological test #7 from 1000 hours to 1830 hours. Displaced fluid in drill pipe with mud.
11-25-78	Laid down test tool. Made trip with 8-3/4" bit and conditioned mud. Made up test tool and ran in hole.
11-26-78	Set packers from 5450' to 5596' and ran hydrological test #8 from 0030 hours to 0330 hours. Dressed tool and set packers from 5250' to 5440'. Started hydrological test #9 at 1745 hours.
11-27-78	Completed test at 0230 hours. Displaced fluid in the drill pipe with mud. Dressed test tool and set packers from 4798' to 4988'. Ran hydrological test #10 from 1545 hours to 2130 hours. Displaced fluid with mud.
11-28-78	Dressed test tool and set packers from 4598' to 4788'. Ran hydrological test #11 from 0630 hours to 1400 hours. Displaced fluid in the drill pipe with mud. Ran tool in the hole.
11-29-78	Set packers from 4302' to 4492'. Ran hydrological test #12 from 0030 hours to 0700 hours. Displaced fluid in the drill pipe with mud. Laid down test tool.
11-30-78	Laid down drill collars. Ran 4-1/2" drill pipe in the hole and conditioned mud. Set plug #1 from 7190' to 6950' using Halliburton with 110 ft^3 (85 sacks) of 50% neat cement, 50% Pozmix A, 8% sand and

(Con't.)

11-30-78 2% calcium chloride. Set plug #2 from 6250' to 6150' with 58 ft^3 (45 sacks) of the same slurry. Cement in place at 0530 hours. Ran 43 joints (1775.83') of 7" O.D., 23#, K-55 casing for a liner. A backoff sub (3.15') was placed on the top joint with 4 external casing packers (11.84' each) on top of joint #25, #31, #39 and #43. A Baker solid guide shoe (1.05') was placed on bottom. Total length of the casing string was 1827.39'. The casing hit an obstruction at 5912' and was stuck at 5957' (5942' GL) fracturing the guide shoe and mud flowed back into the casing. Top of liner at 4130' (4115' GL).

12-1-78 Backed off from the 7" O.D. liner and condtioned mud. Waited on 3-1/2" drill pipe. Ran Schlumberger gauge ring inside the liner to 4685'.

12-2-78 Ran 6-1/8" bit in the hole on 3-1/2" drill pipe, tagged top of liner at 4130' and conditioned mud. Pulled out of hole. Perforated 7" O.D. liner from 5897' to 5898' with 4 holes using Schlumberger. Ran Halliburton EZ Drill SV squeeze packer in the hole using Schlumberger.

12-3-78 Set packer from 5886' to 5888'. Ran seal assembly in the hole on 3-1/2" drill pipe and set in the packer. Squeezed perforations using Halliburton with 367 ft^3 of 50% neat cement, 50% Pozmix A, 2% gel, 2% calcium chloride and o.5% CFR-2 to 2000 psi. Cement in place at 0830 hours. Pulled out of hole and ran McCullough temperature log.

12-4-78 Waited on cement to 0800 hours. Ran McCullough cement bond log.

12-5-78 Ran Lynes production packer in the hole on 3-1/2" drill pipe and set inside the top of the 7" O.D. liner. Pressured up to set the 4 external casing packers to 1100 psi and held for 5 minutes. Pulled out of hole and set Halliburton RTTS packer at 4700'. Perforated 7" O.D. liner from 4800' to 4801' with 4 holes using Oilwell Perforators.

12-6-78 Pressured up on perforations to 1100 psi for 1/2 hour. Reset packer at 4304' and perforated casing from 4420' to 4421' with 4 holes. Pressured up to 1100 psi and pressure held from 400 to 600 psi for 1 hour. Pulled out of hole. Removed blow out equipment. Installed wellhead equipment.

12-7-78 Connected wellhead equipment. Ran in hole to 5850' and displaced mud with water. Hole started flowing water. Pulled out of hole.

12-8-78 Attempted to run a temperature log, could not get below 734'. Ran 6-1/8" bit in the hole and hit tight place at 734'. Pulled out of hole and made trip with a spear, hole was tight from 750' to 1350'. Found fine to medium cuttings inside the spear and drill pipe along with some pieces of cement.

12-9-78 Mixed mud and installed Hydril preventer on the gate valve. Ran 8-3/4" bit in the hole.

12-10-78 Ran 8-3/4" bit in the hole and washed to bottom, hole flowing. Mix mud.

12-11-78	Displaced water with mud at 4125'. Pulled out of hole and went in with a 6-1/8" bit.
12-12-78	Ran 6-1/8" bit to 5850' and circulated hole clean. Pulled out of hole. Made up 7" RTTS packer and set at 4650' and broke down perforations at 4800' to 4801' with water to 1600 psi. Reset packer at 4300' and injected water at 1400 psi. Squeezed perforations at 4420' to 4421' and 4800' to 4801' with 236 ft^3 (200 sacks) of class "G" cement with 1500 psi at a rate of 4 to 5 barrels per minute. Final squeeze pressure was 800 psi. Pulled packer above the 7" liner and conditioned mud.
12-13-78	Pulled out of hole and ran 9-5/8" RTTS packer. Set packer at 1406', pressured up to 1900 psi and broke to 3 barrels per minute. Pulled out of hole and ran 6-1/8" bit, tagged cement at 4423' and drilled to 4463'. Ran 7" RTTS packer and set at 4235'. Pressured up to 1700 psi at 3 barrels per minute. Squeezed perforations from 4420' to 4421' with 112 ft^3 of class "G" cement + 2% calcium chloride followed by 112 ft^3 of class "G" cement. Cement in place at 2045 hours. Released packer, cement set up and could not reverse out. Left 1581' of cement inside the 3-1/2" drill pipe.
12-14-78	Laid down 51 joints of 3-1/2" drill pipe. Made up 9-5/8" RTTS packer and set at 900'. Pressure tested top of 7" O.D. liner to 2000 psi for 10 minutes. Ran 6-1/8" bit in the hole and tagged cement at 4230'. Started drilling cement.
12-15-78	Drilled thru cement at 4600' and ran bit to 5000'. Conditioned mud and pulled out of hole.
12-16-78	Ran 9-5/8" RTTS packer in the hole and set at 1350'. Injected water at 3 barrels per minute to 1700 psi. Ran 7" RTTS packer in the hole and set at 4460'. Squeezed perforations with 118 ft^3 of class "G" cement to 2500 psi. Cement in place at 1200 hours. Reset packer at 4370' and tested perforations at 4420' to 4421' to 2000 psi for 5 minutes. Ran 6-1/8" bit in the hole and tagged cement at 4700'.
12-17-78	Drilled out cement from 4700' to 4800' and circulated hole to 5000'. Pulled bit and set 9-5/8" RTTS packer at 860' and pressure tested to 2000 psi for 10 minutes. Pressure tested above the packer to 1000 psi for 10 minutes. Ran drill pipe to 4500' and displaced mud with water. Laid down drill pipe.
12-18-78	Completed laying down drill pipe. Rigged up Oilwell Perforators and perforated the 7" O.D. liner from 4373' to 4393' with 4 holes per foot. Ran second gun and hit object at the top of the liner, spudded thru and ran gun to 4347'. Perforated from 4337' to 4357' with 4 holes per foot. Pulled gun to 4146' and stuck. Pumped water in hole at 500 psi for 15 minutes and pulled gun free. Hit bridge at approximately 825' and worked gun out of the hole. Flowed hole.
12-19-78	Continued flowing hole. Pumped into casing for 1-1/4 hours attempting to wash down plug at 825'. Spudded on plug with a sinker bar and 20' perforating gun while pumping. Pumped into formation at 450 to 600 psi at a rate of 8.7 barrels per minute. Removed blow out equipment and installed a blind flange on the 10" gate valve. Released rig at 2300 hours. Hole completed.

HOLE DEVIATION

DATE	DEPTH	DEVIATION-DEGREES
8-15-78	108	0
	150	1/4
8-16-78	350	1
	155	1/4
8-17-78	350	3/4
8-19-78	406	1/2
8-20-78	499	1/2
	598	1/2
	700	3/4
	907	1-1/4
8-21-78	1000	1-1/2
	936	1-1/4
	530	3/4
8-22-78	624	3/4
	812	1
	904	1
8-23-78	1000	1
8-28-78	1109	1-1/4
8-29-78	1170	3/4
	1264	1
	1357	1-1/2
8-30-78	1451	1
	1600	2
8-31-78	1663	1-3/4
	1725	2
	1786	2
	1848	2
9-1-78	1911	2-1/4
	1973	2
	2036	2
	2099	2-3/4
	2142	2-1/2
9-2-78	2209	2
	2270	2
9-3-78	2340	2-1/2
	2402	2-1/2
9-4-78	2496	3
	2553	3-1/4
	2617	3
	2680	2-3/4
9-5-78	2710	3
	2773	2-3/4
	2804	3
	2866	2-1/2
	2929	2-3/4
9-6-78	2990	2-1/2
	3053	2-1/2
	3117	3

HOLE DEVIATION

DATE	DEPTH	DEVIATION-DEGREES
9-7-78	3184	3
	3273	3
9-8-78	3336	3
9-9-78	3491	2
	3585	1-3/4
9-10-78	3637	1-1/2
9-11-78	3763	2-1/2
	3858	2-3/4
9-12-78	3983	2
	4077	2
9-13-78	4035	2-1/2
9-16-78	4300	2
9-25-78	1175	1/2
9-26-78	1329	1-3/4
	1485	1-1/4
9-27-78	1642	1-1/4
	1767	1-3/4
9-28-78	1955	1-3/4
	2112	1-3/4
	2300	1-3/4
9-29-78	2425	3
9-30-78	2579	2-3/4
	2641	3
10-1-78	2790	3
10-2-78	3033	2-3/4
10-7-78	3853	2-1/4
10-12-78	4320	2
10-18-78	4600	1-1/2
11-2-78	5830	2-3/4
11-7-78	6375	3-1/4

LOG INDEX

(Con't)

TYPE LOG	DATE	RUN NO.	DEPTH DRILLER	DEPTH LOGGER	LOGGED FROM	LOGGED TO
Borehole Compensated Sonic	11-17-78	3	7196	7186	4230	7185
Temperature	8-20-78	1	1000	996	130	996
	11-20-78	3	7196	7188	4310	7188

MUD AND CHEMICAL RECORD

Note: Material copied from tour sheets. Mud properties copied from mud service company reports when available, otherwise from tour sheets.

Date	Material Added	Weight lbs/gal	Viscosity Seconds	Water Loss CC's
8-15-78	Gel 42 sacks, Lime 5 sacks, Caustic Soda 2 sacks	8.9	42	
8-16-78	Gel 80 sacks	8.9	46	
8-17-78	Gel 35 sacks, Caustic Soda 1 sack	8.7	43	
8-18-78	None			
8-19-78	Gel 60 sacks, Bicarbonate 2 sacks, Caustic Soda 3 sacks, Soda Ash 1 sack	8.6	55	
8-20-78	Gel 65 sacks, Bicarbonate 1 sack, Rayflow 2 sacks, Cypan 1 sack, Dakolite 3 sacks	8.8	78	20
8-21-78	Gel 12 sacks, Dakolite 2 sacks, Rayvan 1 sack	8.9	68	10.6
8-22-78	Gel 25 sacks, Dakolite 2 sacks, Soda Ash 1 sack, Rayvan 1 sack	8.8	38	16
8-23-78	Gel 24 sacks, Dakolite 1 sack, Rayvan 4 sacks, Bicarbonate 1 sack	8.9	42	
8-24-78	Gel 70 sacks, Rayvan 3 sacks, Bicarbonate 1/2 sack	8.9	36	17.8
8-25-78	Gel 14 sacks, Bicarbonate 1/2 sack	9.1	46	14
8-26-78	None	9.0	57	
8-27-78	None			
8-28-78	Gel 120 sacks, Soda Ash 1 sack, Rayvan 5 sacks, Bicarbonate 1 sack, Cypan 2 sacks, Fiber 15 sacks	8.8	40	
8-29-78	Gel 88 sacks, Rayvan 4 sacks, Cypan 3 sacks	8.9	44	
8-30-78	Gel 50 sacks, Rayvan 2 sacks, Mica 10 sacks, Fiber 3 sacks	8.9	46	8.8
8-31-78	Gel 73 sacks, Rayvan 2 sacks, Fiber 5 sacks, Mica 11 sacks, Superlube 4 sacks, Cypan 1 sack	9.3	53	7.6

Date	Material Added	Weight lbs/gal	Viscosity, Seconds	Water Loss CC's
10-1-78	Gel 55 sacks, Barite 25 sacks, Dakolite 6 sacks, Rayvan 4 sacks, Caustic Soda 4 sacks	10.6	70	7.2
10-2-78	Gel 30 sacks, Barite 30 sacks, Rayvan 1 sack, Dakolite 1 sack, Caustic Soda 1 sack, Mica 4 sacks	10.6	80	7.0
10-3-78	Gel 81 sacks, Barite 114 sacks, Rayvan 8 sacks, Dakolite 7 sacks, Caustic Soda 5 sacks, Soda Ash 3 sacks, Fiber 7 sacks, Mica 4 sacks	10.2	85	7.0
10-4-78	Gel 109 sacks, Barite 84 sacks, Rayvan 6 sacks, Dakolite 6 sacks, Caustic Soda 6 sacks, Soda Ash 2 sacks	10.3	70	6.8
10-5-78	Gel 42 sacks, Barite 290 sacks, Rayvan 4 sacks, Dakolite 7 sacks, Caustic Soda 2 sacks, Soda Ash 2 sacks, Fiber 14 sacks	10.3	66	9.5
10-6-78	Gel 15 sacks, Barite 620 sacks, Rayvan 1 sack, Dakolite 2 sacks, Caustic Soda 1 sack	11.3	61	8.0
10-7-78	Gel 25 sacks, Barite 60 sacks, Rayvan 4 sacks, Dakolite 3 sacks, Caustic Soda 3 sacks, Soda Ash 1 sack, Fiber 5 sacks	11.2	64	7.0
10-8-78	Gel 37 sacks, Barite 96 sacks, Rayvan 7 sacks, Caustic Soda 4 sacks, Soda Ash 2 sacks	11.3	66	7.8
10-9-78	Gel 40 sacks, Barite 30 sacks, Rayvan 3 sacks, Dakolite 4 sacks, Caustic Soda 2 sacks, Soda Ash 1 sack	11.2	70	6.6
10-10-78	Gel 20 sacks, Barite 95 sacks, Dakolite 4 sacks, Rayvan 6 sacks, Caustic Soda 1 sack, Soda Ash 3 sacks	11.4	69	7.0
10-11-78	Gel 30 sacks, Barite 20 sacks, Dakolite 2 sacks, Rayvan 3 sacks, Caustic Soda 2 sacks, Soda Ash 3 sacks	11.2	66	7.2
10-12-78	Gel 40 sacks, Barite 130 sacks, Dakolite 2 sacks, Rayvan 1 sack, Caustic Soda 1 sack, Soda Ash 2 sacks	11.4	72	7.2
10-13-78	Gel 21 sacks, Barite 105 sacks, Rayvan 4 sacks, Soda Ash 1 sack	11.0	43	

Date	Material Added	Weight lbs/gal	Viscosity Seconds	Water Loss CC's
10-14-78	Gel 20 sacks, Barite 437 sacks, Rayvan 11 sacks, Dakolite 2 sacks, Bicarbonate 4 sacks, Phosphate 4 sacks	11.1	44	7.4
10-15-78	Gel 13 sacks, Barite 35 sacks, Dakolite 1 sack, Desco 1 sack, Driscose 1 sack	11.0	40	
10-16-78	Barite 110 sacks, Rayvan 2 sacks, Dakolite 1 sack, Fiber 15 sacks	11.1	68	
10-17-78	Gel 45 sacks, Barite 250 sacks, Rayvan 10 sacks, Dakolite 9 sacks, Bicarbonate 1 sack, Driscose 2 sacks, Soda Ash 4 sacks	10.9	51	9.2
10-18-78	Gel 29 sacks, Dakolite 4 sacks, Rayvan 6 sacks, Barite 294 sacks, Soda Ash 3 sacks	11.0	40	9.8
10-19-78	Gel 20 sacks, Cypan 1 sack, Rayvan 4 sacks, Dakolite 4 sacks, Barite 50 sacks, Fiber 6 sacks, Soda Ash 2 sacks	11.0	44	10.4
10-20-78	Gel 10 sacks Dakolite 3 sacks, Rayvan 4 sacks, Barite 45 sacks, Soda Ash 3 sacks, Caustic Soda 1 sack, Driscose 1 sack	11.0	42	8.8
10-21-78	Gel 27 sacks, Dakolite 4 sacks, Rayvan 4 sacks, Cypan 1 sack, Barite 65 sacks, Caustic Soda 1 sack, Soda Ash 1 sack	10.9	45	8.8
10-22-78	Gel 10 sacks, Dakolite 4 sacks, Rayvan 3 sacks, Cypan 1 sack, Soda Ash 2 sacks, Barite 15 sacks, Diesel 500 gals, No-Stick 15 gals.	10.9	44	6.8
10-23-78	Barite 100 sacks, Superlube 4 sacks, Caustic Soda 3 sacks, Soda Ash 6 sacks, Rayvan 6 sacks, Fiber 3 sacks	10.9	47	6.4
10-24-78	Gel 29 sacks, Barite 70 sacks, Rayvan 7 sacks, Caustic Soda 4 sacks, Soda Ash 5 sacks, Superlube 1 sack	11.0	47	7.2
10-25-78	Gel 25 sacks, Barite 75 sacks, Bicarbonate 4 sacks, Rayvan 5 sacks, Caustic Soda 4 sacks, Soda Ash 6 sacks	10.9	44	8.8

Date	Material Added	Weight lbs/gal	Viscosity Seconds	Water Loss CC's
10-26-78	Gel 30 sacks, Barite 165 sacks, Rayvan 5 sacks, Caustic Soda 6 sacks, Soda Ash 9 sacks	10.9	50	9.0
10-27-78	Soda Ash 7 sacks, Rayvan 2 sacks, Fiber 7 sacks	11.1	52	7.2
10-28-78	Barite 60 sacks, Fiber 5 sacks, Soda Ash 8 sacks, Gel 10 sacks, Caustic Soda 3 sacks, Rayvan 3 sacks	11.2	54	7.4
10-29-78	Gel 45 sacks, Soda Ash 4 sacks, Rayvan 5 sacks, Caustic Soda 4 sacks, Dakolite 4 sacks, Barite 220 sacks	11.2	60	7.2
10-30-78	Barite 140 sacks, Caustic Soda 6 sacks, Soda Ash 6 sacks, Rayvan 7 sacks,Gel 31 sacks, Dakolite 4 sacks, Fiber 5 sacks	11.0	52	9.2
10-31-78	Soda Ash 2 sacks, Rayvan 2 sacks	11.0	44	9.7
11-1-78	Dakolite 1 sack, Rayvan 6 sacks, Caustic Soda 3 sacks, Barite 15 sacks, Soda Ash 2 sacks, Gel 14 sacks	11.2	53	9.6
11-2-78	Gel 40 sacks, Barite 170 sacks, Soda Ash 1 sack, Fiber 28 sacks	10.9	47	8.6
11-3-78	Gel 30 sacks, Barite 86 sacks, Soda Ash 3 sacks, Rayvan 3 sacks, Driscose 1 sack, Caustic Soda 2 sacks	11.0	42	9.4
11-4-78	Gel 112 sacks, Barite 325 sacks, Soda Ash 6 sacks, Rayvan 2 sacks, Caustic Soda 5 sacks, Mica 10 sacks, Fiber 5 sacks, Driscose 2 sacks, Q-Seal 5 sacks	10.9	58	9.5
11-5-78	Gel 23 sacks, Rayvan 8 sacks, Caustic Soda 4 sacks, Soda Ash 4 sacks, Driscose 1 sack	10.8	48	8.0
11-6-78	Gel 26 sacks, Barite 170 sacks, Soda Ash 6 sacks, Mica 5 sacks, Rayvan 8 sacks, Caustic Soda 4 sacks, Dakolite 1 sack	10.7	42	8.4
11-7-78	Gel 27 sacks, Rayvan 8 sacks, Soda Ash 6 sacks, Caustic Soda 3 sacks, Barite 135 sacks	10.8	43	8.4

Date	Material Added	Weight lbs/gal	Viscosity Seconds	Water Loss CC's
11-8-78	Gel 49 sacks, Soda Ash 5 sacks, Caustic Soda 2 sacks, Rayvan 5 sacks, Dakolite 6 sacks	10.9	55	8.0
11-9-78	Gel 32 sacks, Soda Ash 6 sacks, Rayvan 8 sacks, Caustic Soda 1 sack, Dakolite 5 sacks, Barite 60 sacks	10.8	49	8.4
11-10-78	Gel 33 sacks, Soda Ash 5 sacks, Barite 70 sacks, Rayvan 8 sacks, Dakolite 4 sacks	10.9	52	8.4
11-11-78	Barite 86 sacks, Rayvan 5 sacks, Dakolite 1 sack, Soda Ash 3 sacks, Caustic Soda 1 sack	10.7	49	8.0
11-12-78	Barite 60 sacks, Rayvan 4 sacks, Dakolite 6 sacks, Soda Ash 5 sacks	10.8	56	8.4
11-13-78	Gel 18 sacks, Barite 18 sacks, Soda Ash 7 sacks, Rayvan 4 sacks	11.0	54	7.8
11-14-78	Barite 20 sacks, Rayvan 6 sacks, Soda Ash 4 sacks	10.9	58	8.0
11-15-78	Gel 69 sacks, Barite 280 sacks, Rayvan 8 sacks, Caustic Soda 3 sacks, Mica 21 sacks, Fiber 28 sacks, Kwik Seal 3 sacks	10.9	57	8.0
11-16-78	Gel 27 sacks, Barite 95 sacks, Rayvan 5 sacks, Soda Ash 2 sacks, Fiber 12 sacks	10.9	47	8.2
11-17-78	None (Logging)			
11-18-78	None (Logging)			
11-19-78	None (Logging)			

Geology of test well

The following formation tops and sample and core description were photocopied from the report from Irvin Kranzler and John R. Warne. The stratigraphic nomenclature from their report and that on table 1 have not been checked for conformance with the nomenclature presently used by the U.S. Geological Survey.

Cores listed in table 1 are described in the sample and core descriptions section of this report except for core no. 1 which was taken in a PVC liner which was not opened at the well site. The core-analysis results are from the report furnished by Core Laboratories, Inc., Denver, Colo.

Table 1.--*Core intervals*

[Depths are from kelly bushing (3,039.8 ft above sea level), which is 15.5 ft above land surface]

Core	Interval (depth in ft)	Cored (ft)	Recovered (ft)	Formation
1	2270 -2300	30	24.5	Mowry
2	3184 -3214	30	29	Dakota
3	3380 -3410	30	24	Lakota
4	3701 -3737	36	36	Swift
5	4135 -4165	30	30	Tensleep
6	4300 -4360	60	15	Madison (Mission Canyon)
7	4360 -4387	27	16	Madison (Mission Canyon)
8	4387 -4411	24	21	Madison (Mission Canyon)
9	4470 -4484	14	12	Madison (Mission Canyon)
10	4600 -4621	21	20	Madison (Mission Canyon)
11	4621 -4648.5	27.5	27.5	Madison (Mission Canyon)
12	4710 -4725.5	15.5	15.5	Madison (Mission Canyon)
13	4848 -4878	30	30	Madison (Mission Canyon)
14	5285 -5345	60	60	Madison (Lodgepole)
15	5375 -5423	48	48	Devonian
16	5658 -5683.7	25.7	25.7	Stony Mountain
17	5683.7-5698.4	14.7	14.7	Stony Mountain
18	5830 -5861	31	31	Red River
19	7071 -7095.4	24.4	24.4	Flathead
20	7174 -7190	16	16	Precambrian
Totals		594.8	520.3	

FORMATION TOPS

Formation and Age	Log Depth (in feet)	Datum
CRETACEOUS		
Eagle	245 (sample)	+2795
Telegraph Creek	700	+2340
Shannon	789	+2251
Colorado	823	+2217
Niobrara	938	+2102
Frontier	1796	+1244
Normal Fault (90' cut out)	2143	+ 897
Mowry	2216	+ 824
Thermoplis	2457	+ 583
Muddy (?)	2833	+ 207
Skull Creek	2886	+ 154
Dakota Silt	2993	+ 47
Dakota Sand	3123	- 83
Kootenai	3208	- 168
Lakota	3390	- 350
JURASSIC		
Morrison	3442	- 402
Swift	3650	- 610
Rierdon	3788	- 748
Normal Fault (90' cut out)	3830	- 790
Piper Shale	3876	- 836
Piper Limestone	3942	- 902
TRIASSIC		
Spearfish	4046	-1006
PENNSYLVANIAN		
Tensleep	4128	-1088
Amsden	4178	-1138
MISSISSIPPIAN		
Madison	4300	-1260
Lodgepole	4986	-1946
DEVONIAN		
Devonian	5368	-2328
ORDOVICIAN		
Stony Mountain	5612	-2572
Red River	5724	-2684
CAMBRIAN		
Snowy Range	5963	-2923
Dry Creek	6454	-3414
Pilgrim	6535	-3495
Gros Ventre	6642	-3602
Flathead	7073	-4033
PRECAMBRIAN		
Gneiss	7142	-4102
Total Depth (Driller)	7190	-4150

From	To	Descriptions
840	880	As above. Decrease in mica and carbonaceous material. Trace very small tan specks.
880	905	Shale, medium brown-gray, blocky, silty, slightly calcareous mica. Streaks Sandstone very fine to Siltstone, light gray to white, micaceous, tight. Gas kick up to 58 units.
905	910	As above, decreasing gas.
910	938	Shale, medium gray-brown, blocky, silty, calcareous with tan calcareous specks. Intercalated Sandstone, very fine, light gray and brown-gray, micaceous, calcareous, tight.
		NIOBRARA 938 feet (Log)
938	950	Shale as above. Specks more numerous. Less Sandstone.
950	1000	As above, tan to orange calcareous specks abundant; some dark brown pyritic carbonaceous material; trace cream to brown *Inoceramus* prisms.
1000	1020	Shale, dark gray, flaky, slightly calcareous, traces white to clear calcite nodules (probably parts of concretions).
1020	1050	Shale, dark gray, flaky, slightly calcareous; a very few pieces with brown calcareous specks; traces black carbonaceous material in part.
1050	1160	Shale, dark gray, flaky, slightly calcareous; traces *Inoceramus* prisms and other shell fragments.
1160	1170	Shale, dark gray, flaky, non-calcareous to slightly calcareous in part; traces *Inoceramus* prisms and other shell fragments; traces white and brown calcite nodules; trace Sandstone, medium gray, very fine grained, scattered biotite flakes and black grains, white clay cement, no visible porosity, no fluorescnece or cut fluorescence.
1170	1280	Shale very dark gray, flaky to lumpy, non-calcareous to slightly calcareous in part; traces *Inoceramus* prisms and other shell fragments; traces white and brown calcite nodules and pyrite.
1280	1320	Shale, dark gray, lumpy, non-calcareous; with a little Bentonite, white to light gray, earthy, scattered biotite flakes; traces shell fragments and white calcite nodules and pyrite; with a little Sandstone, light gray, very fine grained, scattered biotite flakes, much white bentonitic clay matrix (grades to sandy Bentonite) no porosity, no fluorescence or cut fluorescence.
1320	1430	Shale, medium gray, flaky to lumpy, silty, slightly calcareous, trace glauconite grains increasing to numerous glauconite grains from 1370 to 1430; with Bentonite, tan to light gray, earthy to waxy, scattered biotite flakes, sandy in part.
1430	1450	Shale, dark gray, flaky to lumpy, silty, sandy, glauconite grains in part; Siltstone grading to very fine Sandstone, medium gray, silty, argillaceous, slightly calcareous, scattered glauconite grains, tight, no fluorescnece or cut fluorescence.
1450	1520	Shale, dark gray, flaky, non-calcareous to slightly calcareous in part, scattered biotite flakes; traces shell fragments; traces Bentonite, white to light gray, earthy, scattered biotite flakes, sandy in part.
1520	1570	Shale, dark gray, flaky calcareous in part to slightly calcareous in part, white and tan calcareous specks in a few pieces; traces shell fragments and calcite nodules. From 1520 to 1556 traces Sandstone, light gray, very fine argillaceous, calcareous, scattered black and gray grains, tight, no fluorescence or cut fluorescence.
1570	1600	Shale, dark gray, flaky, calcareous, numerous tan calcareous specks, a few white calcareous specks.

From	To	Descriptions
1600	1640	Shale, dark gray, flaky, slightly calcareous in part, calcareous in part; traces shell fragments and calcite nodules.
1640	1760	Shale, dark gray, flaky, calcareous in part to non-calcareous in part; a little Siltstone grading to Sandstone, very fine calcareous in part, numerous black and gray grains tight, no fluorescence or cut fluorescence; trace shell fragments and pyrite.
1760	1800	Shale, dark gray, flaky, non-calcareous to slightly calcareous in part; traces Siltstone, medium gray, argillaceous; trace shell fragments.

FRONTIER 1796 feet (Log)

From	To	Descriptions
1800	1830	Shale and Siltstone as above with a little Sandstone, medium gray and light gray, very fine grained, silty and argillaceous, scattered black and gray grains, biotite in part, tight, no fluorescence or cut fluorescence.
1830	1850	Shale, Siltstone and Sandstone as above with a little Bentonite, light gray, waxy.
1850	1910	Shale, dark gray flaky, calcareous in part, non-calcareous in part; trace Siltstone grading to Sandstone, medium gray, very fine grained, argillaceous, calcareous scattered black grains, tight, no fluorescence or cut fluorescence, trace shell fragments.
1910	1920	Shale, dark brown-gray, some gray-brown, blocky, silty calcareous, firm. Trace Sandstone, medium gray-brown, very fine, very pyritic calcareous, dull orange specks (very small gas kick on mud log at 1911).
1920	1935	Shale, gray-brown, blocky, calcareous, silty, scattered mica; trace Sandstone, light to medium gray brown, fine to very fine, calcareous, pyritic, micaceous, tight.
1935	1964	Shale, dark gray, some brown-gray, blocky, silty, micaceous, slightly calcareous.
1964	1972	Much Bentonite, white, some light gray, micaceous; Shale, as above.
1972	2005	Shale, dark gray, some brown-gray, blocky, bentonitic, silty; streaks Sandstone, light gray, very fine, slightly calcareous and glauconitic, argillaceous, tight; some Bentonite, white, micaceous, _Inoceramus_ prisms.
2005	2010	Bentonite, light gray, some white, micaceous; Shale as above.
2010	2030	Shale, dark gray, some brown-gray, blocky, less silty, trace glauconite, micaceous; Bentonite, light gray to white, micaceous. Trace Sandstone, medium gray, very fine, argillaceous, micaceous, trace glauconite, slightly calcareous, tight; _Inoceramus_ prisms.
2030	2045	Shale, dark gray, blocky, very silty, trace brown carbonaceous material; Bentonite, white, cream, light gray-brown, micaceous.
2045	2055	Shale, medium gray to dark gray, blocky, silty, micaceous. Increase in Bentonite, white to cream, some light gray, micaceous.
2055	2065	Shale, dark gray, blocky, very silty to sandy, trace pyrite and glauconite; trace Bentonite, light brown-gray micaceous.
2065	2075	As above, increase in pyrite and glauconite. Trace Sandstone, medium gray, very fine to fine, calcareous, glauconitic, tight. Bentonite as above.
2075	2085	Abundant calcite, milky to light brown (concretion? fault?). Abundant Bentonite, white, micaceous; Shale, as above, sandy, glauconitic.
2085	2100	Shale, dark brown-gray, blocky, very sandy grading to very fine, argillaceous Sandstone, glauconitic, micaceous, trace pyrite, very slightly calcareous, tight. Bentonite, white and light gray, mica.
2100	2125	Sandstone, medium to dark gray, some green-gray, some light gray, very fine, glauconitic, argillaceous, micaceous, non-calcareous, tight, slightly pyritic. Shale, dark gray, blocky, silty; Bentonite, white and gray, micaceous.

From	To	Descriptions
2995	3060	Siltstone, medium gray, calcareous in part; interbedded with Shale, very dark gray, fissile, non-calcareous to slightly calcareous; traces pyrite.
3060	3080	Siltstone, light to medium gray, slightly calcareous, blebs and hairline partings of dark gray silty Shale; traces pyrite.
3080	3110	Siltstone as above; interbedded with Shale, dark gray, fissile.

DAKOTA 3123 feet (Log)

3110	3155	Shale, dark gray, fissile; interbedded with a little Sandstone, light gray to white, very fine grained grading to Siltstone, slightly calcareous slightly siliceous, tight, no show. Slight increase in Sandstone from 3120 to 3140 feet.
3155	3184	Siltstone, light gray, slightly calcareous; and Siltstone, medium gray to brownish gray, argillaceous grading to silty Shale, slightly calcareous.

CORE No. 2 3184-3214 feet. Recovered 29 feet. (Pipe strap shows bottom of the hole 3 feet deeper than Geolograph but no correction made).

3184.	3186.4	Shale, dark gray with irregular and wavy laminae and blebs up to 1 cm thick of very dark gray carbonaceous Shale, light gray Shale and light gray silty Shale grading to Siltstone, light gray argillaceous, (80% dark gray Shale); Siltstone increasing toward base; burrowed.
3186.4	3186.6	Siltstone, light gray, a few scattered black grains and very fine muscovite and biotite flakes, slightly calcareous, ripple bedded, burrowed at top.
3186.6	3188.1	Siltstone, light gray, grading to very fine grained Sandstone in part, a few scattered black grains and fine muscovite flakes, tight, no show; Shale, dark gray and Shale, light gray silty; scattered pyrite (60% Shale, 40% Siltstone-Sandstone); Siltstone and Shale in irregular laminae and blebs up to 2 cm thick; bioturbated (highly burrowed).
3188.1	3188.5	Siltstone, grayish brown, argillaceous.
3188.5	3192.1	Shale, dark gray, bioturbated with irregular blebs and laminae up to 2 cm thick of Siltstone, light gray, calcareous in part; Shale light gray; fine laminae of black carbonaceous Shale (about 50% dark gray Shale, 50% Siltstone and light gray Shale. Siltstone increasing toward base). Scattered pyrite.
3192.1	3202.8	Shale, dark gray burrowed in part, with a few laminae and blebs of medium gray Shale and a very few laminae of Siltstone, light gray; traces pyrite. Dark gray Shale 80% at top increasing to 95% near base.
3202.8	3203.4	Sandstone, light gray, very fine grained, a few scattered black, brown and pink grains, scattered muscovite flakes, calcareous, white clay cement, tight, no show, burrowed with blebs of medium gray and tan very sandy clay.
3203.4	3204.9	Sandstone, light gray, very fine grained grading to Siltstone, slightly calcareous, white clay cement; flecks and hairline partings of black carbonaceous material, tight, no show, in laminae up to 3 cm thick; ripple bedded in part, burrowed in part; interbedded with Shale, dark gray in layers up to 1 cm thick (about 70% Sandstone, 30% Shale).
3204.9	3206.5	Sandstone, light gray, very fine grained grading to Siltstone, a few scattered black grains, muscovite flakes and biotite flakes, calcareous in part, no visible porosity, no show, ripple bedded, slightly burrowed near base; with irregular dark Shale laminae up to 5 cm thick increasing toward base.

From	To	Descriptions
3206.5	3209.5	Shale, dark gray, finely interlayered with laminae and blebs of light gray Shale and a few streaks light gray Siltstone; ripple bedded in part, mostly burrowed in upper part, less burrowed in lower part.

KOOTENAI 3209.5 feet (Core), 3208 feet (Log)

3209.5	3213	Claystone, pale gray to olive green and a little brown, waxy to earthy, slickensided, crumbly.
3213	3214	Not recovered.

END CORE No. 2

3214	3250	Claystone, pale gray, gray-green and maroon (some mottled pale green and maroon); with a little Siltstone, brick-red and maroon; trace ochre Shale.
3250	3280	Shale, maroon and brick red, silty.
3280	3340	Shale and Claystone, medium gray with Shale, maroon and brick-red, silty; traces brownish gray cryptocrystalline calcite nodules.
3340	3356	As above with trace Sandstone, white, coarse grained, scattered black grains, brown and white grains, calcareous in part, white clay cement, no visible porosity, no show.
3356	3369	Shale, light gray and brick-red, silty in part; trace Sandstone, white, fine to medium grained, angular to subangular, scattered black and gray grains and orange grains, pyritic, calcareous, some white clay cement, traces porosity, no show.
3369	3380	Sandstone, white, fine grained, rare black, brown and orange grains, trace green grains, slightly calcareous, some white clay cement, tight in part, fair porosity in part, no show.

CORE No. 3 — 3380-3410 feet. Recovered 24 feet. Drilling time and core continuity suggest unrecovered portion is between 3389.6 and 3396.6.

3380	3386	Sandstone, white, very fine grained (between very fine grained Sandstone and Siltstone), almost all quartz grains, very rare black and orange grains, non-calcareous, white clay cement, no visible porosity, no fluorescence or cut fluorescence. Bedding obscure in part, horizontal in part with a few zones containing clasts of light gray and greenish gray clay up to 10 cm long. Near-vertical fractures 3383-3384 feet.
3386	3388.5	Interbedded Sandstone, light gray, very fine grained grading to Siltstone, very rare black and pink grains, argillaceous, non-calcareous, no visible porosity, no fluorescence or cut fluorescence; Claystone, light greenish gray and little light brown (reddish brown toward base), silty in part. Bedding horizontal in part, mottled in part, ripple bedded in part.
3388.5	3389.6	Claystone, reddish brown, mottled pale greenish gray in part, silty in part, crumbly, slickensided.

LAKOTA 3390 feet (Log)

3389.6	3396.6	Mostly not recovered. Recovered fragments are Claystone as above aggregating about 1½ feet.
3396.6	3397.5	Claystone as above.
3397.5	3399.7	Siltstone, medium gray (some with reddish brown cast) very argillaceous, sandy, non-calcareous. Bedding is obscure to horizontal, mottled in part.

From	To	Descriptions
3737	3750	Shale, medium gray-brown, blocky, silty, grading to argillaceous Siltstone.
3750	3780	Sandstone, medium to light gray, very fine, some fine, argillaceous, calcareous, glauconitic, biotitc, tight. Trace pyritic fragments. Trace Chert, milky to light brown.
3780	3790	Shale, medium to dark gray-brown, blocky, silty to sandy, slightly calcareous.

RIERDON 3788 feet (Log)

3790	3837	Shale, medium to light gray, blocky, calcareous. Trace brown-gray shell fragments.
3837	3850	Shell fragments, tan, gray, cream; trace Marl, light gray; Shale as above; trace pyrite.
3850	3860	Shale, light gray, splintery, bentonitic, slightly calcareous, crumbly.
3860	3880	Shale, light gray, blocky, silty, calcareous. Shell fragments, cream and gray. Trace Pentacrinus fragments. Trace Chert, milky. Trace Pyrite.

PIPER SHALE 3876 feet (Log)

3880	3890	Shale, pale dirty orange, blocky to very soft, silty, bentonitic, calcareous; trace Sandstone, rose, fine, siliceous, calcareous, hard, tight. Trace shell and pyrite fragments. Streaks Shale, light gray, bentonitic, fossiliferous.
3890	3910	Shale, light orange, blocky to lumpy, bentonitic, anhydritic, silty; Shale, brick-red, blocky, silty. Limestone nodules, cream, light brown, dense.
3910	3948	Shale, light orange, mushy; and Shale, orange, blocky, very bentonitic, anhydritic; Anhydrite, white chalky.

PIPER LIMESTONE 3942 feet (Log)

3948	3955	Limestone, cream, tan, gray, spotted light brown (oolitic), dense anhydritic.
3955	3965	Limestone, cream, tan, medium brown some dark brown mottled, fragmental (oolitic), some is chalky, anhydritic, fossiliferous, tight, dull yellow sample fluorescence, no cut fluorescence, slight petroliferous odor in acid.
3965	3970	As above increase in medium and dark brown Limestone, pyritic in part, petroliferous odor in acid.
3970	3980	Limestone, cream, tan, brown, mottled, oolitic, fragmental, chalky, anhydritic, tight, no show. Streaks Shale, light gray, blocky, pyritic.
3980	3990	Shale, maroon to purple, blocky, silty, anhydritic.
3990	4005	Limestone, cream, tan gray-brown, brown, mottled, fragmental, oolitic, anhydritic, some gray Shale pebbles; gray and brown dense Limestone at base.
4005	4020	Shale, grayish orange, orange, maroon, blocky, some mushy, silty, anhydritic.
4020	4030	Limestone, medium gray, gray-brown, brown, dense, argillaceous; Anhydrite, white, very fine sucrosic to crystalline; red Shale intercalations; Shale, light gray, calcareous.
4030	4040	Sandstone, white to light gray, very fine calcareous, well cemented, tight, no show. Possible, interbeds Shale, orange, maroon, purple, blocky, silty, some mushy.
4040	4045	Shale, light gray, blocky calcareous; Limestone, light gray to medium brown, dense to slightly chalky.

From	To	Descriptions
		SPEARFISH 4046 feet (Log)
4045	4050	Anhydrite, white, mottled red in part, finely crystalline.
4050	4090	Shale, bright orange, very sandy, grades to very argillaceous Sandstone, very fine, anhydritic, Possible streaks Shale, medium gray, blocky, silty to sandy, scattered very fine glauconite grains, rare black grains, trace pyrite. Rare fragment gilsonite (?) at 4070-4080 (contamination?), weak cut fluorescence.
4090	4128	Shale, as above, less silty; streaks Shale, gray and green.
		TENSLEEP 4128 feet (Log)
4128	4135	Sandstone, clear to white, medium to fine, euhedral in part, slightly quartzitic, dolomitic, tight, no show. Tripolite, chalk-white, floating medium to fine sand grains; trace Dolomite, white, very finely sucrosic, floating fine to medium sand grains, tight, now show, trace Chert, milky.
CORE NO. 5		4135-4165 feet. Recovered 30 feet.
4135	4137	Sandstone, white with light green cast in part, very fine, dolomitic, calcite veinlets, no visible porosity, no show. Bedding dip is flat.
4137	4138	As above with intercalated Dolomite, tan, dense.
4138	4139	Dolomite, cream, very finely sucrosic, very sandy, calcite veinlets, tight, no show.
4139	4140	Quartzitic Sandstone, tan and light green-gray, mottled, very fine, dolomitic, calcite veinlets, tight no show.
4140	4142.5	Quartzitic Sandstone, white, mottled light apple-green, fine to very fine, slightly dolomitic, pyritic, no visible porosity, no show.
4142.5	4143	As above with intercalated Dolomite, very light greenish gray, very finely crystalline, pyritic, argillaceous, pyritized hairline fracture.
4143	4145.5	Quartzitic Sandstone, very light greenish gray to white, fine, dolomitic, tight, no show.
4145.5	4146	Intercalated Shale, medium apple-green, subwaxy, pyritic, flaky, dolomitic; and Dolomite, very light gray, speckled with very fine pyrite, dense.
4146	4148	Dolomite, tan to light brown, very fine to extremely fine crystalline, sandy, tight no show.
4148	4149	Quartzitic Sandstone, mottled light green-gray and light red-brown, very dolomitic, tight, no show.
4149	4150	Core shattered; intercalated, Shale, medium apple-green, subwaxy, pyritic, flaky; and Dolomite, light gray, very finely crystalline, speckled with very fine pyrite.
4150	4151.5	Dolomite, light green and white mottled, very fine sucrosic, very sandy, pyritic; some may be very dolomitic Quartzite.
4151.5	4152	As above, with Shale, green, subwaxy pyritic. Shattered.
4152	4154	Dolomite, cream, dense, trace red and green spots. Shale interbeds and intercalations, light green-gray, very pyritic, dolomitic.
4154	4155	Sandstone, light green, very fine, quartzitic, pyritic, dolomitic, tight, no show. Core shattered.
4155	4158	Quartzite, white, very fine to fine, subvitreous, pyritic, dolomitic, hard tight, no show. Core is shattered.
4158	4159	Quartzite, very light gray, vitreous, fine, hard, tight.
4159	4159.5	Shale, very light apple-green, sub-waxy, dolomitic, flaky.

From	To	Descriptions
4159.5	4160.5	Dolomite, cream to tan, dense to very fine crystalline, some green spots, tight, no show.
4160.5	4161.5	Shale, light apple-green, flaky, very pyritic, sub-waxy.
4161.5	4163	Quartzitic Sandstone, white, fine to very fine, slightly dolomitic, tight, no show.
4163	4164.5	As above, trace pyrite; thin gray Shale laminations.
4164.5	4165	Shale, medium apple-green, flaky, pyritic, dolomitic.

END CORE NO. 5

4165	4170	Poor sample (Trip and water flow). Sandstone, white, fine to medium, some coarse, slightly dolomitic, trace porosity, rare fragment with good intergranular porosity.

AMSDEN 4178 feet (Log)

4170	4180	Dolomite, cream to tan, some white, dense to finely crystalline, anhydritic, evidence of vugular porosity, fast drilling, no stain or fluorescence or cut fluorescence. Anhydrite, white to clear, dense to coarse cyrstalline; Chert, milky and white, some clear. Foram and oolite ghosts in Dolomite and Chert.
4180	4190	Dolomite, cream,tan, light rose, some white, coarse crystalline, some dense, anhydritic,appears to have good vugular and fair to poor intercrystalline porosity, no show; Chert, milky; Anhydrite, white to milky, some clear.
4190	4200	Dolomite, cream, some white, some light tan, dense to very fine crystalline, some fine, trace vugs, trace possible large vugs, as above, no show; erratic drilling.
4200	4215	Dolomite, cream to white, dense to very fine crystalline, some white, very fine sucrosic, siliceous in part, tight. Trace Chert, milky. Tripped for bit at 4203; water flowed again.
4215	4228	Dolomite, cream to tan and a little pale pink, mostly dense with a little very fine crystalline, trace coarse crystalline, trace, vugs, no show; a little Chert, white to clear; and Anhydrite, white.
4228	4300	Dolomite, white to cream and tan, dense to very fine crystalline, sucrosic in part, trace to fair intercrystalline porosity in part, a few vugs, scattered white chert, no show; a little Dolomite, pale pink, dense to microcrystalline; a little Anhydrite, white; trace white chert. At 4270 trace Dolomite, white, dense with green specks.

MADISON 4300 feet (Log)

CORE NO. 6	4300-4360 feet. Recovered 12 feet core plus crushed material representing approximately two additional feet. Following description starts with top of recovered portion; assignment of depth within cored interval not possible.
3 feet	Dolomite, white to cream, fine crystalline to microcrystalline, trace intercrystalline porosity, good vuggy porosity, no show; mottled with a little Dolomite, pale tan, dense, tight, no show; top 3 inches Dolomite, pale tan, dense with a few stylolites lined with black residue, tight,no show; a few rounded ovoid light gray siliceous fossil ? relicts about 2 mm long.
5.5 feet	Dolomite, white to cream, very fine crystalline, trace intercrystalline porosity, scattered vugs, no show; a few scattered light gray ovoid siliceous fossil (?) relicts; a few veinlets of Dolomite, white microcrystalline, tight.

From	To	Descriptions
3.5 feet		Dolomite, white to cream, very fine crystalline, trace medium intercrystalline porosity with good vugular porosity, no show; and Dolomite, white microcrystalline in part, tight, scattered vugs in part, no show; numerous anastamozing veinlets of Dolomite white, microcrystalline, tight no show.
2 feet		Crushed mixture of Dolomites as above plus a little Limestone, white, chalky; Dolomite, light gray, dense, tight no show.
END CORE NO. 6		
CORE NO. 7		4360-4387 feet. Recovered 16 feet.
4360	4364.3	Dolomite, cream, microcrystalline, with some very fine crystalline, no intercrystalline porosity, trace vugs, no show; vertical fractures, slickensided; stylolite with black residue at 4364 feet.
4364.3	4370	Dolomite, cream, very fine crystalline to microcrystalline, trace intercrystalline porosity in part, poor to medium vuggy porosity in part, no show; a few veinlets of white microcrystalline Dolomite; suggestion of relict Brachiopod shell ribs at 4369; vertical fracture at 4365.
4370	4375.3	Dolomite, cream, mottled very fine crystalline, microcrystalline and cryptocrystalline, scattered vugs, possible relict shell fragments and Crinoid fragments, no show; at 4373.5 irregular mass about 4" long of Anhydrite, white, earthy with numerous clear crystals.
4375.3	4376	Crushed fragments of Dolomite, cream, mostly dense, some fine crystalline, a few vugs in fine crystalline part, no show.
4376	4387	Not Recovered.
END CORE NO. 7		
CORE NO. 8		4387-4411 feet. Recovered 21 feet.
4387	4395.3	Breccia of angular chunks and mottlings of Dolomite, cream to pale tan, fine crystalline with scattered vugs, trace intercrystalline porosity, trace pink stain around some of the vugs; Dolomite, white, microcrystalline, chalky; Dolomite, pale gray to light tan, dense, with scattered vugs; scattered shell casts; a few stylolites at 4387-4388; numerous white Dolomite veinlets; a few healed vertical fractures; a few anhydrite crystals; numerous irregular non-vertical cracks; at 4388.8 spherical nodule about 10 cm in diameter of Dolomite, white, coarse crystalline, a few vugs, cut by small vertical fracture with about 1 cm of vertical displacement. No show.
4395.3	4398.5	Breccia of Dolomite, light gray, pale tan and brown, dense to microcrystalline, scattered vugs, no show; irregualr fractures and white Dolomite veinlets.
4398.5	4402.5	Recovered only broken and crushed fragments of Dolomite as above plus a little Limestone, tan, microcrystalline matrix with Crinoid fragments in part and coral fragments in part, tight, no show; a few fine partings of pale green clay.
4402.5	4406	Breccia of Dolomite, brown, microcrystalline, tight no show; Dolomite, white to tan, earthy matrix with numerous Crinoid fragments, tight, no show; fracture face and stylolite at 4402.7 with black residue, no fluorescence or xylene cut fluorescence; a few vertical fractures plus irregular cracks and white Dolomite veinlets.
4406	4408	Recovered only broken and crushed fragments of Dolomite as above, some with fine partings of pale green shale.
4408	4411	Not Recovered.
END CORE NO. 8		

From	To	Descriptions
4411	4427	Washed down with less than 5,000 pounds on bit. Hole appeared to have been drilled while circulating. Samples are mostly cavings.
4427	4440	Dolomite, cream microsucrosic to crystalline, scattered pinpoint and small vugs (5%). Trace Anhydrite, medium brown, very finely crystalline. No show; dull gold to yellow sample fluoresence.
4440	4450	Dolomite as above, some with grayish cast, vugs as above. Trace Anhydrite, white with orange stain, chalky. Fluorescence, as above, trace pyrite.
4450	4460	Dolomite, gray-buff, some cream, microcrystalline, slightly anhydritic, tight to trace vugs. Dull gold with some dull yellow sample fluorescence. No show. Trace chalky Anhdyrite as above. Trace pyrite.
4460	4465	Dolomite cream to buff, some grayish, microcrystalline to dense, tight. Anhydrite (10%), medium brown, trace dark brown, very finely crystalline some with pellet casts. Drilled rough.
4465	4470	Dolomite cream to buff, micro to very fine sucrosic, slightly anhydritic, 5-10% small vugs, some slightly honeycomb, dull gold sample fluorescence, no show; trace Anhydrite, white chalky, drilled rough.
CORE NO. 9		4470-4484 feet. Recovered 12 feet.
4470	4471	Dolomite, cream, very fine crystalline to sucrosic, some is fragmented with trace shell fragments, limey, high angle (75°) closed fractures, good vugular porosity, no show, dull yellow mineral fluorescence.
4471	4472	Dolomite, tan to buff, very fine sucrosic, closed vertical fractures, good vugular porosity, now show. Trace Anhydrite, white, sucrosic.
4472	4473	Dolomite, tan, very fine to fine sucrosic, good vugular porosity, slightly anhydritic.
4473	4474.5	Dolomite, cream, fine sucrosic, tight to trace intergranular and rare vugular porosity, slightly anydritic, closed vertical fractures.
4474.5	4476	Brecciated and intercalated dolomite, tan, very fine sucrosic; and Anhydrite, white, very finely sucrosic, tight.
4476	4478	Not recovered.
4478	4479	Dolomite, tan to buff, very fine sucrosic, tight; intercalated with Anhydrite, white very fine sucrosic.
4479	4480	Dolomite, buff to tan, very fine sucrosic; Anhydrite, white, very fine sucrosic.
44780	4481.5	Dolomite, buff, very fine sucrosic, fair vugular porosity, no show.
4481.5	4482	Dolomite, tan, microsucrosic to crystalline, tight.
4482	4483	As above with Anhydrite blebs and intercalations, tight, some closed vertical fractures.
4483	4483.5	Shattered Dolomite, tan to buff, very fine sucrosic to crystalline tight.
4483.5	4484	Dolomite, tan, very fine to fine sucrosic, anhydritic, tight. Intercalated Anhydrite, white, very fine sucrosic.
END CORE NO. 9		
4484	4490	Dolomite, cream, buff, tan microsucrosic to crystalline, anhydritic, tight; Anhydrite, white, chalky, soft, washes out. Dull yellow to bright yellow mineral fluorescence.
4490	4505	Anhydrite, pink to light rose, microsucrosic, dolomitic, some grades to very anhydritic Dolomite. Anhydrite, white to buff, very fine sucrosic, anhydritic, tight.

From	To	Descriptions
4505	4515	As above, Some gray tinted Anhydrite. Trace shale, maroon, blocky, silty.
4515	4525	Anhydrite, white to light gray-brown mottled, microcrystalline to chalky. Some pink Anhydrite, as above.
4525	4545	Anhydrite, mottled as above with some maroon mottling. Some Anhydrite, medium gray to white mottled, microcrystalline to chalky, slightly argillaceous.
4545	4558	Anhydrite, white to tan to brown-gray and purple, microcrystalline to chalky, trace microsucrosic and dolomitic.
4558	4565	Dolomite, light gray-tan mottled maroon dense, tight, anhydritic. Anhydrite, cream to white, microcrystalline to very fine sucrosic to chalky, dolomitic in part.
4565	4575	Anhydrite, rose, cream, white, microsucrosic to crystalline to chalky, dolomitic, Trace Dolomite, tan, dense. Healed fractures lined with fine Anhydrite crystals.
4575	4585	Dolomite, lavender to light rose, dense to microcrystalline, anhydritic, tight. Anhydrite, cream and white, very fine sucrosic to microcrystalline to chalky; trace of bright orange chert.
4585	4595	Dolomite, buff to tan, dense to microcrystalline, anhydritic, tight. Anhydrite as above.
4595	4600	Dolomite, buff to tan, some light gray-brown, ochre mottling in part, microcrystalline, tight, anhydritic. Anhydrite, white, sucrosic; Anhydrite, milky, chalky; Anhydrite, buff, microcrystalline.

CORE NO. 10 4600-4621 feet. Recovered 20 feet.

4600	4606.2	Anhydrite, white, fine crystalline, interbedded (and mottled in part) with Anhydrite, tan and light gray, cryptocrystalline, dolomitic, calcareous in part, grading to anhydritic dolomite, no porosity, no show. Bedding nearly horizontal.
4606.2	4611	Dolomite, tan, fine crystalline, tight in part, scattered vugs and traces intercrystalline porosity in part, no xylene cut fluorescence; scattered blebs up to 1 cm long of Anhydrite, white, and a few veinlets of white to clear Anhydrite, microcrystalline to coarse crystalline; a few vertical and irregular fractures. Bedding dip 0° to 5°. Anhydrite inclusions larger from 4610-4611 with one 10 cm across.
4611	4612.7	Dolomite, tan, microcrystalline to fine crystalline, no visible porosity, no xylene cut fluorescence; irregular blebs up to 1 cm long of Anhydrite, white fine crystalline; a few stylolite; a few veinlets of Anhydrite, white and clear, fine crystalline to coarse crystalline.
4612.7	4618.3	Dolomite, tan to brown, fine crystalline; scattered vugs and traces intercrystalline porosity, no xylene cut fluorescence; scattered blebs of Anhydrite up to 1 cm long; a few vertical fractures; bedding almost horizontal.
4618.3	4620	Breccia of Dolomite, tan, microcrystalline, tight, no xylene cut fluorescence; and Anhydrite, white to light gray; numerous irregular fractures.
4620	4621	No recovery.

END CORE NO. 10

CORE NO. 11 4621 to 4648.5 feet. Recovered 27.5 feet.

4621	4622	Breccia of Dolomite, tan, microcrystalline, tight no xylene cut fluorescence; Anhydrite, white and light gray, fine crystalline and coarse crystalline; stylolite, with black residue, irregular fractures.

From	To	Descriptions
4622	4626	Dolomite, brown and brownish gray, fine crystalline, anhydritic in part, possible relict Crinoid fragments, tight in part, patches with scattered vugs and a few patches with good porosity; no xylene cut fluorescence; vertical fractures, scattered veinlets of Anhydrite; scattered blebs of Anhydrite up to 5 cm long.
4626	4633	As above with irregular beds of Dolomite, tan, microcrystalline, tight, no xylene cut fluorescence. White Anyydrite inclusions increasing in number and size with depth (up to 15 cm long); irregular fractures, some with black residue (no xylene cut fluorsecence).
4633	4639	Interbedded Anhydrite, white and light gray, and tan, fine crystalline, dolomitic; Dolomite, tan, microcrystalline, anhydritic, tight, no show; thin bedded in part, irregular bedding grading to breccia in part; stylolites and irregular fractures, some with black residue (no xylene cut fluorescnece).
4639	4648.5	Dolomite, tan, microcrystalline, tight, no show; interbedded with Dolomite, tan to grayish tan, fine crystalline, anhydritic, tight in part, poor to medium vuggy porosity and traces intercrystalline porosity in part, no show; blebs of white Anhydrite up to 1 cm long; irregular and vertical fractures and Anhydrite veinlets; a few stylolites with black residue (no xylene cut fluorescence).

END CORE NO. 11

4648.5	4663	Dolomite, cream to tan, microcrystalline to fine crystalline, mostly tight, a few pieces with poor to medium vuggy porosity, no show; a little Anhydrite, white, pink and tan, microcrystalline.
4663	4670	As above with increase in number of pieces with vuggy porosity (fast drilling break).
4670	4680	Dolomite, pale tan, mostly very fine crystalline with some microcrystalline, mostly tight with about 10% of the pieces having small vugs and traces intercrystalline porosity, no show.
4680	4685	Dolomite as above with increase to 20% in number of pieces with porosity.
4685	4694	Dolomite, tan microcrystalline to very fine crystalline, mostly tight, traces very small vugs, no show.
4694	4710	Dolomite, tan microcrystalline to very fine crystalline tight in part, very small vugs and traces intercrystalline porosity in part.

CORE NO. 12 — 4710 to 4725.4 feet. Recovered 15.5 feet.

4710	4714	Dolomite, tan, mostly microcrystalline with some cryptocrystalline, mostly tight with a few scattered vugs in part, no show; a few stylolites; a few high-angle fractures; bedding 0^{o} to 5^{o}.
4714	4721	Dolomite, tan, very fine to fine crystalline, tight in part with scattered vugs in part, no show; a few stylolites; a few high-angle fractures. Bedding 0^{o} to 5^{o}.
4721	4725	Mixture of irregular chunks of Anhydrite, white and tan, fine to coarse crystalline; and Dolomite grayish tan, cryptocrystalline and microcrystalline, tight, no show.
4725	4725.5	Dolomite, tan, fine crystalline, mostly tight with a few scattered vugs, no show; scattered blebs of Anhydrite, white and tan, up to 1 cm long.

END CORE NO. 12

From	To	Descriptions
4725.5	4735	Dolomite, buff, microcrystalline, very thin Anhydrite veinlets, tight. Dolomite, tan, very fine sucrosic, slightly anhydritic, trace small vugs. Dolomite, cream, chalky, small anhydritic veinlets.
4735	4745	Dolomite, tan, some with grayish cast, very fine crystlline, anhydritic, tight. Dolomite, cream, chalky. Trace Anhydrite, white, fine sucrosic.
4745	4770	Dolomite, light grayish brown, microcrystalline, anhydritic, tight; Anhydrite, white to tan and light gray, fine crystalline; trace Anhydrite, white with light gray spherical dolomite pellets or relict oolies about 0.5 mm in diameter; trace Anhydrite, brick-red, dolomitic.
4770	4781	Anhydrite, light gray, cryptocrystalline; Anhydrite white and tan, earthy, dolomitic.
4781	4786	Limestone, dolomitic grading to limy Dolomite, very fine crystalline, to microcrystalline in part, anhydritic, trace Crinoid fragments, trace intergranular porosity, faint xylene cut fluorescnece; blebs Anhydrite, white, fine crystalline.
4786	4805	Anhydrite, white earthy; Anhydrite, dark gray mottled with white, microcrystalline, dolomitic, faint xylene cut fluorescence in part; Dolomite, brown, very limy, microcrystalline, tight, faint xylene cut fluorescence in part.
4805	4835	Dolomite, brown and light brown, microcrystalline and cryptocrystalline, relict pellets or oolites in part, tight, no show; a little Anhydrite, white and light gray.
4835	4848	Limestone, light brown, microgranular to fine grained, oolitic in part, tight, no show; a little Limestone, cream to tan, fine grained oolitic, tight no show from 4845-4848 feet.
CORE NO. 13		4848 to 4878 feet. Recovered 30 feet.
4848	4851	Limestone, tan and light gray grain-supported, fine to medium grained, pellets or oolites with scattered Crinoid fragments, micrite cement, tight in part, poor intergranular porosity in part; a few stylolites; a few high-angle fractures with drusy calcite lining, traces black residue with faint xylene cut fluorescence on fracture.
4851	4854	Limestone, cream, mud-spported, very fine calcite grains, scattered oolites and Crinoid fragments in micrite matrix, mostly tight, trace intergranular porosity in part, no show; a few high angle fractures with drusy calcite lining.
4854	4855	Limestone, tan, microgranular matrix with scattered shell fragments, tight, no show.
4855	4863.3	Dolomite, tan, microcrystalline to very fine crystalline, a very few relict Crinoid fragments, tight from 4855 to 4857, mostly tight with a few vugs and traces intercrystalline porosity from 4857 to 4863.3; no show. Core shattered from 4855 to 4857.
4863.3	4868	Limestone, pale tan, mud-supported, scattered Crinoid, shell and algal (?) fragments in micrite matrix, appears tight but effluorescence on core surface suggests trace porosity, no show; a few high-angle fractures, mostly healed.
4868	4873	Limestone, pale tan to light gray, scattered Crinoid and shell fragments, in microgranular to very fine granular matrix, tight, no show; a few irregular fractures.
4873	4874.3	Limestone, tan, grain-supported, fine-grained, pellets in micrite matrix, tight, no show.

From	To	Descriptions
4874.3	4874.7	Dolomite, light brown, cryptocrystalline to microcrystalline, tight, no show.
4874.7	4878	Limestone, tan, grain-supported in part, mud-supported in part, Crinoid and shell fragments, pellets and oolites, in microgranular to very fine granular matrix, mostly tight with traces intergranular porosity in part; Brachiopod shell at 4877; a few high-angle fractures, mostly healed but some with dark calcite crystals; traces black residue with fair xylene cut fluorescence.

END CORE NO. 13

4878	4885	Limestone, light brown, mud-supported in most, trace grain-supported, scattered pellets or oolites, Crinoid fragments and lumps in micrite matrix, tight; a little Limestone, cream, chalky.
4885	4895	Limestone, tan, grain-supported, pellets, oolite and Crinoid fragments in micrite matrix, chalky in part, tight.
4895	4905	Dolomite, light gray-brown, fine crystalline, scattered vugs (3-5%), white calcite veinlets, stylolitic, no show.
4905	4915	Limestone, buff to tan, grain-supported, pelletal and oolitic in micrite matrix, chalky in part, tight.
4915	4925	Dolomite, light gray-brown to grayish tan, fine to occasionally medium crystalline, 2-3% vugs and trace intergranular porosity, calcite veinlets, stylolitic, no show.
4925	4935	Dolomite, as above, slightly grayer, fine crystalline, tight to trace porosity.
4935	4945	Limestone, buff to tan, grain-supported, pelletal, oolitic, fragmental in micrite matrix, some is chalky, tight, calcite veinlets.
4945	4953	Dolomite, medium brown-gray, cryptocrystalline to microcrystalline, calcite veinlets, stylolitic, tight.
4953	4960	Dolomite, light brown, fine to very fine crystalline, calcite veinlets, stylolitic, fair vugular and intergranular porosity, no stain or fluorescence.
4960	4975	Dolomite, tan, some with gray tint, very fine to fine crystalline, tight. Possible interbeds, Limestone, buff, grain-supported, pelletal and oolitic in micrite matrix, some chalky, tight.
4975	4985	Interbedded Limestone and Dolomite, as above.

LODGEPOLE 4986 feet (Log)

4985	4995	Limestone, medium brown-gray to buff mottled, grain-supported, pellets and oolites and some fossil fragments in micrite matrix, slightly chalky, slightly argillaceous, pyritic, tight. Thin beds Limestone, buff to light gray mottled, grain-supported, pellets and oolites in micrite matrix, chalky,tight.
4995	5005	Dolomite, light to medium brown-gray, microcrystalline to very fine crystalline, slightly argillaceous, tight. Interbeds of Limestone, medium gray to white mottled, grain-supported, pellets and oolites in micrite matrix, slightly chalky, trace pyrite, tight.
5005	5015	Trace Shale, orange to maroon, blocky, slightly calcareous and anhydritic, Dolomite, light to medium brown, some gray-brown, very fine crystalline to sucrosic, red mottling in part, veinlets Anhydrite, white crystalline to sucrosic, tight.

From	To	Descriptions
5015	5025	Dolomite, mottled red as above. Trace Dolomite, orange, anhydritic, argillaceous. Anhydrite veinlets as above.
5025	5035	Dolomite, light brown and gray-brown, fine crystalline to sucrosic, no visible porosity, red mottling more prevalent, trace red shale inclusions. Trace Anhydrite, white, very fine sucrosic. White calcite veinlets.
5035	5065	As above. Interbeds Limestone, grain-supported to mud-supported, fragmental to chalky, tight.
5065	5075	Limestone, buff to cream, mud-supported to grain-supported, chalky, abundant hematite-red mottling, pelletal and oolitic, anhydritic, slightly argillaceous, tight.
5075	5085	Dolomite, light grayish-tan, mottled light red and purple, speckled rust-red in part, very fine sucrosic to crystalline, anhydritic, tight. Possible interbeds Limestone, as above.
5085	5105	Limestone, buff to tan, mottled pink to orange to hematite-red, grain-supported, oolites and pellets and trace Crinoid stems in micrite matrix, chalky in part, tight.
5105	5125	Limestone, buff to light brown, grain-supported to mud-supported, small pellets and oolites in micrite matrix, some cryptocrystalline and some chalky, anhydritic, stylolitic, tight.
5125	5135	Trace Shale, orange to maroon, blocky, calcareous. Limestone as above, less oolites and pellets. Trace Dolomite, light brown very fine sucrosic. Trace milky chert.
5135	5155	Limestone, tan to light brown, mud-supported, cryptocrystalline, some chalky, tight, stylolitic, trace small clear Anhydrite blebs, trace relict oolites.
5155	5172	Limestone, buff to cream, mud supported/grain supported, crypto-crystalline to chalky, some pelletal and oolitic in micrite matrix, anhydritic in part, tight, stylolitic.
5172	5179	Dolomite, tan, fine to medium crystalline to sucrosic, good vugular porosity, trace red mottling, no show.
5179	5200	Limestone, cream to buff to tan, mottled, grain supported/mud supported, oolites and pellets in micrite matrix, fragmental to chalky, stylolitic, anhydritic, tight.
5200	5210	Limestone, tan-buff-cream, mottled, grain supported, oolites and pellets and some lumps in micrite matrix, chalky, slightly anhydritic, tight to trace pinpoint vugs. Limestone, cream to white, chalky.
5210	5220	Limestone, light brown, tan, buff, cream mottled, grain supported, abundant oolites and some pellets and lumps in micrite matrix, chalky, poor to fair pin-point vugular porosity. Limstone, cream to white, chalky.
5220	5240	As above with trace pin-point vugs.
5240	5245	Limestone, light brown-tan-buff mottled, grain supported, oolites and pellets and Crinoid fragmetns in micrite matrix, chalky and fragmental, tight. Limestone, cream to white, chalky.
5245	5250	Limestone, cream, mudsupported to grain supported, microcrystalline to relict oolites to chalky, anhydritic, tight.
5250	5260	Limestone, cream to buff, grain-supported to mud supported, oolitic to microcrystalline to chalky, anhydritic, tight.
5260	5270	Dolomite, light brown to medium gray-brown, grain supported, very fine crystalline to fine sucrosic, anhydritic, fair to good vugular porosity, no stain or cut fluorescnece, clinging bubbles in acid (oil reaction?).

From	To	Descriptions
5270	5283	Dolomite as above, fine to medium crystalline to sucrosic, large vugs, good porosity.
5283	5285	Dolomite, light brown, grain supported, medium to fine crystalline to sucrosic, anhydritic, numerous large and small vugs, excellent porosity.
CORE NO. 14		5285 to 5345 feet. Recovered 60 feet.
5285	5289.5	Dolomite, light brown, fine to medium crystalline, some sucrosic, anhydritic, good pin-point and small vugular porosity, high-angle and vertical fractures.
5289.5	5294	Dolomite, as above, decreasing grain size downward, gray to white Anhydrite inclusions, porosity decreases to poor downward.
5294	5296	Dolomite, as above, very fine to fine crystalline, anhydritic, poor to fair vugular porosity.
5296	5299	Dolomite, tan, very fine sucrosic, some chalk infill, anhydritic, high-angle fractures (closed), scattered vugs (poor to fair porosity).
5299	5300	Dolomite, light brown, fine sucrosic, good vugular porosity, shattered.
5300	5301	Dolomite, cream, mud-supported, microsucrosic to chalky, anhydritic, tight. Irregular beds Dolomite, light brown, fine to medium crystalline good vugular porosity. Large Anhydrite inclusions, white to light gray.
5301	5302	As above. Vertical fractures, chalky along fractures.
5302	5317	Irregular-bedded, white to cream siliceous rock (possibly Tripolite or Porcelanite), dense with floating dolomite crystals; and Dolomite, light brown, very fine sucrosic to fine crystalline, tight. Irregular inclusions Anhydrite, light blue-gray to white. Large stylolite. Possible bioturbation.
5317	5319	As above with Dolomite, light brown, medium crystalline, anhydritic, scattered vugs (poor porosity).
5319	5321.5	Irregular-bedded Dolomite and Tripolite (?) as in 5302-5317.
5321.5	5335	Irregular bedded white Tripolite (?) with floating fine Dolomite grains; and Dolomite, very fine sucrosic, some chalky, tan to light brown, numerous large Anhydrite inclusions. Stylolitic. Irregular occurrences Dolomite, medium to dark brown, very fine sucrosic, tight; some interfingered with Tripolite. Possible bioturbation.
5335	5335.5	As above. Brecciated in part.
5335.5	5345	Irregularly bedded Dolomite and Tripolite (?) as above. Numerous large Anhydrite inclusions, white and light gray, tight. Stylolite. Possibly bioturbated.
END CORE NO. 14		
5345	5355	Dolomite, light grayish-tan, fine to very fine sucrosic, slightly chalky, anhydritic, stylolitic, poor to fair vugular porosity. Interbeds and inclusions Tripolite (?) as above, some becoming cherty. Inclusions Anhydrite.
5355	5372	Dolomite, light brown-gray to tan, very fine microcrystalline, some fine crystalline, scattered green glauconite grains, anhydritic, siliceous, poor vugular porosity. Decrease in Tripolite (?), some with glauconite. Trace very fine Pyrite.
		DEVONIAN 5368 feet (Log)
5372	5375	Dolomite, light gray to buff, some mottled green, microcrystalline to very fine crystalline, tight to trace vugs, anhydritic, pyritic, slightly argillaceous. Trace Dolomite, medium gray, microcrystalline, argillaceous, very pyritic, tight.

From	To	Descriptions
CORE NO. 15		5375-5423 feet. Recovered 48 feet.
5375	5377.2	Shale, pale green, waxy and slickensided in part, trace very fine pyrite in part, very slightly dolomitic, very faint xylene cut fluorescence in part.
5377.2	5397	Breccia of Dolomite, light brown, microcrystalline to very fine crystalline, anhydritic; Dolomite grading to dolomitic Anhydrite, tan cryptocrystalline; Anhydrite, white microcrystalline in part, coarsely crystalline in part, a little Shale, pale green waxy from 5377.2 to 5379; many fine fractures and Anhydrite veinlets; tight from 5377.2 to 5382; trace vugs, efflorescence on core suggests slight intercrystalline and fracture porosity from 5382 to 5397.
5397	5399	Dolomite, tan, microcrystalline, to very fine crystalline, tight; fine Anhydrite veinlets.
5399	5400	Interbedded Dolomite, grayish tan microcrystalline, tight; and Shale, pale green to reddish brown, dolomitic, pyritic.
5400	5403	Dolomite, light grayish brown, fine crystalline, tight; blebs Anhydrite, white and tan, coarse crystalline in part, microcrystallline in part.
5403	5418	Interbedded Shale, pale green, waxy and slickensided in part; Shale, grayish green, dolomitic, pyritic in part; blebs Anhydrite, white; high-angle fracture at 5403 with 2 inches displacement.
5418	5423	Breccia of Dolomite, brownish gray and tan, microcrystalline tight; Anhydrite, tan, dolomitic; Dolomite, gray, microcrystalline to fine crystalline, becoming more abundant toward base, tight, black residue in part with faint xylene cut fluorescence; white Anhydrite veinlets.
END CORE NO. 15		
5423	5430	Dolomite, dark gray, microcrystalline, argillaceous, tight; traces Shale, black, blocky, hard, slightly dolomitic, fair xylene cut fluorescence; a little Anhydrite, white, fine crystalline.
5430	5440	Dolomite, cream to tan, microcrystalline, anhydritic in part, tight; white Anhydrite veinlets.
5440	5450	Limestone, dark gray-brown, microgranular, trace Brachiopod fragments, tight, fair xylene cut fluorescence in part; traces black tarry residue with fair xylene cut fluorescence; Dolomite, pale grayish tan, microcrystalline, very anhydritic or siliceous, tight.
5450	5455	Limestone as above plus Limestone, pale tan, microgranular, earthy.
5455	5461	Dolomite, light greenish gray, microcrystalline, scattered silt-size black grains, very anhydritic grading to dolomitic Anhydrite, traces pyrite, tight, a few pieces yield faint xylene cut fluorescence.
5461	5480	Limestone, medium brown and dark brown, mud-supported, crypto-granular in part, microgranular in part, a few white calcite veinlets, tight, a few pieces yield fair xylene cut fluorescence.
5480	5484	Dolomite, tan, very fine crystalline, tight.
5484	5505	Interbedded Limestone, dark brown, mud-supported, cryptogranular to microgranular, white Anhydrite veinlets and blebs, tight; Limestone, cream to light brown, subchalky matrix with scattered pellets and lumps, tight; streaks Dolomite, light gray and tan, very fine crystalline, tight; streaks Shale, black, calcareous.

From	To	Descriptions
5505	5554	Limestone, tan, cryptogranular to very fine granular, dense to chalky in part, scattered black residue on stylolites (?), no xylene cut fluorescence, tight; Limestone, medium and dark brown, microgranular, with some cryptogranular and some fine granular. Scattered Brachiopod fragments, pellets in part, blebs of white Anhydrite and white calcite, tight; streaks Dolomite, microcrystalline pale gray at 5520 and tan at 5540, tight; trace Shale, black lumpy at about 5545.
5554	5570	Limestone, medium gray with brownish cast, microgranular to fine granular, tight; a little Dolomite, tan, microcrystalline to very fine crystalline, calcareous, trace intercrystalline porosity no show.
5570	5580	Limestone, as above; with Limestone, tan to brown, grain-supported, oolites in subchalky matrix, tight; Limestone, cream and pale gray, microgranular, chalky.
5580	5590	Dolomite, medium gray and light brown, and dark brown, microcrystalline, very argillaceous in part, anhydritic in part, tight.
5590	5605	Dolomite as above with Limestone, dark brown, cryptogranular; and a little Limestone, light grayish brown, grain-supported, oolites in subchalky matrix.
5605	5615	Dolomite, brown to dark brown, fine crystalline, tight.

STONY MOUNTAIN 5612 feet (Log)

From	To	Descriptions
5615	5625	Limestone, dark brown, cryptogranular, white calcite veinlets, tight; Dolomite, light gray, microcrystalline subchalky, calcite veinlets, tight.
5625	5658	Dolomite, white to cream and pale gray, cryptocrystalline to microcrystalline, subchalky in part; trace pin-point porosity, trace Dolomite, tan, very fine crystalline, trace intercrystalline porosity.

CORE NO. 16 5658 to 5683 feet. Recovered 25.7 feet.

From	To	Descriptions
5658	5667.5	Dolomite, cream to pale tan and pale gray, microcrystalline, anhydritic, a few stylolites, fractures and patches with black mineral stain (no xylene cut fluorescence), possible shadowy Crinoid relicts in part, a few scattered vugs, no visible intercrystalline porosity but efflorescence on core indicates some intercrystalline porosity from 5658-5664.5 feet. Very thin irregular partings of Shale, very dark gray, soft from 5665-5666 feet.
5667.5	5682	Mottled mixture of Dolomite, cream and pale tan, microcrystalline, slightly anhydritic; and Dolomite, light gray, cryptocrystalline in part, microcrystalline and very fine crystalline in part; black mineral stain concentrated in fractures, stylolites and boundaries of light gray Dolomite. Rounded shape of light gray patches suggests burrowing. A few scattered vugs; no visible intercrystalline porosity but efflorescence on core suggest some intercrystalline porosity from 5668.5-5682 feet.
5682	5683.7	Broken pieces of Dolomites as above with a little Shale, very dark gray, waxy, soft.

END CORE NO. 16

CORE NO. 17 5683.7 to 5698.4 feet. Recovered 14.7 feet.

From	To	Descriptions
5683.7	5690	Dolomite, pale tan and a little pale gray, microcrystalline with patches cryptocrystalline, slightly anhydritic, a few scattered vugs, no visible intercrystalline porosity, scattered patches of efflorescence on core indicate a little intercrystalline porosity, brecciated or burrowed, scattered stylolites, numerous fine irregular and high-angle fractures with black mineral stain.

From	To	Descriptions
5690	5698.4	Recovered only broken pieces of Dolomite as above.
END CORE NO. 17		
5698.4	5730	Dolomite, pale tan, microcrystalline to cryptocrystalline, a few small vugs, trace stylolites with black mineral lining; streak Limestone, brown to reddish brown, microgranular to very fine granular, tight, from 5700 to 5702 feet (maybe cavings).
		RED RIVER 5724 feet (Log)
5730	5790	Dolomite as above mottled in part with a little Dolomite, pale gray, microcrystalline to cryptocrystalline, tight; a little Dolomite, pale tan, microcrystalline, with relict oolites or pellets and Crinoids (?), a few shell fragments, tight; traces Anhydrite white, chalky, dolomitic, tight.
5790	5820	Dolomite, light brown, microcrystalline and cryptocrystalline, a few blebs of Anhydrite, mostly tight, scattered vugs; a little Dolomite, pale tan, microcrystalline to very fine crystalline, trace intercrystalline porosity, scattered fossil and oolite (?) relicts.
5820	5830	Dolomite, grayish brown, microcrystalline with a little very fine crystalline, trace Crinoid (?) fragments, trace intercrystalline porosity in part, tight in most; with Dolomites as above.
CORE NO. 18		5830 to 5861 feet. Recovered 31 feet.
5830	5836	Dolomite, buff-tan-light brown mottled, fine crystalline to fragmental and nodular, chalky in part, anhydritic, limey in part, scattered white Anhydrite inclusions, tight to trace vugular porosity, appearance of bioturbation.
5836		Large Stylolite, 3-4 inches amplitude, separates light colored Dolomite above from dark, much reworked Dolomite below.
5836	5840	Dolomite, medium brown to dark gray-brown, fine to very fine crystalline, some fragmental and some lightly chalky, very anhydritic with scattered small Anhydrite inclusions, tight to rare vug. Incipient high-angle tight fractures. Appears much bioturbated.
5840	5850	As above with light increase in vugs (poor porosity).
5850	5853.75	Dolomite, buff-light brown-medium brown mottled, fine to very fine crystalline to nodular to fragmental, slightly chalky in part, anhydritic, bioturbated, poor porosity as above. Tight vertical fractures, slightly slickensided.
5853.75	5855	Scattered small vugs, poor to fair porosity.
5855	5856	Bioturbated Dolomite, as above, no vugs.
5856	5859.5	Dolomite, medium brown, some tan and buff mottling, very fine to fine crystalline, some nodular and fragmental, slightly chalky in part, anhydritic, reworked, trace vugs, tight high-angle and vertical fractures.
5859.5	5861	Shattered core, Dolomite and Anhydrite, brecciated, medium to dark brown and dark brown-gray, very fine to fine crystalline to nodular and fragmental, some chalky, no visible porosity.
END CORE NO. 18		
5861	5880	Dolomite, medium gray-brown, some light brown, very fine crystalline to sucrosic, some fragmental, styloli̇tic, anhydritic, rare vugs. Trace Limestone, cream, chalky to dense.
5880	5890	As above with increase in Limestone. Trace fine pyrite.

From	To	Descriptions
5890	5910	Dolomite, tan, fine crystalline to sucrosic, some slightly chalky, some fragmental, anhydritic, poor vugular porosity, stylolitic.
5910	5940	Dolomite, cream to tan, fine to very fine crystalline to sucrosic some chalky, fragmental in part, anhydritic, trace vugs. Trace Limestone, white to cream, chalky.
5940	5967	Dolomite, tan to light brown, very fine to fine crystalline to sucrosic, anhydritic, stylolitic, slight increase in vugs, (trace to poor porosity).

CAMBRIAN SNOWY RANGE 5963 feet (Log)

5967	5975	Limestone, mottled white-gray-tan, very fine to fine crystalline, pyritic, anhydritic, varved appearance in part, tight, rare green tint.
5975	5985	Limestone, mottled as above, microcrystalline to very fine crystalline, rare pin-point glauconite grain, pyritic, anhydritic, tight.
5985	6005	Interbedded Limestone, light to medium gray, some dark very fine crystalline, anhydritic, pyritic; Limestone, cream to tan, fine to medium crystalline, pyritic, anhydritic, tight. Trace pin-point glauconite.
6005	6025	Limestone, buff-tan-cream-gray mottled; also cream to white chalky; fine to very fine crystalline, anhydritic, rare green mottling and very rare pin-point glauconite, pyritic, dolomitic in part, stylolitic, tight. Trace Shale, gray and green, blocky, calcareous.
6025	6045	Limestone, cream-buff-tan, light gray mottled, trace bright green mottling, fine crystalline, some very fine, pyritic, dolomitic, some grading to limey Dolomite, tight. Trace Shale, medium brown, blocky, calcareous; and Shale, medium gray, very pyritic, calcareous.
6045	6065	Limestones, as above, increase in green and gray-green mottling.
6065	6119	Limestone, cream to buff, mottled light to dark gray, trace green and gray-green spots, rare pin-point glauconite, fine to very fine crystalline, some microcrystalline and some chalky, pyritic, anhydritic in part, tight.
6119	6135	Limestone, white to light gray mottled, some green tint and mottling, very fine to fine glauconite grains, anhydritic in part, chalky to very fine crystalline, tight. Limestone, light gray, numerous floating fine sand grains, occasionally grading to very calcareous Sandstone, glauconitic.
6135	6145	As above, and Dolomite, tan to light brown, very fine crystalline, some slightly chalky, tight.
6145	6155	Sandstone, light gray and green-gray; very fine to fine, very calcareous, very glauconitic; grades to very sandy Limestone. Limestone, white/cream/light gray, microcrystalline to fine crystalline to chalky, some green mottling, glauconitic, tight.
6155	6165	As above, with Dolomite, light brown, microsucrosic, tight.
6165	6175	Limestone, cream-buff-light gray, fine to medium crystalline, some chalky, sandy, glauconitic, trace pyrite, tight. Thin beds Sandstone, light to medium green-gray, very fine to fine, very calcareous and glauconitic, tight.
6175	6185	As above. Trace Shale, dark-gray, fissile, calcareous.
6185	6195	Shale, light to medium gray-green, fissile, slightly calcareous, glauconitic in part, Limestone, as above.

From	To	Descriptions
6195	6215	Limestone, light gray to green-gray, very sandy, glauconitic, grades to very calcareous Sandstone, very fine. Interbeds Dolomite, tan to light brown, very fine sucrosic to crystalline; Shale, medium green, fissile, glauconitic in part.
6215	6235	Siltstone, to very fine Sandstone, light gray and green-gray, very glauconitic, calcareous, grades to very silty Limestone. Streaks Shale, medium green, fissile; Limestone, white, fine crystalline to chalky, muscovite flakes.
6235	6275	Increase in Shale as above; Limestone, white-buff-light gray, very fine to fine crystalline, sandy and glauconitic, muscovite flakes.
6275	6285	Limestone, white to light gray, mottled bright green in part, cryptocrystalline, some very fine, very fine to pinpoint glauconite grains, trace pyrite, tight.
6285	6295	Limestone, light green-gray, microcrystalline, very glauconitic, scattered pyrite. Streaks Dolomite, tan to light brown, very fine to microsucrosic.
6295	6305	Shale, light gray and medium green, fissile, calcareous, trace silt and glauconite. Limestone and Dolomite as above.
6305	6325	Shale as above and Limestone, white to buff, chalky to medium crystalline, pin-point glauconite, scattered pyrite, tight, some bright green mottling
6325	6335	Limestone, white to cream, some very light gray, chalky to microcrystalline to fine crystalline, pin-point clauconite, bright green mottling, tight. Shale, light to medium green and gray green fissile, calcareous, silty and glauconitic in part.
6335	6360	Shale and Limestone as above, stylolitic.
6360	6380	Limestone, buff-cream-light gray, some light green mottling scattered pyrite and glauconite, fine to very fine crystalline to chalky, silty in part, tight. Shale, as above.
6380	6400	Siltstone, grading to very fine Sandstone, light gray, calcareous, scattered glauconite grains, tight; interbedded with Shale, medium grayish green, calcareous, fissile; Limestone, cream, tan, light gray, microgranular to very fine granular, silty in part, chalky in part.
6400	6455	Interbedded Shale, medium grayish green, slightly dolomitic, fissile; Limestone, brown, tan and cream, microgranular to fine granular, silty in part, scattered coarse grains, tight.

<u>DRY CREEK 6454 feet</u> (Log)

From	To	Descriptions
6455	6465	Limestone, mottled orange, cream and pink, microgranular to cryptogranular, silty in part; Limestone, white, cream, tan and light gray, microgranular, glauconitic in part; a little Sandstone light gray, very fine grained, very limey, glauconitic, tight; interbedded with Shale, green, fissile; trace Shale, maroon, fissile.
6465	6495	Shale, green, fissile; Siltstone, grading to very fine Sandstone, light gray and light brown, calcareous to very calcareous, glauconitic in part, tight; trace Shale, maroon fissile.
6495	6505	Shale, green, trace dark gray and maroon, fissile, (sample appears to have been taken from coarse side of sieve).
6505	6536	Shale as above with Limestone, cream, pale gray and tan, micro-granular and cryptogranular, silty in part; Limestone, brown and grayish brown, very fine granular to fine granular with scattered coarse grains; trace Siltstone, light gray, glauconitic, calcareous; trace Siltstone, yellow-brown and orange, calcareous, scattered black grains.

From	To	Descriptions
		PILGRIM 6535 feet (Log)
6536	6560	As above with little Limestone, cream, tan and grayish tan, microgranular to coarse granular with pebbles of green and brown cryptogranular Limestone; trace Limestone, cream, very fine to fine granular, scattered black grains and rounded fine sand grains.
6560	6575	Sandstone, light gray, very fine to fine, very glauconitic, calcareous, tight; Limestone, tan fine to medium granular, sandy in part, scattered fossil fragments and pebbles of tan, green and gray cryptogranular Limestone, tight; Shale, green, fissile; trace Dolomite, tan, microcrystalline, tight.
6575	6585	Sandstone, light gray and cream, very fine grained, very calcareous, scattered glauconite, scattered black grains in part, scattered tan coarse calcaite grains, tight; Limestone, cream to light brown, microgranular to medium granular, sandy in part, scattered pyrite.
6585	6615	Limestone, tan and light grayish brown, microgranular to fine granular, silty in part, slightly glauconitic in part, tight; interbedded with Shale, green and dark gray, fissile.
6615	6630	As above with a little Sandstone, white, very fine grained, calcareous, scattered black grains and rare glauconite grains in part, mostly tight, traces porosity.
6630	6645	Limestone, tan microgranular, chalky, argillaceous, sandy in part, scattered fossil fragments; Limestone, light brown, fine to medium granular, scattered coarse grains, rare glauconite grains, scattered black grains, trace pebbles of green argillaceous microgranular Limestone; Shale, gray-green, micaceous in part, fissile.
		GROS VENTRE 6642 feet (Log)
6645	6665	Shale, mostly green with a little dark gray, silty and sandy in part, fissile; Sandstone, light gray and grayish green, very fine grained, scattered black grains and glauconite grains, scattered coarse calcite grains (fossil fragments ?), very calcareous in part, very argillaceous in part grading to sandy shale, scattered muscovite flakes, tight,
6665	6745	As above with Siltstone, grayish green, glauconitic, calcareous; Sandstone, light gray, very fine grained grading to siltstone, very glauconitic, scattered muscovite flakes, very calcareous, tight. A little Limestone, tan, microgranular, with fossil fragments and traces Dolomite, tan microgranular at about 6740 feet.
6745	6845	Shale, dark gray, green and trace maroon, muscovite falkes and silty in part, fissile; a little Sandstone, light gray to light green, very fine grained grading to Siltstone in part, scattered black grains, glauconite and muscovite flakes, (in part very glauconitic and very micaceous), calcareous, trace pyrite, tight; traces Limestone, tan and light gray, microgranular and Limestone tan, fine granular with scattered coarse calcite, very fine glauconite grains and muscovite flakes, sandy in part, tight.

From	To	Descriptions
6845	6965	Sandstone, light gray, very fine grained, glauconitic, scattered black grains and muscovite flakes, calcareous, tight; Sandstone, greenish gray, very fine grained, silty, argillaceous grading to sandy Shale, very micaceous (muscovite), slightly calcareous, tight; Shale, dark gray, greenish gray and green with trace maroon, fissile; traces tan fossil fragments; increase in Shale from 6885-6905; traces Sandstone, light gray, very fine grained, glauconitic, calcareous, with scattered black and green pebbles and coarse grains, trace chlorite flakes, tight, from 6905-6915 feet.
6965	6970	As above with Limestone, tan and grayish brown, microgranular, subchalky in part, slightly glauconitic in part, tight; trace Limestone, tan, fine granular with scattered oolites, tight; trace Dolomite, tan microcrystalline and very fine crystalline, tight.
6970	6985	Shale, medium to dark green and gray-green, splintery, trace purple, micaceous. Trace Dolomite, tan, very fine to microsucrosic.
6985	7005	Sandstone, light orange, light green-gray, some medium green-gray, fine to very fine, glauconitic, micaceous, siliceous, slightly calcareous, tight, no show.
7005	7042	Shale, medium gray-green, green and gray, some purple, splintery, micaceous in part, slightly calcareous in part.
7042	7050	Sandstone, white to very light green-gray, medium to fine, some coarse, glauconitic, quartzitic to friable, non-calcareous, some spotty red-orange stain, no visible porosity, no show.
7050	7062	Traces Sandstone as above. Trace Limestone, buff to tan, dense to subchalky. Shale, green and purple, as above.
7062	7067	Sandstone, white, medium to coarse, friable in part, glauconitic, trace mica, white clay infill in part, no visible porosity; trace rust stain.
7067	7072	Sandstone, white to very light green-gray, medium to fine some coarse quartzitic to friable, glauconitic, rust stain in part.
		Pipe strap correction, 7072=7071 after correction
CORE NO. 19		7071 to 7095.4 feet. Recovered 24.4 feet.
7071	7072	Irregular-bedded Shale, medium to dark green, fissile (poker chip), sandy; Sandstone, light gray, some gray-green, medium to coarse, glauconitic, tight. One-inch bed of Sandstone at 7071.5 feet.
7072	7074.5	Burrowed Shale and Sandstone as above, bedding destroyed. Large subrounded quartz fragments floating in Sandstone.
		FLATHEAD SANDSTONE 7073 feet (Log)
7074.5	7075.3	Sandstone as above with irregular Shale beds as above.
7075.3	7080	Burrowed Sandstone and very sandy Shale, as above, bedding destroyed. Scattered red rust spots in Sandstone.
7080	7080.5	Sandstone and Shale as above, irregularly bedded, scattered red rust spots in Sandstone.
7080.5	7083	Sandstone, white to tan, coarse to medium, floating large rounded and subrounded quartz grains, pyritic, trace rust spots, very slightly calcareous in part, some white clay (Tripolite ?) infill, tight to trace porosity.
7083	7085.25	Interbedded Sandstone, white to cream, fine to coarse, poorly sorted calcareous, tight; and Shale, dark brown and green-gray, fissile, very sandy, burrowed in part.
7085.25	7091	Sandstone, white to light gray, some cream, fine to coarse, poorly, sorted, tripolitic, calcareous, rare brown and black grains and rust spots, tight. Occasional thin gray and green Shale partings, sandy.

From	To	Descriptions
7091	7092	Sandstone, cream to tan, medium to coarse, clay filled, tight.
7092	7093	Sandstone, rust red to maroon, medium to coarse, some large quartz and chert grains, rounded to euhedral, argillaceous, tight.
7093	7093.5	Sandstone, cream, coarse and conglomeratic to medium, trace light green chlorite, slightly calcareous, scattered light orange and light yellow coarse quartz grains, tight.
7093.5	7095.4	Sandstone, rust red to maroon, medium to conglomeratic, very poorly sorted, very argillaceous (red clay matrix , large quartz grains are rounded to euhedral, some are frosted and pitted), slightly calcareous with one small calcite veinlet, tight. Small scale cross-beds.

END CORE NO. 19

From	To	Descriptions
7095	7120	Sandstone, rust red, coarse to medium, argillaceous, and Sandstone; white, medium to coarse, quartzitic in part, trace glauconite; tight.
7120	7135	Conglomerate to very coarse Sandstone, rust red, maroon, white to cream, milky chert and clear quartz grains, quartzitic in part, some amber and yellow grains and mottling, red and white clay infill, tight to trace intergranular porosity.
7135	7140	As above. Trace Tripolite, white and light orange, some mottled.
7140	7145	Poor sample. Lost circulation material. Rough drilling. As above with increase in Tripolite.

PRECAMBRIAN GNEISS 7142 feet (Log)

From	To	Descriptions
7145	7160	Samples composed of quartz, biotite and minor amount of feldspar, clear, orange, pinkish, some amber, white Tripolite with biotite.
7160	7170	Milky to white quartz and feldspar, black biotite, trace green and orange; Tripolite, white, biotitic.
7170	7174	As above, clear to milky, some white, trace red and green spots (Hematite ?). Tripolite, white, biotitic. Trace pyrite.

CORE NO. 20 7174 to 7190 feet. Recovered 16 feet.

From	To	Descriptions
7174	7177	Gneiss, composed of quartz, feldspar (orthoclase and plagioclase) and biotite; accessory minerals are green clay-like mineral (chlorite ?) and hematite, coarse grained; color mostly gray to black with orange to pinkish and white. High-angle flow structures (70-90°). Rare yellow-green transparent mineral.
7177	7183	As above with addition of medium green clay-like (chlorite ?) mineral, slight increase in yellow-green transparent mineral.
7183	7185	As above with increase in orange to pinkish feldspar. Schlieren flow structure with quartz and feldspar predominant.
7185	7188	Gneiss, gray and white colors about equal. Schlieren flow structure pronounced. Dominant minerals are quartz, plagioclase feldspar and biotite. Accessory minerals are hematite and trace yellow-green mineral. Trace pyrite.
7188	7190	As above with veritcal to high-angle flow structures (70-85°).

END CORE NO. 20

TOTAL DEPTH 7189 feet (Log), 7190 (Driller)

CL-811.2

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS, TEXAS

Company UNITED STATES GEOLOGICAL SURVEY Formation ______ Page 1 of 3

Well MADISON NO. 3 Cores ______ File RP-2-5807

Field ______ Drilling Fluid ______ Date Report 3-13-79

County ______ State ______ Elevation ______ Analysts RM

Location ______ Remarks ______

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS HORIZONTAL (K_A)	PERMEABILITY MILLIDARCYS VERTICAL	POROSITY PERCENT	RESIDUAL SATURATION OIL % VOLUME	RESIDUAL SATURATION OIL % PORE	RESIDUAL SATURATION TOTAL WATER % PORE	PROBABLE PRODUCTION	REMARKS
1	4300.5	1.6		10.9					MADISON LIMESTONE (MISSION CANYON)
2	4302.6	5.1		10.2					
3	4305.8	41	49	12.7					
4	4308.9	27		13.2					
5	4310.7	91	35	14.8					
6	4362.1	5.8		9.9					
7	4368.2	14		9.2					
8	4369.1	12		8.7					
9	4370.5	28	4.5	12.5					
10	4388.1	5.2		10.2					
11	4388.5	0.27		8.2					
12	4389.7	*11		7.1					
13	4390.8	0.33		8.9					
14	4391.5	*9.9		7.8					
15	4392.5	0.53		5.8					
16	4397.5	0.26		2.8					
17	4400.0	0.08		13.4					
18	4403.5	1.5		6.4					
19	4472.3	42	3.7	13.8					
20	4474.3	6.1		4.6					
21	4479.7	12		4.6					
22	4481.0	6.1		5.5					
23	4600.5	0.05		0.3					
24	4603.6	0.06		0.4					
25	4604.9	0.05		0.6					
26	4609.2-09.4	0.98		4.5					
27	4611.0	0.17		7.2					
28	4613.5-13.6	5.3		13.2					
29	4618.2-18.6	0.52		8.2					
30	4623.3	0.07		2.8					
31	4624.0	3.6		6.8					
32	4625.8	4.1		16.7					
33	4626.8	0.24		7.4					
34	4629.7	2.1		9.0					
35	4633.4-33.7	0.69		7.6					
36	4634.1	0.07		5.6					

*HAIRLINE FRACTURE

NOTE:
(*) REFER TO ATTACHED LETTER.
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED.
(2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS.

CL-311-2

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS, TEXAS

Company UNITED STATES GEOLOGICAL SURVEY Formation ____

Well MADISON NO. 3 Cores ____ File RP-2-5807

Field ____ Drilling Fluid ____ Date Report 3-13-79

County ____ State ____ Elevation ____ Analysts RM

Location ____ Remarks ____

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS		POROSITY PERCENT	RESIDUAL SATURATION		PROBABLE PRODUCTION	GRN. DNS.	REMARKS
		HORIZONTAL (K_A)	VERTICAL		OIL % VOLUME % PORE	TOTAL WATER % PORE			
37	4635.7-35.9	0.15		9.2					MADISON LIMESTONE (MISSION CANYON)
38	4637.4-37.7	0.15		4.5					
39	4642.7-43.0	0.11		4.6					
40	4646.0	1.3		9.1					
41	4711.5-12.0	0.55		13.2					
42	4713.4-13.6	0.98		11.8					
43	4715.7-16.1	0.07		4.9					
44	4717.1-17.4	0.06		5.9					
45	4726.2-25.5	0.12		6.7					
46	4848.3-48.6	0.02		2.8					
47	4854.2-54.5	0.14		6.8					
48	4855.5	87	123	17.1					
49	4859.1-59.3	45	154	17.1					
50	4861.2-61.5	9.1		14.1				2.85	
51	4864.6-64.9	0.22		3.7					
52	4871.1-71.3	0.76		7.2					
53	4875.1-75.3	0.07		4.7					
54	5285.4-85.7	44	3.5	18.3					MADISON LIMESTONE (LODGE-POLE)
55	5287.4	3.8		10.2				2.85	
56	5289.7-90.0	0.79		9.7				2.84	
57	5290.6	4.3		14.9					
58	5297.5-97.8	33	3.4	16.5					
59	5305.7	0.85		22.1					
60	5314.3	0.72		18.7					
61	5318.7	3.6		21.4				2.74	
62	5323.2	0.28		11.8				2.67	
63	5326.3	2.1		15.7				2.76	
64	5336.1	0.48		10.4					
65	5336.8	0.37		13.7				2.69	
66	5376.3	0.04		1.0					DEVONIAN UNDIVIDED
67	5379.8	0.23		3.5					
68	5383.9	4.3		6.9					
69	5386.6-87.0	0.26		6.2				2.85	
70	5392.6	0.10		5.7					
71	5393.8-93.9	0.09		5.8					
72	5398.1-98.6	0.04		3.8					
73	5400.0-00.3	0.04		1.6					
74	5410.2	0.05		0.5					

NOTE:
(*) REFER TO ATTACHED LETTER.
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED.
(2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS.

CL-811-2

CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

DALLAS, TEXAS

Company UNITED STATES GEOLOGICAL SURVEY Formation ______ Page 3 of 3

Well MADISON NO. 3 Cores ______ File RP-2-5807

Field ______ Drilling Fluid ______ Date Report 3-13-79

County ______ State ______ Elevation ______ Analysts RM

Location ______ Remarks ______

CORE ANALYSIS RESULTS

(Figures in parentheses refer to footnote remarks)

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS HORIZONTAL (K_A)	PERMEABILITY MILLIDARCYS VERTICAL	POROSITY PERCENT	RESIDUAL SATURATION OIL % VOLUME	RESIDUAL SATURATION OIL % PORE	RESIDUAL SATURATION TOTAL WATER % PORE	PROBABLE PRODUCTION	GRN. DNS.	REMARKS
75	5415.0-15.3	0.06		2.6					2.85	DEVONIAN UNDIVIDED
76	5419.5-19.8	0.03		1.7						
77	5659.4	0.85		12.0						STONY MOUNTAIN FORMATION
78	5661.3-61.6	0.68		9.0						
79	5664.8-65.0	0.08		5.0						
80	5665.9-66.3	0.07		5.9						
81	5668.2		0.08							
82	5668.4-68.6	0.08		4.3						
83	5671.6	0.45		7.4						
84	5673.2	1.3		6.6					2.86	
85	5674.6-74.9	*4.2		10.6						
86	5677.6-77.9	1.2		10.7						
87	5679.6-79.9	4.4		11.3						
88	5681.0	0.75		7.5					2.85	
89	5684.8-85.1	0.93		7.6						
90	5686.3-86.6	1.9		7.6						
91	5690.0-90.3	0.31		6.7					2.85	
92	5830.3-30.5	0.11		3.5						RED RIVER FORMATION
93	5832.9-33.1	0.47		8.2						
94	5835.5-35.9	0.20		4.9						
95	5839.1-39.4	0.63		6.6						
96	5842.9-43.2	0.33		7.3					2.85	
97	5847.5-47.8	0.47		6.2					2.85	
98	5850.1-50.4	0.41		6.6						
99	5853.6-53.8	1.7		7.8					2.85	
100	5856.2-56.5	0.54		7.4					2.85	
101	5858.3-58.7	2.2		10.4					2.86	
102	7078.2-78.3	0.95		3.9					2.76	FLATHEAD SANDSTONE
103	7079.4-79.5	0.50		3.2						
104	7083.3-83.5	0.47		2.5					2.76	
105	7086.1-86.2	0.08		1.9					2.78	
106	7088.2	0.04		2.8					2.66	
107	7092.3	0.11		6.3						
108	7094.5	0.23		6.1					2.65	
109	7097.0	0.10		5.6					2.64	
110	7097.6	0.23		7.7					2.65	
111	7099.0	0.13		3.5					2.70	
112	7101.2	0.05		5.1					2.66	

*HAIRLINE FRACTURE

NOTE:
(*) REFER TO ATTACHED LETTER.
(1) INCOMPLETE CORE RECOVERY—INTERPRETATION RESERVED.
(2) OFF LOCATION ANALYSES—NO INTERPRETATION OF RESULTS.

Hydrologic testing

Twelve conventional drill-stem tests were made in the open hole (table 2). Eleven of these give clues to pressure heads of the water in the intervals tested; the pressure head was not obtained in one test because of very low effective permeability. Water flowed at land surface during nine of the tests, and the final flow periods for these tests were extended to permit collection of water samples representative of the intervals isolated with packers. Considerations for determining the length of time for final flow periods (discharge of water) were (1) volume of flow, (2) hole diameter and confidence in packer seats, and (3) competence of rock type, i.e. lithology and structure, in the isolated intervals. The objective was to obtain the best possible water sample without exceeding the normal risks involved in retrieving the packers and testing tools from the hole. In many cases the flows were terminated before complete stabilization of geochemical field parameters, such as specific conductance, temperature, and pH.

Intervals for testing were selected after preliminary interpretation of geophysical logs and examination of cores. Primary considerations were the presence of interstitial and (or) fracture porosity, suitable hole diameter for packer seats, and a representation of the major rock types and formations penetrated in the hole. Approximately 54 percent of the Paleozoic section was isolated with packers and tested.

Two conventional drill-stem tests (DST) (2 and 4) were made using a single inflatable packer. All other tests were made using two inflatable packers with spacing between packers to isolate selected intervals (fig. 6).

In Madison Limestone test wells 1 and 2, straddle-packer treating-and-testing tools and production-injection packers, run on 2-7/8-in EUE 8-round tubing, were used in addition to conventional drill-stem testing tools run on 4½-in drill pipe. Also, in test wells 1 and 2, packers were deflated and the tool reset to test other intervals, higher or lower in the hole, without making a trip out of the hole. However, in test well 3 only conventional drill-stem testing tools on 4½-in drill pipe were used, and the tools were removed from the hole after each test. The reasons for this were (1) pressure gradients for intervals tested in this well were anomalously high (maximum of 0.548 $lb/in^2/ft$ to a minimum of 0.502 $lb/in^2/ft$), (2) uniform spacing between packers for running several tests without making a trip out of the hole was not possible because of the constraints, listed in the previous paragraph regarding selection of intervals for testing, and (3) cores and geophysical logs indicated that most of the rocks were highly fractured and that pieces of rock might break away from the wall of the bore hole after removal of mud from the isolated intervals and possibly create problems in retrieving packers and tools. Drill pipe can withstand more pulling weight and torque without parting than can 2-7/8-in tubing.

Flow from intervals isolated with packers, measured at the end of the discharge pipe, ranged from 13 to 115 gal/min; back pressures while flowing ranged from 0 to 65 lb/in^2. The sum of the flows from all productive intervals tested was about 560 gal/min. The calculated average production

Table 2.--*Summary of drill-stem-test data*

[Kelly bushing (KB) is 15.5 ft above land surface and 3,039.8 ft above sea level. A constant of 2.307 was used to convert pressure to feet of head for potentiometric surface elevations. Elevation of surface pressure gauge was 3,042 ft]

Test	Formation	Interval (ft below KB)	Recorder elevation	Extrapolated pressure (lb/in^2)	Bottom-hole-temperature (°C)	Potentiometric surface elevation	Time of pipe fill-up and flow (min)	Flow volume (gal/min)	Back-pressure while flowing (lb/in^2)	Shut-in pressure at surface gauge (lb/in^2)	Water analysis	Calculated average production rate during test[1] (gal/min)
1	Lakota Sandstone--	3,407-3,441	-374	1,802	48.9	3,783	0	0	0	0	No	---
2	Madison (Mission Canyon)---------	4,290-4,414	-1,256	2,344	52.2	4,152	14	115	56	450	Yes	178
3	Lower Tensleep Sandstone and Upper Amsden----	4,150-4,234	-1,118	2,262	46.7	4,100	13	86	46	452	Yes	184
4	Flathead Sandstone and Precambrian gneiss----------	6,984-7,190	-3,954	3,513	76.4	4,150	31	83	36	[2]301	Yes	131
5	Pilgrim Limestone--------	6,550-6,635	-3,520	Not usable; no effective permeability	62.2	-----	0	0	0	0	No	---
6	Red River---------	5,748-5,940	-2,718	[3]2,914 2,862	55.8	[3]4,005 3,885	32	53	45	444	Yes	104
7	Upper Red River and Stony Mountain--------	5,608-5,743	-2,578	2,852	52.6	4,001	81	20	0	441	Yes	40
8	Devonian (undivided)--------	5,450-5,596	-2,418	2,816	51.1	4,078	0	0	0	0	No	---
9	Upper Devonian and Madison (Lodgepole)-----	5,250-5,440	-2,218	2,750	54.3	4,126	82	13	0	>432	Yes	37
10	Madison (Mission Canyon)---------	4,798-4,988	-1,766	2,536	50.3	4,084	19	63	16	450	Yes	145
11	---do-------------	4,598-4,788	-1,566	2,409	Not valid	3,992	35	43	3	444	Yes	75
12	---do-------------	4,302-4,492	-1,270	2,318	49.9	4,078	24	85	65	448	Yes	102

[1]The calculated average production rate which occurred during flowing tests is based upon a full fill-up of water in the drill collars and drill pipe and the total elapsed flowing time at which fluid reached the surface. A constant of 0.5972 gal/ft was used to calculate fill-up in the 4½-in, 16.6-lb drill pipe.

[2]Low surface shut-in pressure probably due to high salinity of water column in drill pipe.

[3]The difference between the extrapolated initial and final shut-in pressures (52 lb/in^2) indicates that depletion of the aquifer may have been caused by the final flow period. The tested reservoir may be of limited areal extent, or a boundary condition may exist a relatively short distance from the well-bore.

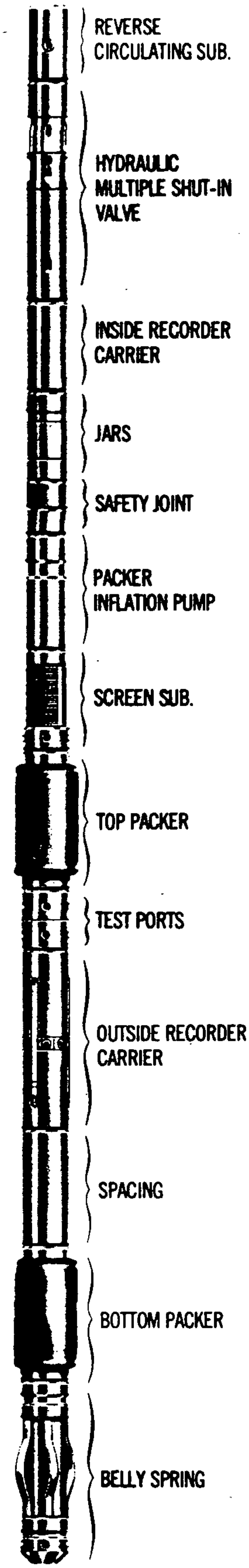


Figure 6.--Inflatable straddle-packer tool for conventional drill-stem tests. (Courtesy Lynes, Inc., Houston, Texas)

rate for all tested intervals, based upon a complete fill-up of water in the drill collars and drill pipe and the total elapsed time for the water to reach the surface, was about 1,000 gal/min. The measured and calculated production totals are less than the potential production of the well due to the effect of restrictions within the test tool and possible damage to the formation near the well bore. An estimated value to compensate for the effect of the restrictions and other factors can be calculated from the slope of extrapolation plots for the final shut-in pressure build-up curve. This is reported as the damage ratio in drill-stem-test analysis. This damage ratio cannot be calculated for those tested intervals where mechanical stabilization of the pressure recorder occurs in a very short time because a slope of the extrapolation plot is indeterminate.

Roger L. Hoeger, consultant to Lynes, Inc., analyzed all drill-stem-test data. His interpretations are reproduced in this report. Pressure data from five of the tests were adequate for interpretation of the slope of the shut-in-pressure extrapolation plot to calculate numerical values for reservoir properties such as transmissivity, permeability, and damage ratio. Shut-in-pressure build-up curves stabilized too rapidly in five other tests to permit calculation of reservoir properties. However, Hoeger (written communication, January 1979) states "..... in a number of tests, the transmissibility of the tested zone was so great that the maximum reservoir pressure was recorded within a matter of a few minutes after the tool was closed for the shut-in pressure build-up period..... It has been noted in the analysis reports, however, that the character of the pressure records, in addition to the volume rates of flow which occurred, make it obvious that the transmissibility of these reservoirs is excellent, even though a numerical value for this reservoir parameter is not calculable." The small volume and nature of the recovered fluid in the tubing and the character of the shut-in-pressure build-up curves, obtained from the two remaining tests, indicated very low transmissivities and therefore no calculations were possible.

Potentiometric-surface elevations in Paleozoic rocks, based on extrapolated pressure data from subsurface gages and using a conversion constant of 2.307 to convert lb/in^2 to feet of head, ranged from 4,000 to 4,150 ft above sea level. Potentiometric-surface elevations, based on pressure data from gages installed on surface connections to the flow line--about 18 ft above land surface--ranged from 4,055 to 4,085 ft. One exception was saline water from the Cambrian (DST 5). The higher specific gravity of this saline water in the drill pipe depressed the shut-in pressure at the surface by 345 ft.

After completing all packer tests, two cement plugs were set in the open hole to isolate Cambrian rocks that contained saline water. One plug is from the bottom of the well to 6,935 ft below land surface, and the other is from 6,235 to 6,135 ft. A 7-in O.D. casing liner with four external casing packers, positioned to isolate selected water-bearing zones, was run in the open hole. While running the casing into the hole, a bridge or plug was encountered at 5,942 ft, about 114 ft short of the projected casing point. Because the casing could not be raised or lowered in the hole, it was cemented in place by perforating and squeezing cement through perforations into the annular space. The 7-in casing presently is perforated at two water-bearing zones in the Madison Limestone--one between 4,378 and 4,358 ft and the other between 4,342 and 4,322 ft. Although there are some bridges or plugs in the 13-3/8-in and 9-5/8-in casing, caused by sloughing of cement after mud was removed from the well, the well is flowing more than 40 gal/min from the perforated intervals.

Completion of the well, including removing of the sloughing cement and bridges in the casing, perforating additional water-bearing zones, and testing, will be done in July or August 1979.

Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo. 80751

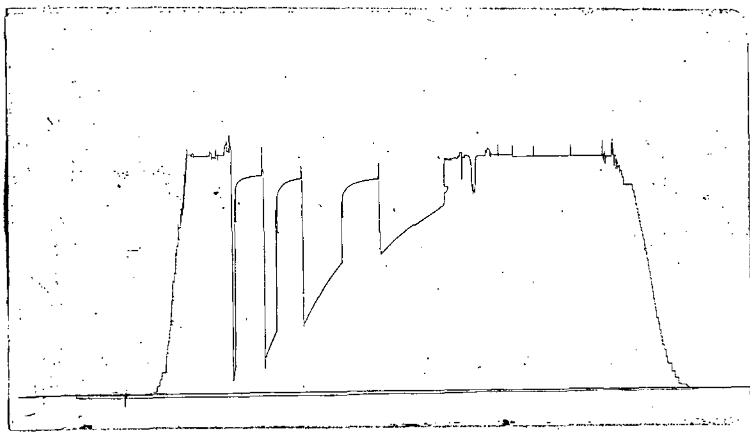
Operator United States Geological Survey
Address See Distribution

Contractor Molen Drlg. Co. Inc.
Rig No. 4
Spot --
Sec. 35
Twp. 2 N
Rng. 27 E
Field Wildcat
County Yellowstone
State Montana
Elevation 3039.8' "K.B."
Formation Lakota Sandstone

Top Choke 1"
Bottom Choke 9/16"
Size Hole 8 3/4"
Size Rat Hole --
Size & Wt. D. P. 4 1/2" 16.60
Size Wt. Pipe 4 1/2" 274'
I. D. of D. C. 2 1/4"
Length of D. C. 291'
Total Depth 4414'
Interval Tested 3407-3441'
Type of Test Inflate Straddle

Flow No. 1 6 Min.
Shut-in No. 1 62 Min.
Flow No. 2 30 Min.
Shut-in No. 2 60 Min.
Flow No. 3 92 Min.
Shut-in No. 3 90 Min.
Flow No.. 4 150 Min.
Bottom Hole Temp. 120°F
Mud Weight 10.8
Gravity --
Viscosity 58

Tool opened @ 3:45 PM.



Outside Recorder
PRD Make Kuster K-3
No. 8889 Cap. 3000 @ 3414'

Press		Corrected
Initial Hydrostatic	A	1954
Final Hydrostatic	K	1923
Initial Flow	B	116
Final Initial Flow	C	243
Initial Shut-in	D	1791
Second Initial Flow	E	324
Second Final Flow	F	539
Second Shut-in	G	1766
Third Initial Flow	H	595
Third Final Flow	I	1079
Third Shut-in	J	1755
4th Initial Flow		1140
4th Final Flow		1537

Lynes Dist.: Billings, MT.
Our Tester: J. Rescoe
Witnessed By: D. Blankenagel

Well Name and No: Madison Limestone Test Well #3
Ticket No. 16505
Date 9-21-78
DST No. 1
No. Final Copies 5

Did Well Flow -- Gas No Oil No Water No

RECOVERY IN PIPE: 3363' Total Fluid
2714 Slightly mud cut water = 38.54 bbl.
649' Drilling mud = 4.81 bbl.

REMARKS:

1st Flow - Tool opened with no blow, increased to a strong blow off bottom of bucket in 4 minutes and remained thru flow period.

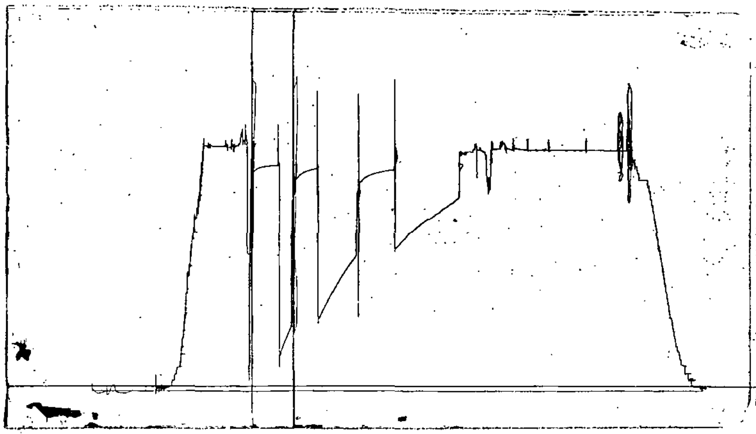
2nd Flow - Tool opened with a 5" underwater blow, increased to bottom of bucket in 3 minutes and remained thru flow period.

3rd Flow - Tool opened with a 4" underwater blow, increased to bottom of bucket in 3 minutes and remained thru flow period.

4th Flow - Tool opened with a good blow, increased to bottom of bucket in 2 minutes and continued to increase thru remainder of flow period.

LYNES, INC.

Operator United States Geological Survey　Lease & No. Madison Limestone Test Well #3　DST No. 1

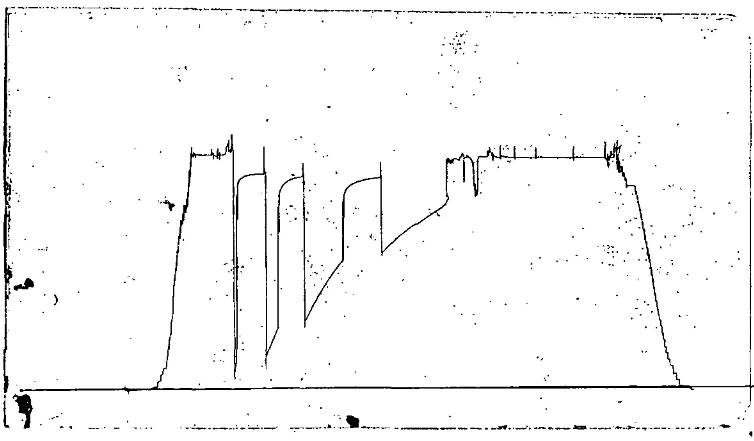


Inside Recorder

PRD Make Kuster K-3

No. 13137 Cap. 2950 @ 3383'

Press		Corrected
Initial Hydrostatic	A	1936
Final Hydrostatic	K	1908
Initial Flow	B	89
Final Initial Flow	C	238
Initial Shut-in	D	1790
Second Initial Flow	E	295
Second Final Flow	F	524
Second Shut-in	G	1764
Third Initial Flow	H	582
Third Final Flow	I	1064
Third Shut-in	J	1755
4th Initial Flow		1124
4th Final Flow		1530
Pressure Below Bottom Packer Bled To		



Outside Recorder

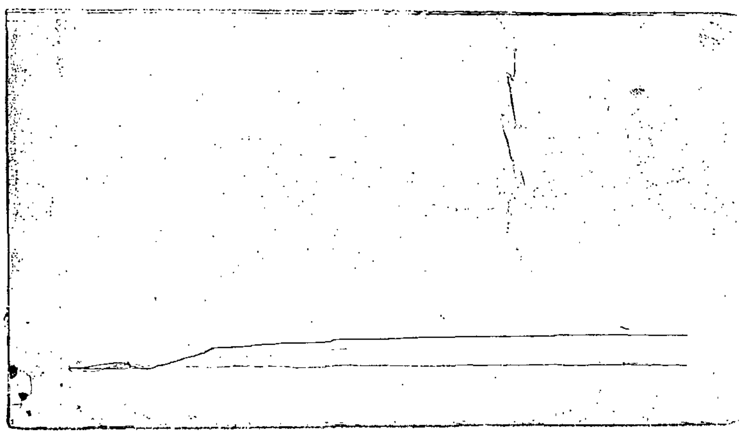
PRD Make Kuster K-3

No. 12773 Cap. 3050 @ 3414'

Press		Corrected
Initial Hydrostatic	A	1953
Final Hydrostatic	K	1924
Initial Flow	B	109
Final Initial Flow	C	237
Initial Shut-in	D	1799
Second Initial Flow	E	319
Second Final Flow	F	535
Second Shut-in	G	1773
Third Initial Flow	H	589
Third Final Flow	I	1087
Third Shut-in	J	1763
4th Initial Flow		1143
4th Final Flow		1545
Pressure Below Bottom Packer Bled To		

LYNES, INC.

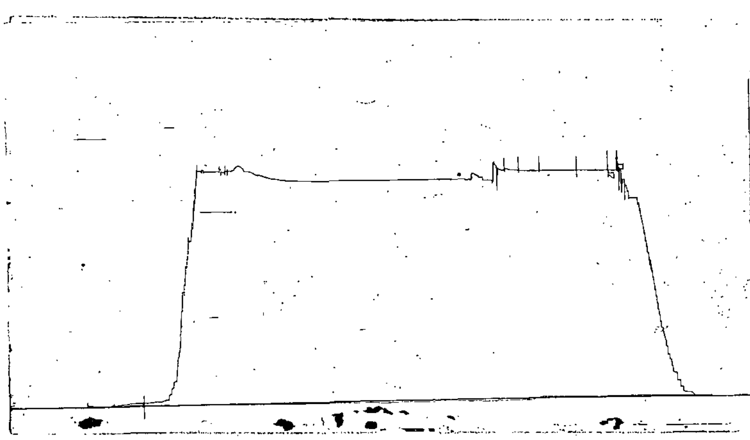
Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 1



Outside Recorder

PRD Make Kuster K-3T
No. 6083 Cap. 277°F @ 3414'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum Temperature		120°F
Pressure Below Bottom Packer Bled To		



Outside Recorder

PRD Make Kuster K-3
No. 12775 Cap. 3050 @ --

Press		Corrected
Initial Hydrostatic	A	1974
Final Hydrostatic	K	1952
Initial Flow	B	--
Final Initial Flow	C	--
Initial Shut-in	D	--
Second Initial Flow	E	--
Second Final Flow	F	--
Second Shut-in	G	--
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--
Minimum psi		1878
Pressure Below Bottom Packer Bled To		1878

LYNES, INC.

Fluid Sample Report

Company: United States Geological Survey — Date: 9-21-78

Well Name & No. Madison Limestone Test Well #3 — Ticket No. 16505

County: Yellowstone — State: Montana

Test Interval: 3407-3441' — DST No. 1

Total Volume of Sampler: 2800 cc.

Total Volume of Sample: 2750 cc.

Pressure in Sampler: 20 psig

Oil: None cc.

Water: None cc.

Mud: 2750 cc.

Gas: None cu. ft.

Other: None

R.W. 1.2 @ 105°F = 3300 ppm.chl.

Resistivity

Make Up Water 2.3 @ 70°F of Chloride Content 2500 ppm.

Mud Pit Sample 1.6 @ 74°F of Chloride Content 3500 ppm.

Gas/Oil Ratio ______ Gravity ______ °API @ ______ °F

Where was sample drained: On location

Remarks:

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 1

Comments relative to the analysis of the pressure chart from DST #1, Interval: 3407-3441', which was run in the captioned well located in Section 35, T2N-R27E, Yellowstone County, Montana:

For purposes of this analysis, the following reservoir and fluid properties and test parameters have been used:

> BHT = 120°F., μ = 1.0 cp., h = 29 feet, t = 278 minutes, m (of the extrapolation curve for the 3rd shut-in pressure build-up curve) = 110 psi/log cycle.

1. Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 1802 psi at the recorder depth of 3414 feet. Extrapolation of the Second Shut-in pressure build-up curve indicates a maximum reservoir pressure of 1802 psi. Extrapolation of the Third (Final) Shut-in pressure build-up curve indicates a maximum reservoir pressure of 1797 psi. The difference between the three extrapolated pressures (a total difference of 5 psi) is considered insignificant.

   The indicated maximum reservoir pressure is reasonably consistent with original reservoir pressures which were found in the Lakota formation at comparable depths and earlier dates in the general area of this formation test.

2. The calculated Average Production Rate which was used in this analysis, 224.5 BPD, is based upon the total fluid recovery of 43.35 barrels and the total flowing time of 278 minutes (includes the 150-minute Fourth Flow period).

3. The calculated Damage Ratio of 1.2 indicates that no significant wellbore damage was present at the time of this formation test.

4. The calculated Effective Transmissibility of 332.5 md.-ft./cp. indicates an Average Permeability to the produced fluid of 11.4 md. for the reported 29 feet of effective porosity within the total 34 feet of interval tested.

5. The evaluation criteria used in the DST Analysis System indicate that the results obtained in this analysis should be reliable within reasonable limits relative to the assumptions which have been made.

Roger L. Hoeger
Roger L. Hoeger
Consultant to Lynes, Inc.

Form 2

LYNES INC.

REPORT #1272

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 1

RECORDER NUMBER - 8889

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	243
6.2	1.9677	1720
12.4	1.4839	1754
18.6	1.3226	1768
24.8	1.2419	1775
31.0	1.1935	1781
37.2	1.1613	1784
43.4	1.1382	1786
49.6	1.1210	1788
55.8	1.1075	1790
62.0	1.0968	1791

EXTRAPOLATION OF FIRST SHUT IN = 1802.41

LYNES INC.

REPORT #1272

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 1

RECORDER NUMBER - 8889

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	539
6.0	7.0000	1648
12.0	4.0000	1690
18.0	3.0000	1714
24.0	2.5000	1730
30.0	2.2000	1740
36.0	2.0000	1748
42.0	1.8571	1754
48.0	1.7500	1759
54.0	1.6667	1763
60.0	1.6000	1766

EXTRAPOLATION OF SECOND SHUT IN = 1803.40

LYNES INC.

REPORT #1272

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 1

RECORDER NUMBER - 8889

THIRD SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	1079
9.0	15.2222	1656
18.0	8.1111	1691
27.0	5.7407	1709
36.0	4.5556	1721
45.0	3.8444	1731
54.0	3.3704	1738
63.0	3.0317	1744
72.0	2.7778	1749
81.0	2.5802	1753
90.0	2.4222	1755

FITTED LINE: LOG((TO+PHI)/PHI) = -.00911 PSIG + 16.36800

EXTRAPOLATION OF THIRD SHUT IN = 1797.19 M = 109.80

RESERVOIR PARAMETERS:

COLLAR RECOV	565.000	PIPE RECOVRY	2798.000	INIT FLO TIM	6.000
FINL FLO TIM	92.000	MUD EXPANSN	1.000	BOTTM HOL TM	120.000
API GRAVITY	10.000	SPEC GRAVITY	1.000	VISCOSITY	1.000
PAY THICKNES	29.000	SUBSEA DEPTH	-374.200	WATER GRADNT	.433

LYNES INC.

REPORT #1272

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 1

RECORDER NUMBER - 8889

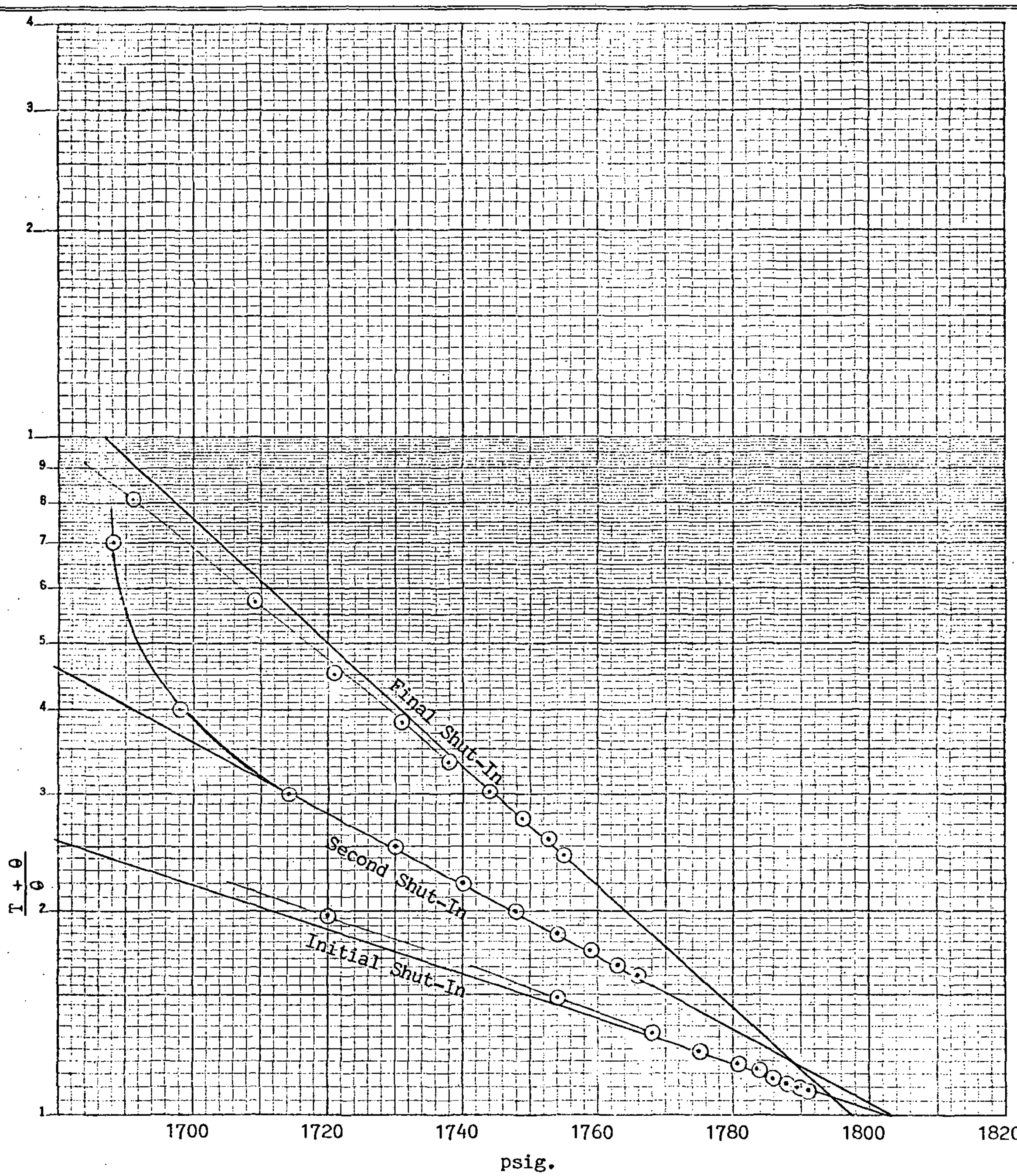
CALCULATIONS: THIRD SHUT IN

EXTRAPOLATED RESERVOIR PRESS.(PSIG)	1797.2
NO. OF POINTS ENTERED..........................	11.0
NO. OF POINTS USED IN EXTRAPOLATION	5.0
ROOT MEAN SQUARE DEVIATION OF BEST FIT LINE(PSI) .	.008
TOTAL FLOW TIME(MIN)	128.0
AVERAGE PRODUCTION RATE DURING TEST(BBLS/DAY)	224.5
TRANSMISSIBILITY(MD-FT/CP)	332.5
IN SITU CAPACITY(MD-FT)	332.5
AVERAGE EFFECTIVE PERMEABILITY(MD)	11.46
PRODUCTIVITY INDEX(BBLS/DAY-PSI)	.313
DAMAGE RATIO	1.2
PRODUCTIVITY INDEX WITH DAMAGE REMOVED(BBLS/DAY-PSI) ...	.374
RADIUS OF INVESTIGATION(FT)	38.3
DRAWDOWN FACTOR(%)	.3
POTENTIOMETRIC SURFACE(FT)	3776.3

LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey   Lease & No. Madison Limestone #3   DST No. 1



Phone
522-1206 Area 303

LYNES, INC.

Box 712
Sterling, Colo. 80751

Operator: United States Geological Survey
Address: See Distribution
Well Name and No.: Madison Limestone Test Well #3
Ticket No.: 16506
Date: 9-22-78
DST No.: 2
No. Final Copies: 5

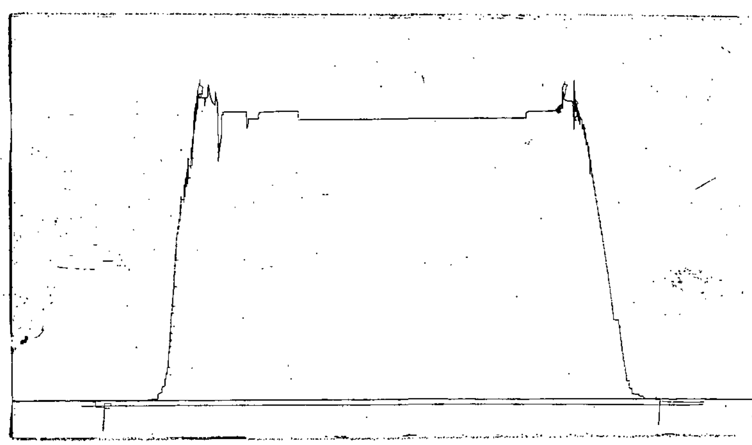
Contractor: Molen Drlg. Co. Inc.
Rig No.: 4
Spot: --
Sec.: 35
Twp.: 2 N
Rng.: 27 E
Field: Wildcat
County: Yellowstone
State: Montana
Elevation: 3039.8' "K.B."
Formation: Madison

Top Choke: 1"
Bottom Choke: 9/16"
Size Hole: 8 3/4"
Size Rat Hole: --
Size & Wt. D. P.: 4 1/2" 16.60
Size Wt. Pipe: 4 1/2" 274'
I. D. of D. C.: 2 1/4"
Length of D. C.: 187'
Total Depth: 4414'
Interval Tested: 4290-4414'
Type of Test: Bottom Hole Inflate

Flow No. 1: 10 Min.
Shut-in No. 1: 60 Min.
Flow No. 2: 30 Min.
Shut-in No. 2: 90 Min.
Flow No. 3: 560 Min.
Shut-in No. 3: 30 Min.

Bottom Hole Temp.: 126°F
Mud Weight: 10.8
Gravity: --
Viscosity: 58

Tool opened @ 5:30 PM.



Outside Recorder
PRD Make: Kuster K-3
No. 8889 Cap. 3000 @ 4296

Press		Corrected
Initial Hydrostatic	A	2449
Final Hydrostatic	K	2419
Initial Flow	B	1948
Final Initial Flow	C	2157
Initial Shut-in	D	2340
Second Initial Flow	E	2210
Second Final Flow	F	2284
Second Shut-in	G	2344
Third Initial Flow	H	2276
Third Final Flow	I	2288
Third Shut-in	J	2344

Lynes Dist.: Billings, MT.
Our Tester: J. Rescoe
Witnessed By: D. Blankenagel

Did Well Flow – Gas No Oil No Water Yes
RECOVERY IN PIPE: Test Flowed Water.

1st Flow - Tool opened with a good blow and remained thru flow period.

2nd Flow - Water to surface in 4 minutes.

3rd Flow - Water to surface. Flowed at 115 gallons per minute with 56 psi back pressure.

REMARKS:

-----

2. The calculated Average Production Rate which was used in this analysis, 3942.9 BPD, is based upon the reported measured water flow rate of 115 gallons/minute, which was measured during a portion of the third flow period.

3. The calculated Damage Ratio of 1.5 indicates that slight well-bore damage was present at the time of this formation test. The Damage Ratio implies that the production rate should have been 1.5 times greater than that which occurred (or 5914.4 BPD) if well-bore damage had not been present. It should be noted, however, in view of the magnitude of the flow rate which occurred during this test, that the indicated well-bore damage is most probably due to the choke effect of restrictions within the test tool rather than actual formation damage.

4. The calculated Effective Transmissibility of 79,913.0 md.-ft./cp. indicates an Average Permeability to the produced fluid of 823.9 md. for the reported 97 feet of effective porosity within the total 124 feet of interval tested.

5. The evaluation criteria used in the Drill-Stem-Test Analysis System indicate that the tools and recorder functioned properly; however, as noted above, because of the question concerning the reliability of the interpreted slope of the extrapolation plot for the Final Shut-in pressure build-up curve, the numerical results obtained in this analysis should be considered as indicators rather than quantitative values.

Roger L. Hoeger
Consultant to Lynes, Inc.

LYNES INC.

REPORT #1273

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 2

RECORDER NUMBER - 8889

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2157
6.0	2.6667	2337
12.0	1.8333	2338
18.0	1.5556	2339
24.0	1.4167	2339
30.0	1.3333	2339
36.0	1.2778	2339
42.0	1.2381	2339
48.0	1.2083	2339
54.0	1.1852	2340
60.0	1.1667	2340

EXTRAPOLATION OF FIRST SHUT IN = 2342.30

REPORT #1273

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 2

RECORDER NUMBER - 8889

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2284
9.0	5.4444	2337
18.0	3.2222	2339
27.0	2.4815	2340
36.0	2.1111	2341
45.0	1.8889	2342
54.0	1.7407	2343
63.0	1.6349	2343
72.0	1.5556	2343
81.0	1.4938	2344
90.0	1.4444	2344

EXTRAPOLATION OF SECOND SHUT IN = 2346.64

LYNES INC.

REPORT #1273

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 2

RECORDER NUMBER - 8889

THIRD SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2288
3.0	201.0000	2338
6.0	101.0000	2340
9.0	67.6667	2341
12.0	51.0000	2341
15.0	41.0000	2342
18.0	34.3333	2343
21.0	29.5714	2343
24.0	26.0000	2343
27.0	23.2222	2343
30.0	21.0000	2344

FITTED LINE: LOG((TO+PHI)/PHI) = -.12465 PSIG + 293.49426

EXTRAPOLATION OF THIRD SHUT IN = 2354.61 M = 8.02

RESERVOIR PARAMETERS:

COLLAR RECOV	461.000	PIPE RECOVRY	3829.000	INIT FLO TIM	10.000
FINL FLO TIM	560.000	MUD EXPANSN	1.000	BOTTM HOL TM	126.000
API GRAVITY	10.000	SPEC GRAVITY	1.000	VISCOSITY	1.000
PAY THICKNES	97.000	SUBSEA DEPTH	-1256.200	WATER GRADNT	.433

LYNES INC.

REPORT #1273

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 2

RECORDER NUMBER - 8889

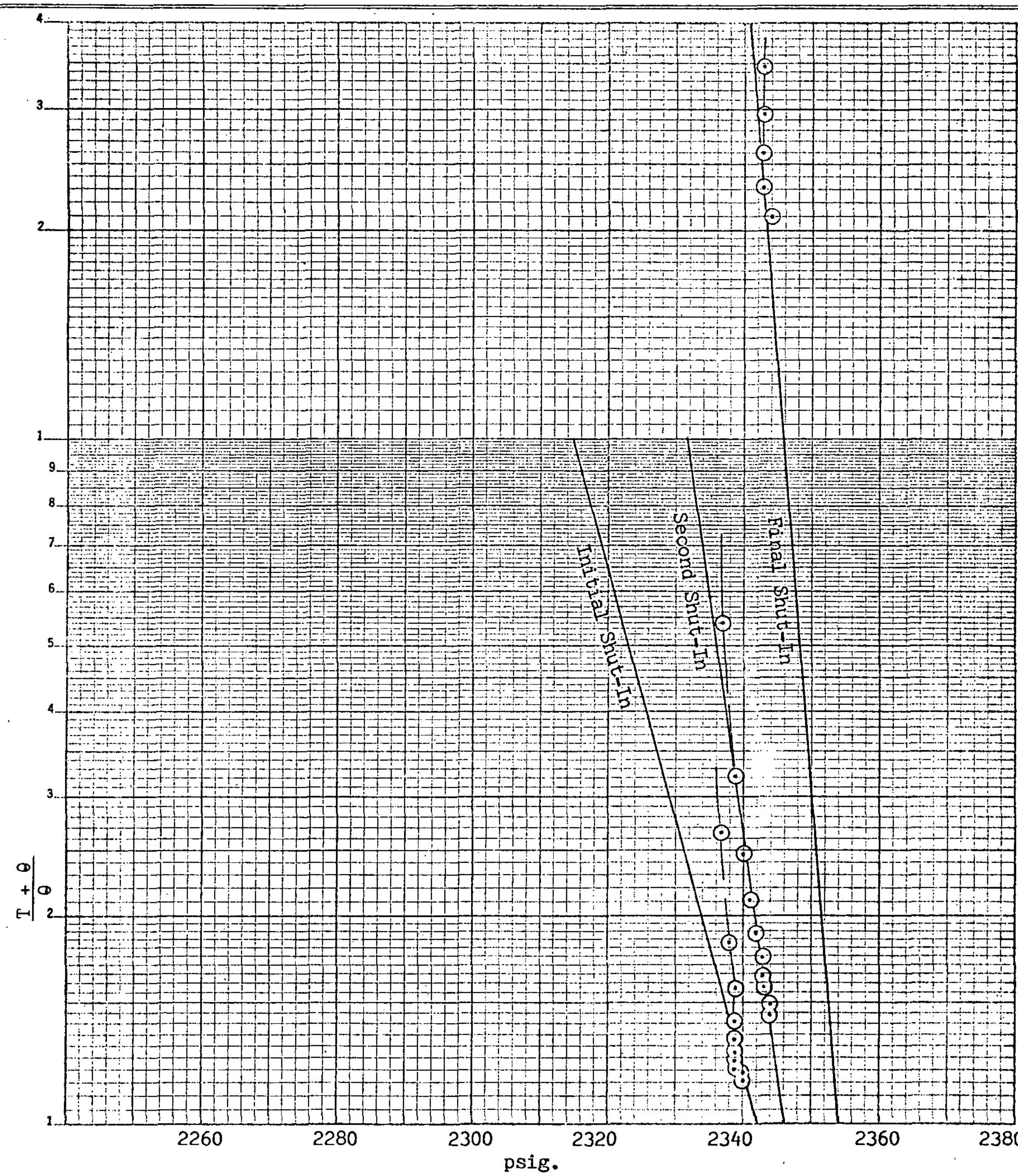
CALCULATIONS: THIRD SHUT IN

EXTRAPOLATED RESERVOIR PRESS.(PSIG)	2354.6
NO. OF POINTS ENTERED............................	11.0
NO. OF POINTS USED IN EXTRAPOLATION	5.0
ROOT MEAN SQUARE DEVIATION OF BEST FIT LINE(PSI) .	.062
TOTAL FLOW TIME(MIN)	600.0
AVERAGE PRODUCTION RATE DURING TEST(BBLS/DAY)	3942.9
TRANSMISSIBILITY(MD-FT/CP)	79913.0
IN SITU CAPACITY(MD-FT)	79913.0
AVERAGE EFFECTIVE PERMEABILITY(MD)	823.85
PRODUCTIVITY INDEX(BBLS/DAY-PSI)	59.196
DAMAGE RATIO	1.5
PRODUCTIVITY INDEX WITH DAMAGE REMOVED(BBLS/DAY-PSI) ...	89.939
RADIUS OF INVESTIGATION(FT)	703.1
DRAWDOWN FACTOR(%)	.0
POTENTIOMETRIC SURFACE(FT)	4181.7

LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 2



LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 3

Comments relative to the analysis of the pressure chart from DST #3, Interval: 4150-4234', which was run in the captioned well located in Section 35, T2N-R27E, Yellowstone County, Montana:

For purposes of this analysis, the following reservoir and fluid properties and test parameters have been used:

BHT = 116°F., μ = 1.0 cp., h = 50 feet, t = 33 minutes,
m = 34 psi/log cycle.

1. Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2259 psi at the recorder depth of 4158 feet. Extrapolation of the Final Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2262 psi. The difference between the extrapolated Initial and Final Shut-in pressures (3 psi) is considered insignificant.

   The indicated maximum reservoir pressure is reasonably consistent with original reservoir pressures which have been found in the Madison formation at comparable depths and earlier dates in the general area of this formation test. It should be noted, however, that there is a difference of about 77 feet of potentiometric surface elevation between that which was found in the Madison zone tested in DST #2 in this well and that which was calculated from pressure data recorded in this test.

2. The calculated Average Production Rate which was used in this analysis, 2948.6 BPD, is based upon the reported water flow rate of 86 gallons/minute, which was measured during the 348-minute third flow period.

3. The calculated Damage Ratio of 1.1 indicates that no significant wellbore damage was present at the time of this formation test.

4. The calculated Effective Transmissibility of 14,005.1 md.-ft./cp. indicates an Average Permeability to the produced fluid of 280.1 md. for the reported 50 feet of effective porosity within the total 84 feet of interval tested.

5. The evaluation criteria used in the Drill-Stem-Test Analysis System indicate that the results obtained in this analysis should be reliable within reasonable limits relative to the assumptions which have been made.

Roger L. Hoeger
Consultant to Lynes, Inc.

REPORT #1274

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 3

RECORDER NUMBER - 8889

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	1343
6.0	1.5000	2241
12.0	1.2500	2249
18.0	1.1667	2252
24.0	1.1250	2253
30.0	1.1000	2254
36.0	1.0833	2254
42.0	1.0714	2255
48.0	1.0625	2255
54.0	1.0556	2256
60.0	1.0500	2256

EXTRAPOLATION OF FIRST SHUT IN = 2258.61

LYNES INC.

REPORT #1274

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 3

RECORDER NUMBER - 8889

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2059
9.0	4.6667	2248
18.0	2.8333	2251
27.0	2.2222	2252
36.0	1.9167	2253
45.0	1.7333	2254
54.0	1.6111	2255
63.0	1.5238	2255
72.0	1.4583	2256
81.0	1.4074	2256
90.0	1.3667	2257

FITTED LINE: LOG((TO+PHI)/PHI) = -.02921 PSIG + 66.06546

EXTRAPOLATION OF SECOND SHUT IN = 2261.64 M = 34.23

RESERVOIR PARAMETERS:

COLLAR RECOV	483.000	PIPE RECOVRY	3621.000	INIT FLO TIM	3.000
FINL FLO TIM	30.000	MUD EXPANSN	1.000	BOTTM HOL TM	116.000
API GRAVITY	10.000	SPEC GRAVITY	1.000	VISCOSITY	1.000
PAY THICKNES	50.000	SUBSEA DEPTH	-1118.200	WATER GRADNT	.433

LYNES INC.

REPORT #1274

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - U.S.G.S.

DST NUMBER - 3

RECORDER NUMBER - 8889

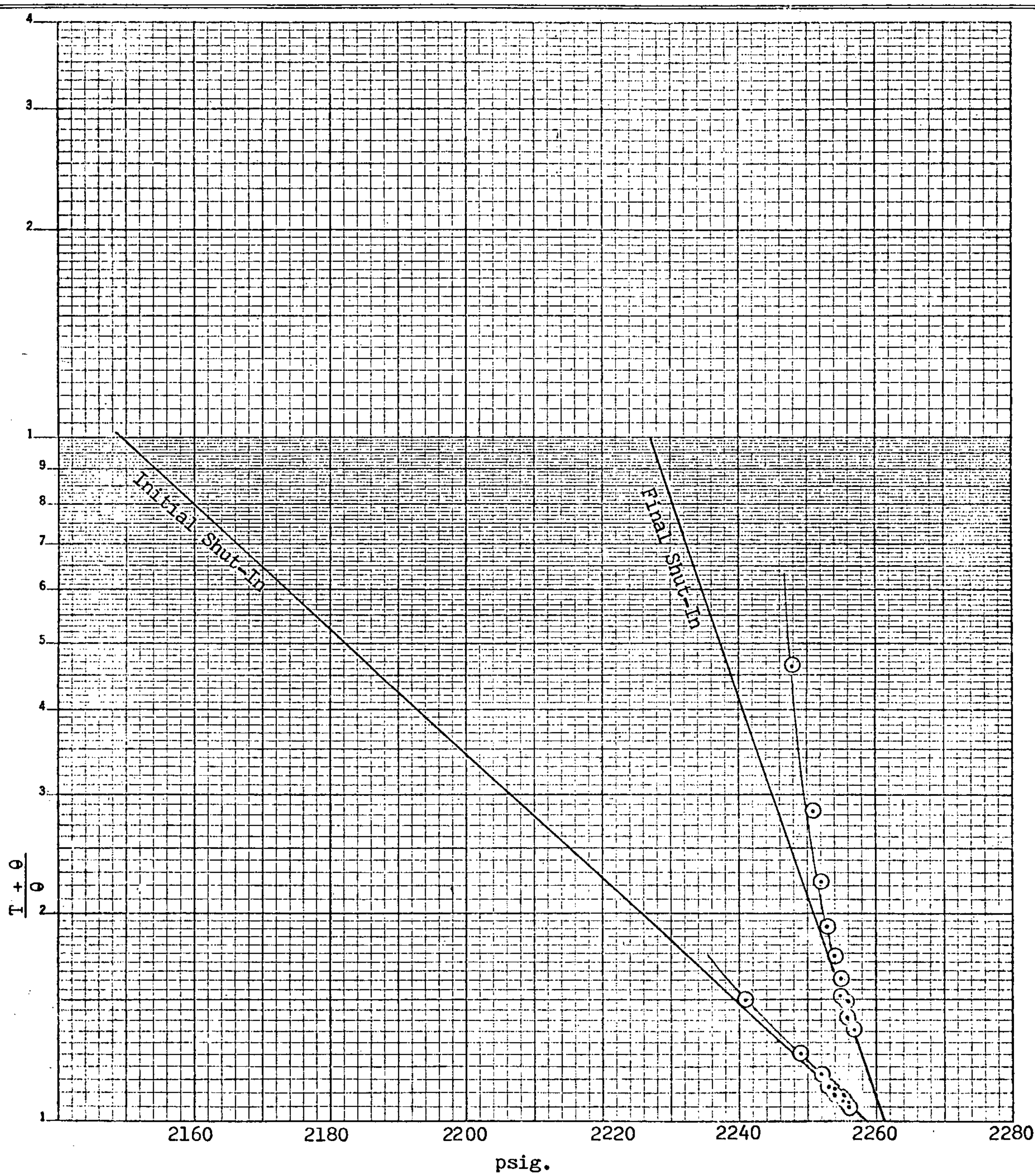
CALCULATIONS: SECOND SHUT IN

EXTRAPOLATED RESERVOIR PRESS.(PSIG)	2261.6
NO. OF POINTS ENTERED..........................	11.0
NO. OF POINTS USED IN EXTRAPOLATION	6.0
ROOT MEAN SQUARE DEVIATION OF BEST FIT LINE(PSI) .	.013
TOTAL FLOW TIME(MIN)	33.0
AVERAGE PRODUCTION RATE DURING TEST(BBLS/DAY)	2948.6
TRANSMISSIBILITY(MD-FT/CP)	14005.1
IN SITU CAPACITY(MD-FT)	14005.1
AVERAGE EFFECTIVE PERMEABILITY(MD)	280.10
PRODUCTIVITY INDEX(BBLS/DAY-PSI)	14.551
DAMAGE RATIO	1.1
PRODUCTIVITY INDEX WITH DAMAGE REMOVED(BBLS/DAY-PSI) ...	15.762
RADIUS OF INVESTIGATION(FT)	96.1
DRAWDOWN FACTOR(%)	.0
POTENTIOMETRIC SURFACE(FT)	4105.0

LYNES, INC.

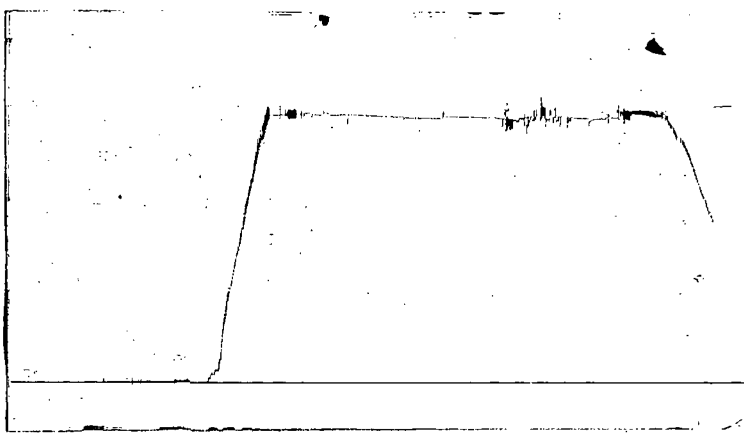
Pressure Extrapolation Plot

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 3



LYNES, INC.

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No.: 4



Inside Recorder

PRD Make: Kuster K-3

No. 15242 Cap. 5450 @ 7202'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

Bottom chart indicates no communications.

PRD Make

No. Cap. @

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Sampler Report

Company: United States Geological Survey — Date: 11-20-78

Well Name & No.: Madison Limestone Test Well #3 — Ticket No.: 16520

County: Yellowstone — State: Montana

Test Interval: 6984-7196' — DST No.: 4

Total Volume of Sampler: 2000 cc.

Total Volume of Sample: 1950 cc.

Pressure in Sampler: 2140 psig

Oil: None cc.

Water: 1950 cc.

Mud: None cc.

Gas: Trace cu. ft.

Other: None

R.W. .3 @ 70°F = 22,000 ppm. chl.

Resistivity

Make Up Water 10.0 @ 69°F of Chloride Content 550 ppm.

Mud Pit Sample 6.6 @ 70°F of Chloride Content 800 ppm.

Gas/Oil Ratio ______ Gravity ______ °API @ ______ °F

Where was sample drained: On location.

Remarks:

Form 5

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 4

Comments relative to the analysis of the pressure chart from DST #4, Interval: 6984-7196', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

For purposes of this analysis, the following reservoir and fluid properties and test parameters have been used:

BHT = 169.6°F., μ = 1.0 cp., h = 50 feet, t = 31 minutes,
m = 161 psi/log cycle.

1. Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 3475 psi at the recorder depth of 6994 feet. Extrapolation of the Final Shut-in pressure build-up curve indicates a maximum reservoir pressure of 3513 psi. The difference between the extrapolated Initial and Final Shut-in pressures (38 psi) is considered unimportant and is indicated to be due to the use of insufficient time for the shut-in periods.

   The extrapolated Final Shut-in pressure at the recorder depth is equivalent to a subsurface pressure gradient of 0.502 psi/ft. This pressure gradient is anomalously high compared to a "normal" hydrostatic pressure gradient which ranges from about 0.43 to 0.47 psi/ft., depending upon formation water salinity. This anomalous reservoir pressure condition suggests that its cause is the relatively high elevation of recharge areas for this aquifer system compared to the ground elevation at this well location.

2. The calculated Average Production Rate which was used in this analysis, 4422.7 BPD, is based upon a full fill-up of water in the pipe (95.2 barrels) in an effective flowing time of 31 minutes (the total elapsed flowing time at which fluid reached the surface).

3. The calculated Damage Ratio of 0.3 indicates that no significant wellbore damage was present at the time of this formation test.

Form 2

4. The calculated Effective Transmissibility of 4458.7 md.-ft./cp. indicates an Average Permeability to water of 89.2 md. for the estimated 50 feet of effective porosity within the total 212 feet of interval tested.

5. The evaluation criteria used in the Drill-Stem-Test Analysis System indicate that the results obtained in this analysis should be reliable within reasonable limits relative to the assumptions which have been made.

Roger L. Hoeger
Consultant to Lynes, Inc.

LYNES INC.

REPORT #1471

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 4

RECORDER NUMBER - 5155

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2952
2.0	11.0000	3379
4.0	6.0000	3389
6.0	4.3333	3395
8.0	3.5000	3400
10.0	3.0000	3404
12.0	2.6667	3408
14.0	2.4286	3411
16.0	2.2500	3414
18.0	2.1111	3417
20.0	2.0000	3420
22.0	1.9091	3423
24.0	1.8333	3426
26.0	1.7692	3429
28.0	1.7143	3432
30.0	1.6667	3434

EXTRAPOLATION OF FIRST SHUT IN = 3474.68

LYNES INC.

REPORT #1471

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 4

RECORDER NUMBER - 5155

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	3213
6.0	34.3333	3308
12.0	17.6667	3333
18.0	12.1111	3347
24.0	9.3333	3360
30.0	7.6667	3372
36.0	6.5556	3381
42.0	5.7619	3390
48.0	5.1667	3397
54.0	4.7037	3403
60.0	4.3333	3409
66.0	4.0303	3415
72.0	3.7778	3420
78.0	3.5641	3425
84.0	3.3810	3428
90.0	3.2222	3431

FITTED LINE: LOG((TO+PHI)/PHI) = -.00620 PSIG + 21.78075

EXTRAPOLATION OF SECOND SHUT IN = 3512.96 M = 161.29

RESERVOIR PARAMETERS:

COLLAR RECOV	281.000	PIPE RECOVRY	6703.000	INIT FLO TIM	20.000
FINL FLO TIM	180.000	MUD EXPANSN	1.000	BOTTM HOL TM	169.600
API GRAVITY	10.000	SPEC GRAVITY	1.000	VISCOSITY	1.000
PAY THICKNES	50.000	SUBSEA DEPTH	-3954.200	WATER GRADNT	.433

LYNES INC.

REPORT #1471

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 4

RECORDER NUMBER - 5155

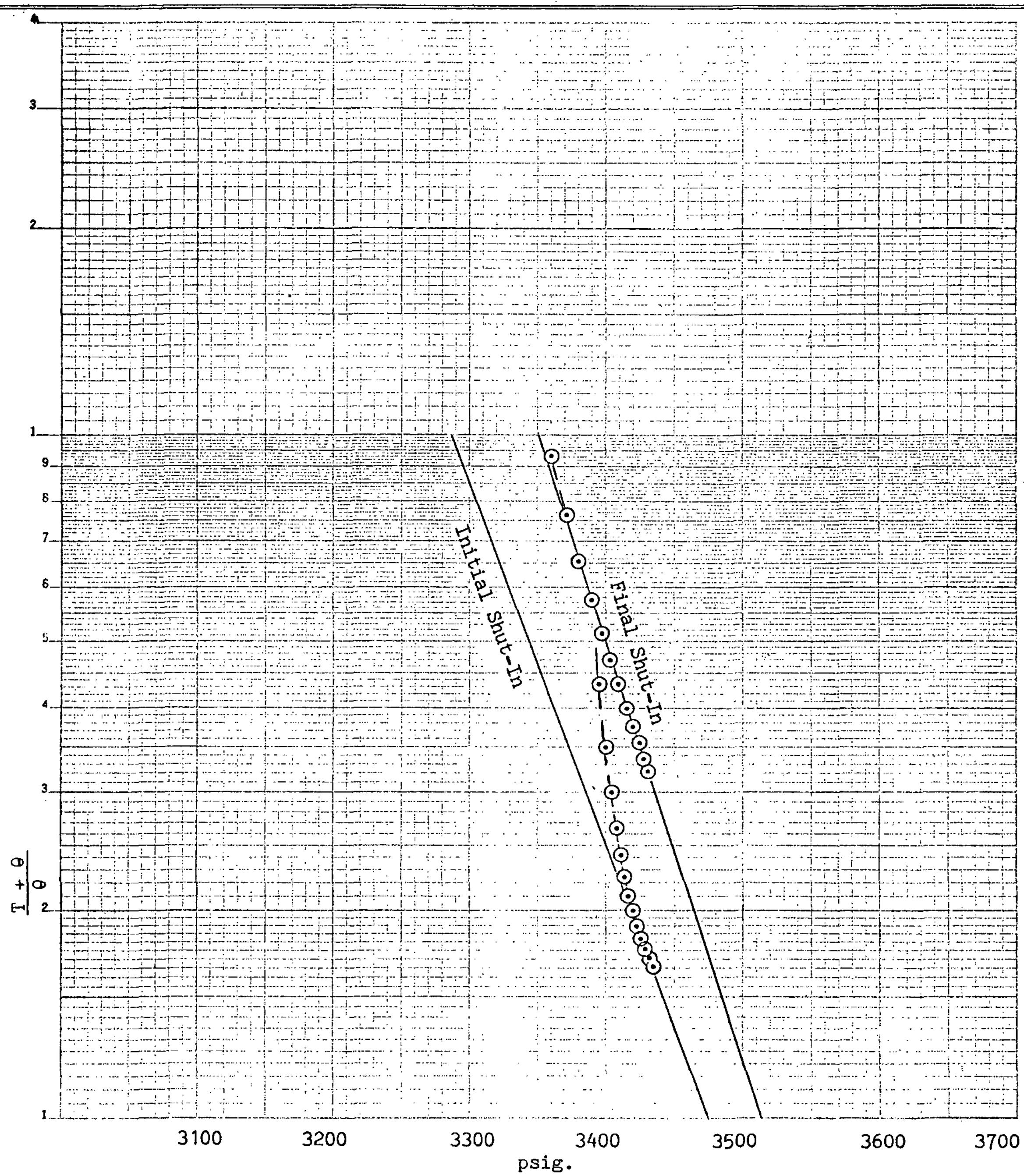
CALCULATIONS: SECOND SHUT IN

EXTRAPOLATED RESERVOIR PRESS.(PSIG)	3513.0
NO. OF POINTS ENTERED.............................	16.0
NO. OF POINTS USED IN EXTRAPOLATION	6.0
ROOT MEAN SQUARE DEVIATION OF BEST FIT LINE(PSI) .	.005
TOTAL FLOW TIME(MIN)	200.0
AVERAGE PRODUCTION RATE DURING TEST(BBLS/DAY)	4422.7
TRANSMISSIBILITY(MD-FT/CP)	4458.7
IN SITU CAPACITY(MD-FT)	4458.7
AVERAGE EFFECTIVE PERMEABILITY(MD)	89.17
PRODUCTIVITY INDEX(BBLS/DAY-PSI)	14.744
DAMAGE RATIO	.3
PRODUCTIVITY INDEX WITH DAMAGE REMOVED(BBLS/DAY-PSI) ...	5.018
RADIUS OF INVESTIGATION(FT)	133.5
DRAWDOWN FACTOR(%)	.0
POTENTIOMETRIC SURFACE(FT)	4158.9

LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 4



Phone
522-1206 Area 303

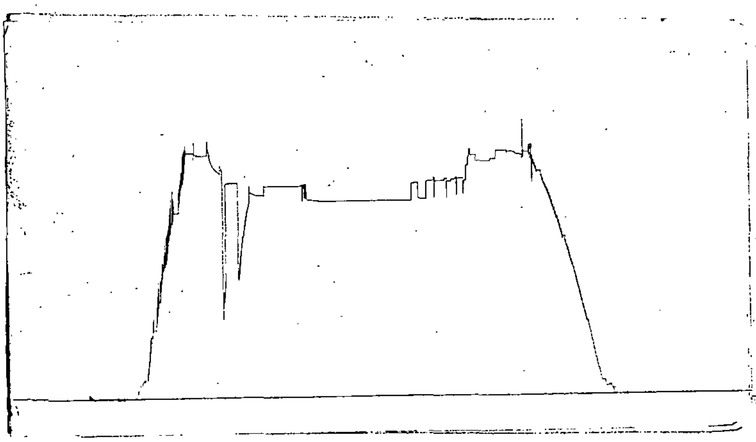
LYNES, INC.

Box 3600
Sterling, Colo. 80751

Contractor	Molen Drlg. Co., Inc.	Top Choke	1"
Rig No.	4	Bottom Choke	9/16"
Spot	SE-NE	Size Hole	8 3/4"
Sec.	35	Size Rat Hole	--
Twp.	2 N	Size & Wt. D. P.	4 1/2" 16.60
Rng.	27 E	Size Wt. Pipe	124'
Field	Wildcat	I. D. of D. C.	2 1/2"
County	Yellowstone	Length of D. C.	281'
State	Montana	Total Depth	7196'
Elevation	3039.8' "K.B."	Interval Tested	5748-5940'
Formation	Red River	Type of Test	Inflate Straddle

Flow No. 1	6 Min.
Shut-in No. 1	30 Min.
Flow No. 2	60 Min.
Shut-in No. 2	90 Min.
Flow No. 3	294 Min.
Shut-in No. 3	-- Min.
Bottom Hole Temp.	132.4°F
Mud Weight	10.8
Gravity	--
Viscosity	50

Tool opened @ 11:30 AM.



Outside Recorder

PRD Make Kuster K-3
No. 5155 Cap. 5000 @ 5758'

Press.		Corrected
Initial Hydrostatic	A	3269
Final Hydrostatic	K	3251
Initial Flow	B	1067
Final Initial Flow	C	1558
Initial Shut-in	D	2910
Second Initial Flow	E	1591
Second Final Flow	F	2736
Second Shut-in	G	2862
Third Initial Flow	H	2680
Third Final Flow	I	2649
Third Shut-in	J	--

Lynes Dist.: Billings, Mt.
Our Tester: Jack Rescoe
Witnessed By: --

Did Well Flow – Gas No Oil No Water Yes

RECOVERY IN PIPE: Test was reverse circulated.

1st Flow - Tool opened with a strong blow, increased to bottom of bucket in 1 minute and remained thru flow period.

2nd Flow - Tool opened with a strong blow. Fluid to surface in 26 minutes.

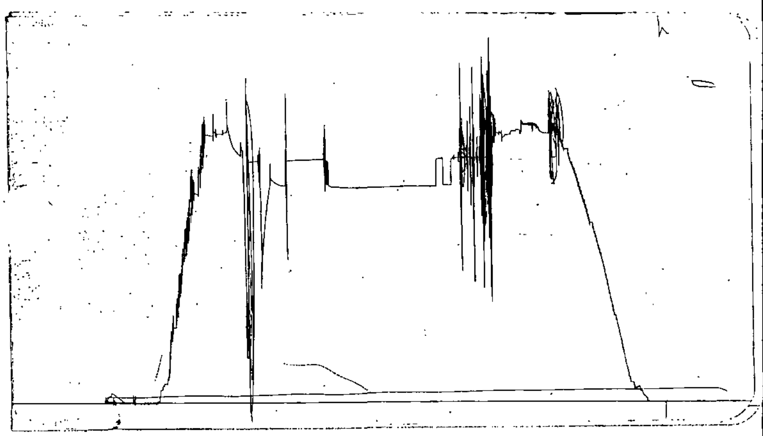
REMARKS:

3rd Flow - Tool opened with fluid to surface.

Operator United States Geological Survey
Address See Distribution
Well Name and No. Madison Limestone Test Well #3
Ticket No. 16522
Date 11-23-78
DST No. 6
No. Final Copies 5

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 6

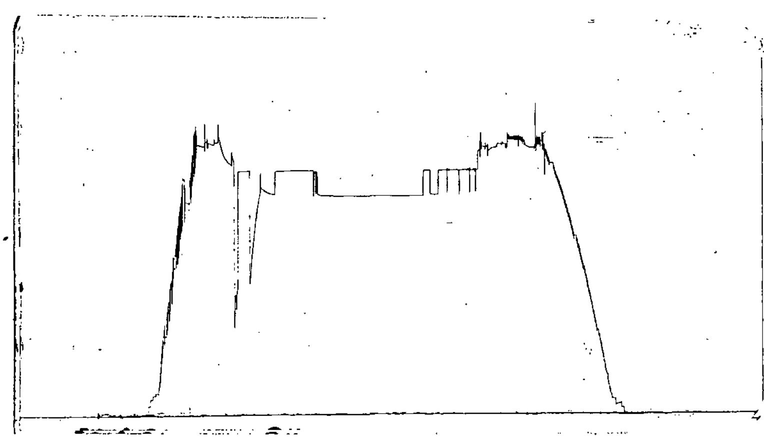


Inside Recorder

PRD Make Kuster K-3

No. 13641 Cap. 4450 @ 5711'

Press		Corrected
Initial Hydrostatic	A	3245
Final Hydrostatic	K	3220
Initial Flow	B	**
Final Initial Flow	C	**
Initial Shut-in	D	2890
Second Initial Flow	E	1558
Second Final Flow	F	2701
Second Shut-in	G	2845
Third Initial Flow	H	2649
Third Final Flow	I	2618
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		



Outside Recorder

PRD Make Kuster K-3

No. 16445 Cap. 4500 @ 5758'

Press		Corrected
Initial Hydrostatic	A	3262
Final Hydrostatic	K	3248
Initial Flow	B	1061
Final Initial Flow	C	1550
Initial Shut-in	D	2902
Second Initial Flow	E	1583
Second Final Flow	F	2725
Second Shut-in	G	2857
Third Initial Flow	H	2674
Third Final Flow	I	2642
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		

LYNES, INC.

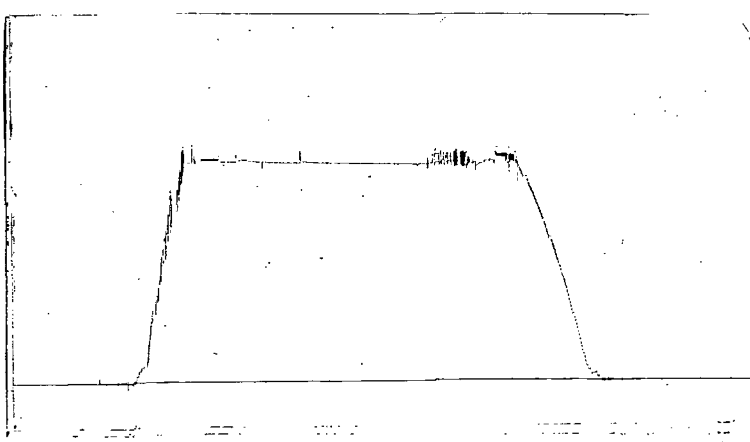
Operator United States Geological Survey   Lease & No. Madison Limestone Test Well #3   DST No. 6

Outside Recorder

PRD Make Kuster K-3T

No. 12355 Cap. 35-249 @ 5758'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum Temperature		132.4
Pressure Below Bottom Packer Bled To		



Outside Recorder

PRD Make Kuster K-3

No. 15242 Cap. 5450 @ 5958'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

Bottom chart indicates no communications.

LYNES, INC.

Fluid Sample Report

Company: United States Geological Survey Date: 11-23-78

Well Name & No.: Madison Limestone Test Well #3 Ticket No.: 16522

County: Yellowstone State: Montana

Test Interval: 5748-5940' DST No.: 6

Total Volume of Sampler: 2000 cc.

Total Volume of Sample: 1960 cc.

Pressure in Sampler: 2500 psig

Oil: None cc.

Water: 1960 cc.

Mud: None cc.

Gas: Trace cu. ft.

Other: None

R.W. 2.5 @ 70°F = 2,300 ppm. chl.

Resistivity

Make Up Water 10.0 @ 69°F of Chloride Content 550 ppm.

Mud Pit Sample 6.6 @ 70°F of Chloride Content 800 ppm.

Gas/Oil Ratio ______ Gravity ______ °API @ ______ °F

Where was sample drained: On location.

Remarks:

FORM 5

LYNES, INC.

Operator: United States Geological Survey | Lease & No. Madison Limestone Test Well #3 | DST No. 6

Comments relative to the analysis of the pressure chart from DST #6, Interval: 5748-5940', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2914 psi at the recorder depth of 5758 feet. A maximum reservoir pressure of 2862 psi was recorded mechanically during the 90-minute Final Shut-in period. The difference between the extrapolated Initial and Final Shut-in pressures (52 psi) indicates that depletion may have been caused by the 60-minute Final Flow period. This evidence of depletion, although of relatively small magnitude, indicates that the tested reservoir is of limited areal extent, or indicates a boundary condition in the reservoir at a relatively short distance from the well-bore.

The condition of mechanical stabilization of the pressure recorder during the Final Shut-in period precludes the use of the Horner analysis method for calculating a numerical value for the transmissibility of the tested reservoir. It is obvious, however, on the basis of the character of the pressure record which was obtained in this test, plus the volume-rate of flow which was observed at the surface, that the transmissibility of the tested zone is excellent.

The indicated maximum reservoir pressure at the recorder depth is equivalent to a subsurface pressure gradient of 0.506 psi/ft. This pressure gradient, although somewhat anomalously high, is in reasonably close agreement with those which have been determined for all of the other Paleozoic reservoirs which were drill-stem tested in this well.

The calculated Average Production Rate which occurred during this test, 3537.0 BPD, is based upon a full fill-up of water in the pipe (78.6 barrels) in an effective flowing time of 32 minutes (the total elapsed flowing time at which fluid reached the surface).

The evaluation criteria used in the DST Analysis System indicate that the tools and recorder functioned properly; however, as noted above, because mechanical stabilization of the pressure recorder occurred throughout the majority of the 90-minute Final Shut-in period, it is not possible to calculate numerical values for the tested reservoir's transmissibility, permeability and damage ratio by the use of the Horner analysis method.

Roger L. Hoeger
Consultant to Lynes, Inc.

Form 2

LYNES INC.

REPORT #1472

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 6

RECORDER NUMBER - 5155

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	1558
3.0	3.0000	2902
6.0	2.0000	2904
9.0	1.6667	2905
12.0	1.5000	2906
15.0	1.4000	2907
18.0	1.3333	2908
21.0	1.2857	2908
24.0	1.2500	2908
27.0	1.2222	2909
30.0	1.2000	2910

EXTRAPOLATION OF FIRST SHUT IN = 2914.18

LYNES INC.

REPORT #1472

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 6

RECORDER NUMBER - 5155

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2736
9.0	8.3333	2862
18.0	4.6667	2862
27.0	3.4444	2862
36.0	2.8333	2862
45.0	2.4667	2862
54.0	2.2222	2862
63.0	2.0476	2862
72.0	1.9167	2862
81.0	1.8148	2862
90.0	1.7333	2862

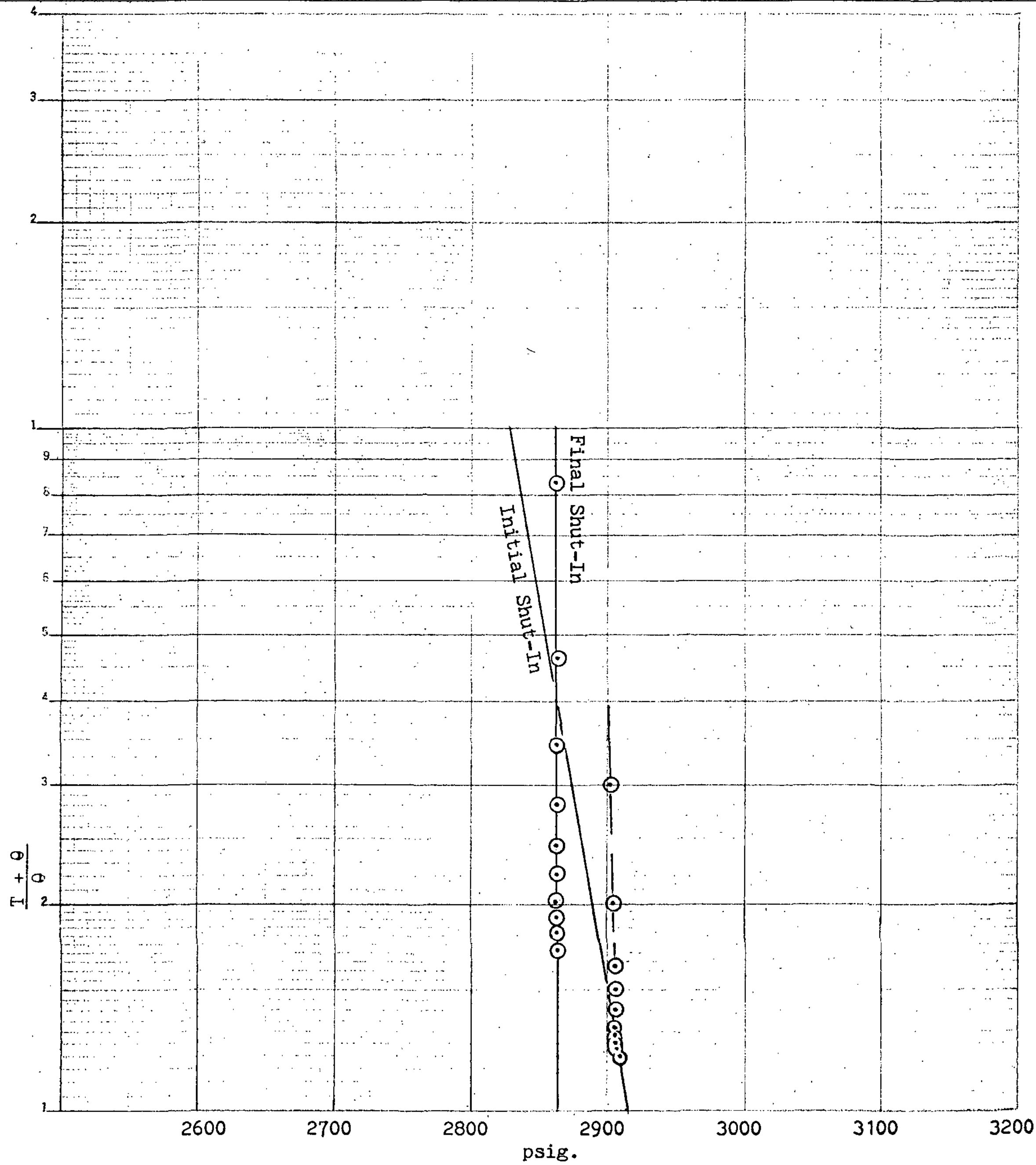
FITTED LINE: LOG((TO+PHI)/PHI) = -10.41971 PSIG + 29821.56250

EXTRAPOLATION OF SECOND SHUT IN = 2862.03 M = .10

LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 6



Phone
522-1206 Area 303

LYNES, INC.

Box 3600
Sterling, Colo. 80751

Operator: United States Geological Survey
Address: See Distribution
Well Name and No.: Madison Limestone Test Well #3
Ticket No.: 16523
Date: 11-24-78
DST No.: 7
No. Final Copies: 5

Contractor	Molen Drlg. Co., Inc.
Rig No.	4
Spot	SE-NE
Sec.	35
Twp.	2 N
Rng.	27 E
Field	Wildcat
County	Yellowstone
State	Montana
Elevation	3039.8' "K.B."
Formation	Stony Mountain

Top Choke	1"
Bottom Choke	9/16"
Size Hole	8 3/4"
Size Rat Hole	--
Size & Wt. D. P.	4 1/2" 16.60
Size Wt. Pipe	93'
I. D. of D. C.	2 1/2"
Length of D. C.	281'
Total Depth	7196'
Interval Tested	5608-5743'
Type of Test	Inflate Straddle

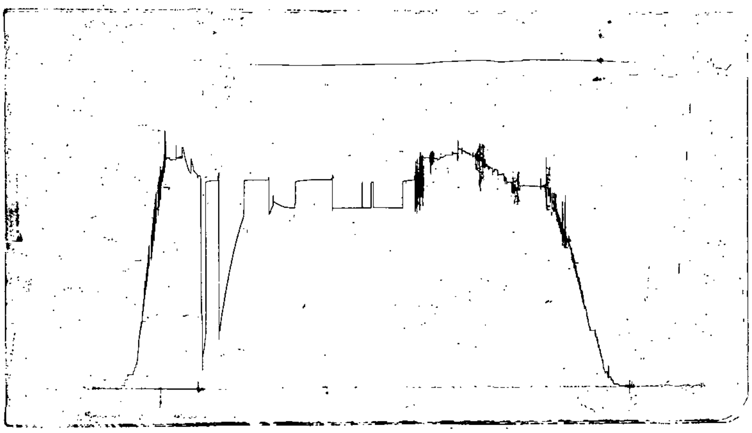
Flow No. 1	10 Min.
Shut-in No. 1	30 Min.
Flow No. 2	60 Min.
Shut-in No. 2	59 Min.
Flow No. 3	60 Min.
Shut-in No. 3	90 Min.
Flow No. 4	159 Min.
Bottom Hole Temp.	126.6°F
Mud Weight	10.8
Gravity	--
Viscosity	50

Tool opened @ 10:27 AM.

Outside Recorder

PRD Make Kuster K-3
No. 5155 Cap. 5000 @ 5618'

Press		Corrected
Initial Hydrostatic	A	3161
Final Hydrostatic	K	3144
Initial Flow	B	258
Final Initial Flow	C	729
Initial Shut-in	D	2848
Second Initial Flow	E	790
Second Final Flow	F	2358
Second Shut-in	G	2852
Third Initial Flow	H	2397
Third Final Flow	I	2469
Third Shut-in	J	2852
Fourth Initial		2464
Fourth Final Flow		2464



Lynes Dist.: Billings, Mt.
Our Tester: Gene Braley
Witnessed By: --

Did Well Flow – Gas No Oil No Water Yes

RECOVERY IN PIPE: Test was reverse circulated.

REMARKS:

1st Flow - Tool opened with a strong blow, increased to bottom of bucket in 1 minute and remained thru flow period.

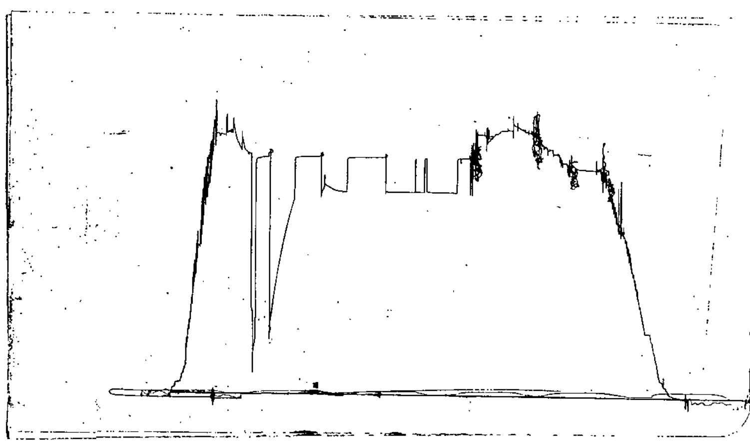
2nd Flow - Tool opened with a strong blow and remained thru flow period.

3rd Flow - Tool opened with a strong blow. Fluid to surface in 11 minutes.

4th Flow - Tool opened with fluid to surface.

LYNES, INC.

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No.: 7

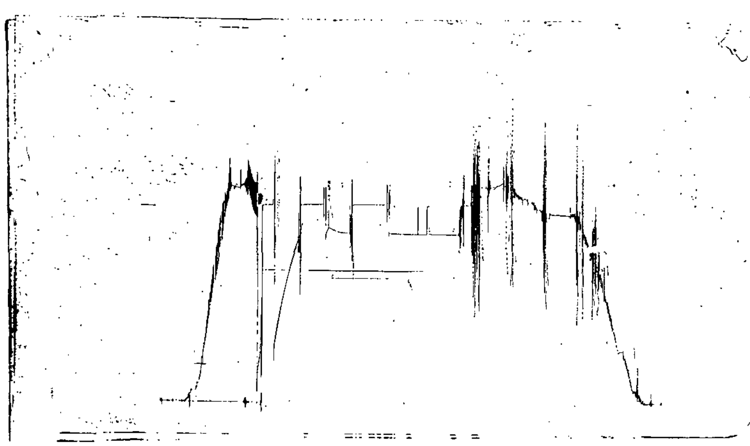


Outside Recorder

PRD Make: Kuster K-3

No. 13641 Cap. 4450 @ 5618'

Press		Corrected
Initial Hydrostatic	A	3153
Final Hydrostatic	K	3138
Initial Flow	B	281
Final Initial Flow	C	703
Initial Shut-in	D	2849
Second Initial Flow	E	781
Second Final Flow	F	2349
Second Shut-in	G	2851
Third Initial Flow	H	2381
Third Final Flow	I	2460
Third Shut-in	J	2851
Fourth Initial Flow		2455
Fourth Final Flow		2455
Pressure Below Bottom Packer Bled To		



Inside Recorder

PRD Make: Kuster K-3

No. 15242 Cap. 5450 @ 5571'

Press		Corrected
Initial Hydrostatic	A	3154
Final Hydrostatic	K	3154
Initial Flow	B	152
Final Initial Flow	C	719
Initial Shut-in	D	2851
Second Initial Flow	E	756
Second Final Flow	F	2365
Second Shut-in	G	2855
Third Initial Flow	H	2370
Third Final Flow	I	2465
Third Shut-in	J	2855
Fourth Initial Flow		2467
Fourth Final Flow		2464
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 7

Comments relative to the analysis of the pressure chart from DST #7, Interval: 5608-5743', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2852 psi at the recorder depth of 5618 feet. Mechanical stabilization of the pressure recorder occurred during the Second and Third Shut-in periods and indicates a maximum reservoir pressure of 2852 psi.

The condition of mechanical stabilization of the pressure recorder during the Second and Third Shut-in periods precludes the use of the Horner analysis method for calculating a numerical value for the transmissibility of the tested reservoir. It is obvious, however, on the basis of the character of the pressure record which was obtained in this test, plus the volume-rate of flow which was observed at the surface, that the transmissibility of the tested zone is excellent.

The indicated maximum reservoir pressure at the recorder depth is equivalent to a subsurface pressure gradient of 0.508 psi/ft. This pressure gradient, which again is somewhat anomalously high, is in reasonably close agreement with that which has been determined for the other Paleozoic reservoirs which were drill-stem tested in this well.

The calculated Average Production Rate which occurred during this test, 1366.5 BPD, is based upon a full fill-up of water in the pipe (76.9 barrels) in an effective flowing time of 81 minutes (the total elapsed flowing time at which fluid reached the surface).

The evaluation criteria used in the DST Analysis System indicate that the tools and recorder functioned properly; however, as noted above, because mechanical stabilization of the pressure recorder occurred throughout the majority of the Second and Final Shut-in periods, it is not possible to calculate numerical values for the tested reservoir's transmissibility, permeability and damage ratio by the use of the Horner analysis method.

Roger L. Hoeger
Consultant to Lynes, Inc.

Form 2

LYNES INC.

REPORT #1474

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 7

RECORDER NUMBER - 5155

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	729
3.0	4.3333	2826
6.0	2.6667	2837
9.0	2.1111	2841
12.0	1.8333	2843
15.0	1.6667	2845
18.0	1.5556	2846
21.0	1.4762	2847
24.0	1.4167	2847
27.0	1.3704	2848
30.0	1.3333	2848

EXTRAPOLATION OF FIRST SHUT IN = 2851.55

LYNES INC.

REPORT #1474

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 7

RECORDER NUMBER - 5155

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2358
5.9	12.8644	2850
11.8	6.9322	2851
17.7	4.9548	2852
23.6	3.9661	2852
29.5	3.3729	2852
35.4	2.9774	2852
41.3	2.6949	2852
47.2	2.4831	2852
53.1	2.3183	2852
59.0	2.1864	2852

EXTRAPOLATION OF SECOND SHUT IN = 2852.04

LYNES INC.

REPORT #1474

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 7

RECORDER NUMBER - 5155

THIRD SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2469
9.0	15.4444	2837
18.0	8.2222	2841
27.0	5.8148	2847
36.0	4.6111	4851
45.0	3.8889	2852
54.0	3.4074	2852
63.0	3.0635	2852
72.0	2.8056	2852
81.0	2.6049	2852
90.0	2.4444	2852

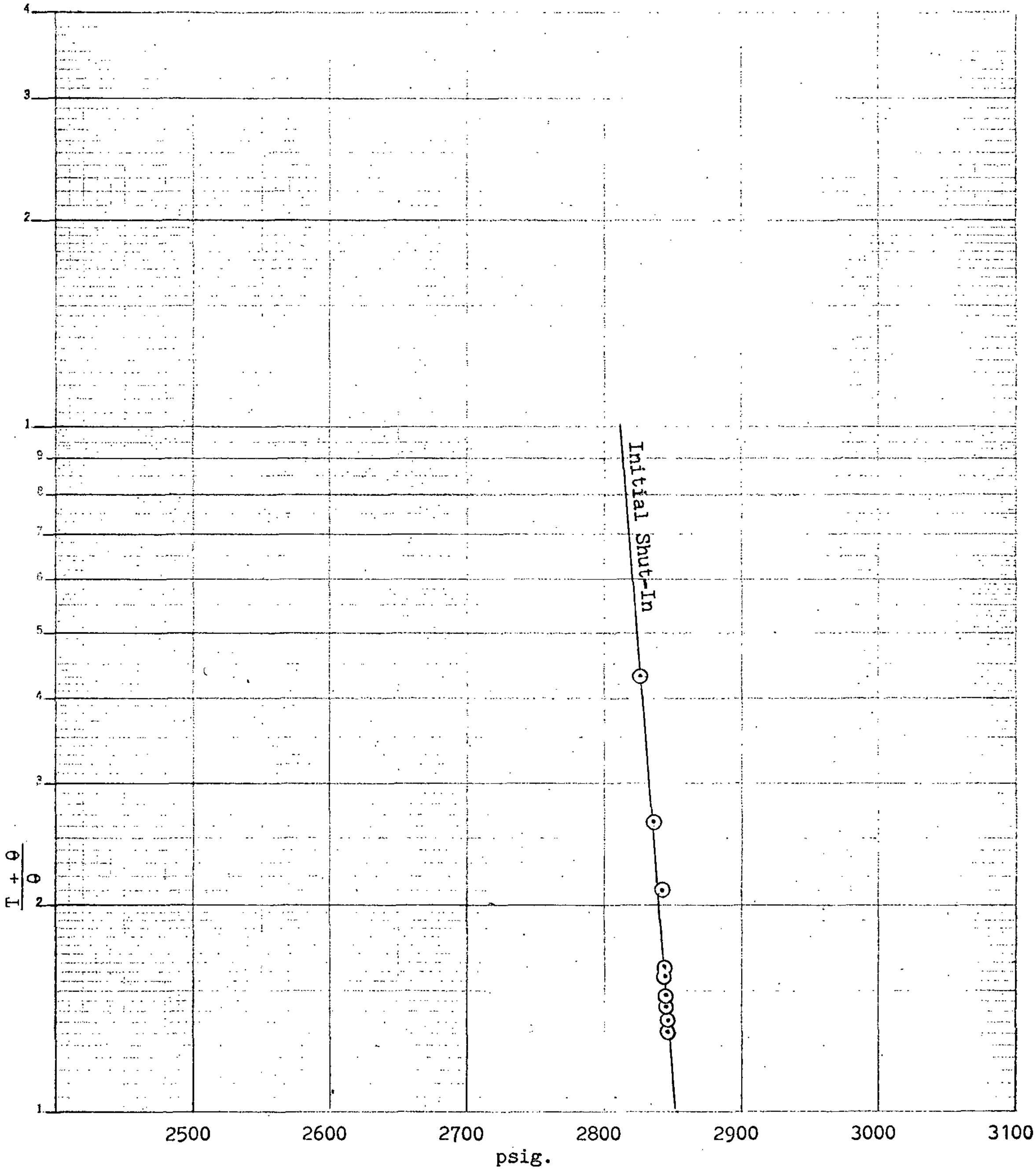
FITTED LINE: LOG((TO+PHI)/PHI) = -10.88268 PSIG + 31037.89844

EXTRAPOLATION OF THIRD SHUT IN = 2852.05 M = .09

LYNES, INC.

Pressure Extrapolation Plot

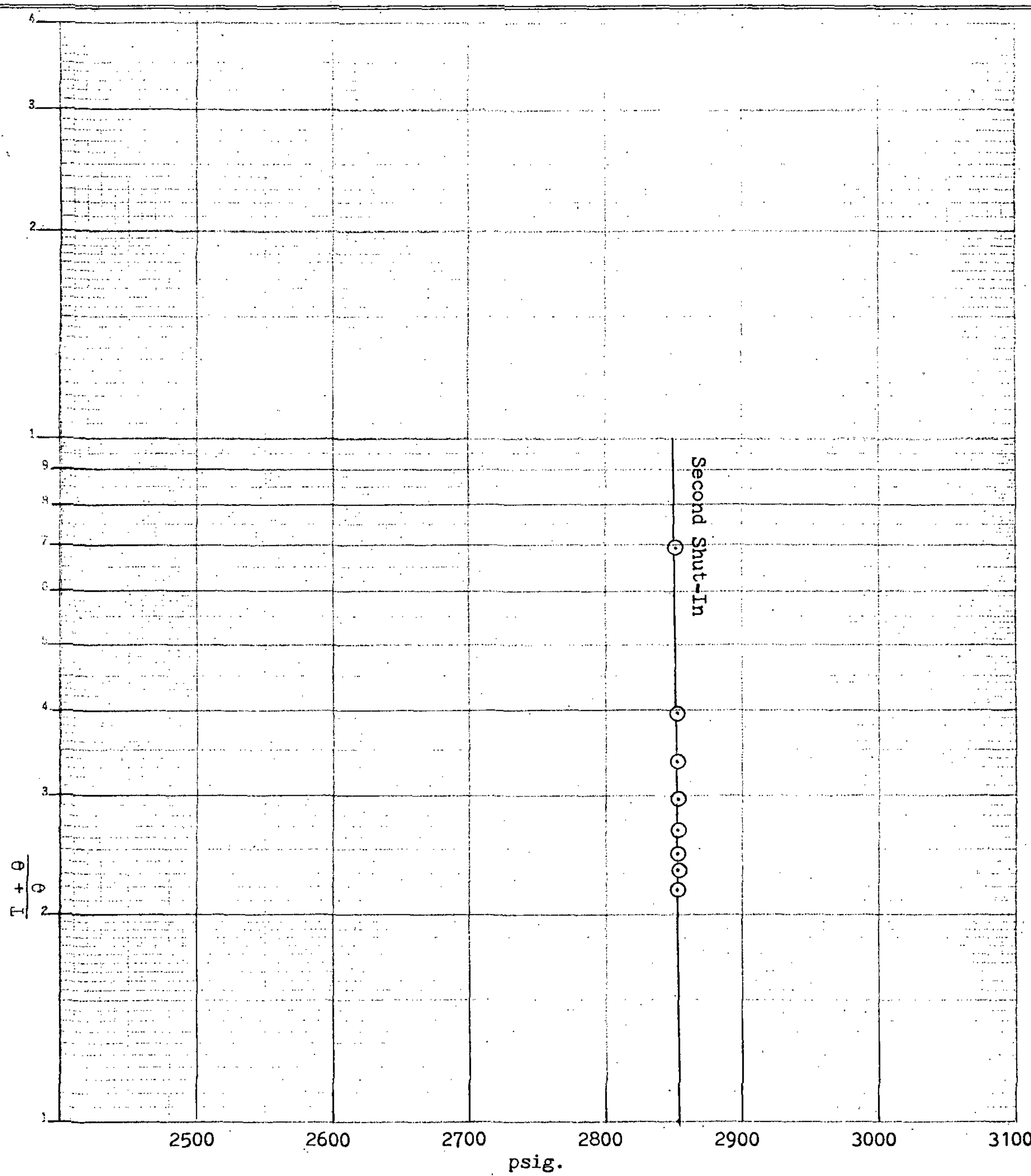
Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 7



LYNES, INC.

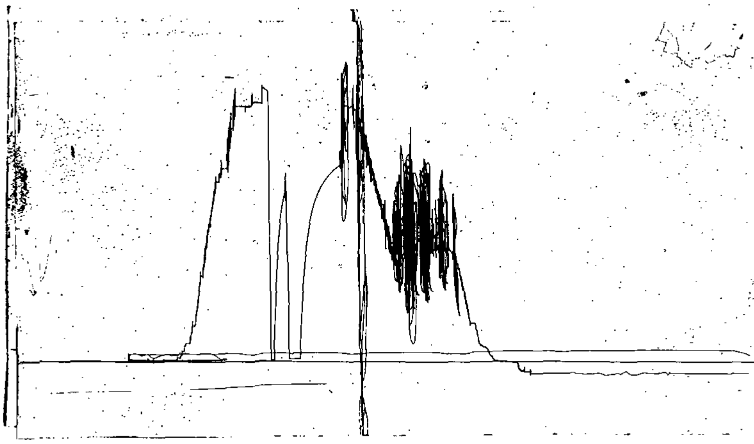
Pressure Extrapolation Plot

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 7



LYNES, INC.

Operator: United States Geological Survey Lease & No.: Madison Limestone Test Well #3 DST No.: 8

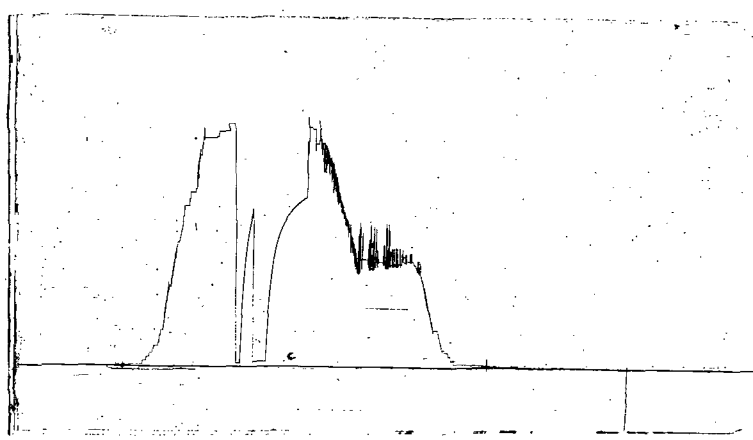


Inside Recorder

PRD Make: Kuster K-3

No. 13641 Cap. 4450 @ 5412'

Press		Corrected
Initial Hydrostatic	A	3280
Final Hydrostatic	K	3040
Initial Flow	B	50
Final Initial Flow	C	45
Initial Shut-in	D	2074
Second Initial Flow	E	55
Second Final Flow	F	60
Second Shut-in	G	2395
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		



Outside Recorder

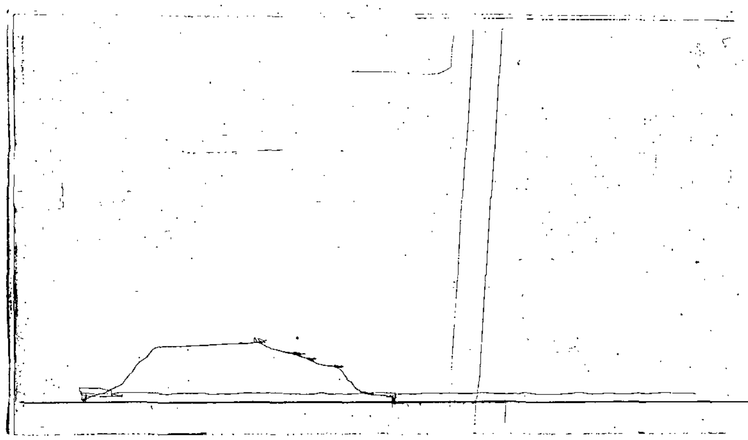
PRD Make: Kuster K-3

No. 5155 Cap. 5000 @ 5458'

Press		Corrected
Initial Hydrostatic	A	3303
Final Hydrostatic	K	3065
Initial Flow	B	74
Final Initial Flow	C	74
Initial Shut-in	D	2081
Second Initial Flow	E	92
Second Final Flow	F	92
Second Shut-in	G	2410
Third Initial Flow	H	--
Third Final Flow	I	--
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 8



Outside Recorder

PRD Make: Kuster K-3

No. 12355 Cap. 35-249 @ 5458'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum Temperature		124 °F
Pressure Below Bottom Packer Bled To		

PRD Make

No. Cap. @

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

REPORT #1475

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 8

RECORDER NUMBER - 16445

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	50
4.0	3.5000	525
8.0	2.2500	776
12.0	1.8333	986
16.0	1.6250	1153
20.0	1.5000	1302
24.0	1.4167	1427
28.0	1.3571	1538
32.0	1.3125	1630
36.0	1.2778	1718
40.0	1.2500	1797
44.0	1.2273	1864
48.0	1.2083	1928
52.0	1.1923	1983
56.0	1.1786	2032
60.0	1.1667	2079

LYNES INC.

REPORT #1475

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 8

RECORDER NUMBER - 16445

SECOND SHUT IN PRESSURE

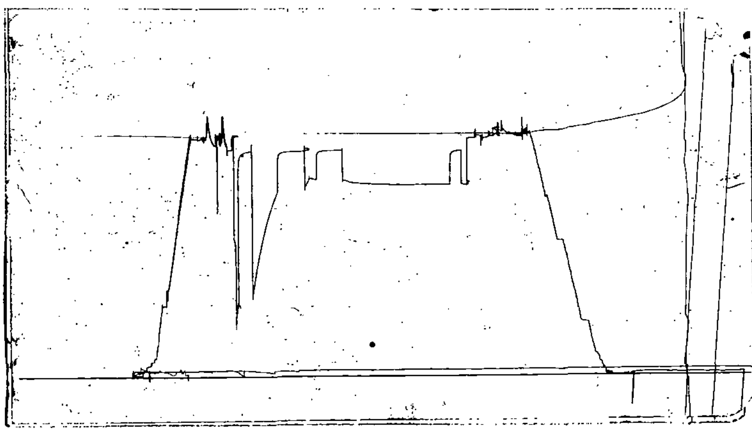
TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	72
6.0	7.6667	951
12.0	4.3333	1322
18.0	3.2222	1564
24.0	2.6667	1738
30.0	2.3333	1881
36.0	2.1111	1991
42.0	1.9524	2075
48.0	1.8333	2142
54.0	1.7407	2198
60.0	1.6667	2247
66.0	1.6061	2290
72.0	1.5556	2327
78.0	1.5128	2357
84.0	1.4762	2385
90.0	1.4444	2408

FITTED LINE: LOG((TO+PHI)/PHI) = -.00039 PSIG + 1.10249

EXTRAPOLATION OF SECOND SHUT IN = 2815.89 M = 2554.12

LYNES, INC.

Operator United States Geological Survey — Lease & No. Madison Limestone Test Well #3 — DST No. 9

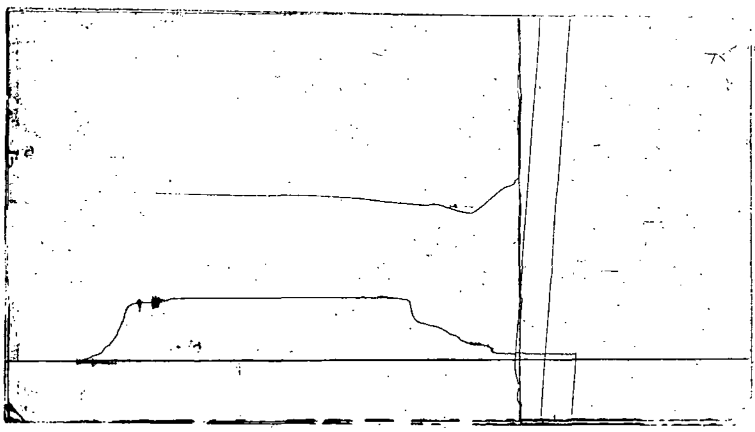


Inside Recorder

PRD Make Kuster K-3

No. 13641 Cap. 4450 @ 5212'

Press		Corrected
Initial Hydrostatic	A	2903
Final Hydrostatic	K	2898
Initial Flow	B	566
Final Initial Flow	C	922
Initial Shut-in	D	2726
Second Initial Flow	E	926
Second Final Flow	F	2234
Second Shut-in	G	2730
Third Initial Flow	H	2255
Third Final Flow	I	2377
Third Shut-in	J	2731
Fourth Initial Flow		2373
Fourth Final Flow		2312
Pressure Below Bottom Packer Bled To		



Outside Recorder

PRD Make Kuster K-3 T

No. 12355 Cap. 35-249 @ 5258'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum Temperature		129.7
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Sampler Report

Company: United States Geological Survey — Date: 11-26-78

Well Name & No.: Madison Limestone Test WEll #3 — Ticket No.: 16525

County: Yellowstone — State: Montana

Test Interval: 5250-5440' — DST No.: 9

Total Volume of Sampler: 2000 cc.

Total Volume of Sample: 1960 cc.

Pressure in Sampler: 1930 psig

Oil: None cc.

Water: 1960 cc.

Mud: None cc.

Gas: Trace cu. ft.

Other: None

R.W. 2.2 @ 60°F = 3,000 ppm. chl.

Resistivity

Make Up Water 10.0 @ 60°F of Chloride Content 550 ppm.

Mud Pit Sample 6.6 @ 70°F of Chloride Content 800 ppm.

Gas/Oil Ratio ______ Gravity ______ °API @ ______ °F

Where was sample drained On location.

Remarks:

Form 5

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 9

Comments relative to the analysis of the pressure chart from DST #9, Interval: 5250-5440', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

For purposes of this analysis, the following reservoir and fluid properties and test parameters have been used:

BHT = 129.7°F., μ = 1.0 cp., h = 50 feet, t = 82 minutes,
m = 11 psi/log cycle.

1. Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2750 psi at the recorder depth of 5258 feet. Extrapolation of the Second Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2752 psi. Extrapolation of the Final Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2745 psi. The maximum difference between the extrapolated shut-in pressures (7 psi) is considered insignificant.

   The indicated maximum reservoir pressure at the recorder depth is equivalent to a subsurface pressure gradient of 0.523 psi/ft. This pressure gradient is anomalously high compared to a "normal" hydrostatic pressure gradient; however, it is in reasonably close agreement with the datum pressures which have been found to be present in the other Paleozoic reservoirs which were drill-stem tested in this same well.

2. The calculated Average Production Rate which was used in this analysis, 1256.1 BPD, is based upon a full fill-up of water in the pipe (71.5 barrels) and an effective flowing time of 82 minutes (the total elapsed flowing time at which fluid reached the surface).

3. The calculated Damage Ratio of 6.3 indicates that significant well-bore damage was present at the time of this formation test. The character of the pressure record and the magnitude of the flow rate that occurred during this test suggest, however, that the indicated well-bore damage may be due to restrictions within the test tool rather than being due to formation damage.

Form 2

4. The calculated Effective Transmissibility of 18974.1 md.-ft./cp. indicates an Average Permeability to the produced fluid of 379.5 md. for the estimated 50 feet of effective porosity within the total 190 feet of interval tested.

5. The evaluation criteria used in the Drill-Stem-Test Analysis System indicate that the results obtained in this analysis should be reliable within reasonable limits relative to the assumptions which have been made.

Roger L. Hoeger
Roger L. Hoeger
Consultant to Lynes, Inc.

LYNES INC.

REPORT #1484

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 9

RECORDER NUMBER - 16445

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	937
3.0	4.3333	2526
6.0	2.6667	2668
9.0	2.1111	2696
12.0	1.8333	2708
15.0	1.6667	2717
18.0	1.5556	2723
21.0	1.4762	2726
24.0	1.4167	2728
27.0	1.3704	2730
30.0	1.3333	2732

EXTRAPOLATION OF FIRST SHUT IN = 2749.56

LYNES INC.

REPORT #1484

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 9

RECORDER NUMBER - 16445

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2251
6.0	12.6667	2713
12.0	6.8333	2725
18.0	4.8889	2728
24.0	3.9167	2731
30.0	3.3333	2733
36.0	2.9444	2735
42.0	2.6667	2737
48.0	2.4583	2738
54.0	2.2963	2739
60.0	2.1667	2740

EXTRAPOLATION OF SECOND SHUT IN = 2752.17

LYNES INC.

REPORT #1484

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 9

RECORDER NUMBER - 16445

THIRD SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2376
6.0	17.6667	2723
12.0	9.3333	2730
18.0	6.5556	2734
24.0	5.1667	2736
30.0	4.3333	2737
36.0	3.7778	2738
42.0	3.3810	2739
48.0	3.0833	2740
54.0	2.8519	2740
60.0	2.6667	2740

FITTED LINE: LOG((TO+PHI)/PHI) = -.09290 PSIG + 254.97226

EXTRAPOLATION OF THIRD SHUT IN = 2744.58 M = 10.76

RESERVOIR PARAMETERS:

COLLAR RECOV	281.000	PIPE RECOVRY	4969.000	INIT FLO TIM	10.000
FINL FLO TIM	30.000	MUD EXPANSN	1.000	BOTTM HOL TM	129.700
API GRAVITY	10.000	SPEC GRAVITY	1.000	VISCOSITY	1.000
PAY THICKNES	50.000	SUBSEA DEPTH	-2218.200	WATER GRADNT	.433

LYNES INC.

REPORT #1484

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 9

RECORDER NUMBER - 16445

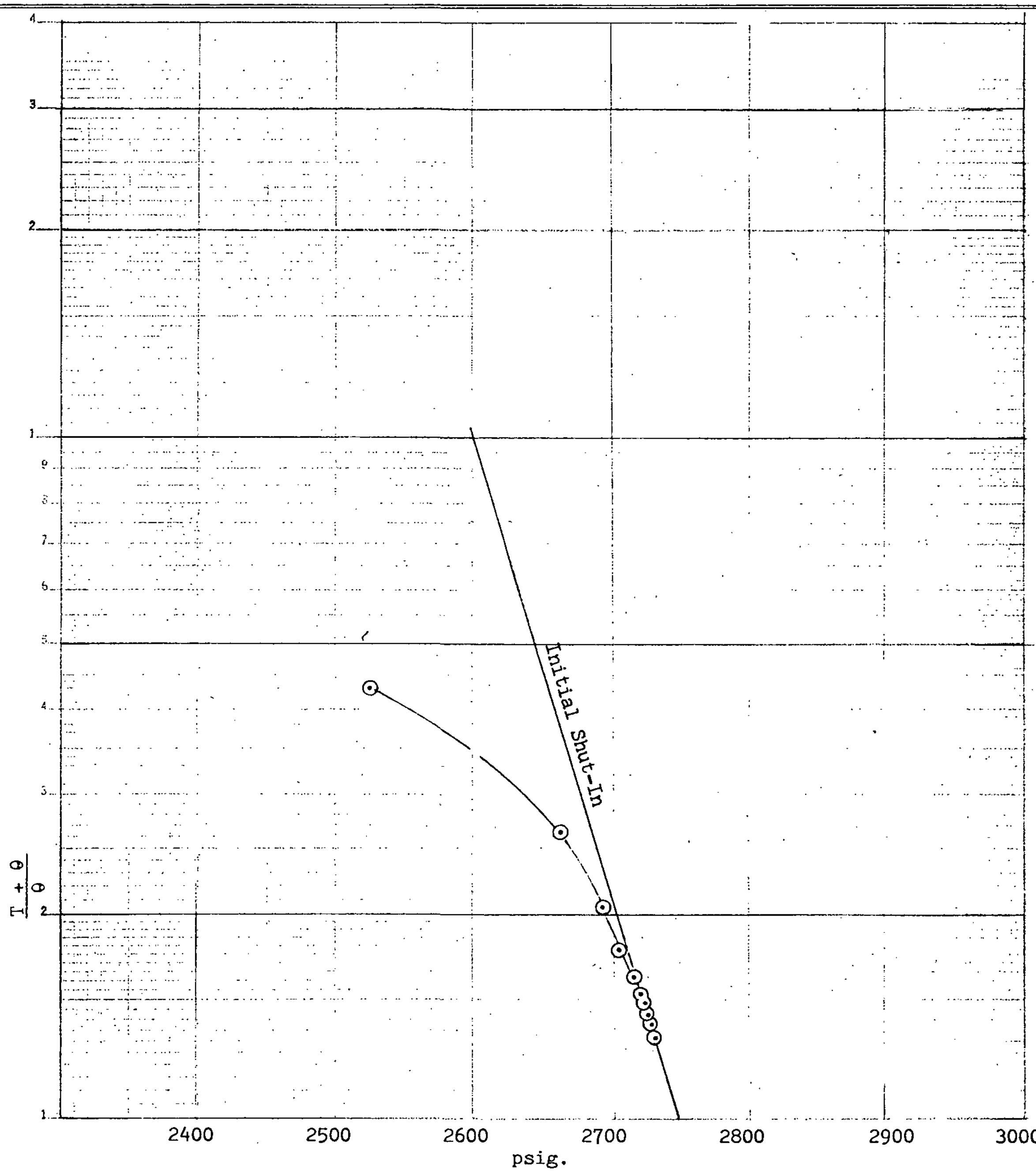
CALCULATIONS: THIRD SHUT IN

EXTRAPOLATED RESERVOIR PRESS.(PSIG)	2744.6
NO. OF POINTS ENTERED.................................	11.0
NO. OF POINTS USED IN EXTRAPOLATION	6.0
ROOT MEAN SQUARE DEVIATION OF BEST FIT LINE(PSI) .	.046
TOTAL FLOW TIME(MIN)	100.0
AVERAGE PRODUCTION RATE DURING TEST(BBLS/DAY)	1256.1
TRANSMISSIBILITY(MD-FT/CP)	18974.1
IN SITU CAPACITY(MD-FT)	18974.1
AVERAGE EFFECTIVE PERMEABILITY(MD)	379.48
PRODUCTIVITY INDEX(BBLS/DAY-PSI)	3.408
DAMAGE RATIO	6.3
PRODUCTIVITY INDEX WITH DAMAGE REMOVED(BBLS/DAY-PSI) ...	21.355
RADIUS OF INVESTIGATION(FT)	194.8
DRAWDOWN FACTOR(%)	.2
POTENTIOMETRIC SURFACE(FT)	4120.3

LYNES, INC.

Pressure Extrapolation Plot

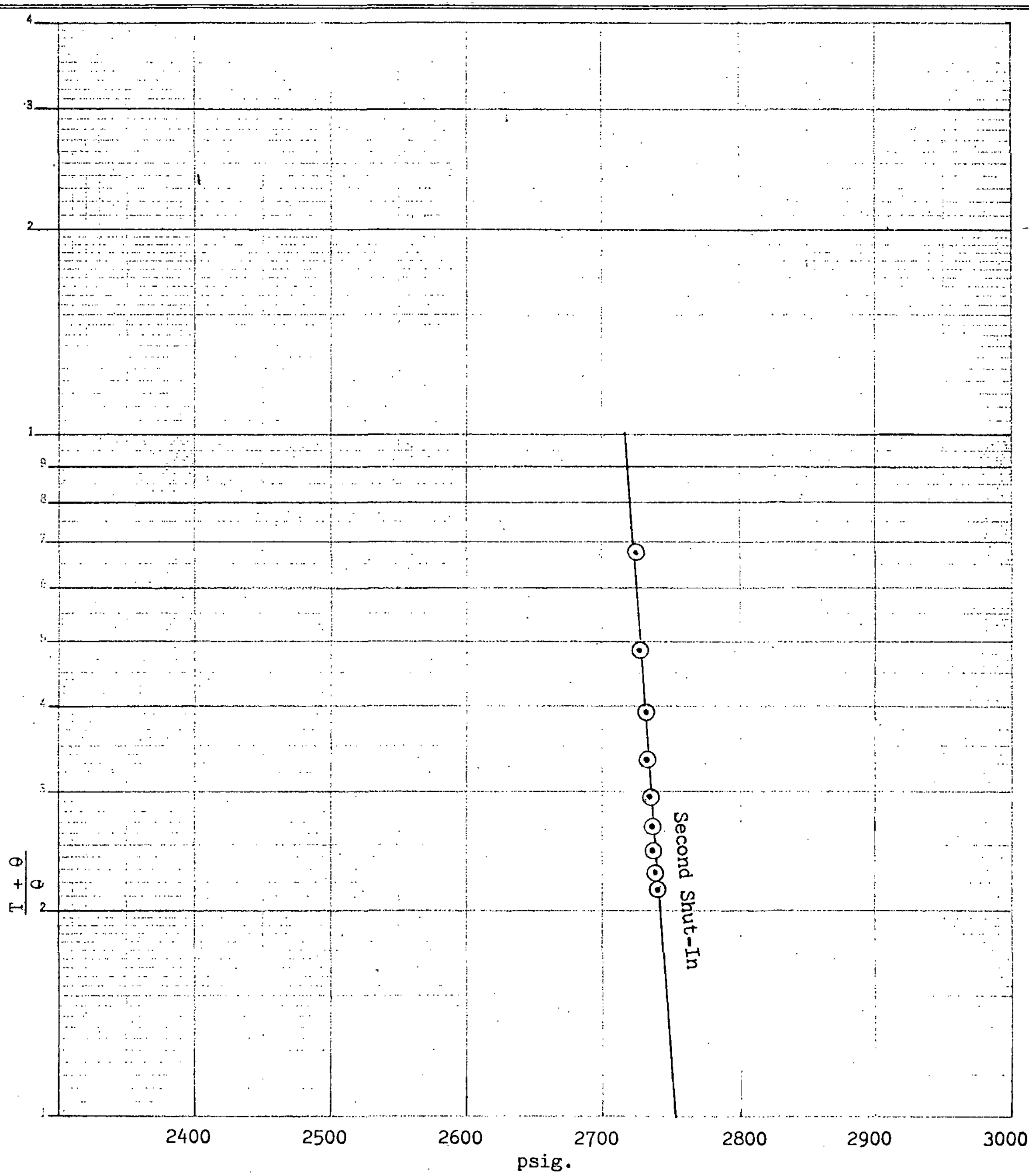
Operator: United States Geological Survey   Lease & No.: Madison Limestone Test Well #3   DST No. 9



LYNES, INC.

Pressure Extrapolation Plot

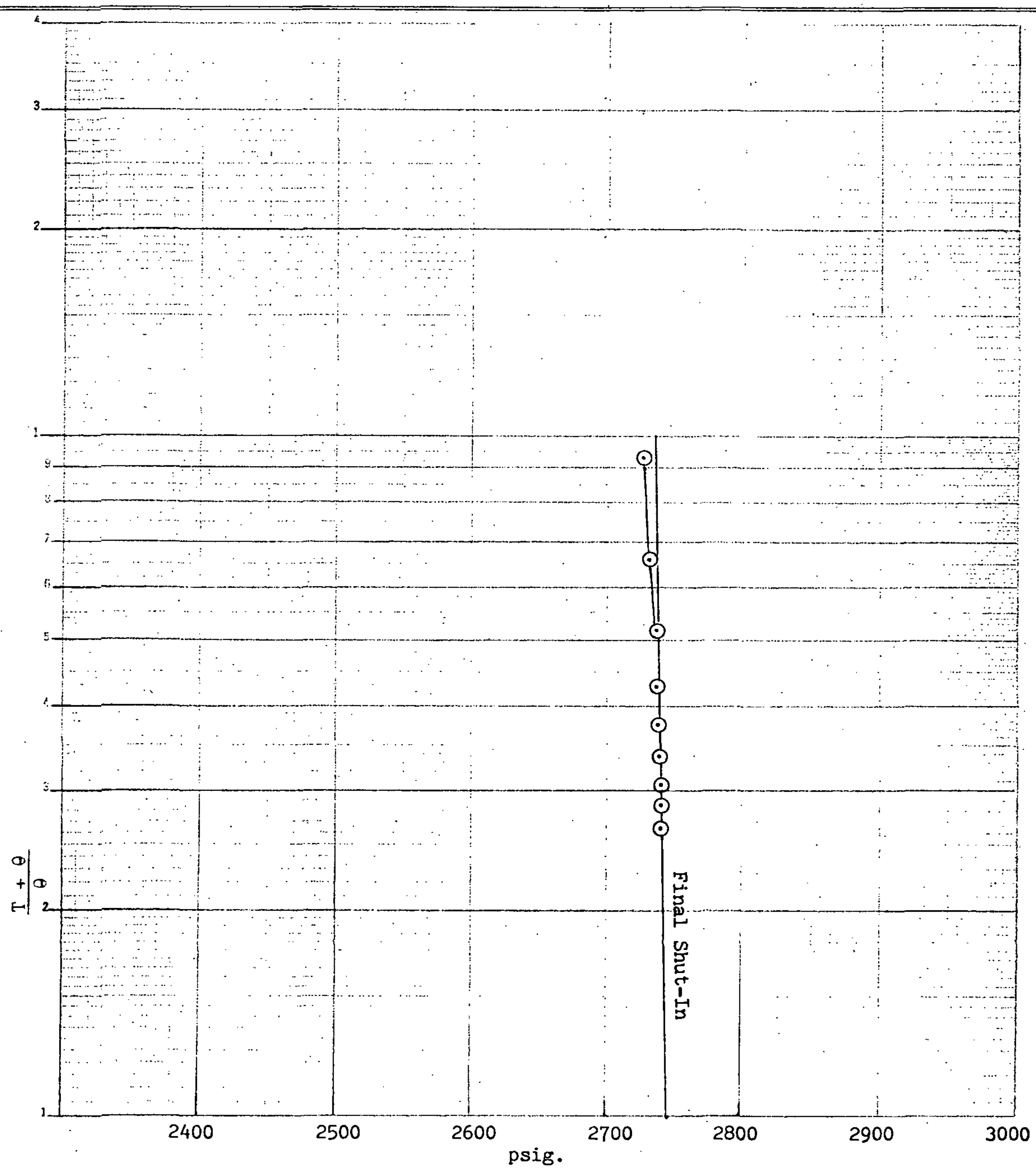
Operator: United States Geological Survey   Lease & No.: Madison Limestone Test Well #3   DST No.: 9



LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 9



Phone
522-1206 Area 303

LYNES, INC.

Box 3600
Sterling, Colo. 80751

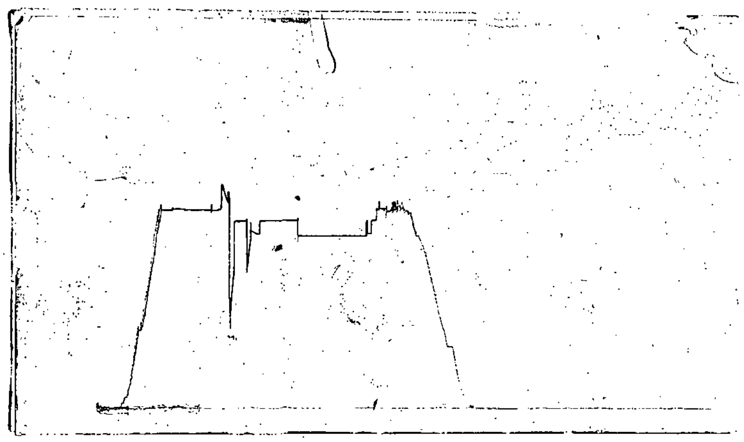
Operator: United States Geological Survey
Address: See Distribution
Well Name and No.: Madison Limestone Test Well #3
Ticket No.: 16452
Date: 11-27-78
DST No.: 10
No. Final Copies: 5

Contractor	Molen Drlg. Co., Inc.	Top Choke	1"
Rig No.	4	Bottom Choke	9/16"
Spot	SE-NE	Size Hole	8 3/4"
Sec.	35	Size Rat Hole	--
Twp.	2 N	Size & Wt. D. P.	4 1/2" 16.60
Rng.	27 E	Size Wt. Pipe	120'
Field	Wildcat	I. D. of D. C.	2 1/2"
County	Yellowstone	Length of D. C.	281'
State	Montana	Total Depth	7196'
Elevation	3039.8' "K.B."	Interval Tested	4798-4988'
Formation	Mission Canyon	Type of Test	Inflate Straddle

Flow No. 1	10	Min.
Shut-in No. 1	30	Min.
Flow No. 2	30	Min.
Shut-in No. 2	90	Min.
Flow No. 3	180	Min.
Shut-in No. 3	--	Min.

Bottom Hole Temp. 122.6°F
Mud Weight 10.8
Gravity --
Viscosity 55

Tool opened @ 3:40 PM.



Outside Recorder
PRD Make Kuster K-3
No. 5155 Cap. 5000 @ 4806'

Press		Corrected
Initial Hydrostatic	A	2678
Final Hydrostatic	K	2678
Initial Flow	B	1088
Final Initial Flow	C	1849
Initial Shut-in	D	2536
Second Initial Flow	E	1849
Second Final Flow	F	2360
Second Shut-in	G	2536
Third Initial Flow	H	2326
Third Final Flow	I	2326
Third Shut-in	J	--

Lynes Dist.: Billings, MT.
Our Tester: Jack Rescoe
Witnessed By: --

Did Well Flow – Gas No Oil No Water Yes

RECOVERY IN PIPE: Test was reverse circulated.

REMARKS:

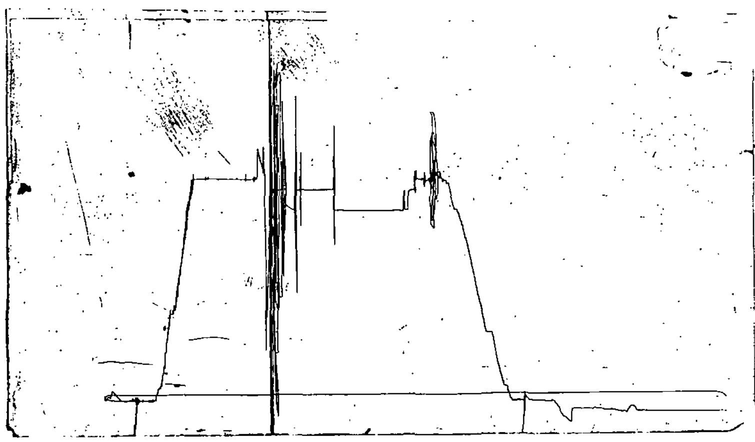
1st Flow - Tool opened with a strong blow, increased to bottom of bucket in 1 minute and remained thru flow period.

2nd Flow - Tool opened with a strong blow, fluid to surface in 9 minutes.

3rd Flow - Tool opened with fluid to surface.

LYNES, INC.

Operator United States Geological Survey   Lease & No. Madison Limestone Test Well #3   DST No. 10



Inside Recorder

PRD Make Kuster K-3

No. 13641 Cap. 4450 @ 4767'

Press		Corrected
Initial Hydrostatic	A	2651
Final Hydrostatic	K	2651
Initial Flow	B	1060
Final Initial Flow	C	*
Initial Shut-in	D	2525
Second Initial Flow	E	*
Second Final Flow	F	*
Second Shut-in	G	2525
Third Initial Flow	H	2296
Third Final Flow	I	2296
Third Shut-in	J	--
*Unreadable		
Pressure Below Bottom Packer Bled To		

Outside Recorder

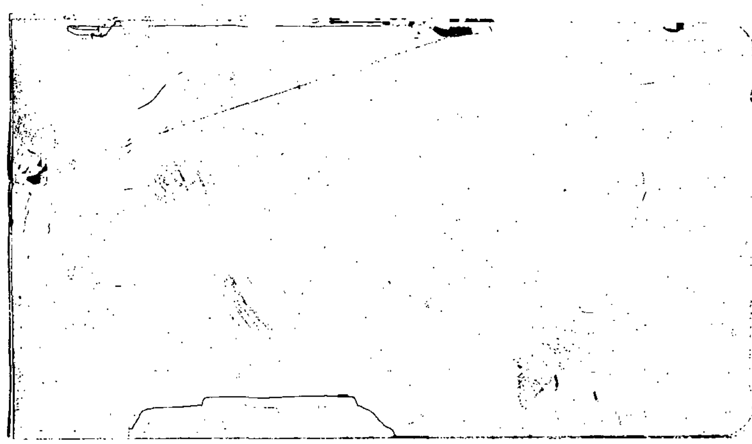
PRD Make Kuster K-3

No. 16445 Cap. 4500 @ 4806'

Press		Corrected
Initial Hydrostatic	A	2672
Final Hydrostatic	K	2672
Initial Flow	B	1078
Final Initial Flow	C	1822
Initial Shut-in	D	2530
Second Initial Flow	E	1822
Second Final Flow	F	2335
Second Shut-in	G	2530
Third Initial Flow	H	2317
Third Final Flow	I	2317
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Operator: United States Geological Survey — Lease & No.: Madison Limestone Test Well #3 — DST No. 10



Outside Recorder

PRD Make: Kuster K-3T
No. 12355 Cap. 35-249 @ 4806'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum temperature		122.6
Pressure Below Bottom Packer Bled To		

PRD Make
No. Cap. @

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

LYNES INC.

REPORT #1477

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 10

RECORDER NUMBER - 5155

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	1849
3.0	4.3333	2529
6.0	2.6667	2533
9.0	2.1111	2536
12.0	1.8333	2536
15.0	1.6667	2536
18.0	1.5556	2536
21.0	1.4762	2536
24.0	1.4167	2536
27.0	1.3704	2536
30.0	1.3333	2536

EXTRAPOLATION OF FIRST SHUT IN = 2536.03

LYNES INC.

REPORT #1477

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 10

RECORDER NUMBER - 5155

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2360
9.0	5.4444	2536
18.0	3.2222	2536
27.0	2.4815	2536
36.0	2.1111	2536
45.0	1.8889	2536
54.0	1.7407	2536
63.0	1.6349	2536
72.0	1.5556	2536
81.0	1.4938	2536
90.0	1.4444	2536

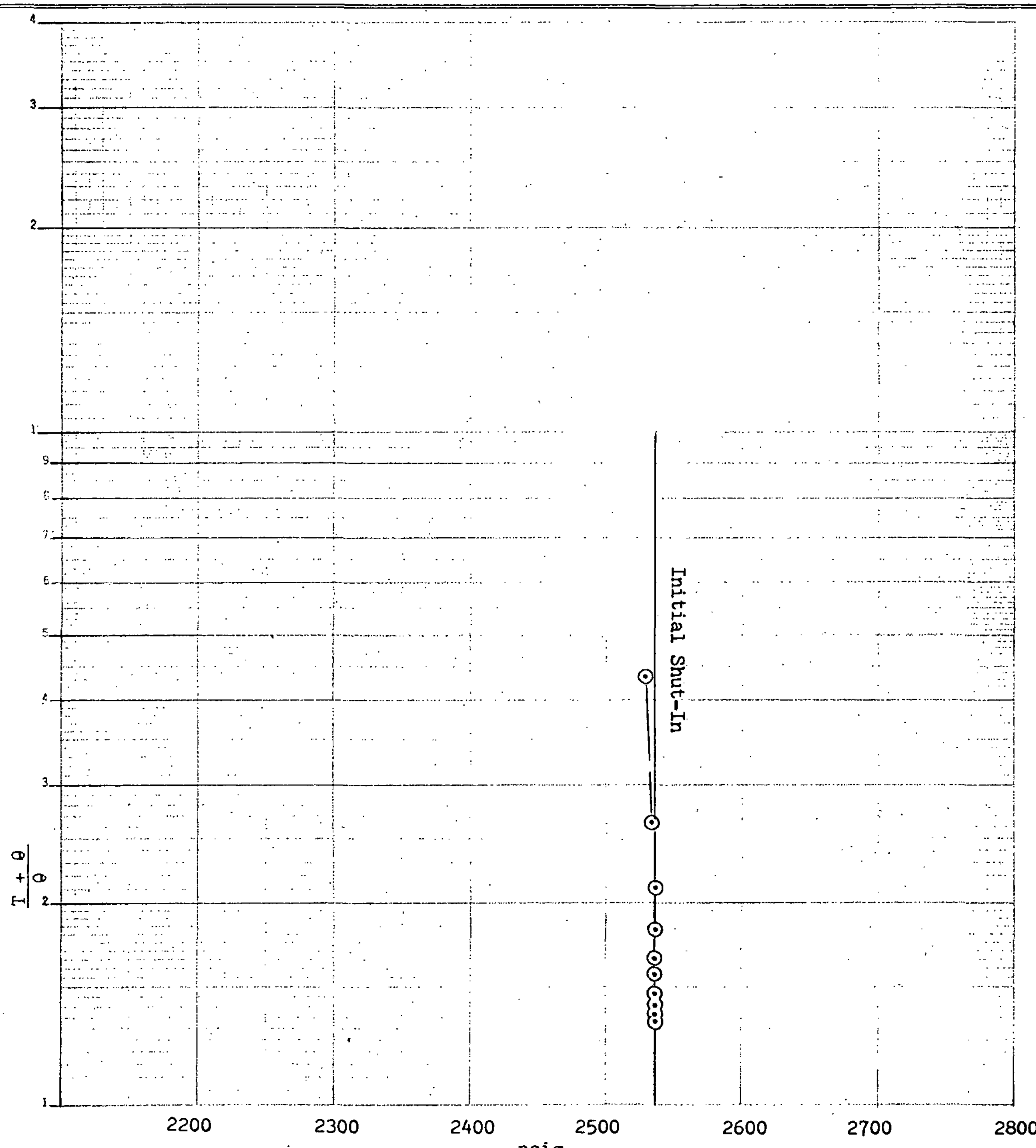
FITTED LINE: LOG((TO+PHI)/PHI) = -6.10546 PSIG + 15483.66797

EXTRAPOLATION OF SECOND SHUT IN = 2536.04 M = .16

LYNES, INC.

Pressure Extrapolation Plot

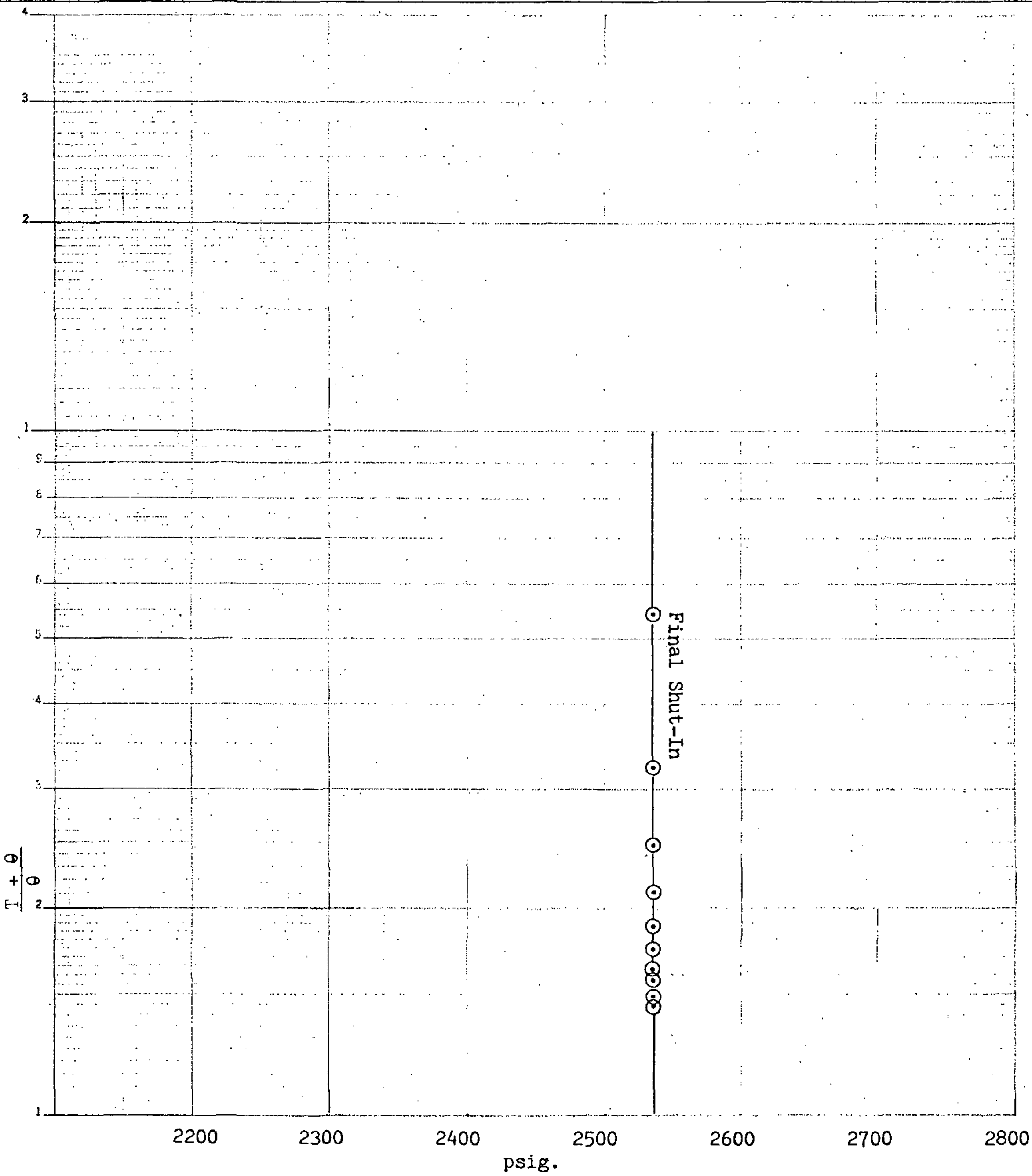
Operator: United States Geological Survey Lease & No.: Madison Limestone Test Well #3 DST No. 10



LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey
Lease & No.: Madison Limestone Test Well #3
DST. No.: 10



Phone
522-1206 Area 303

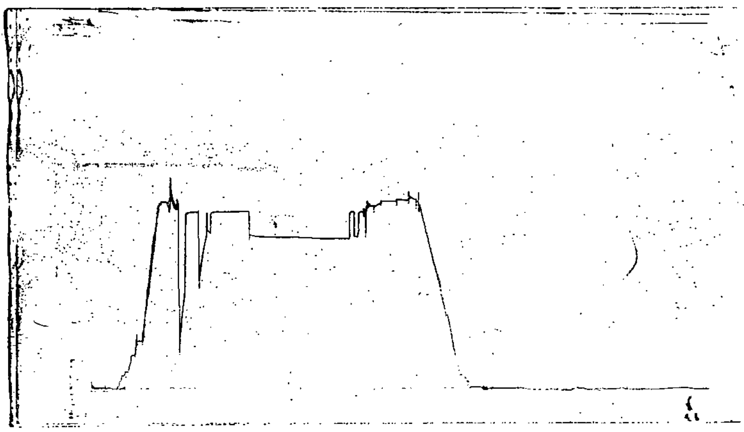
LYNES, INC.

Box 3600
Sterling, Colo. 80751

Contractor	Molen Drlg. Co., Inc.
Rig No.	4
Spot	SE-NE
Sec.	35
Twp.	2 N
Rng.	27 E
Field	Wildcat
County	Yellowstone
State	Montana
Elevation	3039.8' "K.B."
Formation	Mission Canyon

Top Choke	1"
Bottom Choke	9/16"
Size Hole	8 3/4"
Size Rat Hole	--
Size & Wt. D. P.	4 1/2" 16.60
Size Wt. Pipe	150'
I. D. of D. C.	2 1/2"
Length of D. C.	281'
Total Depth	7196'
Interval Tested	4598-4788'
Type of Test	Inflate Straddle

Flow No. 1	15 Min.
Shut-in No. 1	30 Min.
Flow No. 2	30 Min.
Shut-in No. 2	90 Min.
Flow No. 3	270 Min.
Shut-in No. 3	-- Min.
Bottom Hole Temp.	113.4°F
Mud Weight	10.8
Gravity	--
Viscosity	48
Tool opened @	6:35 AM.



Outside Recorder

PRD Make Kuster K-3
No. 5155 Cap. 5000 @ 4606'

Press		Corrected
Initial Hydrostatic	A	2563
Final Hydrostatic	K	2563
Initial Flow	B	477
Final Initial Flow	C	1344
Initial Shut-in	D	2405
Second Initial Flow	E	1386
Second Final Flow	F	2117
Second Shut-in	G	2409
Third Initial Flow	H	2103
Third Final Flow	I	2048
Third Shut-in	J	--

Lynes Dist.: Billings, Mt.
Our Tester: Gene Braley
Witnessed By: --

Did Well Flow – Gas No Oil No Water Yes

RECOVERY IN PIPE: Test was reverse circulated.

1st Flow - Tool opened with a strong blow to bottom of bucket immediately and remained thru flow period.

2nd Flow - Tool opened with a strong blow, fluid to surface in 20 minutes.

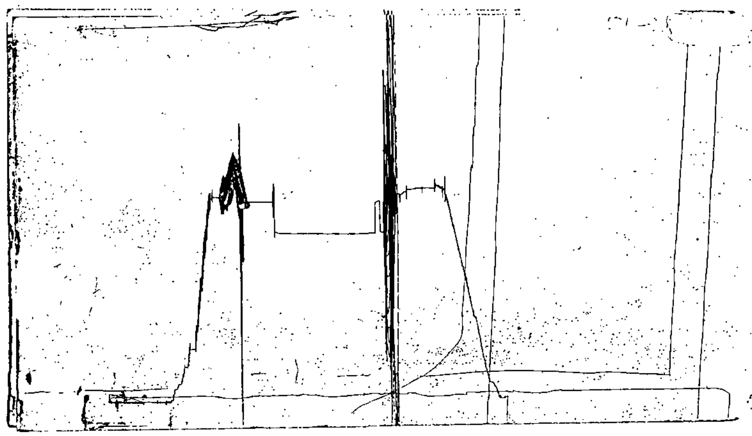
REMARKS:

3rd Flow - Tool opened with fluid to surface.

Operator: United States Geological Survey
Address: See Distribution
Well Name and No.: Madison Limestone Test Well #3
Ticket No.: 16453
Date: 11-28-78
DST No.: 11
No. Final Copies: 5

LYNES, INC.

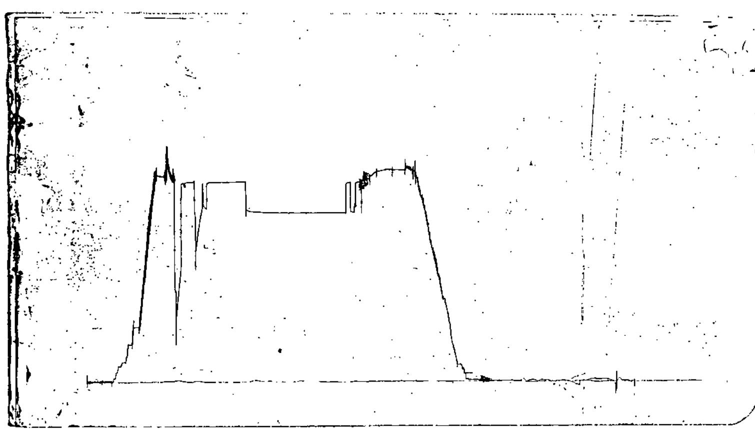
Operator: United States Geological Survey Lease & No.: Madison Limestone Test Well #3 DST No.: 11



Inside Recorder

PRD Make: Kuster K-3
No. 13641 Cap. 4450 @ 4567'

Press		Corrected
Initial Hydrostatic	A	**
Final Hydrostatic	K	**
Initial Flow	B	**
Final Initial Flow	C	**
Initial Shut-in	D	**
Second Initial Flow	E	**
Second Final Flow	F	**
Second Shut-in	G	2393
Third Initial Flow	H	2075
Third Final Flow	I	2040
Third Shut-in	J	--
Unreadable	**	
Pressure Below Bottom Packer Bled To		



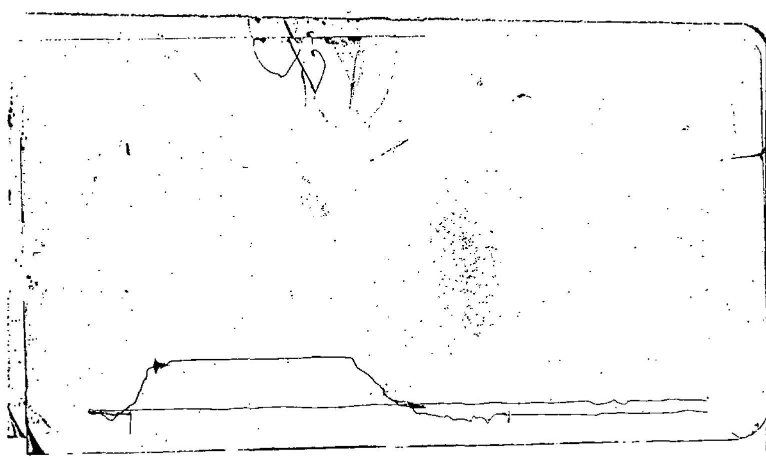
Outside Recorder

PRD Make: Kuster K-3
No. 16445 Cap. 4500 @ 4606'

Press		Corrected
Initial Hydrostatic	A	2553
Final Hydrostatic	K	2553
Initial Flow	B	469
Final Initial Flow	C	1336
Initial Shut-in	D	2401
Second Initial Flow	E	2108
Second Final Flow	F	2109
Second Shut-in	G	2403
Third Initial Flow	H	2094
Third Final Flow	I	2059
Third Shut-in	J	--
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 11



Outside Recorder
PRD Make Kuster K-3T
No. 12355 Cap. 35-249 @ 4606'

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Maximum Temperature		113.4
Pressure Below Bottom Packer Bled To		

PRD Make
No. Cap. @

Press		Corrected
Initial Hydrostatic	A	
Final Hydrostatic	K	
Initial Flow	B	
Final Initial Flow	C	
Initial Shut-in	D	
Second Initial Flow	E	
Second Final Flow	F	
Second Shut-in	G	
Third Initial Flow	H	
Third Final Flow	I	
Third Shut-in	J	
Pressure Below Bottom Packer Bled To		

LYNES, INC.

Fluid Sample Report

Company: United States Geological Survey — Date: 11-28-78

Well Name & No.: Madison Limestone Test Well #3 — Ticket No.: 16453

County: Yellowstone — State: Montana

Test Interval: 4598-4788' — DST No.: 11

Total Volume of Sampler: 2000 cc.

Total Volume of Sample: 1940 cc.

Pressure in Sampler: 1890 psig

Oil: None cc.

Water: 1940 cc.

Mud: None cc.

Gas: Trace cu. ft.

Other: None

R.W. 3.4 @ 90°F = 1,250 ppm. chl.

Resistivity

Make Up Water 10.0 @ 69°F of Chloride Content 550 ppm.

Mud Pit Sample 6.6 @ 70°F of Chloride Content 800 ppm.

Gas/Oil Ratio ______ Gravity ______ $^{\circ}$API @ ______ $^{\circ}$F

Where was sample drained On location.

Remarks:

FORM 5

LYNES, INC.

Operator United States Geological Survey | Lease & No. Madison Limestone Test Well #3 | DST No. 11

Comments relative to the analysis of the pressure chart from DST #11, Interval: 4598-4788', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

Extrapolation of the Initial Shut-in pressure build-up curve indicates a maximum reservoir pressure of 2407 psi at the recorder depth of 4606 feet. A maximum reservoir pressure of 2409 psi was recorded mechanically during the Final Shut-in period. The difference between the extrapolated Initial and Final Shut-in pressures (2 psi) is considered insignificant.

The condition of mechanical stabilization of the pressure recorder during the Final Shut-in period precludes the use of the Horner analysis method for calculating a numerical value for the transmissibility of the tested reservoir. It is obvious, however, on the basis of the character of the pressure record which was obtained in this test, plus the volume-rate of flow which was observed at the surface, that the transmissibility of the tested zone is excellent.

The indicated maximum reservoir pressure at the recorder depth is equivalent to a subsurface pressure gradient of 0.523 psi/ft. This pressure gradient, although anomalously high compared to a "normal" hydrostatic pressure gradient, is reasonably consistent with the subsurface pressure gradients which have been determined for other Paleozoic reservoirs which were drill-stem tested in this same well.

The calculated Average Production Rate which occurred during this test, 2550.9 BPD, is based upon a full fill-up of water in the pipe (62.0 barrels) in an effective flowing time of 35 minutes (the total elapsed flowing time at which fluid reached the surface).

The evaluation criteria used in the DST Analysis System indicate that the tools and recorder functioned properly; however, as noted above, because mechanical stabilization of the pressure recorder occurred throughout the majority of the 90-minute Final Shut-in period, it is not possible to calculate numerical values for the tested reservoir's transmissibility, permeability and damage ratio by the use of the Horner analysis method.

Roger L. Hoeger
Consultant to Lynes, Inc.

LYNES INC.

REPORT #1478

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 11

RECORDER NUMBER - 5155

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	1344
3.0	6.0000	2385
6.0	3.5000	2397
9.0	2.6667	2402
12.0	2.2500	2403
15.0	2.0000	2403
18.0	1.8333	2404
21.0	1.7143	2404
24.0	1.6250	2405
27.0	1.5556	2405
30.0	1.5000	2405

EXTRAPOLATION OF FIRST SHUT IN = 2407.20

LYNES INC.

REPORT #1478

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 11

RECORDER NUMBER - 5155

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2117
9.0	6.0000	2404
18.0	3.5000	2406
27.0	2.6667	2407
36.0	2.2500	2408
45.0	2.0000	2409
54.0	1.8333	2409
63.0	1.7143	2409
72.0	1.6250	2409
81.0	1.5556	2409
90.0	1.5000	2409

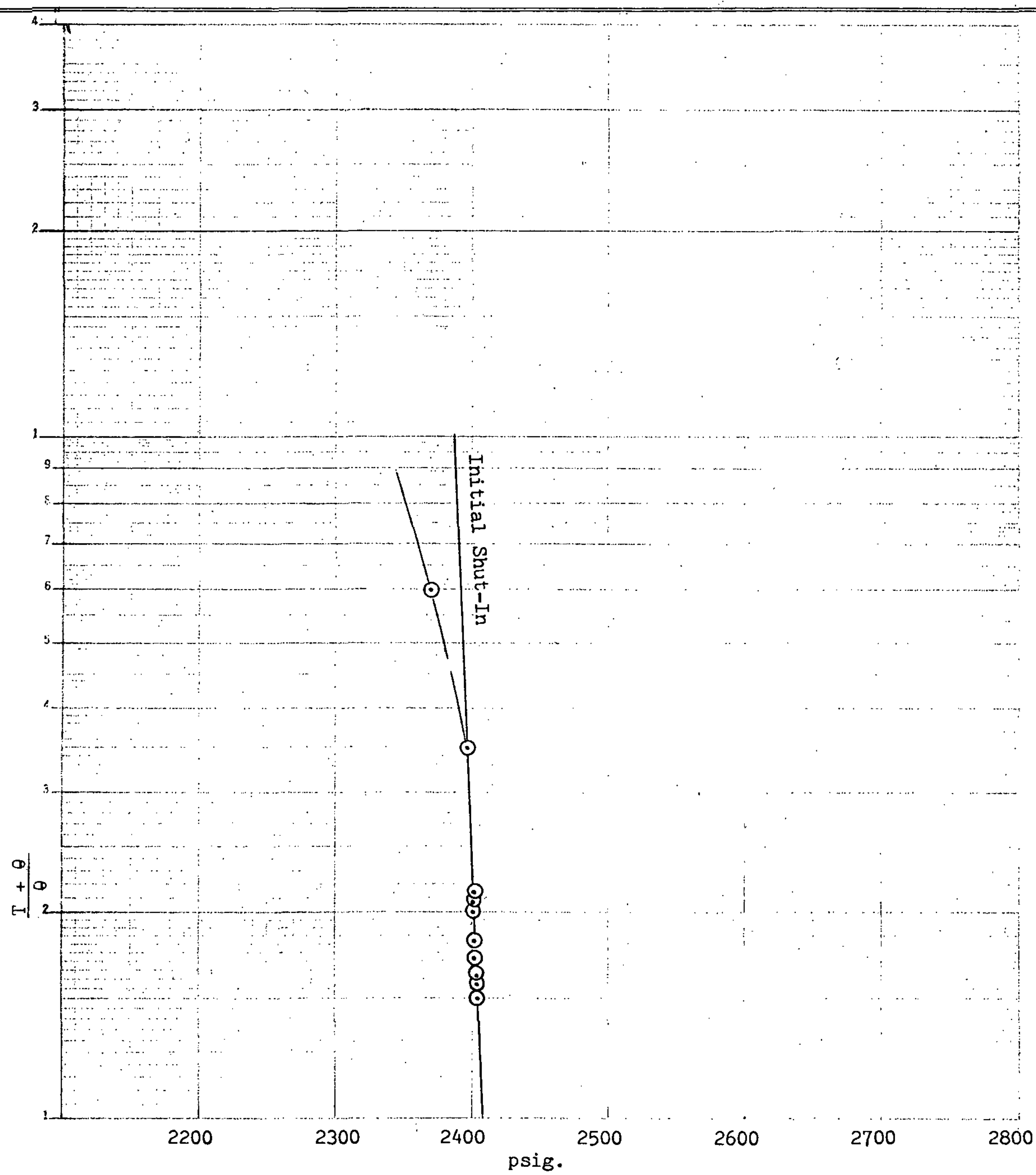
FITTED LINE: LOG((TO+PHI)/PHI) = -5.00987 PSIG + 12069.00195

EXTRAPOLATION OF SECOND SHUT IN = 2409.04 M = .20

LYNES, INC.

Pressure Extrapolation Plot

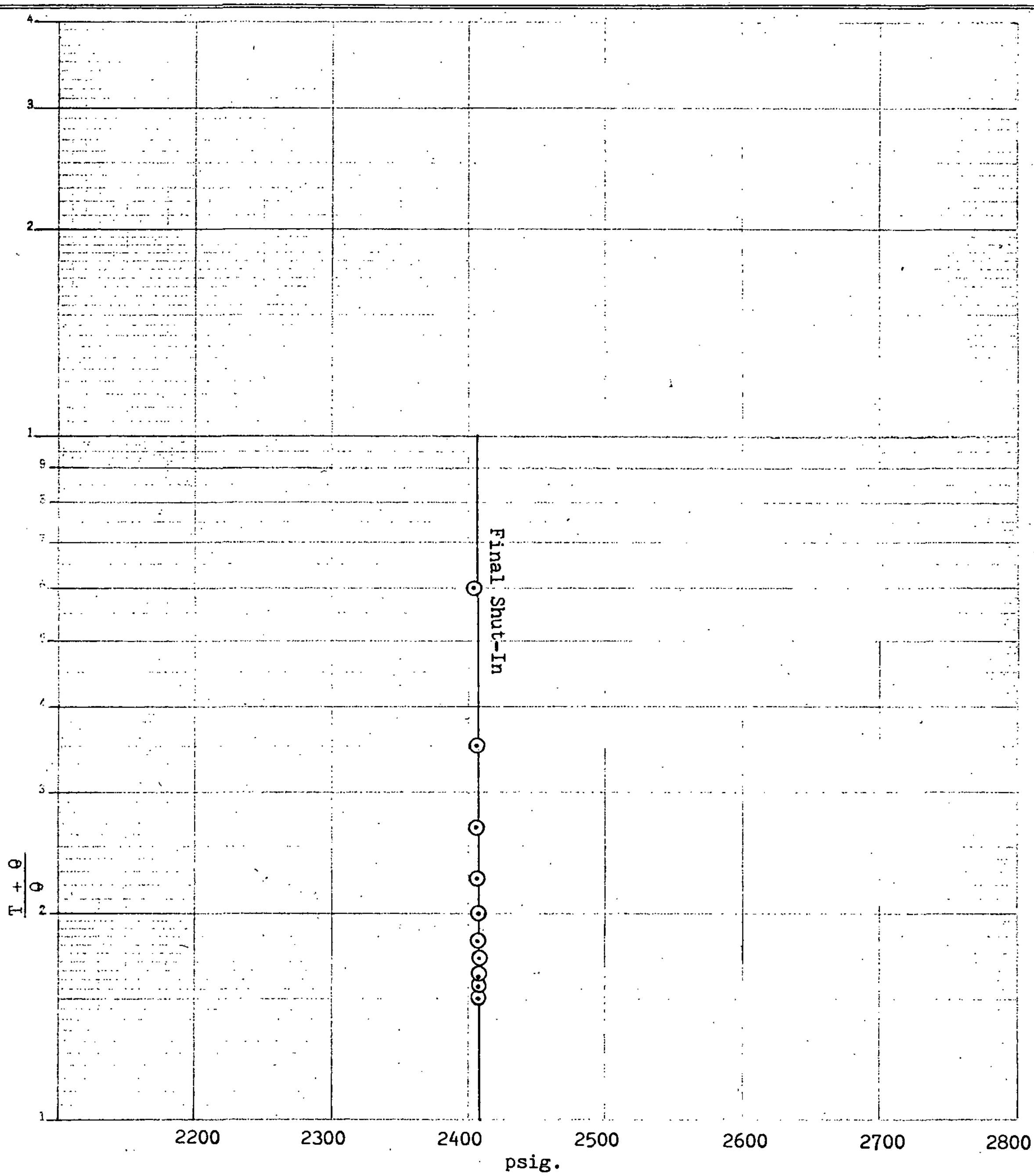
Operator: United States Geological Survey
Lease & No.: Madison Limestone Test Well #3
DST No. 11



LYNES, INC.

Pressure Extrapolation Plot

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 11



Phone
522-1206 Area 303

LYNES, INC.

Box 3600
Sterling, Colo. 80751

Operator: United States Geological Survey
Address: See Distribution
Well Name and No.: Madison Limestone Test Well #3
Ticket No.: 16454
Date: 11-28-78
DST No.: 12
No. Final Copies: 5

Contractor	Molen Drlg. Co., Inc.	Top Choke	1"
Rig No.	4	Bottom Choke	9/16"
Spot	SE-NE	Size Hole	8 3/4"
Sec.	35	Size Rat Hole	--
Twp.	2 N	Size & Wt. D. P.	4 1/2" 16.60
Rng.	27 E	Size Wt. Pipe	150'
Field	Wildcat	I. D. of D. C.	2 1/2"
County	Yellowstone	Length of D. C.	281'
State	Montana	Total Depth	7196'
Elevation	3039.8' "K.B."	Interval Tested	4302-4492'
Formation	Mission Canyon	Type of Test	Inflate Straddle

Flow No. 1	20	Min.
Shut-in No. 1	30	Min.
Flow No. 2	30	Min.
Shut-in No. 2	90	Min.
Flow No. 3	240	Min.
Shut-in No. 3	--	Min.

Bottom Hole Temp. 121.8°F
Mud Weight 10.8
Gravity --
Viscosity 47

Tool opened @ 12:45 PM.

Outside Recorder

PRD Make Kuster K-3
No. 16445 Cap. 4500 @ 4310'

Press		Corrected
Initial Hydrostatic	A	2325
Final Hydrostatic	K	2322
Initial Flow	B	2009
Final Initial Flow	C	2168
Initial Shut-in	D	2318
Second Initial Flow	E	2193
Second Final Flow	F	2239
Second Shut-in	G	2318
Third Initial Flow	H	2239
Third Final Flow	I	2239
Third Shut-in	J	--

Lynes Dist.: Billings, Mt.
Our Tester: Jack Rescoe
Witnessed By: --

Did Well Flow – Gas No Oil No Water Yes

RECOVERY IN PIPE: Test was reverse circulated.

REMARKS:

1st Flow - Tool opened with a strong blow to bottom of bucket immediately and remained thru flow period.

2nd Flow - Tool opened with a strong blow. Fluid to surface in 4 minutes.

3rd Flow - Tool opened with fluid to surface.

LYNES, INC.

Operator United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 12

Comments relative to the analysis of the pressure chart from DST #12, Interval: 4302-4492', which was run in the captioned well located in the NW SE Section 35, T2N-R27E, Yellowstone County, Montana:

A maximum reservoir pressure of 2318 psi was recorded mechanically during both shut-in periods. This maximum reservoir pressure at the recorder depth of 4310 feet is equivalent to a subsurface pressure gradient of 0.538 psi/ft. This pressure gradient, in turn, is anomalously high compared to a "normal" hydrostatic pressure gradient; however, it is reasonably consistent with the pressure gradients which have been determined for other Paleozoic reservoirs which were drill-stem tested in this same well.

Because of mechanical stabilization of the pressure recorders during the shut-in periods, it is not possible to use the Horner analysis method for calculating numerical values for the transmissibility and permeability of the tested reservoir. It is obvious, however, in view of the nature of the pressure record which was obtained in this test, plus the volume-rate of fluid flow which occurred, that the transmissibility of the tested zone is excellent.

The calculated Average Production Rate which occurred during this test, 3467.3 BPD, is based upon a full fill-up of water in the pipe (57.8 barrels) in an effective flowing time of 24 minutes (the total elapsed flowing time at which fluid reached the surface).

The evaluation criteria used in the DST Analysis System indicate that the tools and recorder functioned properly; however, as noted above, because mechanical stabilization of the pressure recorder occurred throughout the majority of both shut-in periods, it is not possible to calculate numerical values for the tested reservoir's transmissibility, permeability and damage ratio by the use of the Horner analysis method.

Roger L. Hoeger
Consultant to Lynes, Inc.

Form 2

LYNES INC.

REPORT #1479

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 12

RECORDER NUMBER - 16445

FIRST SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2168
3.0	7.6667	2310
6.0	4.3333	2312
9.0	3.2222	2316
12.0	2.6667	2317
15.0	2.3333	2318
18.0	2.1111	2318
21.0	1.9524	2318
24.0	1.8333	2318
27.0	1.7407	2318
30.0	1.6667	2318

EXTRAPOLATION OF FIRST SHUT IN = 2318.04

LYNES INC.

REPORT #1479

WELL NAME - MADISON LIMESTONE TEST WELL 3

WELL OPERATOR - UNITED STATES GEOLOGICAL SURVEY

DST NUMBER - 12

RECORDER NUMBER - 16445

SECOND SHUT IN PRESSURE

TIME(MIN) PHI	(T+PHI) /PHI	PSIG
.0	.0000	2239
9.0	6.5556	2316
18.0	3.7778	2317
27.0	2.8519	2318
36.0	2.3889	2318
45.0	2.1111	2318
54.0	1.9259	2318
63.0	1.7937	2318
72.0	1.6944	2318
81.0	1.6173	2318
90.0	1.5556	2318

FITTED LINE: LOG((TO+PHI)/PHI) = -6.98928 PSIG + 16201.41797

EXTRAPOLATION OF SECOND SHUT IN = 2318.04 M = .14

LYNES, INC.

Pressure Extrapolation Plot

Operator: United States Geological Survey Lease & No. Madison Limestone Test Well #3 DST No. 12

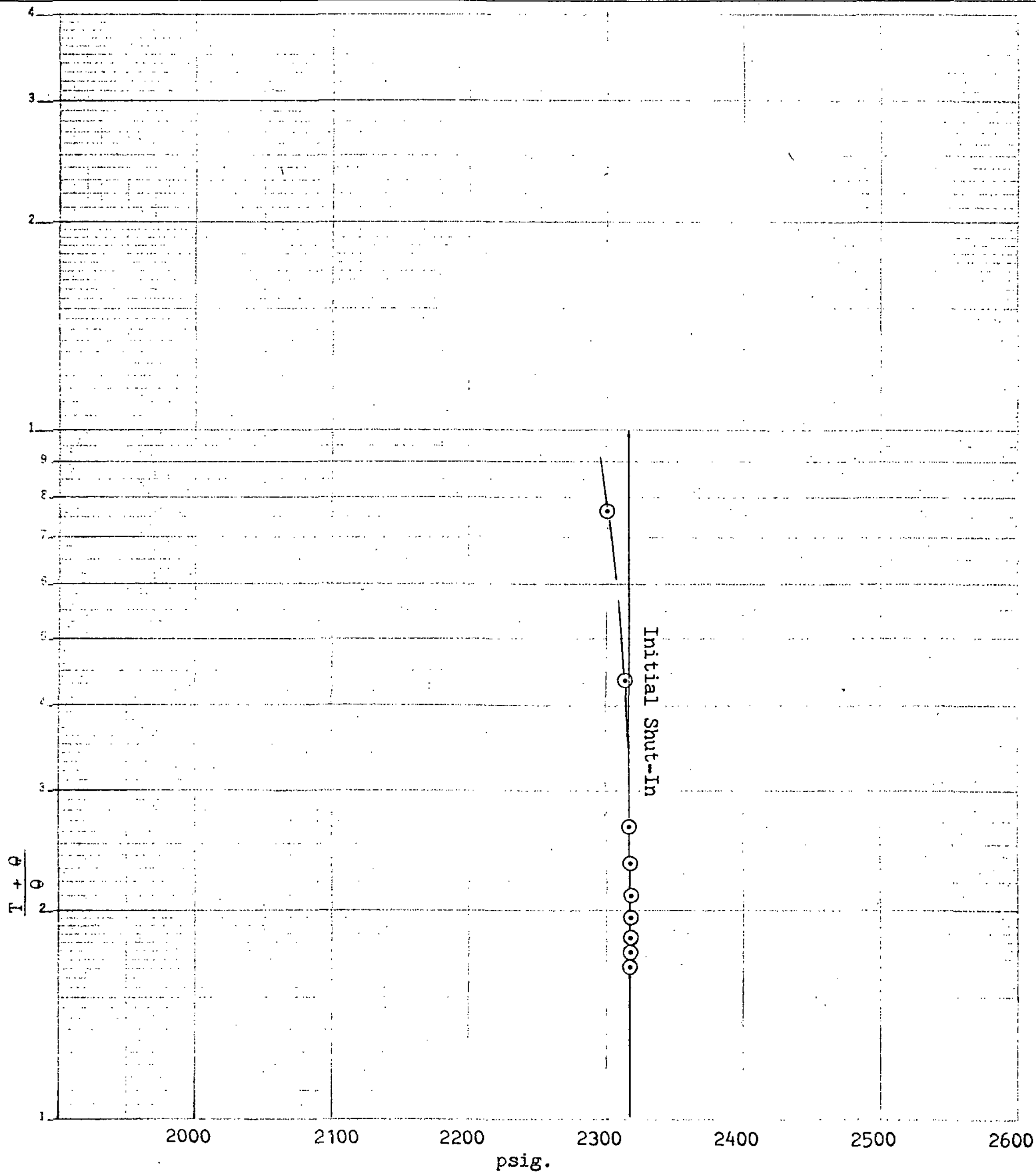


Table 3.--*Chemical analyses of water from Madison Limestone test well 3*

[Analyses by EERC, Inc., unless otherwise indicated. Samples are "slightly mud-cut water" unless otherwise indicated. Chemical constituents are in mg/L]

Formation	Sample interval[1]	Drill-stem test number	Specific conductance (lab) (µmhos/cm @ 25°C)	pH (field)	Temperature (°C)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved solids (Calc.)	Barium (Ba)	Boron (B)	Total iron (Fe)	Lithium (Li)	Selenium (Se)	Strontium (Sr)
Flathead Sandstone and Precambrian rocks--------	6984-7190	4	26,000	7.3	52.0	2,200	170	5,000	170	85	880	11,500	2.7	19,800	3.7	9.1	----	9.0	<0.005	44
Red River------	5748-5940	6	4,200	7.2	48.8	440	87	860	42	230	2,900	70	3.4	4,470	4.4	.32	----	.29	<.005	18
Upper Red River and Stony Mountain-----	5608-5743	7	4,100	7.5	35.5	450	82	610	42	310	2,400	64	3.3	3,810	11	.39	3.9	.31	<.005	6.9
Madison (Lodgepole) and Upper Devonian rocks---	5250-5440	9	7,200	7.6	32.0	490	88	1,300	50	310	4,100	59	3.5	6,190	1.2	.76	.90	.29	<.005	5.7
Madison (lower part of the Mission Canyon)------	4798-4988	10	3,300	6.9	48.1	530	110	240	39	170	2,100	60	3.3	3,100	1.9	.27	----	.30	<.005	7.3
Madison (middle part of the Mission Canyon)------	4598-4788	11	4,300	6.9	46.5	520	130	580	42	220	2,700	65	3.4	4,000	.96	.34	----	.24	<.005	6.5
Madison (upper part of the Mission Canyon)------	4302-4492	12	3,900	7.0	49.5	480	88	500	41	220	2,300	74	3.4	3,600	16.4	.26	----	.29	<.005	6.7
Madison (upper part of the Mission Canyon)[2, 3]--	4290-4414	2	2,880	6.8	51.8	490	100	95	39	155	1,800	39	.7	2,660	0	.37	[4].74	.39	0	9.5

Table 3.--*Chemical analyses of water from Madison Limestone test well 3*--Continued

Formation	Sample interval[1]	Drill-stem test number	Specific conductance (lab) (µmhos/cm @ 25°C)	pH (field)	Temperature (°C)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved solids (Calc.)	Barium (Ba)	Boron (B)	Total iron (Fe)	Lithium (Li)	Selenium (Se)	Strontium (Sr)
Tensleep Sandstone and Amsden[2, 3]---	4150-4234	3	2,300	6.9	49.7	500	110	84	40	151	1,800	41	4.5	2,700	0	0.39	[4]0.97	0.40	0	9.8
Madison (upper part of the Mission Canyon)[3]------	4337-4357 and 4373-4393[5]	---	2,700	7.0	48.8	540	99	84	40	146	1,800	35	3.2	2,670	<.05	.4	1.4	.34	<.005	8.8

[1]Depth in feet from kelly bushing (KB) which is 15.5 ft above land surface and 3,039.8 ft above sea level.
[2]Analyses by U.S.G.S. laboratories.
[3]Long duration flow tests, good clear water.
[4]Dissolved iron.
[5]Perforated interval.

Water from the Tensleep Sandstone and Amsden Formation (DST 3) also was taken after the field parameters had stabilized and the water was clear. It contains mostly calcium and sulfate, and has a dissolved-solids concentration of 2,700 mg/L. The water is nearly identical to that from DST 2 in the Mission Canyon. This may indicate vertical movement of water between the two horizons.

Perforations in the partially completed well are in the top 100 ft of the Mission Canyon Formation. After the well flowed continuously for several weeks, a water sample was collected for analysis. The sample was clear and colorless. The temperature is not comparable to the temperatures of other tests because the discharge point was considerably farther from the well head. The water contains mostly calcium and sulfate and has a dissolved-solids concentration of 2,670 mg/L.

Preliminary results and future plans

Based on the geologic model, the location of the drill site for test well 3 was to be near the intersection of paleostructural lineaments and also along a present-day fault trend. Further, the geologic model indicated high-energy, shallow-water facies should be present in most of the Mississippian rock units. A combination of fracture and intercrystalline porosity was anticipated for the Paleozoic section.

Preliminary examination of the cuttings and cores from the well suggests that the geologic model is valid. On both a local and regional scale, rapid and extreme changes in rock types, facies, and isopach values indicate the drill site was structurally active in Paleozoic time. Shallow-water facies, such as oolite banks and evaporite sequences, comprise most of the Mississip-)ian section. Parts of the cores were highly fractured and brecciated, and howed both fracture and intercrystalline porosity.

The estimated specific capacity of the well, about 1 gal/min/ft of wdown, was lower than predicted. The development of primary and ecially secondary interstitial porosity, which resulted in high water ds in Madison test well 1, was minimal in Madison test well 3. In the er well, although primary porosity in the form of well-sorted oolites and was formed during deposition, the oolite banks and vugs are mostly filled nhydrite. Also, the evaporite sequences were thicker than predicted. ng and fracturing, as predicted in the geologic model, were common and ter production was from faults and fractures. However, many of these e sealed with anhydrite.

ther evaluation of the geologic model will be made after detailed of cores and cuttings have been completed by project petrologists.

from the packer-isolated intervals, measured at the end of the ipe, ranged from 13 to 115 gal/min; back pressures while flowing 0 to 65 lb/in^2. The sum of the flows from all intervals tested was about 560 gal/min. The calculated average production rate for these intervals was about 1,000 gal/min. The sum of the flows and the calculated production total are less than the potential production of the well due to the effect of restrictions within the test tool and possible formation damage.

Pressure gradients for intervals tested in the well were anomalously high, ranging from 0.502 to 0.548 $lb/in^2/ft$. Potentiometric-surface elevations in Paleozoic rocks, based on extrapolated pressure data from subsurface gages, ranged from 4,000 to 4,150 ft above sea level (about 975 to 1,125 ft above land surface).

Freshwater (less than 1,000 mg/L dissolved solids) was not found in any of the intervals tested in the well. Dissolved-solids concentrations ranged from 2,660 to 19,800 mg/L.

Test well 3 is only partially completed. Two cement plugs were set in the open hole to isolate Cambrian rocks that contained saline water. One plug is from the bottom of the well to 6,935 ft below land surface and the other between 4,342 and 4,322 ft. A 7-in casing liner is cemented in the hole from 4,115 ft (183 ft above the base of 9-5/8-in casing) to 5,942 ft below land surface. The top of a cement plug inside the liner is at 4,985 ft. The 7-in casing is perforated at two water-bearing zones in the Madison Limestone--one between 4,378 and 4,358 ft and the other between 4,342 and 4,322 ft. Additional perforations of water-bearing zones were postponed because of bridges in the 13-3/8-in and 9-5/8-in casing caused by sloughing of cement. Despite these bridges, the well is flowing more than 40 gal/min at the surface from the perforated intervals.

Completion of the well is scheduled for July or August 1979. This will be done using a truck-mounted work-over drilling rig. Water flow with high pressure head (about 450 lb/in^2 at land surface) from the perforated intervals will be controlled by pumping a "pill" of heavy mud weighing about 11 lb/gal into the 7-in casing immediately above and through the intervals perforated. A lighter weight mud (about 9 lb/gal) or gel mixture will be used as the circulating fluid to (1) clean cement from the walls of the 13-3/8-in casing, (2) remove bridges and plugs in the 13-3/8-in, 9-5/8-in, and 7-in casings, and (3) dress the tops of the 9-5/8-in and 7-in casings which may be damaged. The mud will then be displaced from the casing, and the casing will be perforated opposite additional water-bearing zones containing water of a quality that meets environmental limitations for disposal into reserve pits, sloughs, or the Huntley Canal. Each perforated interval will be isolated with packers run on 2-7/8-in tubing and tested, developed by swabbing, and possibly acidized. Water samples from the packer-isolated intervals will be collected for chemical, isotopic, and other analyses. Geophysical logs, such as the borehole televiewer (to determine the condition of the casing and the distribution, size, and shape of the perforations), and tracer surveys (to determine the yield from perforations) will be made. Finally, step-drawdown tests of the total flow from the well will be conducted.

The well construction and well-head equipment will be such that the well can be used for several years as an observation point, a test laboratory, and for geophysical surveys.

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Brown, Eugene, Skougstad, M. W., and Fishman, M. J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A-1, 160 p.

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Wood, W. W., 1976, Guidelines for collection and field analysis of ground water samples for selected unstable conditions: U.S. Geological Survey Techniques of Water-Resources Investigations, book 1, chap. D-2, 24 p.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN-FILE REPORT 79-745
PLATE 3

COMPOSITE DUAL-INDUCTION LATEROLOG
332 TO 7189 FEET

Schlumberger

DUAL INDUCTION · LATEROLOG
WITH LINEAR CORRELATION LOG

COUNTY YELLOWSTONE
FIELD WILDCAT
LOCATION 35 2N 27E
WELL MADISON LIMESTONE TEST WELL #3
COMPANY U.S.G.S.

COMPANY U. S. G. S.

WELL MADISON LIMESTONE TEST WELL #3

FIELD WILDCAT

COUNTY YELLOWSTONE STATE MONTANA

LOCATION NW SE

API SERIAL NO	SEC	TWP	RANGE
	35	2N	27E

Other Services:
FDC-GR
SNP-GR
BHC-GR
HRT

Permanent Datum: GROUND LEVEL ; Elev.: 3024.3
Log Measured From K. B. 15 Ft. Above Perm. Datum
Drilling Measured From K. B.

Elev.: K.B. 3039.3
D.F. -
G.L. 3024.3

Date	8-20-78	9-19-78	11-7-78	
Run No.	ONE	TWO	THREE	
Depth—Driller	1000	4411	7196	
Depth—Logger	996	4411	7189	
Btm. Log Interval	990	4405	7183	
Top Log Interval	332	989	97	
Casing—Driller	20 @ 332.5	13 3/8 @ 992	9 5/8 @ 4319	@
Casing—Logger	332	989	4318	
Bit Size	8 3/4	8 3/4	8 3/4	
Type Fluid in Hole	CHEM GEL	FGM	CHEM GEL	
Dens. / Visc.	8.8 / 60	10.7 / 60	10.8 / 51	
pH / Fluid Loss	- / - ml	9.5 / 8.2 ml	9.5 / 8.2 ml	ml
Source of Sample	FLOW LINE	MUD TANK	FLOW LINE	
Rm @ Meas. Temp.	1.26 @ 70 °F	1.59 @ 55 °F	1.25 @ 69 °F	@ °F
Rmf @ Meas. Temp.	1.24 @ 70 °F	1.09 @ 55 °F	SEE REMARKS	@ °F
Rmc @ Meas. Temp.	0.80 @ 70 °F	— @ — °F	— @ — °F	@ °F
Source: Rmf / Rmc	MEAS / CHART	M / —	M / —	
Rm @ BHT	0.85 @ 104 °F	0.73 @ 119 °F	0.47 @ 160 °F	@ °F
TIME Circulation Stopped	8-21 @ 0000	9/18 2000	11/16 2200	
TIME Logger on Bottom	8-21 0130	9/19 0230	11/17 0530	← SEE RE-
Max. Rec. Temp.	104 °F	119 °F	147 °F	MARKS
Equip. / Location	7653 / BLGS.	7675 / CODY	7653 / BLGS.	
Recorded By	MCCOSKERY	BLONKENNDGEL	BEATTIE	
Witnessed By	MILLER GARNS	MILLER	MILLER	

Reproduced By
Electrical Log Services
Midland, Texas 79701

REFERENCE K 2705Y

Run No.	ONE	TWO	THREE	
Service Order No.	48381	48487	48512	
Fluid Level	FULL	FULL	—	
Salinity - PPM CL.	-	—	—	
Speed - F.P.M.	80	90	60	
EQUIPMENT DATA				
Panel No.	307	316	307	
Cart No.	329	329	329	
Sonde No.	99	153	99	
Mem. Panel No.	-	316	847	
G.R. Panel No.	-	—	1787	
G.R. Cart. No.	-	—	510	
Tape Recorder - (TTR)	924	959	929	
Depth Encoder - (DRE)	173	162	173	
Pressure Wheel (CPW)	1772	1770	1772	
Type Centralizers	FIN	4-FIN	—	
Stand Off - Inches	1 1/2 IN.	1 1/2 IN.	—	
CALIBRATION DATA				
Sonde Error - ILM	6.5	4.0	—	
Sonde Error - ILD	13.5	7.2	—	
G.R. BKG. - CPS.		—	0	
G.R. Source - CPS		—	1650	
LOGGING DATA				
S.E. Log - ILM	6.5	4.0	40.0	
S.E. Log - ILD	13.5	7.2	11.5	
S.E. - Set in Hole - Depth		—	4550	
S.E. Corr. - Hole Size		—	—	
G.R. Scale per 100 Div.		—	0-150	
G.R. - T.C.		—	1	
G.R. Sens.		—	0-150	

SCALE CHANGES

Type Log	Depth	Scale Up Hole	Scale Down Hole

REMARKS (RUN THREE)
A SECOND RUN WAS MADE WITH THE DUAL INDUCTION AT 2300 HOURS. THE TEMPERATURE WAS 160° F.

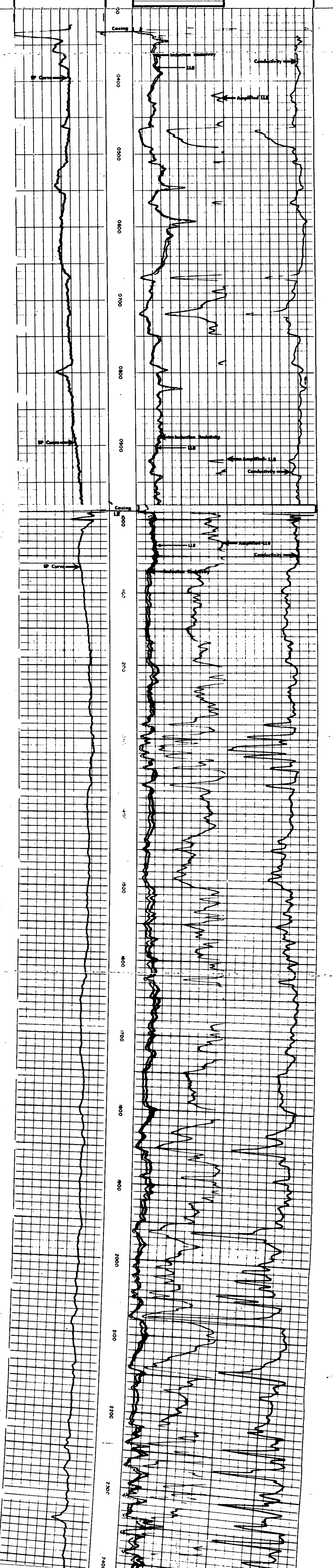
NO FILTRATE TAKEN DUE TO THICK MUD

OTHER SERVICES: CCL, CCL/PSR, TL, CBL/VDL/GR, FIL, SNP/GR, FDC/CNL/GR, DLL/GR, BHC/GR

SPONTANEOUS-POTENTIAL
− | 5 MV | + MILLIVOLTS

CONDUCTIVITY MILLIMHOS/M = 1000 / OHMS M²/M
DEEP INDUCTION
1000 — 500 — 0

RESISTIVITY OHMS M²/M
DEEP INDUCTION
0 — 50
0 — 500
AVERAGED LATEROLOG-8
0 — 50
0 — 500
AMP. AVE. LATEROLOG - 8
0 — 10



UNITED STATES DEPARTMENT OF THE INTERIOR — OPEN-FILE REPORT 79-745
GEOLOGICAL SURVEY — PLATE 3

COMPOSITE DUAL-INDUCTION LATEROLOG
332 TO 7189 FEET

Schlumberger — DUAL INDUCTION-LATEROLOG WITH LINEAR CORRELATION LOG

COUNTY YELLOWSTONE / FIELD WILDCAT / LOCATION 35 2N 27E / WELL MADISON LIMESTONE TEST WELL #3 / COMPANY U.S.G.S.

COMPANY U.S.G.S.

WELL MADISON LIMESTONE TEST WELL #3

FIELD WILDCAT

COUNTY YELLOWSTONE STATE MONTANA

LOCATION NW SE

API SERIAL NO	SEC	TWP	RANGE
	35	2N	27E

Other Services: FDC-GR, SNP-GR, BHC-GR, HRT

Permanent Datum: GROUND LEVEL ; Elev.: 3024.3
Log Measured From K.B. 15 Ft. Above Perm. Datum
Drilling Measured From K.B.

Elev.: K.B. 3039.3, D.F. -, G.L. 3024.3

Date	8-20-78	9-19-78	11-7-78	
Run No.	ONE	TWO	THREE	
Depth—Driller	1000	4411	7196	
Depth—Logger	996	4411	7189	
Btm. Log Interval	990	4405	7183	
Top Log Interval	332	989	97	
Casing—Driller	20 @ 3325	13 3/8 @ 992	9 5/8 @ 4319	@
Casing—Logger	332	989	4318	
Bit Size	8 3/4	8 3/4	8 3/4	
Type Fluid in Hole	CHEM GEL	FGM	CHEM GEL	
Dens. / Visc.	8.8 / 60	10.7 / 60	10.8 / 51	
pH / Fluid Loss	- / - ml	9.5 / 8.2 ml	9.5 / 8.2 ml	ml
Source of Sample	FLOW LINE	MUD TANK	FLOW LINE	
R_m @ Meas. Temp.	1.26 @ 70 °F	1.59 @ 55 °F	1.25 @ 69 °F	@ °F
R_{mf} @ Meas. Temp.	1.24 @ 70 °F	1.09 @ 55 °F	SEE REMARKS	@ °F
R_{mc} @ Meas. Temp.	0.80 @ 70 °F	– @ – °F	– @ – °F	@ °F
Source: R_{mf} / R_{mc}	MEAS / CHART	M / –	M / –	
R_m @ BHT	0.85 @ 104 °F	0.73 @ 119 °F	0.47 @ 160 °F	@ °F
Time: Circulation Stopped	8-21 @ 0000	9/18 2000	11/16 2200	
Time: Logger on Bottom	8-21 0130	9/19 0230	11/17 0530	← SEE RE-
Max. Rec. Temp.	104 °F	119 °F	147 °F	MARKS
Equip. / Location	7653 / BLGS.	7675 / CODY	7653 / BLGS.	
Recorded By	MCCOSKERY	BLONKENNDGEL	BEATTIE	
Witnessed By	MILLER	GARNS MILLER	MILLER	

Reproduced By
Electrical Log Services
MIDLAND, TEXAS 79701

REFERENCE K 2705Y

Run No.	ONE	TWO	THREE	
Service Order No.	48381	48487	48512	
Fluid Level	FULL	FULL	–	
Salinity - PPM CL	-	–	–	
Speed - F.P.M.	80	90	60	
EQUIPMENT DATA				
Panel No.	307	316	307	
Cart No.	329	329	329	
Sonde No.	99	153	99	
Mem. Panel No.	-	316	847	
G.R. Panel No.	-	–	1787	
G.R. Cart. No.	-	–	510	
Tape Recorder - (TTR)	924	959	929	
Depth Encoder - (DRE)	173	162	173	
Pressure Wheel (CPW)	1772	1770	1772	
Type Centralizers	FIN	4-FIN	–	
Stand Off - Inches	1 1/2 IN.	1 1/2 IN.	–	
CALIBRATION DATA				
Sonde Error - ILM	6.5	4.0	–	
Sonde Error - ILD	13.5	7.2	–	
G.R. BKG. - CPS.		–	0	
G.R. Source - CPS		–	1650	
LOGGING DATA				
S.E. Log - ILM	6.5	4.0	40.0	
S.E. Log - ILD	13.5	7.2	11.5	
S.E. - Set in Hole - Depth		–	4550	
S.E. Corr. - Hole Size		–	–	
G.R. Scale per 100 Div.		–	0-150	
G.R. - T.C.		–	1	
G.R. Sens.		–	0-150	

SCALE CHANGES

Type Log	Depth	Scale Up Hole	Scale Down Hole

REMARKS (RUN THREE)
A SECOND RUN WAS MADE WITH THE DUAL INDUCTION AT 2300 HOURS. THE TEMPERATURE WAS 160° F.

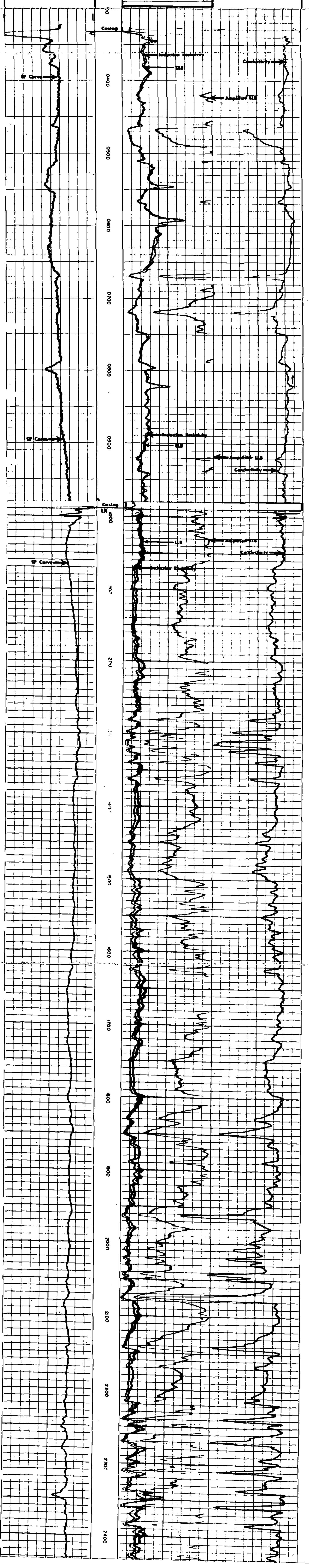
NO FILTRATE TAKEN DUE TO THICK MUD

OTHER SERVICES: CCL, CCL/PSR, TL, CBL/VDL/GR, FIL, SNP/GR, FDC/CNL/GR, DLL/GR, BHC/GR

SPONTANEOUS-POTENTIAL
− |5 MV| + MILLIVOLTS

CONDUCTIVITY MILLIMHOS/M = 1000 / OHMS M²/M
DEEP INDUCTION
1000 — 500 — 0

RESISTIVITY OHMS M²/M
DEEP INDUCTION
0 — 50
0 — 500
AVERAGED LATEROLOG-8
0 — 50
0 — 500
AMP. AVE. LATEROLOG – 8
0 — 10



GEOLOGICAL WELL LOG

JOHN R. WARNE **IRVIN KRANZLER**

Geologists
Billings, Montana

WELL-SITE LOG

DRILLING TIME, LITHOLOGY

Operator: U. S. GEOLOGICAL SURVEY
Well: Madison Test Well No. 3
Location: Sec. 35, T 2 N, R 27 E, Yellowstone Co., Montana
Elevation: 3024 GR, 3040 KB. Total Depth: 7190'
Spud Date: August 15, 1978 Status: Reached TD November 16, 1978; prep. to complete as hydrologic test well.
Casing: 20" at 334' KB; 13-3/8" at 992' KB; 9-5/8" at 4313' KB;
Logged by Irvin Kranzler & John R. Warne
Remarks: Sample descriptions adjusted to drilling time depths. Obvious cavings not described.

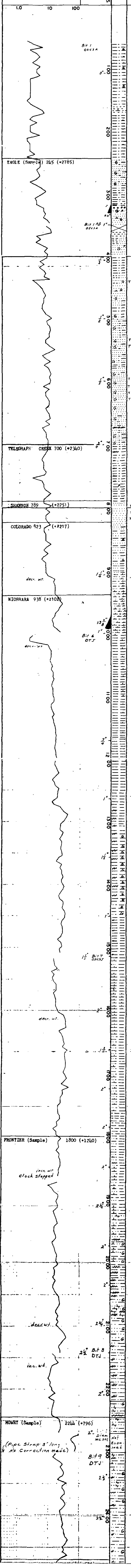
SYMBOLS

- Sandstone
- Siltstone
- Conglomerate
- Shale
- Limestone
- Dolomite
- Anhydrite
- Chert
- Coal
- Bentonite
- Salt
- Igneous
- Metamorphic
- Calcareous
- Dolomitic
- G Glauconite

HYDROCARBON SHOWS
- ● Oil, good (even stain or fluorescence)
- Oil, poor (spotty stain or fluorescence)
- ○ Oil, questionable stain or only cut fluorescence
- D Oil, dead or asphaltic
- Gas bubbles in cuttings or core
- Gas show from mud log

POROSITY
- T Trace
- P Poor
- M Medium
- G Good

DRILLING TIME Minutes per 5 Feet	MECHANICAL DATA	DEPTHS	GRAPHIC LITHOLOGY	POROSITY	HYDROCARB. SHOWS	CORES	SAMPLE DESCRIPTION	DEPTH AT 8:00 A.M.



Driller reported gummy "blue" shale at about 30 feet

Sh, med gy, v slty, tr glauc, v bent, mica, brn carb mat.

Sltst, med gy, v argil, mica, carb, sli calc, tan & lt orange inclus.

Sh, med gy, blky, v slty, bent. Stks Sltst, a.a.

EAGLE (Sample) 245 (+2785)

Ss, lt gy, s&p, vf/slt, sli calc, bent, tr glauc, mica, fri, ti. Sltst & Sh, a.a. Brn Concre frags w/amber Calcite xls.

Sh, med gy, v slty & sdy, bent, mica. Stks Slst & Ss, a.a.

Congl; lt gy Ss w/dk gy pebbles, sli calc, bent, tr glauc, ti.
Ss, lt gy, sli s&p, vf, calc, bent, sli glauc, mica, ti, no show.

No sample. 8-19
Sltst & Sltst/vf Ss, lt/med gy, speckled black, argil.

Ss, med gy, vf, argil, sli glauc, v sli calc, mica, ti, clinging bubbles in acid. Tr Ch peb cl, orange, dk gy, tr grn.

Sh, dk/med gy, v slty, mica

Sltst/vf Ss, med/dk gy, v argil, mica.
Ss, lt gy to brn gy, some med gy, glauc, calc, fri, tr por to ti, no show, pipe dope contam.

Sh, dk gy, blky, slty, bent, mica.

Ss, lt gy, grn gy, brn gy, f/m grdin to vf down, glauc, sli calc, rare orange grains, ti, no fl. Sh dk/med gy, blky, slty, glauc, firm.

Ss, lt gy f/med, scat blk and gy grns, v glauc, tr pink grns, sli clc, mica, ti/tr por, no fl.

A.a., becoming argil.
Sh, med/dk gy, blky, v sdy, tr tan specs.
Ss, med/lt gy, f/vf, tr amber & pink grns, glauc, mica, calc, ti/tr por, tr py, no fl.

Gas kick of 14 units 605-615 feet.

A.a., becoming f/vf, ti, no fl.

Ss, lt gy, vf, glauc, mica, sli calc, argil, ti.

Bent, lt gy, blue-gy, brn-gy, mica, slty in pt.
Ss, vf/Sltst, med brn-gy, v argil, mica, glauc, sli calc, ti. Stks v sdy Sh, blky, med brn-gy. 8-20

TELEGRAPH CREEK 700 (+2340)

Sh, med gy & brn-gy, blky, v slty & sdy, mica, sli glauc. Grades to v argil Sltst. Tr Bent, crm/lt gy.

Bent, crm/lt gy. Slty Sh, a.a.

Sh, med gy, blky, slty. Bent, a.a.

A.a. becoming less slty, tr py.

A.a. Bent, wh, mica.

SHANNON 789 (+2251)

Ss, wh, s&p (mica w/some gy Sh grns), f, tr orange grns, ~~calc, dk brn carb mat, some frags w/cling bubbles in acid,~~ fri, tr por/ti. Gas kick of 38 units. Tr Bent, blue-gy.

COLORADO 823 (+2217)

Ss, lt gy, s&p, vf/f, abund mica and dk brn carb mat, argil, argil, sli calc, ti, no fl, Gas units dropped to 20. Sh, med brn-gy, blky, abund mica and brn carb mat, tr glauc. Tr gy-brn calcite concre frags.

As above, dec in mica & carb mat. Tr v small tan specs.

Sh, med brn-gy, blky, slty, sli calc, mica. Stks Ss vf/Sltst, lt gy/wh, mica, ti. Irreg gas kick up to 58 units

As above, dec in gas.
Sh, med gay-brn, blky, slty, calc w/tan calc specs. Intercal Ss, vf, lt gy, brn-gy, mica, calc, ti, no fl.

As above, specs more numerous. Less Ss.

NIOBRARA 938 (+2102)

As above, tan to orange calc specs abund; some dk brn pyritic carb mat; tr crm/brn Inoceramus prisms.

Sh, dk gy, flaky, sl calc; tr wh-clear calcite nodules. 8-21 thru 8-28

Sh, dk gy, flaky, sl calc, a few pieces w/ tan calc specs; tr carb mat.

Sh, dk gy flaky, sl calc; tr shell frag.

As above w/ tr Ss, med-gry, vf, scat biot, ti, no fl or cut fl.

Sh, v dk gy, flaky/lmpy, noncalc/sl calc; tr shell frag & calcite nodules & pyrite.

8-29

Sh, dk gy, lmpy, noncalc; a little Bent, wh/ lt gy, w/ biot; tr shell frags, wh calcite nodules & pyrite; tr Ss, lt gy, vf, scat biot, much wh bent matrix, ti, no fl or cut fl.

Sh, med gy, flaky/lmpy, slty, sl calc, tr glauc grns at 1320 incr to num glauc grns 1330-1430; Bent, tan/lt gy, earthy/wxy, biot, sdy in pt.

Sh. dk gy, flaky/lmpy, slty, sdy, glauc in pt; Sltst grad to Ss, vf, med gy, slty, arg, glauc, ti, no fl or cut fl.

Sh, dk gy, flaky, non-calc/sl calc, biot; tr shell frag; tr Bent, wh/lt gy, biot, sdy in part.

8-30

Sh, dk gy, flaky, calc to sl calc, scat tan calc specs. Tr Ss, lt gy, vf, arg, calc, ti no fl or cut fl 1520-30.

Sh, dk gy, flaky, calc, num tan calc specs, a few wh calc specs.

Sh, dk gy, flaky, calc/sl calc; tr shell frags & calcite nod.

Sh, dk gy, flaky, calc/non calc; little Sltst grad to Ss, med gy, arg, calc in pt, num blk & gy grns, ti, no fl or cut fl.

8-31

Sh, dk gy, flaky, non-calc/sl calc; tr Sltst, med gy, arg; tr shell frag.

FRONTIER (Sample) 1800 (+1240)

Sh & Sltst as above; a little Ss, med gy, vf, slty, arg, scat blk & gy grns, biot in pt, ti, no fl or cut fl.

Sh, dk gy, flky, calc in pt. Tr Sltst, grding to Ss, med gy, vf, argil, calc, scat blk grns, ti, no fl or cf. Tr Shell frags.

Sh, dk brn-gy, gy-brn, blky, slty, calc, firm. Tr Ss, med gy-brn, vf, v py, calc, dull orange specs. Sli gas kick at 1911.
Sh, gy-brn, blky, calc, slty, scat mica. Tr Ss, lt/med gy-brn, vf/f, calc, py, mica, ti.
Sh, dk gy, some brn-gy, blky, slty, lmica, sli calc.

Much Bent, wh, some lt gy, mica. Sh, a.a.

Sh, dk gy, some brn-gy, blky, bent, slty. Stks Ss, lt gy, vf, sli calc and glauc, argil, ti. Some Bent, wh, mica. Inoceramus prisms.

Bent, lt gy, some wh, mica. Shale, a.a.
Sh, dk gy, some brn-gy, blky, less slty, tr glauc, mica. Bent, lt gy to wh, mica. Tr Ss, med gy, vf, argil, mica, trace glauc, sli calc, ti. Inoceramus prisms. 9-1
Sh, dk gy, blky, v slty, carb. Bent, wh, crm, lt gy-brn, mica
Sh, med gy/dk gy blky, slty, mica. Inc in Bent, a.a.
Sh, dk gy, blky, v slty/sdy, tr py & glauc. Bent, lt brn, mica.
A.A. Inc in Py and Glauc. Tr Ss, med gy, vf/f, calc, glauc, ti.
Abund Calcite, mlky/lt brn (Concretions fragments?).
Sh, dk brn-gy, blky, v sdy grding to v argil Ss, vf, glauc, mica, tr py, v sli calc, ti. Bent, wh/lt gy, mica.

Ss, med/dk gy, some grn-gy, some lt gy, vf, glauc, argil, mica, non-calc, ti, sli py. Sh, dk gy, blky, slty. Bent, wh/gy, mica

Sh, med/dk gy, blky, sdy/slty, sli glauc, mica. Bent, wh/gy, mica.

Inc in Bent. Sh, a.a.
Sh, dk gy, blky, sdy; Ss, med/dk gy, vf, v argil, sli glauc. Tr Py.

Sh, dk gy, blky, slty, bent. Some Sh, med/dk brn-gy, blky, slty/sdy, tr glauc. Stks Bent, wh, mica.

Sh, a.a. Ss, lt gy, some wh and some med gy, f, bent, glauc in pt, mica, sli calc, ti.
Ss, m/lt brn-gy, f/vf, silic in pt, sli calc, hd, ti, no show.
Bent, wh, sdy in pt. Sh, a/a

MOWRY (Sample) 2244 (+796)

Ss, lt brn-gy, sli s&p, f/vf, mica, calc, wh clay infill, hd, ti, silic, carb, sli glauc, tr fl w/quest cut. Sh, dk brn-gy, carb, firm.
Sh, dk brn-gy, dk brn, blky/fis, carb. Ss, aa, finer, more brn. 9-2
Core No. 1: 2270 - 2300 Feet. Rec 24.5 feet. #1
Core caught and sealed in PVC liner. No well-site examination.

Sh, dk gy-brn/brn-gy, slty, tr glauc & py, sli calc & carb, frm. Stks Ss, lt/dk gy-brn, vf, silic, carb, v sli calc in pt, mica, rr glauc & py, hd, ti, no show. Bent, wh, mica. Tr Calcite, wh & amb.

Ss, lt gy, s&p, f, silic, calc, mica, hd, ti.

Sh, dk brn, blky, slty, glauc in pt, firm. Stks Ss, med/lt brn-gy, vf, mica, bent, carb, ti. Bent, wh, lt gy, some lt brn, mica. 9-3

Sh, dk brn-gy/gy, blky, slty, py, mica, sli calc. Some