GTLT - 2

NMSU-DG-2 No. 485
UL: A 27-23S-2E
Dona Ana County
Plugged & Abandoned

YEAR: 3/31/1981

NEW MEXICO STATE UNIVERSITY

Physical Science Laboratory

BOX 3-PSL, LAS CRUCES, NEW MEXICO 88003
AREA (505) 522-9100 TWX 910-983-0541

#495

March 12, 1981

Mr. Carl Ulvog
Senior Petroleum Geologist
New Mexico Oil Conservation Commission
P.O. Box 2086
Santa Fe, New Mexico 87503

Dear Mr. Ulvog:

Enclosed please find Form G-103 for the plugging action on two NMSU test wells.

In confirmation of our telephone discussions, the Form G-103 notifies you of the completion of plugging, and also advises you of a name and number change which records the owner and purpose of the wells in the well name, and uses the State Engineer's well number.

Well NMSU-DG1-LRG 484 formerly was named and numbered NMSU-DG-1 and NMSU-DT-2. It also might have been designated NMSU-2.

Well NMSU-DG2-LRG-485 formerly was named and numbered NMSU-DG-2 and NMSU-DT-1. It also had been designated NMSU-1.

You should have earlier Forms G-103 on these two wells, referring to them as NMSU-DG-1 and NMSU-DG-2, in which I notified you of our intent to repair or plug and abandon. You approved those forms on or about 26 November 1980.

Sincerely yours,

Roy A. Cunniff
Project Director
NMSU
Geothermal Project

cjs
Enclosure

COLLEGE OF ARTS AND SCIENCE

DEPARTMENT OF PHYSICS
Box 3D/Las Cruces, New Mexico 88003
Telephone (505) 646-3831

NEW MEXICO STATE UNIVERSITY

March 12, 1980

#495

Mr. Carl Ulvog
Senior Petroleum Geologist
New Mexico Oil Conservation Commission
P.O. Box 2086
Santa Fe, New Mexico 87503

Dear Mr. Ulvog,

Early in 1979 I received the oral consent of Drs. Chaturvedi and Gunaji of the NMSU Engineering College to use two temperature observation wells, NMSU-DG-1 and NMSU-DG-2, for seismic velocity measurements as part of a Department of Energy funded seismic investigation of the low temperature geothermal field to the east of the NMSU main campus. It was with their full knowledge and consent that small explosive charges were set in these wells, but unfortunately they failed to tell me that the wells were subject to plugging requirements. As the detonation of an explosive charge in a well always carries a significant risk of damaging the well, this lack of communication was an unfortunate oversight.

I have enclosed a copy of a memo to Dr. Chaturvedi giving him the details of the possible damage to the wells. If there is any further information that your office requires regarding this matter, I will be happy to supply it.

Sincerely yours,

Paul Morgan

PAUL MORGAN, Associate Professor
Departments Earth Sci/Physics

PM:nd

Enclosure

COLLEGE OF ARTS AND SCIENCE

DEPARTMENT OF PHYSICS
Box 3D/Las Cruces, New Mexico 88003
Telephone (505) 646-3831

NEW MEXICO STATE UNIVERSITY

March 4, 1980

MEMORANDUM

TO: Dr. Lokesh Chaturvedi

FROM: P. Morgan

SUBJECT: Las Alturas Deep Temperature Test Wells

The caving in holes DT1 and DT2 is indeed unfortunate; if I had been informed that these boreholes were subject to plugging regulations I would not have used the holes for seismic velocity measurements. Although the experiments were designed to minimize the risk of caving in the holes, there was always a significent risk that this would occur. In our informal meetings with Dr. Daw in which I requested permission to use the holes for the seismic measurements, no reference was made to the plugging requirement.

We performed shallow tests (~10m) with the seismic charges in the DT2 (west well) with no caving problems. Charges were then set at 90m and 80m with no problems, but after a charge at 70m we found it impossible to re-enter the hole past approximately 70m. We assume there to be a minor blockage at this depth due to the charge.

The same charge in DT1 (east well) produced disasterous results. A charge at 190m caused major caving from above, burying the cable we were using for detonating the charges. Attempts to pull the cable free failed, so we set a further charge to break the cable to retrieve what we could. The cable broke free immediately after the charge was detonated, but again was buried at a higher level by caving from above. Two further charges were required to completely free the cable. On the last of these charges the casing subsided down the hole.

My sincere apologies for any problems that may arise because of the blocking of DT1 and DT2. If I had known of the plugging requirement I would not have attempted the experiment.

cc: Dr. Daw
Dr. Swanberg

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P. O. Box 2088, Santa Fe 87501

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SANTA FE

Form G-103
Adopted 10/1/74

SUNDRY NOTICES AND REPORTS ON GEOTHERMAL RESOURCES WELLS

5. Indicate Type of Lease State ☐ Fee ☒

5.a State Lease No.

Do Not Use This Form for Proposals to Drill or to Deepen or Plug Back to a Different Reservoir. Use "Application For Permit —" (Form G-101) for Such Proposals.)

1. Type of well: Geothermal Producer ☐ Temp. Observation ☐ Low-Temp Thermal ☐ Injection/Disposal ☐

7. Unit Agreement Name

2. Name of Operator
New Mexico State University, Physical Plant Department

8. Farm or Lease Name
NMSU-DG-2-LRG

3. Address of Operator
New Mexico State University
P.O. Box 3445, Las Cruces, New Mexico 88003

9. Well No.
485

4. Location of Well
Unit Letter A 1000 Feet From The North Line and 500 Feet From The East Line, Section 27 Township 23S Range 2E NMPM.

10. Field and Pool, or Wildcat
NMSU Property

15. Elevation *(Show whether DF, RT, GR, etc.)*
4163 Feet above M.S.L. (GL)

12. County
Dona Ana

16. Check Appropriate Box To Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
PERFORM REMEDIAL WORK ☐	PLUG AND ABANDON ☐	REMEDIAL WORK ☐	ALTERING CASING ☐
TEMPORARILY ABANDON ☐		COMMENCE DRILLING OPNS. ☐	PLUG & ABANDONMENT ☒
PULL OR ALTER CASING ☐	CHANGE PLANS ☐	CASING TEST AND CEMENT JOB ☐	
OTHER ☐		OTHER ☐	

17. Describe Proposed or completed Operations *(Clearly state all pertinent details, and give pertinenet dates, including estimated date of starting any proposed work)* SEE RULE 203.

A total of 173 feet of casing was removed, which had been broken at the 34-feet and 173-feet intervals. A drill rig was used in an attempt to drill around the section from 173 feet of depth to 300 feet, using a 2-inch drill bit. The drill bit encountered another break at 205 feet of depth, and with difficulty, the drilling continued to 245 feet. The drill bit became lodged in the casing at that depth. After several hours, the drill was freed. Because of difficulties in attempting to drill around the broken casing, the drill stem was extracted. A six-inch drill bit was used to enlarge the hole to original diameter down to 173 feet of depth.

Cement was pumped into the hole under pressure, and it was plugged with cement from 245 feet of depth to ground surface. A permanent steel marker was installed.

Work was performed by Cole Drilling Company; completed 11 December 1980.

18. I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNED [signature] TITLE NMSU Geothermal Project DATE 3-13-81

APPROVED BY [signature] TITLE SENIOR PETROLEUM GEOLOGIST DATE 3/20/81

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SANTA FE

Form G-103
Adopted 10/1/74

SUNDRY NOTICES AND REPORTS ON GEOTHERMAL RESOURCES WELLS

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5.a State Lease No.

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1. Type of well: Geothermal Producer ☐ Temp. Observation ☐ Low-Temp Thermal ☐ Injection/Disposal ☐

7. Unit Agreement Name

2. Name of Operator
New Mexico State University, Physical Plant Department

8. Farm or Lease Name
NMSU-DG-2-LRG

3. Address of Operator New Mexico State University
P.O. Box 3445, Las Cruces, New Mexico 88003

9. Well No.
485

4. Location of Well
Unit Letter A 1000 Feet From The North Line and 500 Feet From The East Line, Section 27 Township 23S Range 2E NMPM.

10. Field and Pool, or Wildcat
NMSU Property

15. Elevation *(Show whether DF, RT, GR, etc.)*
4163 Feet above M.S.L. (GL)

12. County
Dona Ana

16. Check Appropriate Box To Indicate Nature of Notice, Report or Other Data

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PERFORM REMEDIAL WORK ☐	PLUG AND ABANDON ☐	REMEDIAL WORK ☐	ALTERING CASING ☐
TEMPORARILY ABANDON ☐		COMMENCE DRILLING OPNS. ☐	PLUG & ABANDONMENT ☒
PULL OR ALTER CASING ☐	CHANGE PLANS ☐	CASING TEST AND CEMENT JOB ☐	
OTHER ☐		OTHER ☐	

17. Describe Proposed or completed Operations *(Clearly state all pertinent details, and give pertinenet dates, including estimated date of starting any proposed work)* SEE RULE 203.

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Work was performed by Cole Drilling Company; completed 11 December 1980.

18. I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNED [signature] TITLE NMSU Geothermal Project DATE 3-13-81

APPROVED BY Carl Ulvog TITLE SENIOR PETROLEUM GEOLOGIST DATE 3/20/81

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NEW MEXICO OIL CONSERVATION COMMISSION
P. O. Box 2088, Santa Fe 87501

Form G-101
10-1-74

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK---GEOTHERMAL RESOURCES WELL

5. Indicate Type of Lease: STATE [ ] FEE [ ]

5A. State Lease No.

1a. Type of Work: Drill [X] Deepen [ ] Plug Back [ ]

b. Type of Well: Geothermal Producer [ ] Temp Observation [X] Low-Temp Thermal [ ] Injection/Disposal [ ]

7. Unit Agreement Name

8. Farm or Lease Name: NMSU Land

2. Name of Operator: NMSU (Lokesh Chaturvedi, Principal Investigator) Low Temperature Goethermal Research Project - DOE

9. Well No.: DG2 -LR6-485 ~~DR-1~~

3. Address of Operator: P. O. Box 3449 - NMSU Las Cruces, NM 88003

10. Field and Pool, or Wildcat

4. Location of Well: UNIT LETTER A LOCATED 350 FEET FROM THE North ~~south~~ LINE AND 200 FEET FROM THE east LINE OF SEC. 27 TWP. 23S RGE. 2E NMPM

12. County: Dona Ana

19. Proposed Depth: 1000-1500 ft

19A. Formation: sediment

20. Rotary or C.T.: rotary

21. Elevations (Show whether DF, RT, etc.): 4200 ft above M.S.L.

21A. Kind & Status Plug. Bond: Not required

21B. Drilling Contractor: Johnson Drilling Co.

22. Approx. Date Work will start: December 15, 1978

23. (refer to letter dated 6/8/78 by Dr. Chaturvedi for well number 1

PROPOSED CASING AND CEMENT PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	SACKS OF CEMENT	EST. TOP

The proposed well islocated on New Mexico State University property where NMSU has both surface and subsurface mineral rights. The purpose of drilling this well is to obtain temperature gradient information. The well will be plugged after logging.

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: IF PROPOSAL IS TO DEEPEN OR PLUG BACK, GIVE DATA ON PRESENT PRODUCTIVE ZONE AND PROPOSED NEW PRODUCTIVE ZONE. GIVE BLOWOUT PREVENTER PROGRAM, IF ANY.

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

Signed [signature] Title Director, Eng. Exp. Sta. Date Dec. 11, 1978

(This space for State Use)

APPROVED BY Carl Ulvog TITLE SENIOR PETROLEUM GEOLOGIST DATE 12/11/78

CONDITIONS OF APPROVAL, IF ANY:

NEW MEXICO OIL CONSERVATION COMMISSION

Form C-102
10-1-74

GEOTHERMAL RESOURCES WELL LOCATION AND ACREAGE DEDICATION PLAT

All distances must be from the outer boundaries of the Section

Operator	Lease	Well No.
NMSU (PI - Dr. Chaturvedi)	NMSU Land	3

Unit Letter	Section	Township	Range	County
A	27	23 S	2 E	Dona Ana

Actual Footage Location of Well:
350 feet from the North line and 200 feet from the East line

Ground Level Elev.	Producing Formation	Pool	Dedicated Acreage:
4200 ft.			Acres

1. Outline the acreage dedicated to the subject well by colored pencil or hachure marks on the plat below.

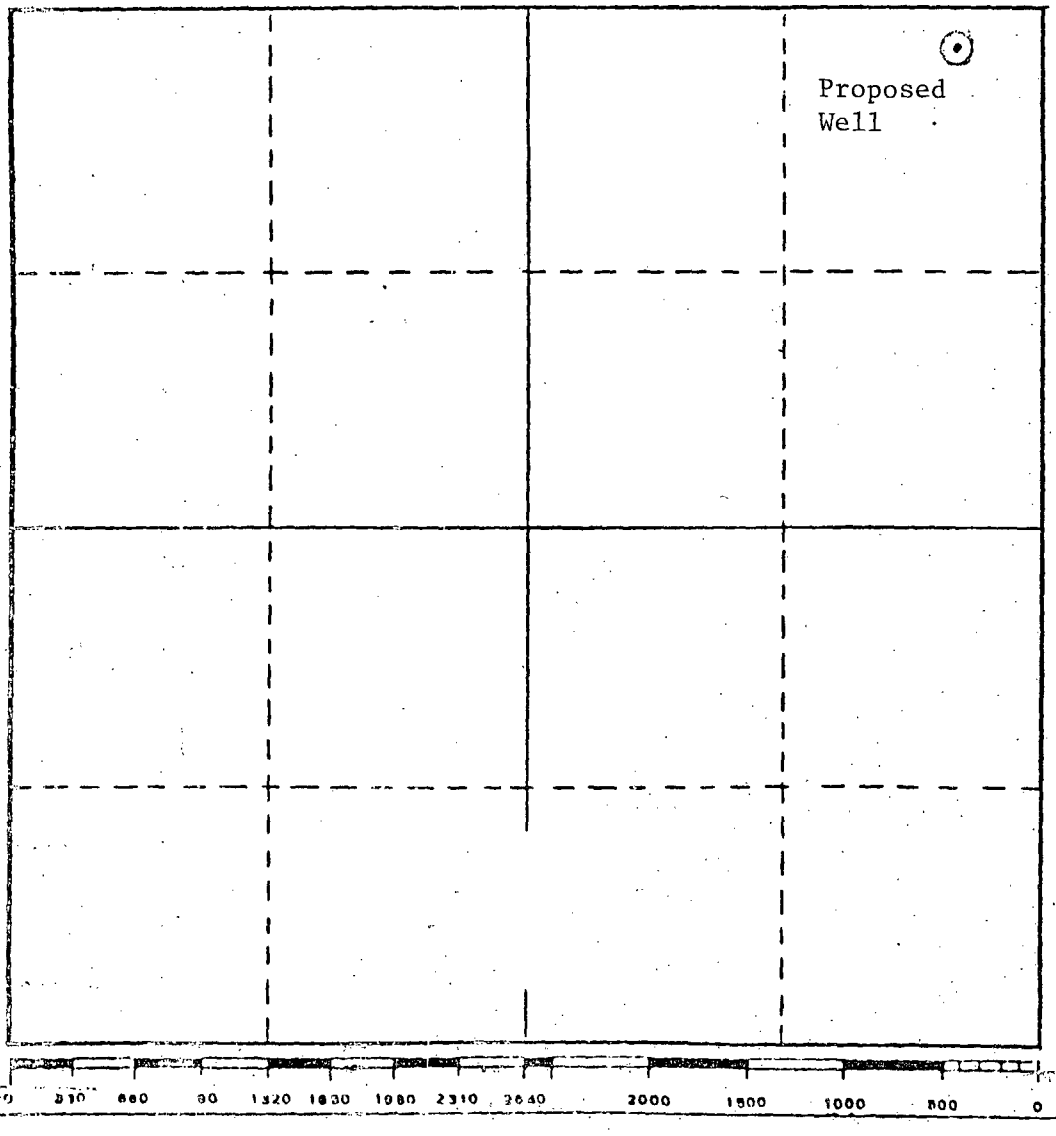
2. If more than one lease is dedicated to the well, outline each and identify the ownership thereof (both as to working interest and royalty).

3. If more than one lease of different ownership is dedicated to the well, have the interests of all owners been consolidated by communitization, unitization, force-pooling. etc?

☐ Yes ☐ No If answer is "yes," type of consolidation _____

If answer is "no," list the owners and tract descriptions which have actually been consolidated. (Use reverse side of this form if necessary.) _____

No allowable will be assigned to the well until all interests have been consolidated (by communitization, unitization forced-pooling, or otherwise) or until a non-standard unit, eliminating such interests, has been approved by the Commission.



CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief.

Narendra N. Gunaji

Name

Director, Eng. Exp. Sta.

Position

New Mexico State University

Company

December 11, 1978

Date

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed

Registered Professional Engineer and/or Land Surveyor

Certificate No.

NMSU – DT – 1 (NMSU DEEP GEOTHERMAL WELL NO. 1)

INTERPRETED SUBSURFACE CONDITIONS BASED ON ALL LOGS

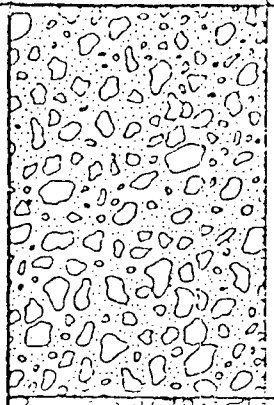
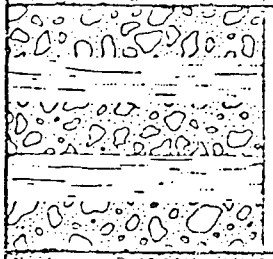
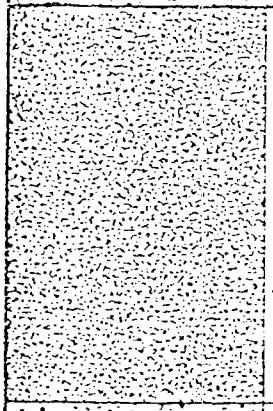
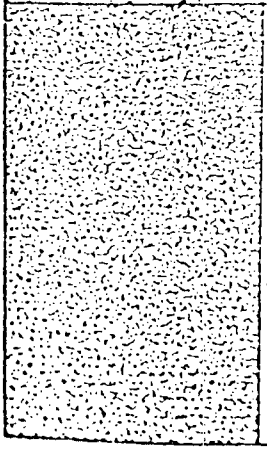
DEPTH (FEET)	GRAPHIC LOG	DESCRIPTION
0 – 250		SAND AND GRAVEL. ROUNDED TO SUBROUNDED GRAVEL PIECES CONSIST OF QUARTZ, FELDSPARS, RHYOLITE, ASH FLOW TUFFS, VARIETY OF IGNEOUS ROCKS, ETC. PROBABLY SANTA FE GROUP BASIN FILL. DRY. ABOVE THE WATER TABLE.
250 – 450		WATER TABLE AT 265FT. BETWEEN 265FT. AND 450FT., THE SECTION CONSISTS OF LAYERS OF SAND, GRAVEL AND CLAY WITH LITHOLOGIC REPRESENTATION OF RHYOLITE, OTHER IGNEOUS ROCKS AND LIMESTONE (?). ASSOCIATED SAND IS INVARIABLY CALCAREOUS. SATURATED SANTA FE GROUP BASIN FILL.
450 – 770		FROM 450FT. TO ABOUT 770FT., ALL LOGS SHOW A VERY UNIFORM SECTION. CUTTINGS FROM DRILLING YIELD ANGULAR TO SUBANGULAR FRAGMENTS WITH AN AVERAGE OF 1/4" DIAMETER OR FINER. LITHOLOGY CONSISTS OF ALMOST 100% RHYOLITIC ROCK FRAGMENTS, WHICH SOMETIMES SHOW BANDED TUFF FEATURES AND SOME PIECES APPEAR GREYISH LIKE ANDESITIC ROCK. IS IT A FANGLOMERATE DEPOSIT OR FRACTURED RHYOLITIC FLOW?
770 – 850		LENSES OF SAND AND GRAVEL, COURSE SAND AND CLAY CONSISTING OF MORE HETEROGENEOUS LITHOLOGY THAN ABOVE. PROBABLY CONTAINS WATER.
850 – 1200		LITHOLOGY AND TEXTURE VERY SIMILAR TO THE 450-770FT. ZONE. RESISTIVITY, GAMMA RAY, COMPENSATED NEUTRON AND COMPENSATED DENSILOG VERY SIMILAR TO THE ABOVE ZONE AS WELL. CALIPER SHOWS RUGGED WALL CONDITIONS. AT 950FT. HEAVY MUD LOSS WAS ENCOUNTERED. RESISTIVITY SHOWS A LOW RESISTIVITY LAYER AND NEUTRON AND DENSILOG SHOW A HIGH POROSITY ZONE ABOUT 5 FT. POSSIBLY A FRACTURED ZONE WITH HOT WATER.

Figure 17. Interpreted composite log of NMSU deep test well DT-1 (Chaturvedi, 1979).

DT-1

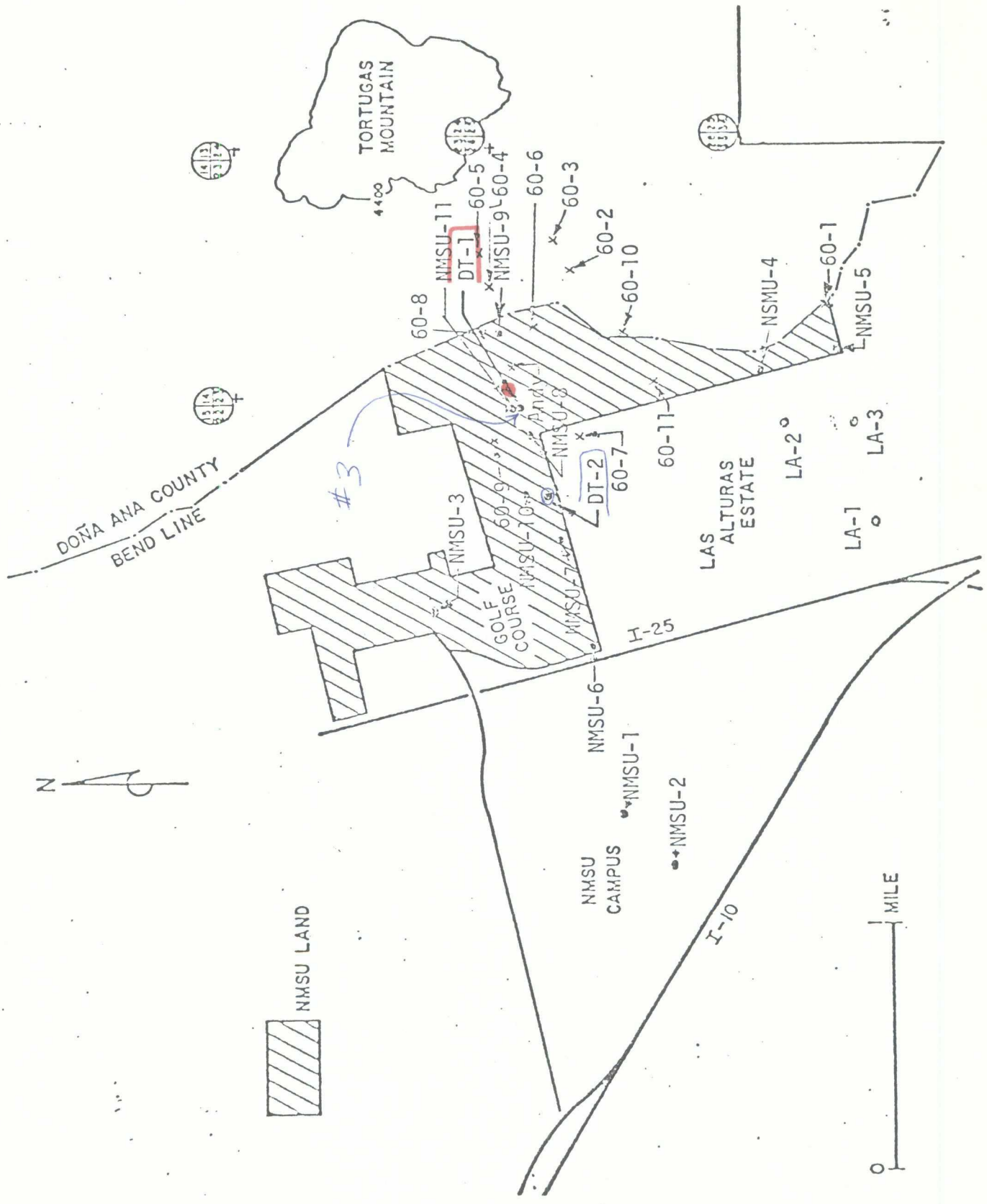
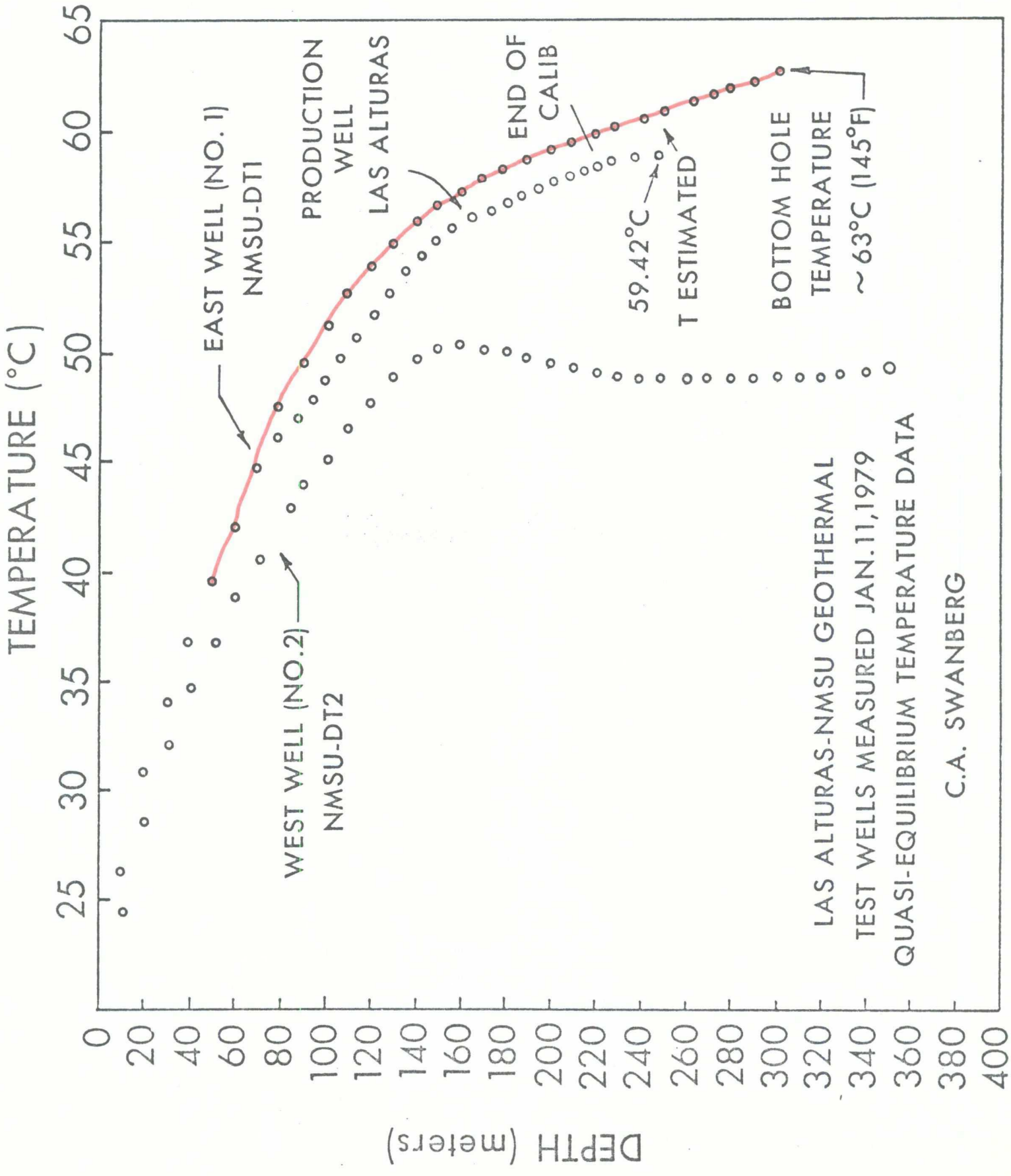


Figure 11. Map of the Las Alturas anomaly area, Las Cruces, New Mexico, showing the location of existing wells and thermal gradient holes.

DT - 1


TEMPERATURE (°C)
25 30 35 40 45 50 55 60 65
DEPTH (meters)
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400
EAST WELL (NO. 1)
NMSU-DT1
WEST WELL (NO.2)
NMSU-DT2
PRODUCTION
WELL
LAS ALTURAS
END OF
CALIB
59.42°C
T ESTIMATED
BOTTOM HOLE
TEMPERATURE
~63°C (145°F)
LAS ALTURAS-NMSU GEOTHERMAL
TEST WELLS MEASURED JAN.11,1979
QUASI-EQUILIBRIUM TEMPERATURE DATA
C.A. SWANBERG

Form G-103
Adopted 10/

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SUNDRY NOTICES AND REPORTS ON GEOTHERMAL RESOURCES WELLS

5. Indicate Type of Lease State ☐ Fee ☐
5.a State Lease No.

Do Not Use This Form for Proposals to Drill or to Deepen or Plug Back to a Different Reservoir. Use "Application For Permit –" (Form G-101) for Such Proposals.)

1. Type of well: Geothermal Producer ☐ Temp. Observation ☒ Low-Temp Thermal ☐ Injection/Disposal ☐
7. Unit Agreement Name

2. Name of Operator
New Mexico State University
8. Farm or Lease Name

3. Address of Operator
Las Cruces, New Mexico 88003
9. Well No.
NMSU-DG-2

4. Location of Well
Unit Letter 1000 Feet From The North Line and 500 Feet From The East Line, Section 27 Township 23 S Range 2 E NMPM.
10. Field and Pool, or Wildcat
NMSU Geothermal

15. Elevation (Show whether DF, RT, GR, etc.)
4163 Feet above M.S.L. (GL)
12. County
Dona Ana

16. Check Appropriate Box To Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☒	PLUG AND ABANDON	☒	REMEDIAL WORK	☐	ALTERING CASING	
TEMPORARILY ABANDON	☐			COMMENCE DRILLING OPNS.	☐	PLUG & ABANDONMENT	
PULL OR ALTER CASING	☐	CHANGE PLANS	☐	CASING TEST AND CEMENT JOB	☐		
OTHER	☐			OTHER			

17. Describe Proposed or completed Operations *(Clearly state all pertinent details, and give pertinenet dates, including estimated date of starting any proposed work)* SEE RULE 203.

Reference is made to a letter from Dr. Lokesh Chaturvedi, Assistant Professor, New Mexico State University, to Mr. Carl Ulvog, Senior Petroleum Geologist, New Mexico Oil Conservation Commission, dated February 12, 1979. This letter forwarded two Form G-103's for two geothermal observation wells NMSU-DG-1 and NMSU-DG-2. The letter notes changes in the location of the two wells from the locations cited in previous correspondence. The locations stated in the Form G-103's of the February 12 letter were the locations where the wells were actually drilled. A subsequent letter from Dr. Paul Morgan of New Mexico State University, dated March 12, 1980, reported damage to the two wells.

This well was drilled as a temperature observation well. It was completed January 4, 1979. Plugging was planned after December 31, 1979. In the course of other research at New Mexico State University, the well was damaged and a portion of the well caved in. The purpose of this Notice is to obtain approval to perform remedial work on the well and then plug and abandon the well. The remedial work will consist of removal of the broken pipe casing and plugging the well with cement from the water table back up to the surface of the ground. All work will be accomplished by a commercial well driller.

18. I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNED [signature] TITLE Assistant Director of Physical Plant Department DATE Nov. 24, 1980

APPROVED BY Carl Ulvog TITLE SENIOR PETROLEUM GEOLOGIST DATE 11-25-80

CONDITIONS OF APPROVAL, IF ANY:

Form G-103
Adopted 10/

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NEW MEXICO OIL CONSERVATION COMMISSION
P. O. Box 2088, Santa Fe 87501

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7. Unit Agreement Name

2. Name of Operator: New Mexico State University
8. Farm or Lease Name

3. Address of Operator: Las Cruces, New Mexico 88003
9. Well No.: NMSU-DG-2

4. Location of Well: Unit Letter 1000 Feet From The North Line and 500 Feet From The East Line, Section 27 Township 23 S Range 2 E NMPM.
10. Field and Pool, or Wildcat: NMSU Geothermal

15. Elevation (Show whether DF, RT, GR, etc.): 4163 Feet above M.S.L. (GL)
12. County: Dona Ana

16. Check Appropriate Box To Indicate Nature of Notice, Report or Other Data

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TEMPORARILY ABANDON ☐		COMMENCE DRILLING OPNS. ☐	PLUG & ABANDONMENT
PULL OR ALTER CASING ☐	CHANGE PLANS ☐	CASING TEST AND CEMENT JOB ☐	
OTHER ☐		OTHER	

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SIGNED [signature] TITLE Assistant Director of Physical Plant Department DATE Nov. 24, 1980

APPROVED BY Carl Ulvog TITLE SENIOR PETROLEUM GEOLOGIST DATE 11-25-80

CONDITIONS OF APPROVAL, IF ANY:

Form G-103
Adopted 10/1/74

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Operator	1	
Land Office		

NEW MEXICO OIL CONSERVATION COMMISSION
P. O. Box 2088, Santa Fe 87501

SUNDRY NOTICES AND REPORTS ON GEOTHERMAL RESOURCES WELLS

5. Indicate Type of Lease State ☐ Fee ☐
5.a State Lease No.

Do Not Use This Form for Proposals to Drill or to Deepen or Plug Back to a Different Reservoir. Use "Application For Permit —" (Form G-101) for Such Proposals.)

1. Type of well: Geothermal Producer ☐ Temp. Observation ☒ Low-Temp Thermal ☐ Injection/Disposal ☐
7. Unit Agreement Name
2. Name of Operator: Lokesh Chaturvedi, Principal Investigator, Department of Energy Geothermal Research Project (Phase II)
8. Farm or Lease Name
3. Address of Operator: Box 3CE, New Mexico State University, Las Cruces, NM 88003
9. Well No. NMSU - DG-2 485
4. Location of Well: Unit Letter ____ 1000 ____ Feet From The North Line and 500 Feet From The East Line, Section 27 Township 23 S. Range 2E NMPM.
10. Field and Pool, or Wildcat: NMSU Geothermal
15. Elevation (Show whether DF, RT, GR, etc.): 4163 Feet above M.S.L. (GL)
12. County: Dona Ana

16. Check Appropriate Box To Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
PERFORM REMEDIAL WORK ☐	PLUG AND ABANDON ☐	REMEDIAL WORK ☐	ALTERING CASING ☐
TEMPORARILY ABANDON ☐		COMMENCE DRILLING OPNS. ☐	PLUG & ABANDONMENT ☐
PULL OR ALTER CASING ☐	CHANGE PLANS ☐	CASING TEST AND CEMENT JOB ☐	
OTHER ☐		OTHER Completion of drilling ☒	

17. Describe Proposed or completed Operations *(Clearly state all pertinent details, and give pertinenet dates, including estimated date of starting any proposed work)* SEE RULE 203.

Drilling started at this location on 12-27-78 at 10:45 a.m. and was completed on 1/3/79 at 7:00 p.m. The drilling was done by Mr. Larry Johnson of Johnson Drilling Company, Las Cruces. Drilling bit size of 5 1/8 inches was used. The hole was completed with a 2-inch diameter steel pipe placed in the entire length of the well. Total depth drilled for the well was 1000 ft. We are making temperature gradient measurements in the well. The drilling and logging was done under the direction and supervision of Dr. N. N. Gunaji, Director, Engineering Experiment Station, NMSU.

FEB 20 1979
OIL CONSERVATION COMM.
Santa Fe

18. I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNED LNChaturvedi TITLE Assistant Professor DATE 2/12/79

APPROVED BY Carl Woog TITLE SENIOR PETROLEUM GEOLOGIST DATE 2/22/79

CONDITIONS OF APPROVAL, IF ANY:

NO. OF COPIES RECEIVED		
DISTRIBUTION		
File	1	✓
N.M.B.M.	1	
U.S.G.S.	1	
Operator	1	
Land Office		

NEW MEXICO OIL CONSERVATION COMMISSION
P. O. Box 2088, Santa Fe 87501

Form G-101
10-1-74

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SANTA FE

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK---GEOTHERMAL RESOURCES WELL

5. Indicate Type of Lease STATE ☐ FEE ☐
5A. State Lease No.

1a. Type of Work: Drill [X] Deepen [ ] Plug Back [ ]

b. Type of Well: Geothermal Producer [ ] Temp Observation [ ] Low-Temp Thermal [X] Injection/Disposal [ ]

7. Unit Agreement Name

8. Farm or Lease Name: NMSU Land

2. Name of Operator: New Mexico State University
Lokesh Chaturvedi, Principal Investigator

9. Well No.: ~~#~~ 485

3. Address of Operator: Box 3CE, NMSU
Las Cruces, NM 88003

10. Field and Pool, or Wildcat

4. Location of Well: UNIT LETTER A LOCATED 1000 FEET FROM THE north LINE
(near existing well NMSU-DG-2)
AND 500 FEET FROM THE east LINE OF SEC. 27 TWP. 23S RGE. 2E NMPM

12. County: Dona Ana

19. Proposed Depth	19A. Formation	20. Rotary or C.T.
850 ft.	sediment	rotary

21. Elevations (Show whether DF, RT, etc.)	21A. Kind & Status Plug. Bond	21B. Drilling Contractor	22. Approx. Date Work will start
4200 ft. above M.S.L.	not required	to be chosen	September 15, 1979

23. PROPOSED CASING AND CEMENT PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	SACKS OF CEMENT	EST. TOP
17 inch	10 inch				

DT-1

The proposed well will be located near NMSU-~~DG-2~~ well (see attached figure). The purpose of this well is to estimate the quality and quantity of hot water at 750 to 850 ft. depths, for possible future use by NMSU.

Prod Well

Order No. R-4860
Exhibit No. B

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: IF PROPOSAL IS TO DEEPEN OR PLUG BACK, GIVE DATA ON PRESENT PRODUCTIVE ZONE AND PROPOSED NEW PRODUCTIVE ZONE. GIVE BLOWOUT PREVENTER PROGRAM, IF ANY.

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

Signed L Chaturvedi Title Associate Professor Date August 24, 1979

(This space for State Use)

APPROVED BY Carl Ulvog TITLE SENIOR PETROLEUM GEOLOGIST DATE 9/4/79

CONDITIONS OF APPROVAL, IF ANY:

NEW MEXICO OIL CONSERVATION COMMISSION

Form G-102
10-1-74

GEOTHERMAL RESOURCES WELL LOCATION AND ACREAGE DEDICATION PLAT

All distances must be from the outer boundaries of the Section

Operator	Lease	Well No.
NMSU - Lokesh Chaturvedi	University Land	485

Unit Letter	Section	Township	Range	County
A	27	23S	2E	Dona Ana

Actual Footage Location of Well:
1000 feet from the north line and 500 feet from the east line

Ground Level Elev.	Producing Formation	Pool	Dedicated Acreage:
4200 ft.	sediment	SANTA FE	Acres

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1. Outline the acreage dedicated to the subject well by colored pencil or hachure marks on the plat below.

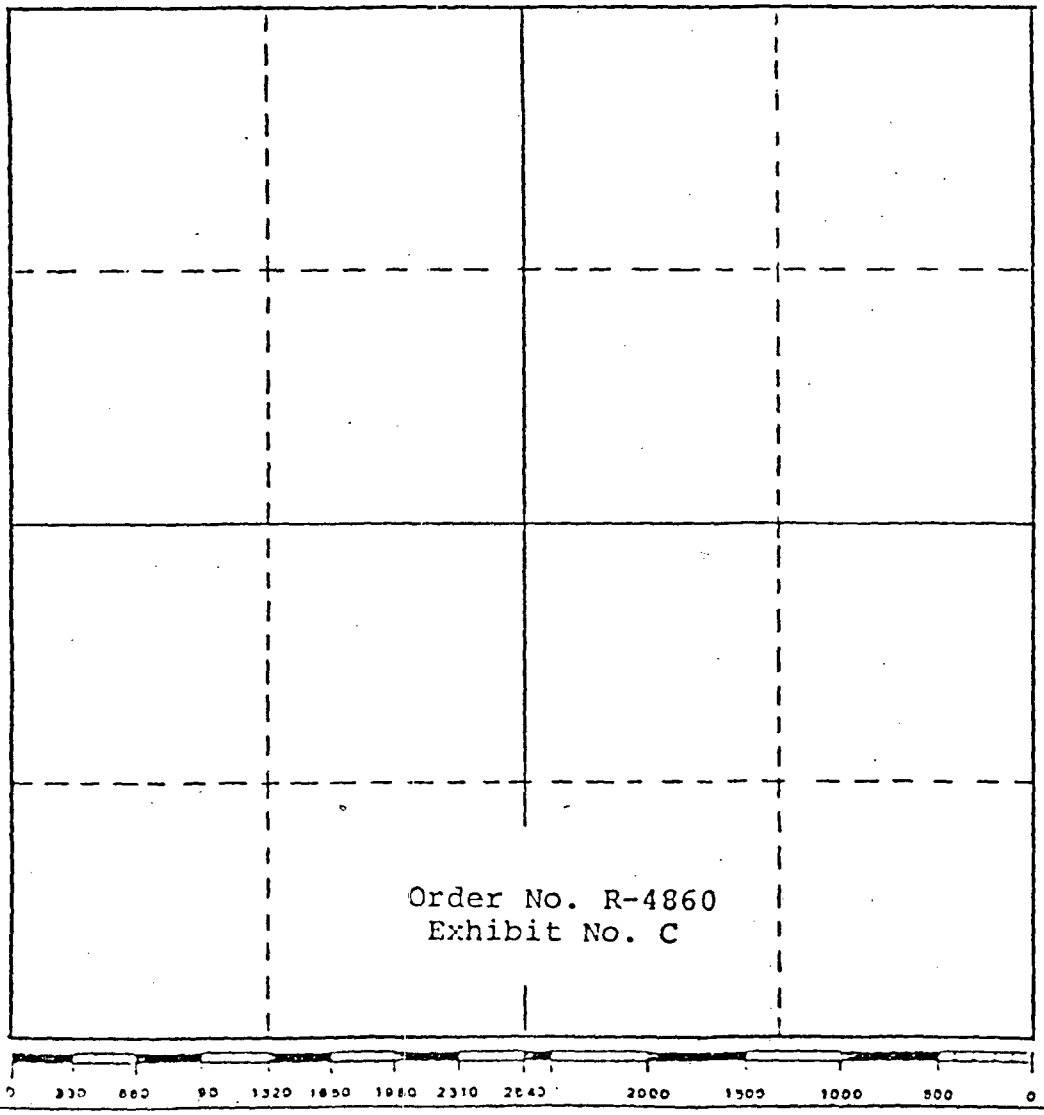
2. If more than one lease is dedicated to the well, outline each and identify the ownership thereof (both as to working interest and royalty).

3. If more than one lease of different ownership is dedicated to the well, have the interests of all owners been consolidated by communitization, unitization, force-pooling. etc?

☐ Yes ☐ No If answer is "yes," type of consolidation _____

If answer is "no," list the owners and tract descriptions which have actually been consolidated. (Use reverse side of this form if necessary.) _____

No allowable will be assigned to the well until all interests have been consolidated (by communitization, unitization, forced-pooling, or otherwise) or until a non-standard unit, eliminating such interests, has been approved by the Commission.



CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief.

L N Chaturvedi

Name: Lokesh Chaturvedi

Position: Associate Professor

Company: New Mexico State University

Date: August 24, 1979

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed

Registered Professional Engineer and/or Land Surveyor

Certificate No.

#3

(3)

now #485

Table 15. Analysis of water sample from the demonstration well for the NMSU campus geothermal project, 1979.

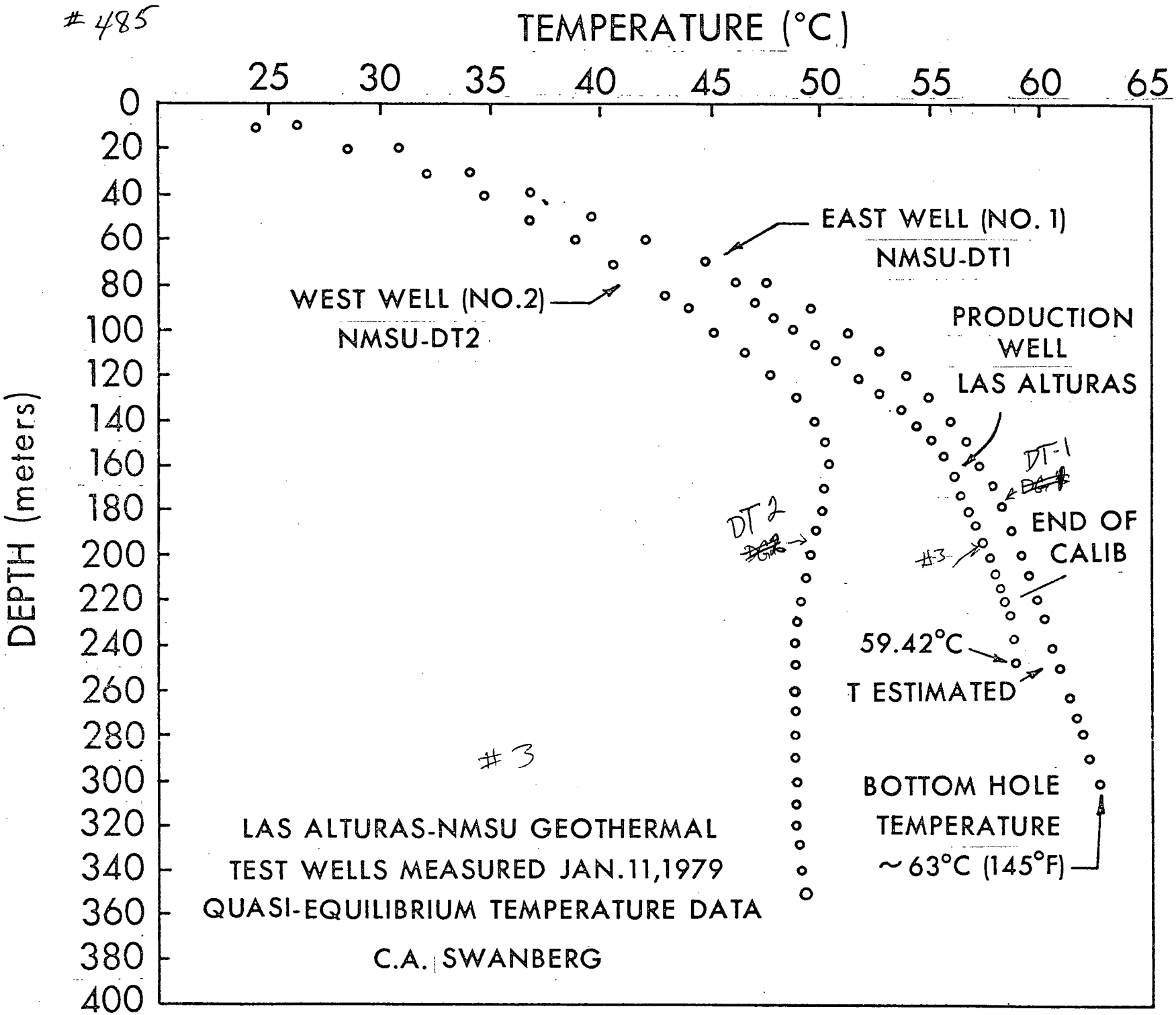
Production

		MMHOS/CM	MG/L				
LAB NO.	PH	E.C.	NA	CA	K	MG	CL
9430	7.25	2.80	372.0	124.0	41.4	25.4	571.1

	MG/L						
SO_4	CO_3	HCO_3	FE	F	B	SiO_2	TDR
52.0	0	579.7	0.10	1.22	0.34	59.5	1820

MG/L (AS $CaCO_3$)	
HARDNESS	ALKILINITY
414	475

#485


TEMPERATURE (°C)
25
30
35
40
45
50
55
60
65
DEPTH (meters)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
EAST WELL (NO. 1)
NMSU-DT1
WEST WELL (NO.2)
NMSU-DT2
PRODUCTION
WELL
LAS ALTURAS
DT-1
DT 2
#3
END OF
CALIB
59.42°C
T ESTIMATED
#3
BOTTOM HOLE
TEMPERATURE
~63°C (145°F)
LAS ALTURAS-NMSU GEOTHERMAL
TEST WELLS MEASURED JAN.11,1979
QUASI-EQUILIBRIUM TEMPERATURE DATA
C.A. SWANBERG

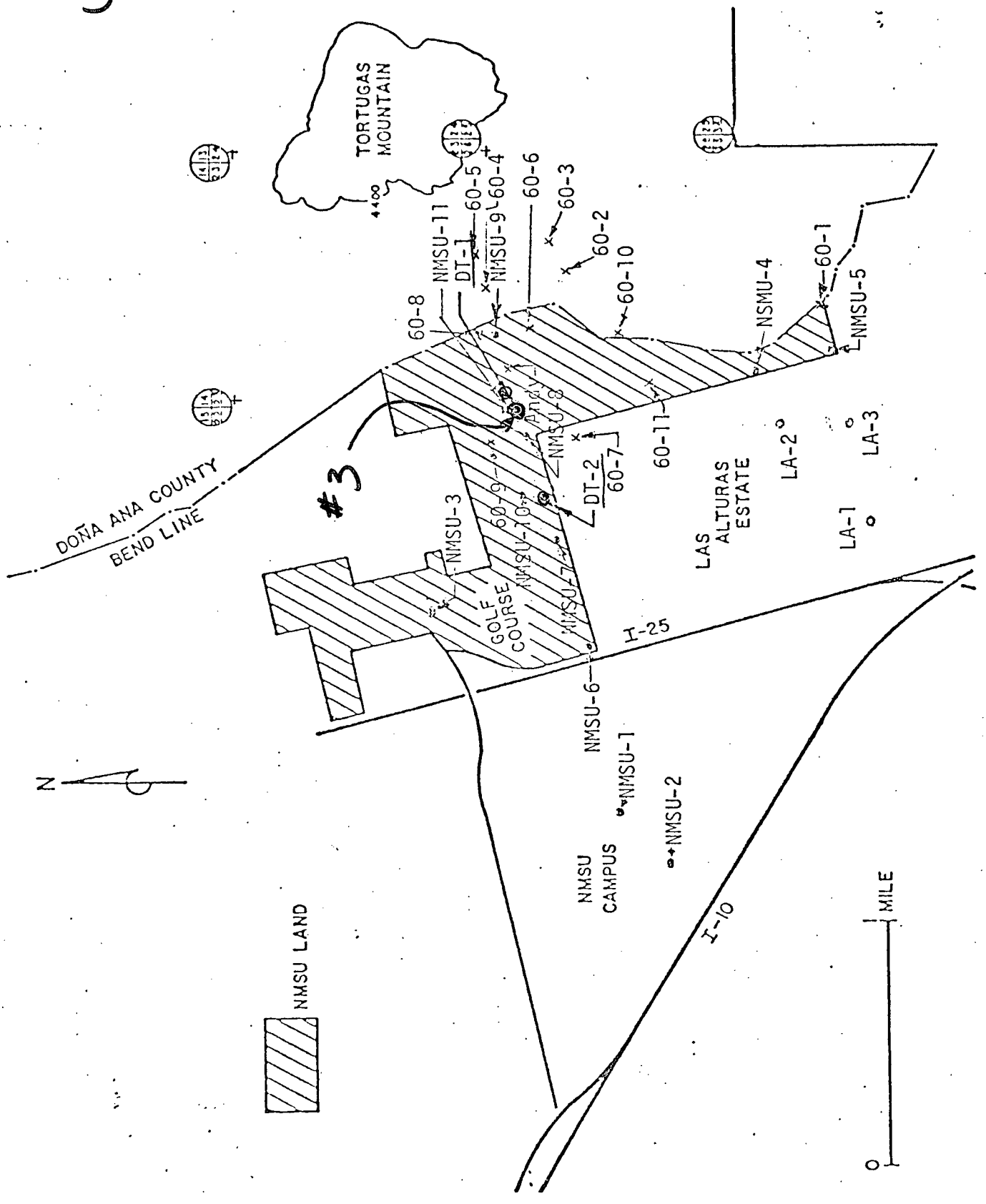
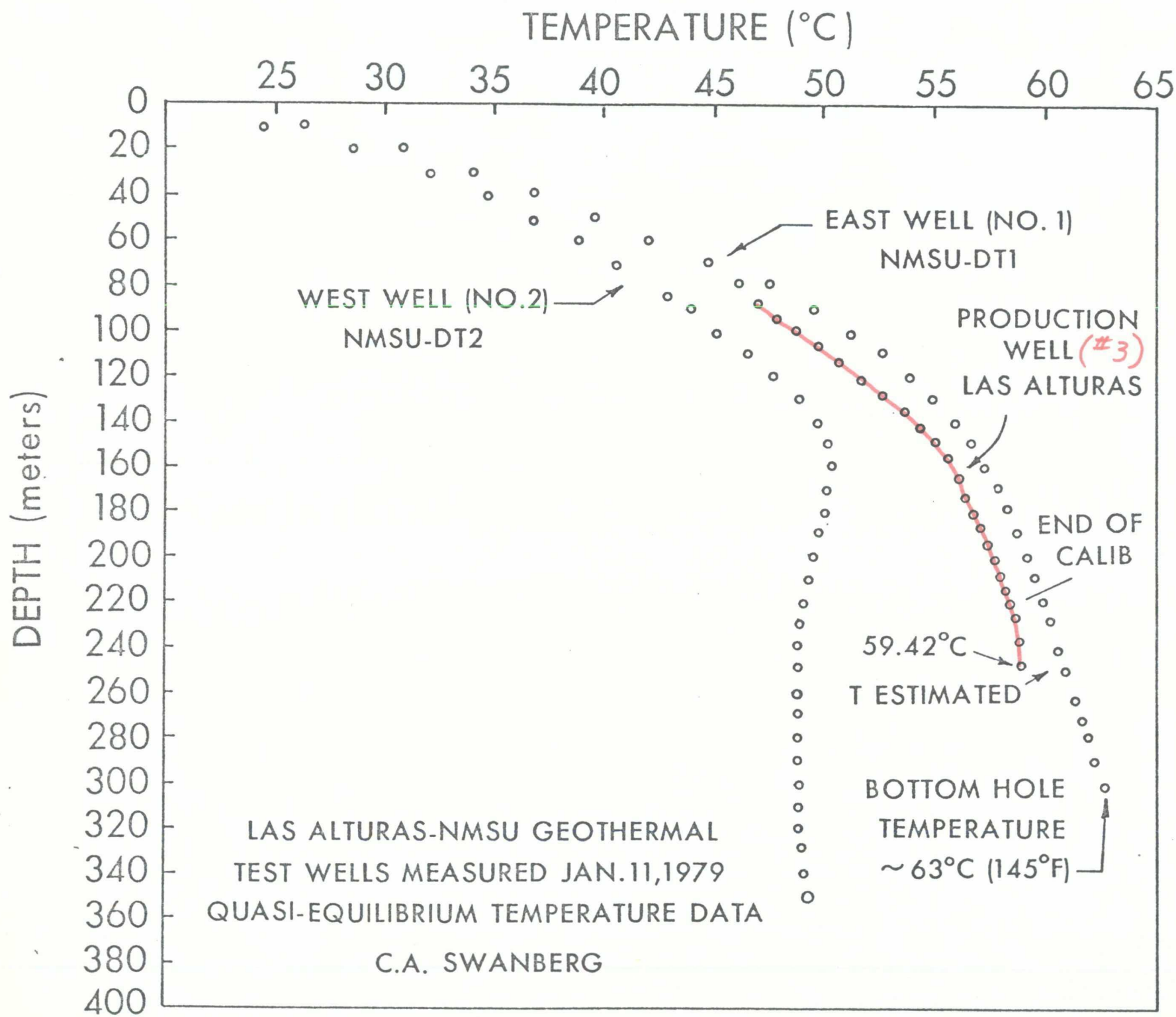


Figure 11. Map of the Las Alturas anomaly area, Las Cruces, New Mexico, showing the location of existing wells and thermal gradient holes.



NMSU #3

well #485

#485

COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING
Box 3CE/Las Cruces, New Mexico 88003
Telephone (505) 646-3803

August 24, 1979

Mr. Carl Ulvog
Senior Petroleum Geologist
New Mexico Oil Conservation Commission
P.O. Box 2086
Santa Fe, NM 87503

Dear Mr. Ulvog:

Please find enclosed a copy of a report on the geological and geophysical log interpretations of the two geothermal wells already drilled on NMSU land east of highway I-25 in Las Cruces.

We are planning to drill a third well, to be called NMSU-DG-3. The purpose of this well is to test the quality and quantity of hot water at 750 ft. to 850 ft. depth, for possible future use by the University. This well will be located near NMSU-DG-2 (see attached map for location). On the basis of experience gained from the previous two wells, we expect a water temperature of 60 to 65°C in this new proposed well.

Kindly also find enclosed forms G-101 and G-102 for permission to drill the new well. We will appreciate it if you could grant us the permission at your earliest convenience.

With best personal regards.

Sincerely yours,

LN Chaturvedi

Lokesh Chaturvedi
Associate Professor

ca
Enclosures: Report
Forms G-101, 102
Well location figure

ANALYSIS OF GEOLOGICAL AND GEOPHYSICAL LOGS OF TWO GEOTHERMAL EXPLORATION WELLS DRILLED ON NMSU LAND, LAS CRUCES, NEW MEXICO

Lokesh Chaturvedi
New Mexico State University
Las Cruces, NM
April, 1979

Work Performed Under Contract No. EW-78-05-07-1717
U. S. Department of Energy
Division of Geothermal Energy

ANALYSIS OF GEOLOGICAL AND GEOPHYSICAL LOGS OF TWO GEOTHERMAL EXPLORATION WELLS DRILLED ON NMSU LAND, LAS CRUCES, NEW MEXICO

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New Mexico State University
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April, 1979

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CONTENTS

ILLUSTRATIONS

ABSTRACT

After careful site selection, two exploratory geothermal wells were drilled on New Mexico State University property in southeastern part of Las Cruces. One of the wells was drilled to a depth of 1200 ft. and the other to 1000 ft. Both wells encountered groundwater table at a depth of 265 feet. An analysis of lithologic log and geophysical logs viz. Resistivity, Spontaneous Potential, Caliper, Gamma Ray, Neutron Porosity and Densilog Porosity shows that both wells encountered essentially the same subsurface geology.

Top 450 ft. appears to consist of gravel and sand with some clay layers belonging to Santa Fe group of basin fill. Underlying this, rhyolite gravels were encountered between 450 and 750 ft. and again between 850 and the bottom of the wells, with an intermediate layer of gravel and sand of heterogenous composition. It has not been determined as yet whether the rhyolite gravels represent a rhyolite flow, such as an extension of soledad rhyolite encountered in Organ Mountains or a deposit of short distance transported material, such as an alluvial fan or bajada slope deposit. The bottom hole temperature in both wells was approximately 63°C.

Introduction

Las Alturas geothermal area, which lies between highway I-25 and Tortugas Mountain in the Southeastern part of Las Cruces, has been under active investigation since at least 1975 (Gunaji, et.al. 1978; Jiracek and Gerety, 1978; Swanberg, 1975). In November, 1978, the decision was made to drill two exploratory wells, 1000 to 1500 ft. deep, to gather information regarding the subsurface conditions -- stratigraphy, temperature gradient, groundwater, etc. Location of the two wells was determined on the basis of previous work completed, primarily electric resistivity and shallow temperature gradient survey. The wells were drilled about 0.6 mile and 1 mile east respectively from the NMSU solar houses south of NMSU golf course along the dirt road going towards Tortugas Mountain. Location of the two wells is shown on Figure 1.

The two wells, numbered NMSU-DG-1 and NMSU-DG-2 (New Mexico State University - Deep Geothermal Wells 1 and 2) were drilled during December 27, 1978 to January 3, 1979, by Johnson Drilling Company of Las Cruces, using a rotary drilling rig. Well no. 2 is located at 52 ft. higher ground elevation compared to well no. 1 (4163 ft. and 4111 ft. above m.s.l. respectively). The bottom hole temperature in both wells was approximately 63°C.

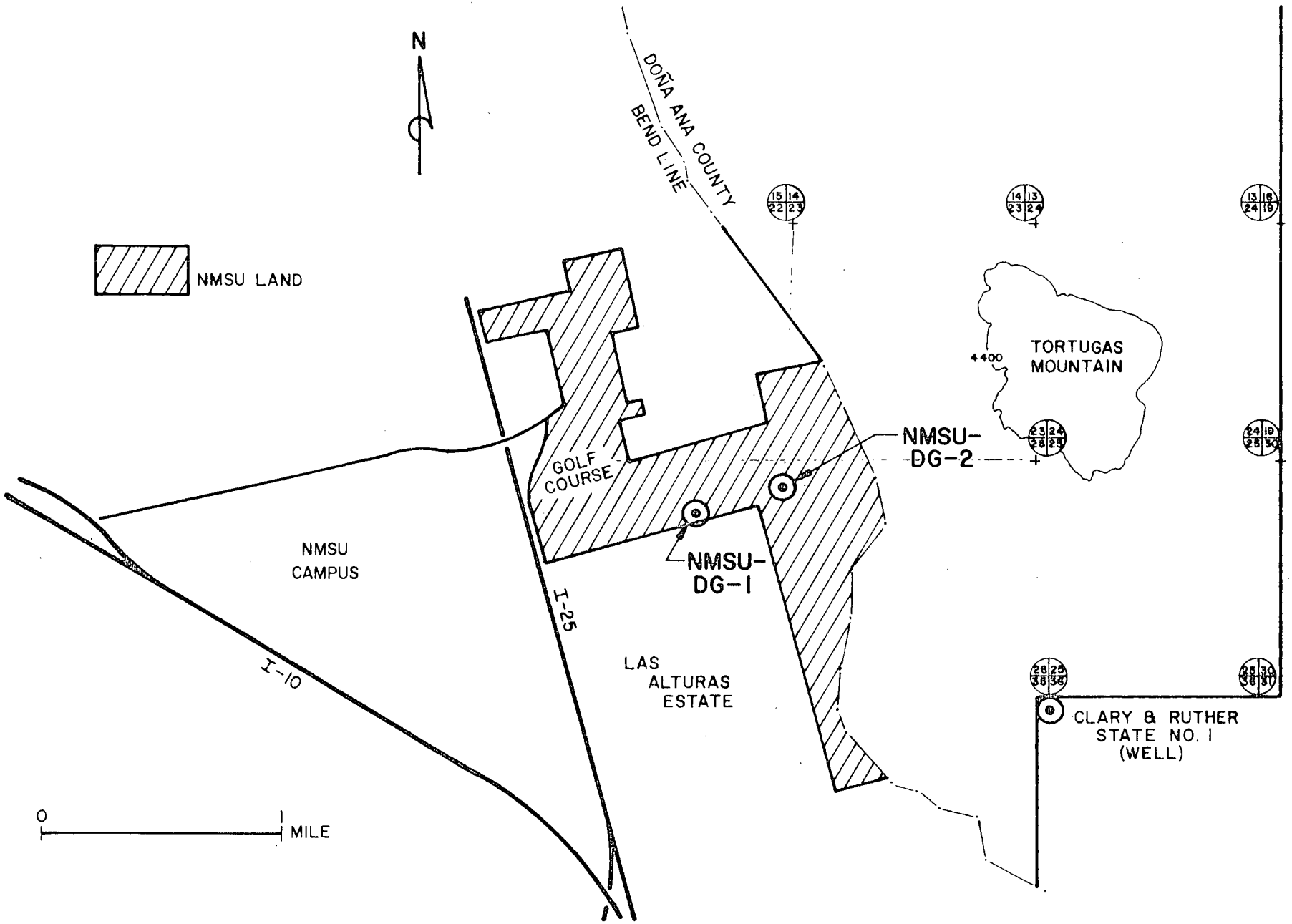


Fig. 1. Location of wells NMSU-DG-1 and NMSU-DG-2

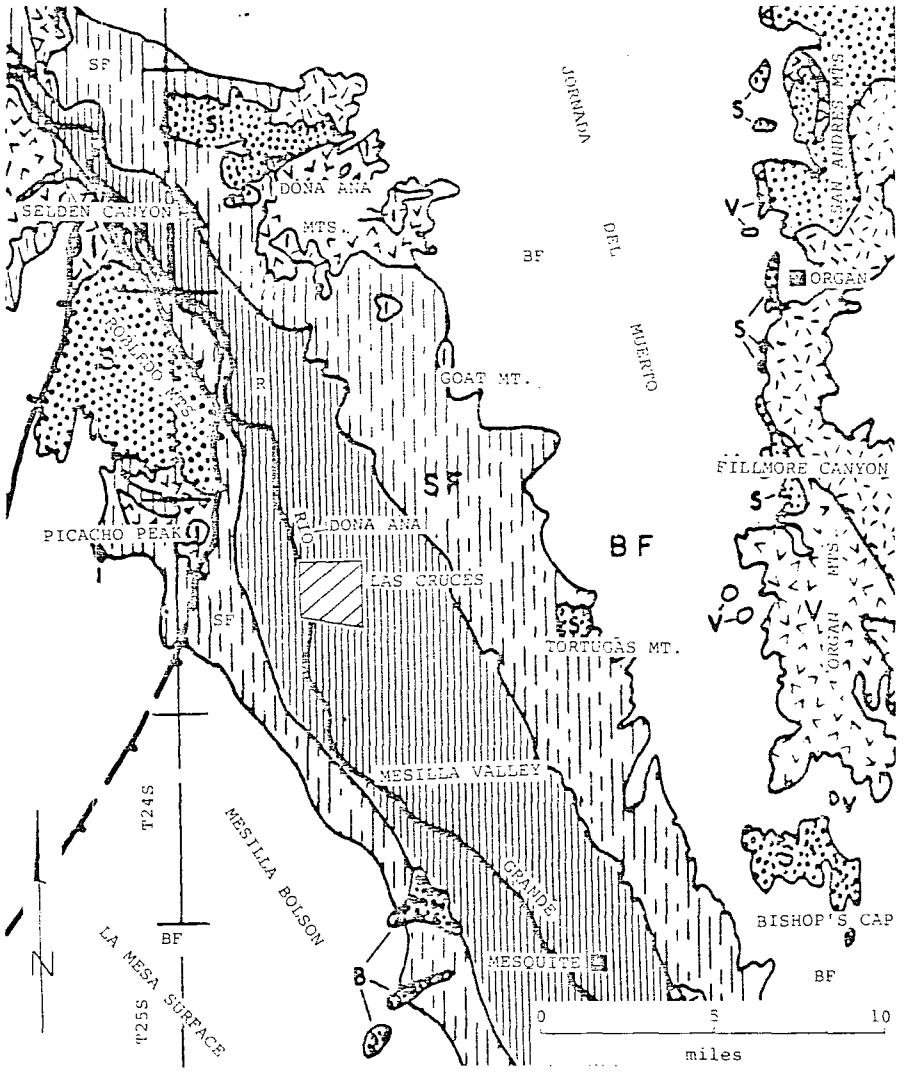
Geologic Setting

Figure 2 shows a generalized geologic map of the Las Cruces area, reproduced here from King and Hawley (1975). The area contains Paleozoic, Cretaceous and Tertiary sedimentary and volcanic rocks. Igneous intrusive rocks of Precambrian and Tertiary age make up the cores of the San Andres-Organ Mountain chain, Dona Ana Mountains, Goat Mountain and Picacho Mountain. Surface geologic material near the wells consists of unconsolidated basin fill alluvium of the Santa Fe group. This material mainly consists of sand and gravel of coalescent alluvial-fan surfaces near the surface.

Since much of the unconsolidated material expected in these wells must have been transported from the Organ mountains and Tortugas Mountain area, a knowledge of rock types exposed in these outcrops is essential. Tortugas Mountain is the nearest rock outcrop and rocks exposed there consist primarily of Paleozoic sedimentary rocks-mainly limestone. Thick sequence of silicic volcanics consisting of basal ash-flow tuffs (cueva tuff) and flow-banded rhyolite and ash-flow tuff (Soledad Rhyolite) is exposed in the Organ Mountains (Seager, 1975). The Organ batholith consists of Quartz Monzonite, which is expected to yield fragments of quartz, feldspars, mica, clay minerals, etc.

Geologic Log

Sampling Procedure. Samples were collected at 10 feet interval from both wells. The material coming out of the well was passed through a screen to remove the drilling mud and then collected unwashed in Canvass sample bags. Even though this method resulted in some samples being dried lumps, it gave a better idea of the percentage of fines in each sample. The bags were numbered according to the depth of sample collection and stored for later study.



EXPLANATION

R — Valley-fill alluvium; late Quaternary; clay to gravel, less than 80 ft thick.

B — Olivine basalt flows and volcanic cones; Quaternary, generally post date the Santa Fe Group.

BF — Basin-fill surface. Santa Fe Group, with discontinuous overlay (generally less than 25 ft thick) of younger alluvial, eolian and minor lacustrine deposits.

SF — Santa Fe Group basin fill; Miocene to middle Pleistocene; clay to gravel; locally as much as 4,000 ft thick. Also discontinuous overlay (generally less than 100 ft thick) of younger valley slope deposits.

V — Volcanic rocks, and associated clastic sedimentary rocks, undifferentiated; early and middle Tertiary.

S — Sedimentary rocks, undifferentiated; Paleozoic, Cretaceous and early Tertiary.

I — Intrusive rocks, undifferentiated, and associated metamorphics; Precambrian and Tertiary.

Faults involving significant dislocements of basin fill.

Fig. 2. Geologic map of Las Cruces area

(From King and Hawley, 1975)

Laboratory Procedure. The samples were examined under a binocular microscope at 10x-25x magnification. Most samples were examined first unwashed and then again after washing them. Examination of unwashed samples gave an idea of the presence of fine material other than the drilling mud. Washing the sample made the identification of rock types much easier.

Interpretations. Figures 3 and 5 show a summary of lithologic logs. These summaries were prepared after a detailed examination of 120 samples for well no. 1 and 100 samples for well no. 2. There is a great deal of similarity of lithologic horizons encountered by the two wells. The contacts encountered by NMSU-DG-2 are 20-50 ft. higher than those found by NMSU-DG-1. This is to be expected, since the sediments (and flow?) are derived from the source area to the east and the dip is to the west. The eastern well (DG-2) is also situated 50 ft. higher than DG-1.

There are five major zones identified by lithologic logging. The top layer consists of sand and medium to coarse size gravel apparently derived from a host of rock types viz. granitic intrusive rock, rhyolite flow, ash flow tuff, and others. The water table was encountered at about 265 ft. below the ground surface in both wells. All geophysical well logs clearly indicate this. Lithology below the water table is similar to that found above the water, except that some distinct layers of clay were encountered in sand and gravel. From about 420 ft. down, the rock cuttings indicate a very uniform lithology, with the exception of an approximately 100 ft. thick layer between 770 ft. to 870 ft. in DG-1 and 720 ft. to 850 ft. in DG-2. This layer consists of clearly fluvial subrounded gravel, sand and some clay, of a heterogenous composition. The layers above and below this apparently fluvial zone present a problem which has not yet been completely resolved. The zone between 420 ft. to 720 ft. and 850 ft. to the bottom consists of very uniform,

NMSU – DG-1 (NMSU DEEP GEOTHERMAL WELL NO. 1)

LOCATION: 1800' FNL, 2200' FEL, SEC. 27, TWP. 23S, R2E
DOÑA ANA COUNTY, NEW MEXICO
GROUND LEVEL: 4111 FEET ABOVE MEAN SEA LEVEL
BIT SIZE: 5-1/8 INCHES
DATE LOGGED: 1-3-1979

DEPTH (FEET)	LITHOLOGY	RESISTIVITY/SP	CALIPER	GAMMA-RAY	COMPENSATED NEUTRON	COMPENSATED DENSILOG
0	SAND AND GRAVEL. SOME CLAY. ROUNDED TO SUBROUNDED (QUARTZ, FELDSPARS, RHYOLITE, IGNEOUS ROCKS)	HIGH RESISTIVITY (≈ 100 ohm-m) (DRY SAND AND GRAVEL)	MINOR FLUCTUATIONS	UNIFORM 100 API UNITS (LOW)	4-10 %	4-10 %
50						
100						
150						
200	COURSE GRAVEL AND SAND		CAVING	FLUCTUATIONS	FLUCTUATING	FLUCTUATING
250		WILD FLUCTUATIONS	CAVING			
300	SAND AND CLAY	LOW, 2-3 ohm-m	MINOR FLUCTUATIONS	UNIFORM 80API	22-30 % (WATER SAT.)	22-30 % (WATER SAT.)
350	LIMESTONE GRAVEL AND CLAY	6-9 ohm-m		WILD FLUCTUATIONS 100-220 API		
400	GRAVEL, SAND, CLAY (RHYOLITE, LIMESTONE IGNEOUS ROCKS SUBROUNDED)	FLUCTUATING, 2-20 (ALTERNATING LAYERS OF CLAY & SAND/GRAVEL)				
450	ANGULAR TO SUBANGULAR, APPROX. 1/4" FRAGMENTS OF RHYOLITE, ANDESITE, RHYOLITIC ASH-FLOW TUFF. NO SAND OR CLAY.	VERY UNIFORM ≈ 15 ohm-m		OFF SCALE CONDITION > 200 API (HIGHLY RADIOACTIVE FORMATION)	14-20 %	14-20 %
500						
550						
600						
650						
700						
750						
800	SAND AND GRAVEL	LAYERS OF 3 ohm-m AND > 10 ohm-m FLUCTUATIONS		WILD FLUCTUATIONS 100-200 API	FLUCTUATING 14-30 %	FLUCTUATING 14-30 %
850	COURSE SAND					
900	ANGULAR TO SUBANGULAR, APPROX. 1/4" FRAGMENTS OF RHYOLITE, RHYOLITIC ASHFLOW TUFF, ETC.	VERY UNIFORM	CAVING	OFF SCALE CONDITION (HIGHLY RADIOACTIVE FORMATION)	12-15 %	12-15 %
950		4 ohm-m	RUGGED WALL (MUCH FLUCTUATIONS)		22 %	22 %
1000		≈ 15 ohm-m EXCEPT A 5 FT. LAYER AT 950-955' (FRACTURED RHYOLIT WITH HOT WATER IN FRACTURES ?)			12-15 %	12-15 %
1050						
1100					14-20 %	14-20 %
1150						
1200						

Fig. 3. Summary of all logs for NMSU-DG-1

NMSU – DG-1 (NMSU DEEP GEOTHERMAL WELL NO. 1)

INTERPRETED SUBSURFACE CONDITIONS BASED ON ALL LOGS

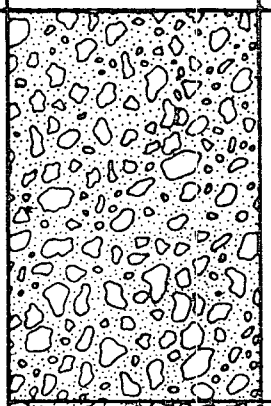
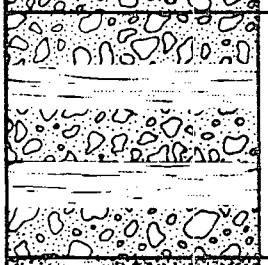
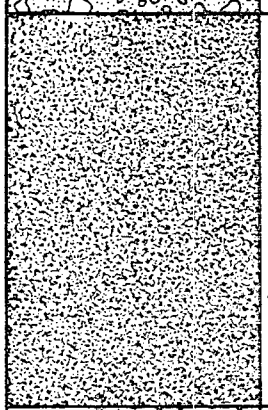
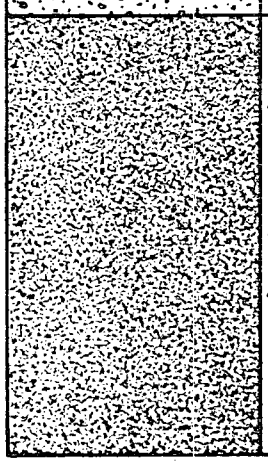
DEPTH (FEET)	GRAPHIC LOG	DESCRIPTION
0 50 100 150 200 250		SAND AND GRAVEL. ROUNDED TO SUBROUNDED GRAVEL PIECES CONSIST OF QUARTZ, FELDSPARS, RHYOLITE, ASH FLOW TUFFS, VARIETY OF IGNEOUS ROCKS, ETC. PROBABLY SANTA FE GROUP BASIN FILL. DRY. ABOVE THE WATER TABLE.
300 350 400 450		WATER TABLE AT 265FT. BETWEEN 265FT. AND 450FT., THE SECTION CONSISTS OF LAYERS OF SAND, GRAVEL AND CLAY WITH LITHOLOGIC REPRESENTATION OF RHYOLITE, OTHER IGNEOUS ROCKS AND LIMESTONE (?). ASSOCIATED SAND IS INVARIABLY CALCAREOUS. SATURATED SANTA FE GROUP BASIN FILL.
500 550 600 650 700 750		FROM 450FT. TO ABOUT 770FT., ALL LOGS SHOW A VERY UNIFORM SECTION. CUTTINGS FROM DRILLING YIELD ANGULAR TO SUBANGULAR FRAGMENTS WITH AN AVERAGE OF 1/4" DIAMETER OR FINER. LITHOLOGY CONSISTS OF ALMOST 100% RHYOLITIC ROCK FRAGMENTS, WHICH SOMETIMES SHOW BANDED TUFF FEATURES AND SOME PIECES APPEAR GREYISH LIKE ANDESITIC ROCK. IS IT A FANGLOMERATE DEPOSIT OR FRACTURED RHYOLITIC FLOW?
800 850		LENSES OF SAND AND GRAVEL, COURSE SAND AND CLAY CONSISTING OF MORE HETEROGENEOUS LITHOLOGY THAN ABOVE. PROBABLY CONTAINS WATER.
900 950 1000 1050 1100 1150 1200		LITHOLOGY AND TEXTURE VERY SIMILAR TO THE 450-770FT. ZONE. RESISTIVITY, GAMMA RAY, COMPENSATED NEUTRON AND COMPENSATED DENSILOG VERY SIMILAR TO THE ABOVE ZONE AS WELL. CALIPER SHOWS RUGGED WALL CONDITIONS. AT 950FT. HEAVY MUD LOSS WAS ENCOUNTERED. RESISTIVITY SHOWS A LOW RESISTIVITY LAYER AND NEUTRON AND DENSILOG SHOW A HIGH POROSITY ZONE ABOUT 5 FT. POSSIBLY A FRACTURED ZONE WITH HOT WATER.

Fig. 4. Interpreted composite log of NMSU-DG-1

fine or medium (approximately 1/8" to 1/4") angular to subangular (and occasionally subrounded) fragments of rhyolite or rhyolitic tuff. It would be easy to call these zones as rhyolite flows (perhaps Soledad Rhyolite) except that there are indications to the contrary. Although a majority of fragments sampled from both wells for these zones are angular, there are enough subangular/subrounded fragments to indicate that these fragments are transported some distance. Also, although the drilling through these zones was difficult, it was not difficult enough to consider these as continuous rhyolite flow beds. These zones could possibly represent highly fractured rhyolite flows separated by a 100-150 ft.-thick sedimentary bed or could possibly represent alluvial fan or bajada deposits developed on rhyolitic bedrock. All geophysical logs attest to the uniformity of these zones. The question is left here unresolved with the suggestion that in any future drilling through these zones, core sampling be done through at least parts of these zones and the cores carefully analyzed.

Geophysical Logs

Introduction. Two sets of logs were run in each well soon after drilling was completed. The logs were run by the commercial logging firm-Dresser Atlas. One set, called "Dual Induction Focused Log" contained Spontaneous Potential and three resistivity logs viz. Shallow Focused, Medium Induction and Deep Induction. The second set, called, "Compensated Densilog/Compensated Neutron" contained Caliper, Gamma Ray, Compensated Neutron and Compensated Densilog. Figures 3 and 5 show the interpretations of each of these logs. Figures 7 and 8 show the original logs for wells no. 1 and 2 respectively. Borehole geophysical logs have been successfully used by petroleum, mining and to a lesser extent, groundwater industries for almost half a century or more.

NMSU-DG-2 (NMSU DEEP GEOTHERMAL WELL NO. 2)

LOCATION: 1000'+ FNL, 500'+ FEL, SEC. 27, TWP. 23S, R2E
DONA ANA COUNTY, NEW MEXICO
GROUND LEVEL: 4163 FEET ABOVE MEAN SEA LEVEL
BIT SIZE: 5-1/8 INCHES
DATE LOGGED: 1-4-1979

DEPTH (FEET)	LITHOLOGY	RESISTIVITY/SP	CALIPER	GAMMA-RAY	COMPENSATED NEUTRON	COMPENSATED DENSILOG
0 50 100 150 200 250	SAND AND GRAVEL, SOME CLAY. ROUNDED TO SUBROUNDED (QUARTZ, RHYOLITE, IGNEOUS ROCKS)	HIGH RESISTIVITY (DRY SAND AND GRAVEL)	UNIFORM 5FT.	UNIFORM 80-100 API UNITS	4-10%	4-10%
250 300 350 400	COURSE GRAVEL AND SAND SAND WITH SOME GRAVEL. SAND AND GRAVEL	LOW RESISTIVITY, MINOR FLUCTUATIONS (WATER SATURATED SAND AND GRAVEL WITH SOME CLAY LAYERS)	CAVING CAVING CAVING UNCAVED	FLUCTUATIONS 80-160 API UNITS	22-30% (WATER SAT.)	22-30% (WATER SAT.)
450 500 550 600 650 700	SUBANGULAR TO SUBROUNDED FRAGMENTS, MOSTLY RHYOLITE AND ANDESITIC ASH FLOW TUFF - APPROX. 1/4 INCH PIECES	VERY UNIFORM RESISTIVITY PROFILE AT 10-20 ohm-m. VERY LITTLE SEPARATION BETWEEN DEEP INDUCTION AND SHALLOW FOCUSED LOGS	MANY ZONES OF CAVING 2' TO 10' THICK EACH (MAXIMUM HOLE DIAMETER IS 7 INCHES)	HIGH GAMMA-RAY > 200 API UNITS	16-20%	16-20%
750 800 850 900 950 1000	GRAVEL AND SAND OF VARIED COMPO. WITH SOME ROUNDED GRAVEL OF ANDESITE FINE PIECES OF RHYOLITE, SOME QUARTZ & FELDSPARS, ETC.	LOW RESISTIVITY, MINOR FLUCTUATIONS (POSSIBLE WATER SAT. WITH SAND & GRAVEL WITH CLAY LAYERS) VERY UNIFORM RESISTIVITY PROFILE AT 10-15 ohm-m VERY LITTLE SEPARATION		100-160 API >200 API 100-200 API >200 API UNITS	12-26% 12-16%	12-26% 12-16%

Fig. 5. Summary of all logs for NMSU-DG-2

NMSU-DG-2 (NMSU DEEP GEOTHERMAL WELL NO. 2)

INTERPRETED SUBSURFACE CONDITIONS BASED ON ALL LOGS

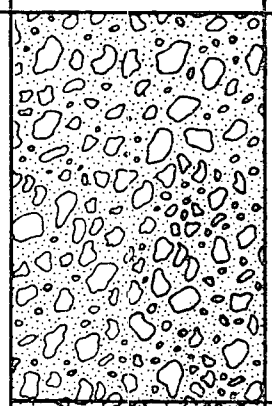
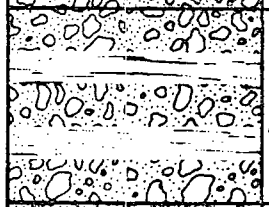
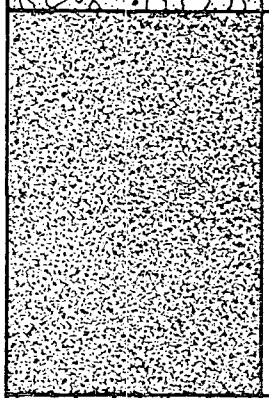
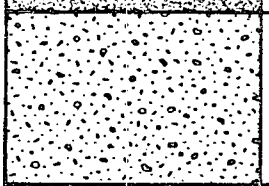
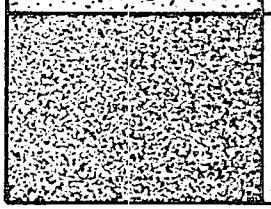
DEPTH (FEET)	GRAPHIC LOG	DESCRIPTION
0 50 100 150 200 250		SAND AND GRAVEL. ROUNDED TO SUBROUNDED GRAVEL PIECES CONSIST OF QUARTZ, FELDSPARS, RHYOLITE, ASH FLOW TUFFS, A VARIETY OF IGNEOUS ROCKS, ETC. HIGH RESISTIVITY, UNIFORM CALIPER WITH MINOR FLUCTUATIONS, UNIFORM GAMMA RAY AND UNIFORM LOW POROSITY DENSILOG AND NEUTRON. PROBABLY SANTA FE GROUP BASIN FILL. DRY. ABOVE THE WATER TABLE.
300 350 400		WATER TABLE CLEARLY INDICATED BY ALL LOGS AT 265FT BELOW SURFACE. FROM 265FT. DOWN TO ABOUT 420FT., THERE APPEAR TO BE LAYERS OF SAND AND GRAVEL ALTERNATING WITH LAYERS OF CLAY. LOW RESISTIVITY, CAVED ZONES, FLUCTUATING GAMMA RAY, HIGH POROSITY VALUES AND LITHOLOGY ALL INDICATE THIS.
450 500 550 600 650 700		BETWEEN 420 AND 450FT. BELOW SURFACE DOWN TO 720FT., THERE IS A ZONE OF SUBANGULAR TO SUBROUNDED FRAGMENTS OF RHYOLITE, RHYOLITIC ASH FLOW TUFF, ANDESITE AND ANDESITE ASH FLOW TUFF - APPROX. 1/4 INCH DIAMETER PIECES OR FINER. UNIFORM RESISTIVITY AND HIGH GAMMA RAY FOR THIS ZONE.
750 800 850		FROM 720FT. TO 850FT., THERE ARE GRAVEL AND SAND OF MORE HETEROGENEOUS COMPOSITION WITH SOME FLATTENED, ROUNDED GRAVELS OF ANDESITE.
900 950 1000		FROM 850FT TO THE BOTTOM OF THE WELL, THE ZONE IS CHARACTERIZED BY VERY UNIFORM PROFILES OF RESISTIVITY, GAMMA RAY, NEUTRON AND DENSILOG. LITHOLOGY SHOWS FINE CHIPS OF RHYOLITE AND MINOR AMOUNTS OF QUARTS, FELDSPARS, ETC.

Fig. 6. Interpreted composite log of NMSU-DG-2

Log interpretation techniques have, therefore, been perfected for sedimentary strata analysis. Log interpretation of logs run in igneous rocks sequence generally has to rely on known properties of such materials and how these may affect various logging parameters. Not much interpretation literature is available for log interpretation for geothermal parameters identification, i.e. rock permeability, temperature vs. salinity affects on resistivity and spontaneous potential in igneous rock sequence.

Following is a summary of points of special interest concerning each log type.

Resistivity/Spontaneous Potential. Spontaneous potentials are usually produced by interactions between shale, interstitial water in sandstone and drilling fluid. Since there are no classic shale, sandstone, limestone sequence here, SP curve is generally flat and is not of much use.

Resistivity contrasts too are not as pronounced here as would be expected in a classic sedimentary sequence. However, induction and shallow focused resistivity profiles are used here to identify water-bearing gravel beds from essentially dry and uniform rhyolite rock matrix.

Caliper. Caliper log has been used to delineate areas of caving and of rugged rock like section. It has also been used to correctly interpret other logs, since in caved areas, other log responses are seriously affected by the borehole fluids rather than formation properties.

Gamma Ray. Gamma Ray log is a passive log. It counts natural radiation without providing any stimulation. In sedimentary sequence, Gamma Ray log is commonly known as shale log, since Potassium 40 found in shales show a high response. In the two holes presently under discussion, Gamma Ray showed a high value (>200 A.P.I. units) against rhyolite zones. This is to be expected, since rhyolite has abundant potassium feldspar (orthoclase) and potassium mica (Sericite/muscovite), which contain radioactive Potassium 40.

Neutron/Densilog Porosity. These logs are a measure of hydrogen ion concentration in the formation rock. The highest porosity in both the wells is indicated, as would be expected, against water saturated gravel and sand just below the water table. However, fairly high porosity (16-20% in the upper rhyolite layer, 12-16% in the lower rhyolite layer) is indicated against rhyolite layers. This could be due to water trapped within crystals in igneous rocks in minerals such as biotite and hornblende. There must be water in fractures as well. The porosity indicated is, therefore, most likely much higher than the acutal porosity of these zones. Densilog is a variation of Neutron logging. Both provide almost identical values for each strata.

Interpretations. Figures 3 and 5 show a summary of characteristics noted for different zones by each logging device. The acutal logs are shown in Figures 7 and 8.

There is a good correspondence between responses recorded by each logging tool. Thus, dry sand and gravel show relatively high resistivity (approx. 100 ohm-m), uniform and relatively low gamma ray response (80 to 100 A.P.I. units) and low neutron/densilog porosity indicating dry conditions.

Alternating layers of sand/gravel and clay show fluctuating resistivity, caving zones in caliper log, fluctuating gamma ray (high against clay due to presence of potassium 40) and fluctuating porosity log response.

Water table is clearly indicated by all logs. Resistivity curves record a sharp decrease after some fluctuations, perhaps due to the presence of capillary water above the actual water table. Highest porosity values are indicated by Neutron and Densilog against the water saturated zones.

Against Rhyolite zones, resistivity values are higher and uniform throughout, gamma ray response is highest (>200 A.P.I. units) and porosity values are 14-20% (probably high, as explained above).

Conclusion.

The two wells, NMSU-DG-1 and NMSU-DG-2 have encountered Bolson sediments of Santa Fe group to a depth of approximately 450 ft. Below this level, rhyolite rock gravel was encountered which could be a fractured rhyolite flow or an ancient alluvium fan deposit derived from Soledad rhyolite. There is a second layer of gravel and sand between approximately 750 to 850 feet, below which another layer of rhyolite "gravel" was encountered. Ground water table in both wells was encountered at 265 feet below the ground surface.

The ground surface, as well as all the horizons, slope to the west, dropping about 50 feet in 0.4 mile, i.e. a dip of about 1.4°.

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Discussions with Professors William R. Seager and Robert Robinson of the Earth Science Department (NMSU) helped in clarifying some points regarding local geologic setting.

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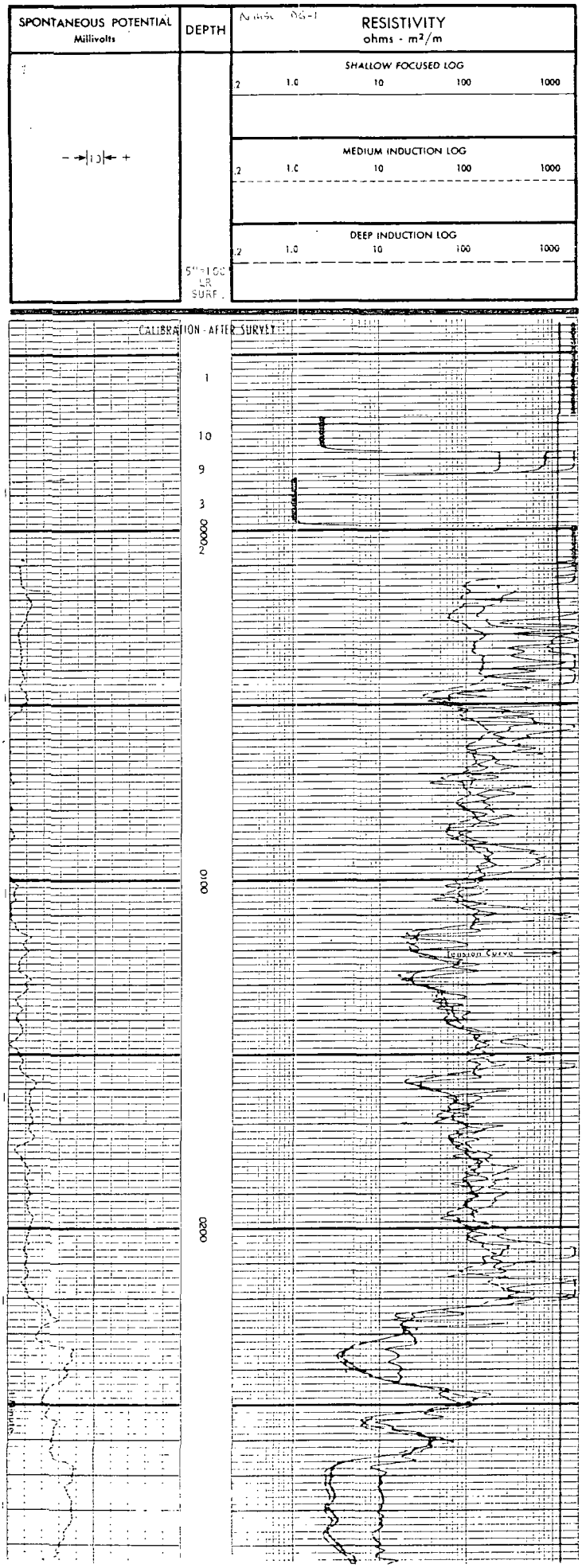
APPENDICES

Copies of geophysical logs

Figures 7 and 8



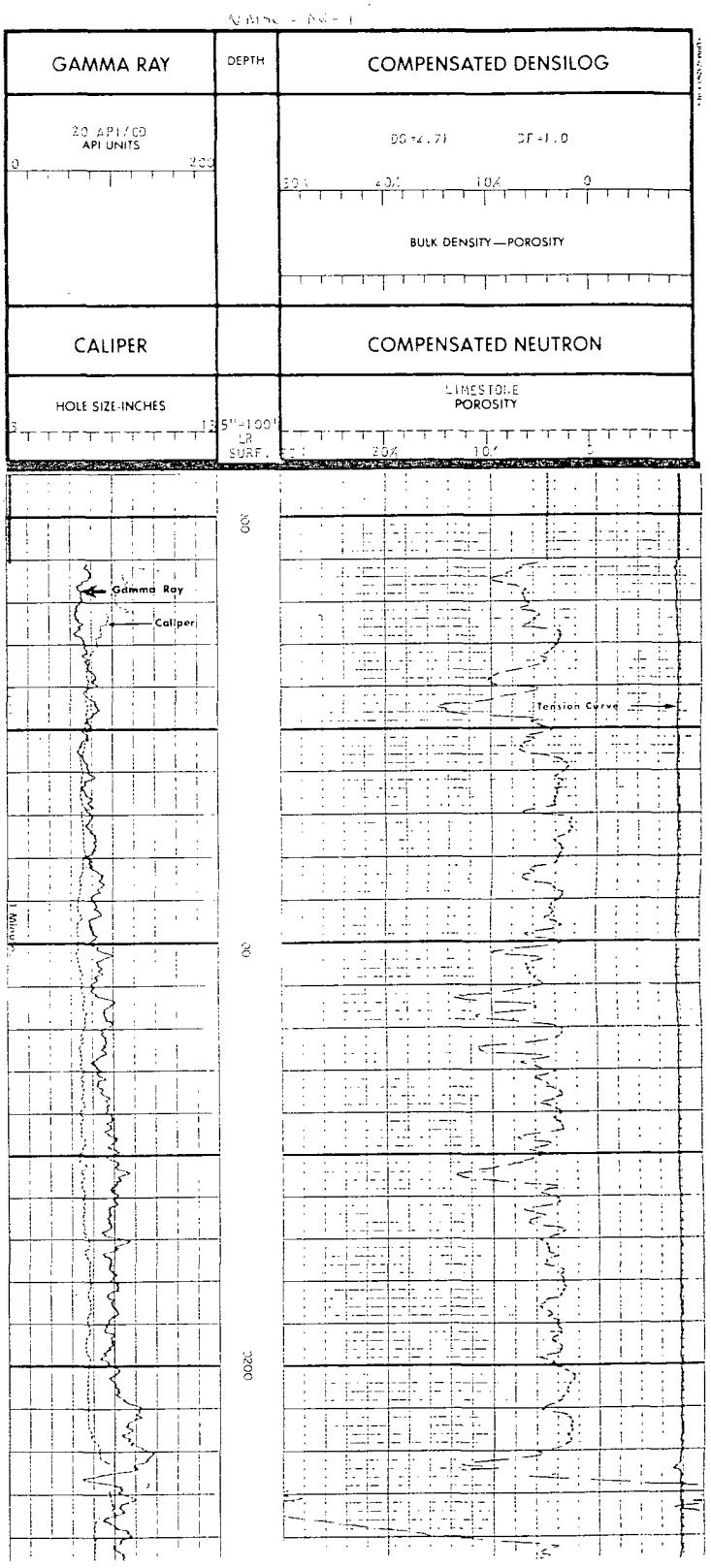
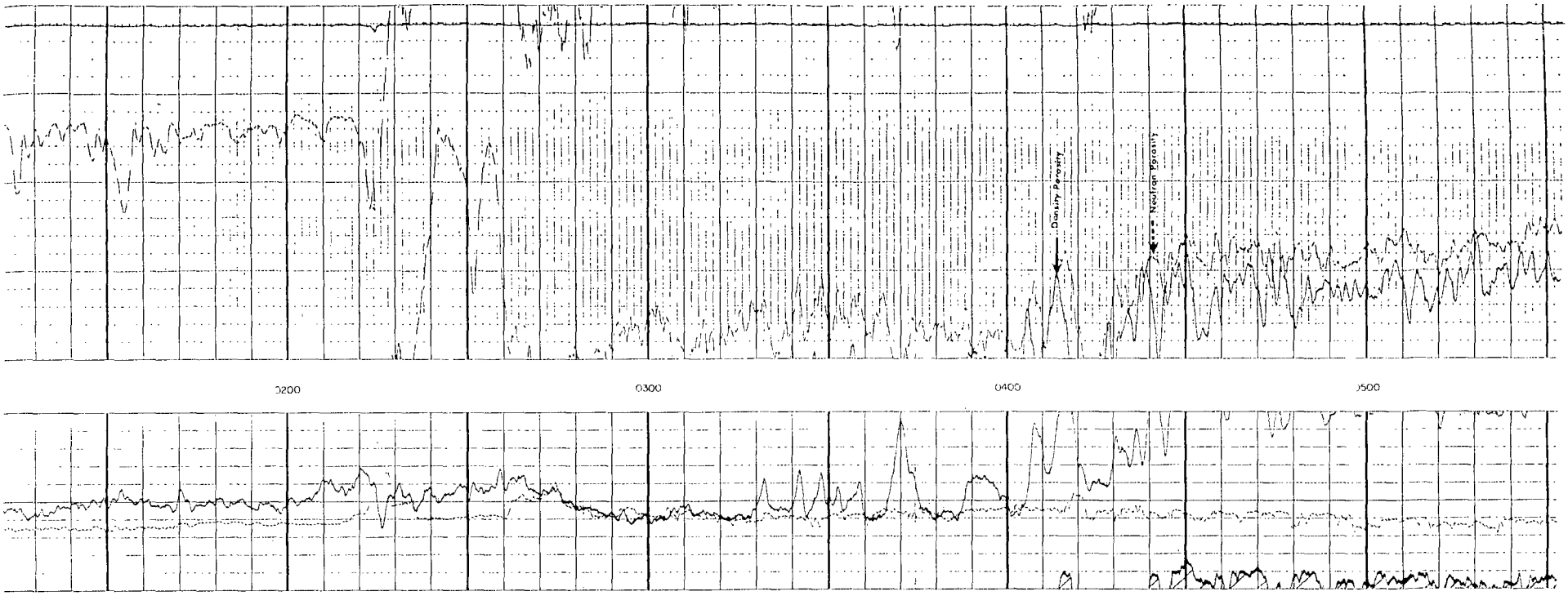
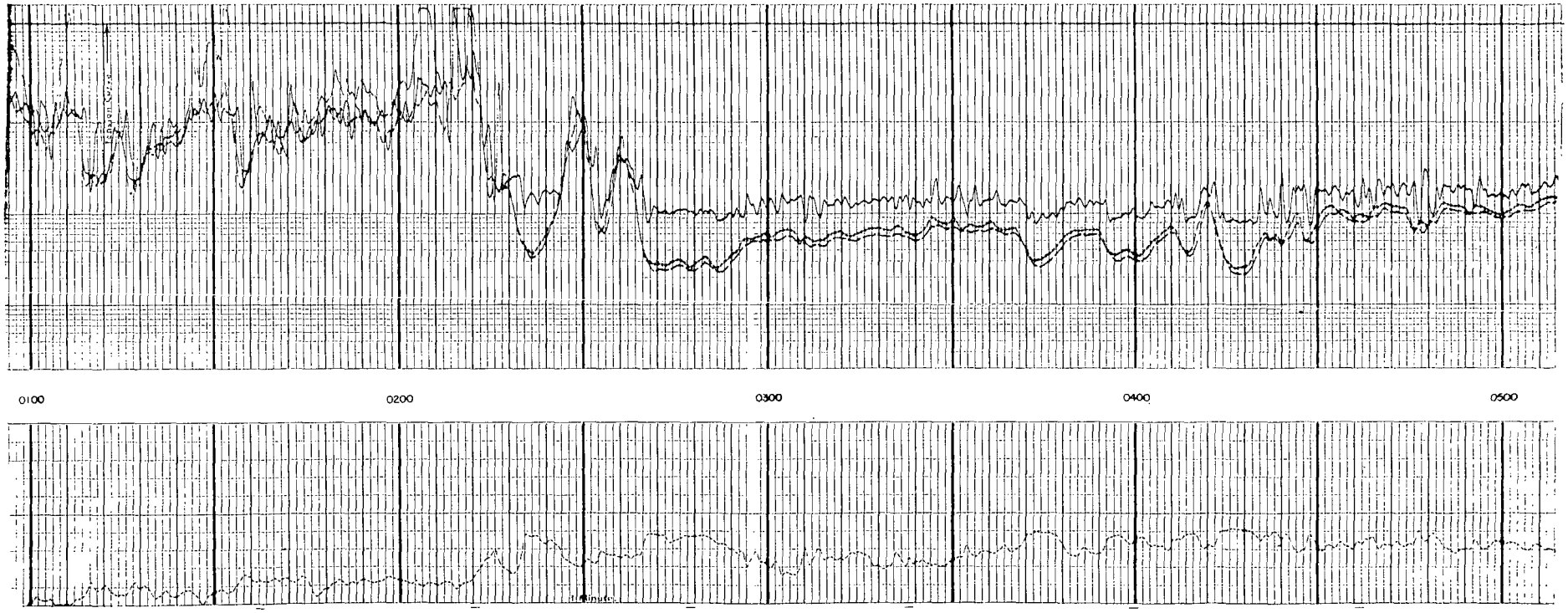
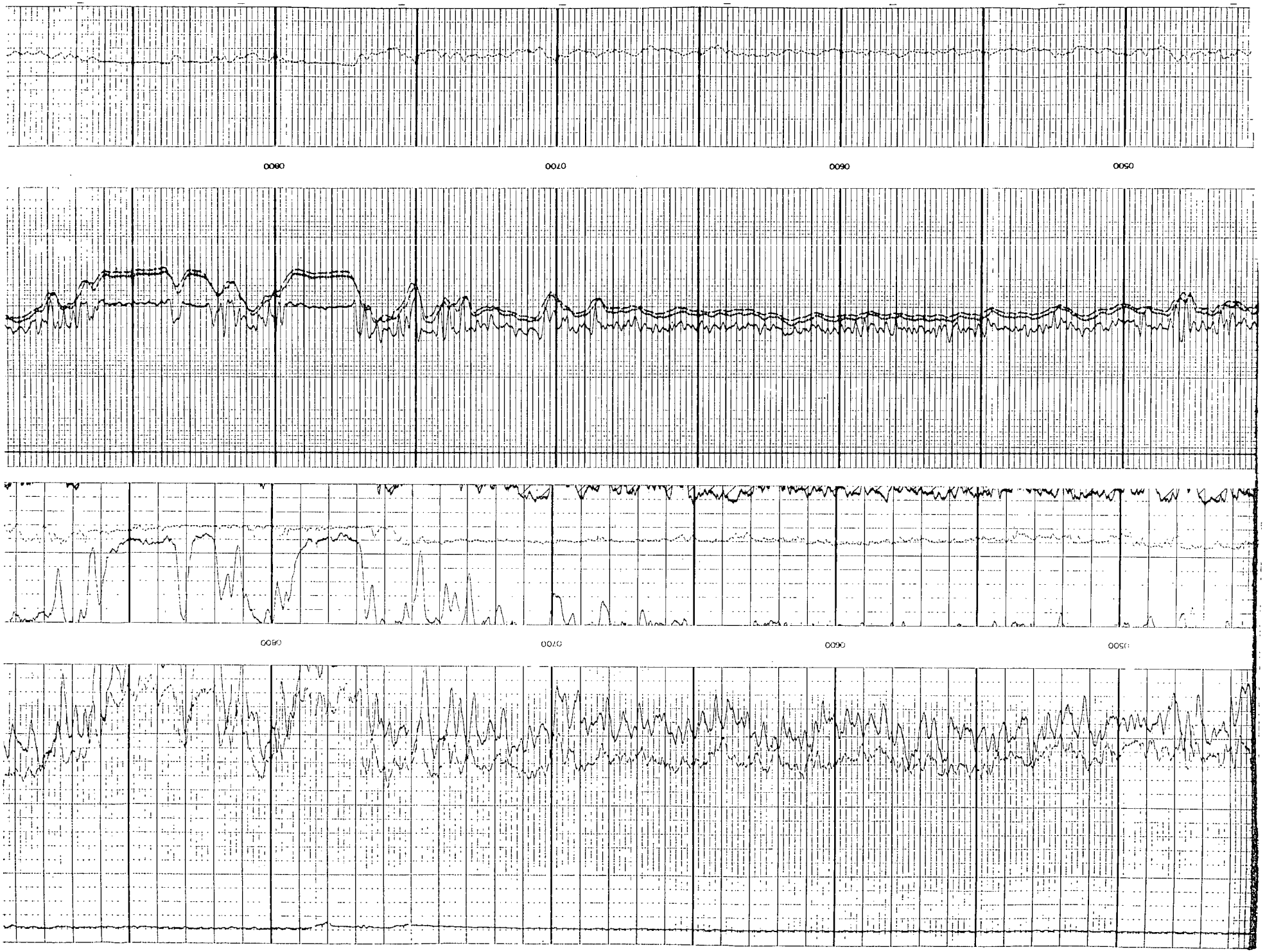
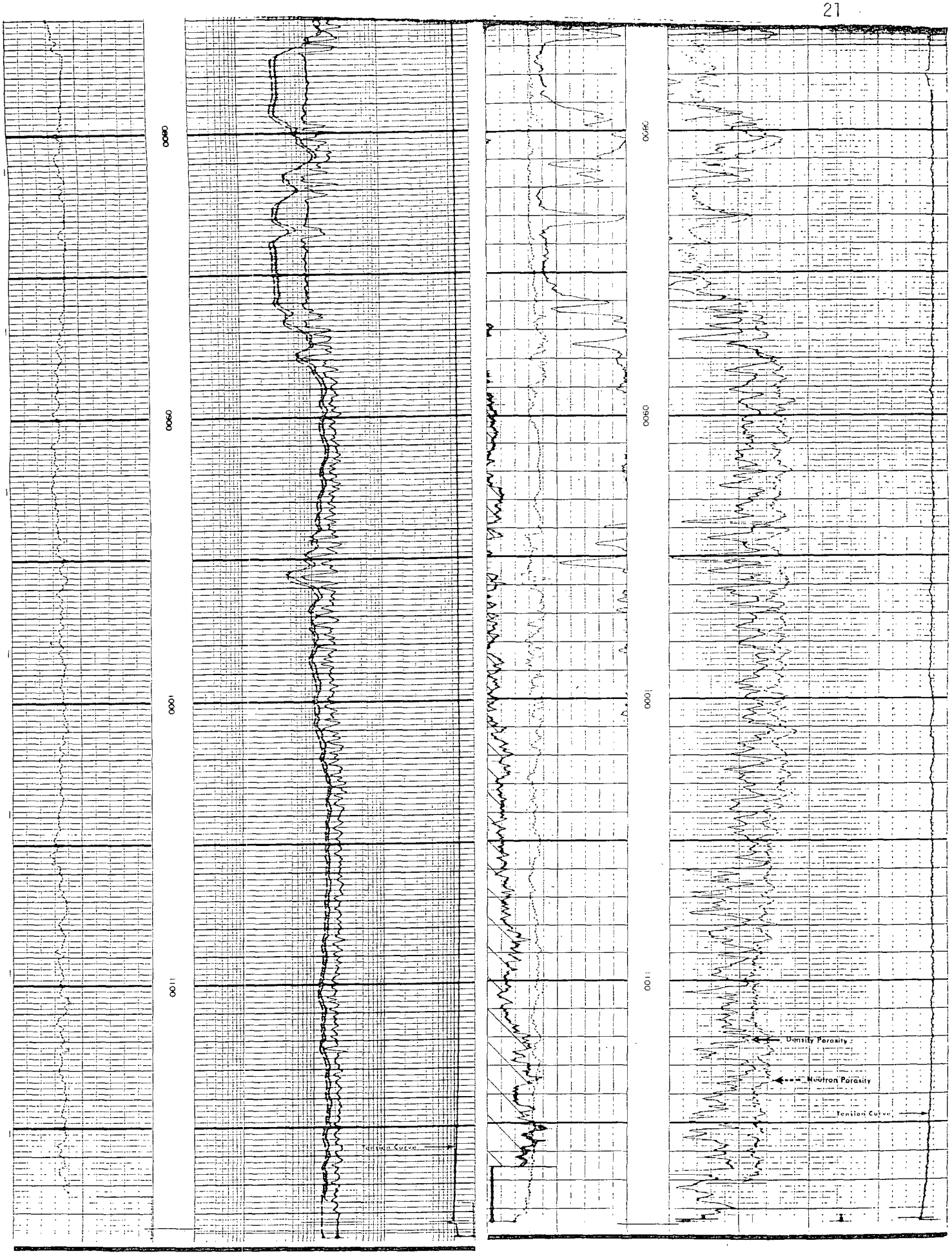


Fig. 7. Geophysical Logs of NMSU-DG-1


Density Porosity
Neutron Porosity
0200
0300
0400
0500


Lithology Curve
0100
0200
0300
0400
0500


0800
0700
0600
0500
0800
0700
0600
0500


0080
0060
0001
0011
Tension Curve
0080
0060
0001
0011
Density Porosity
Neutron Porosity
Tension Curve

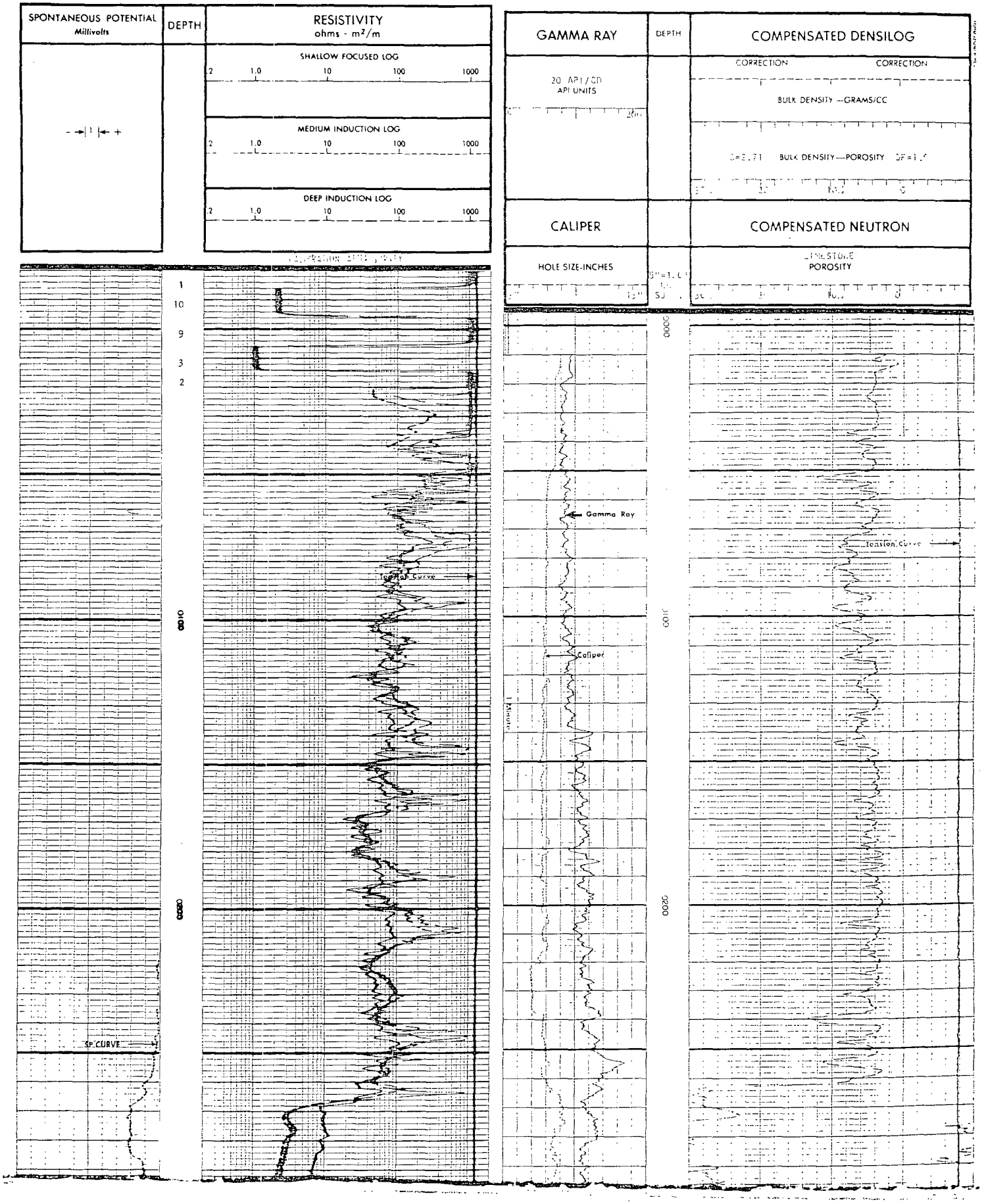
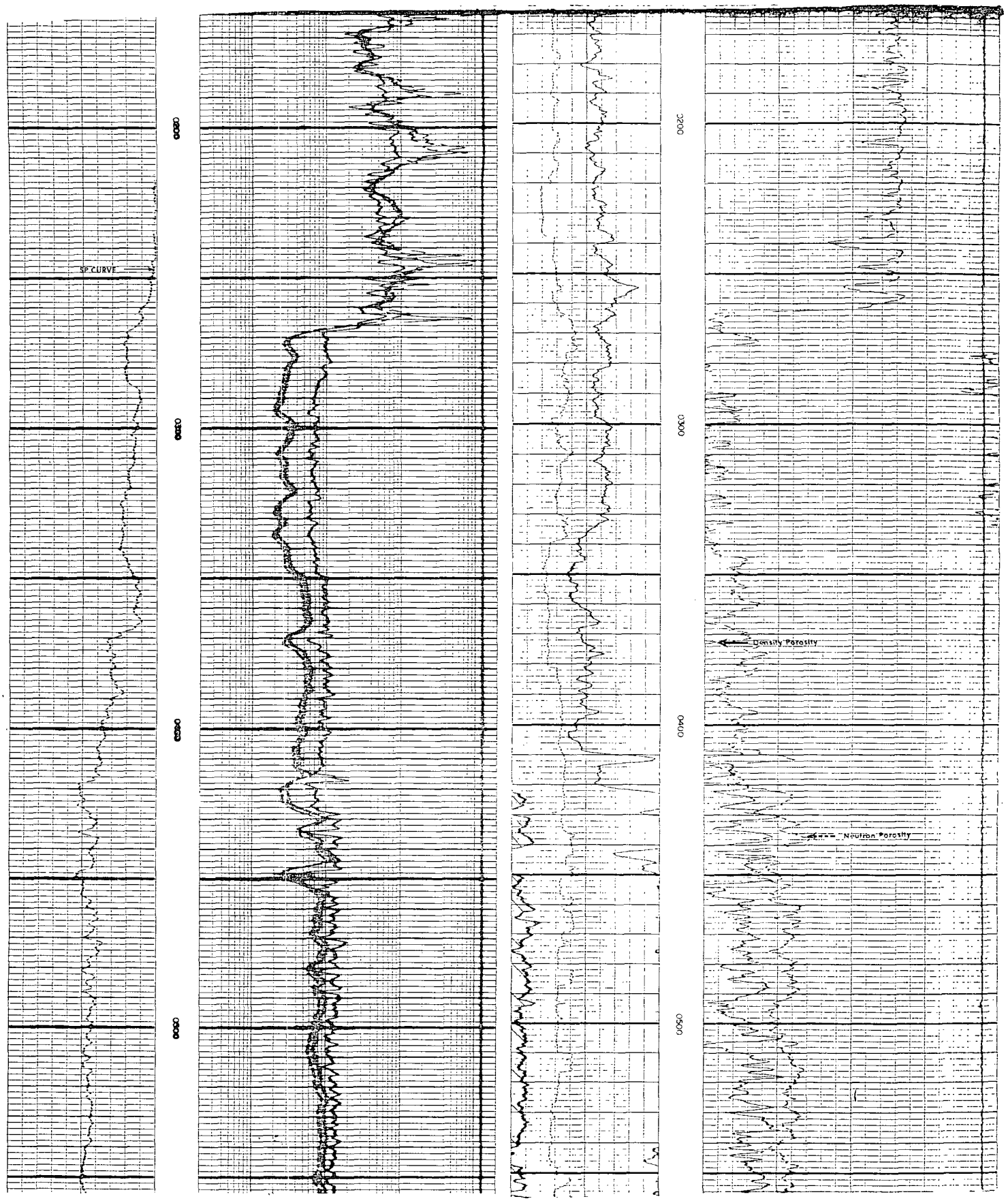
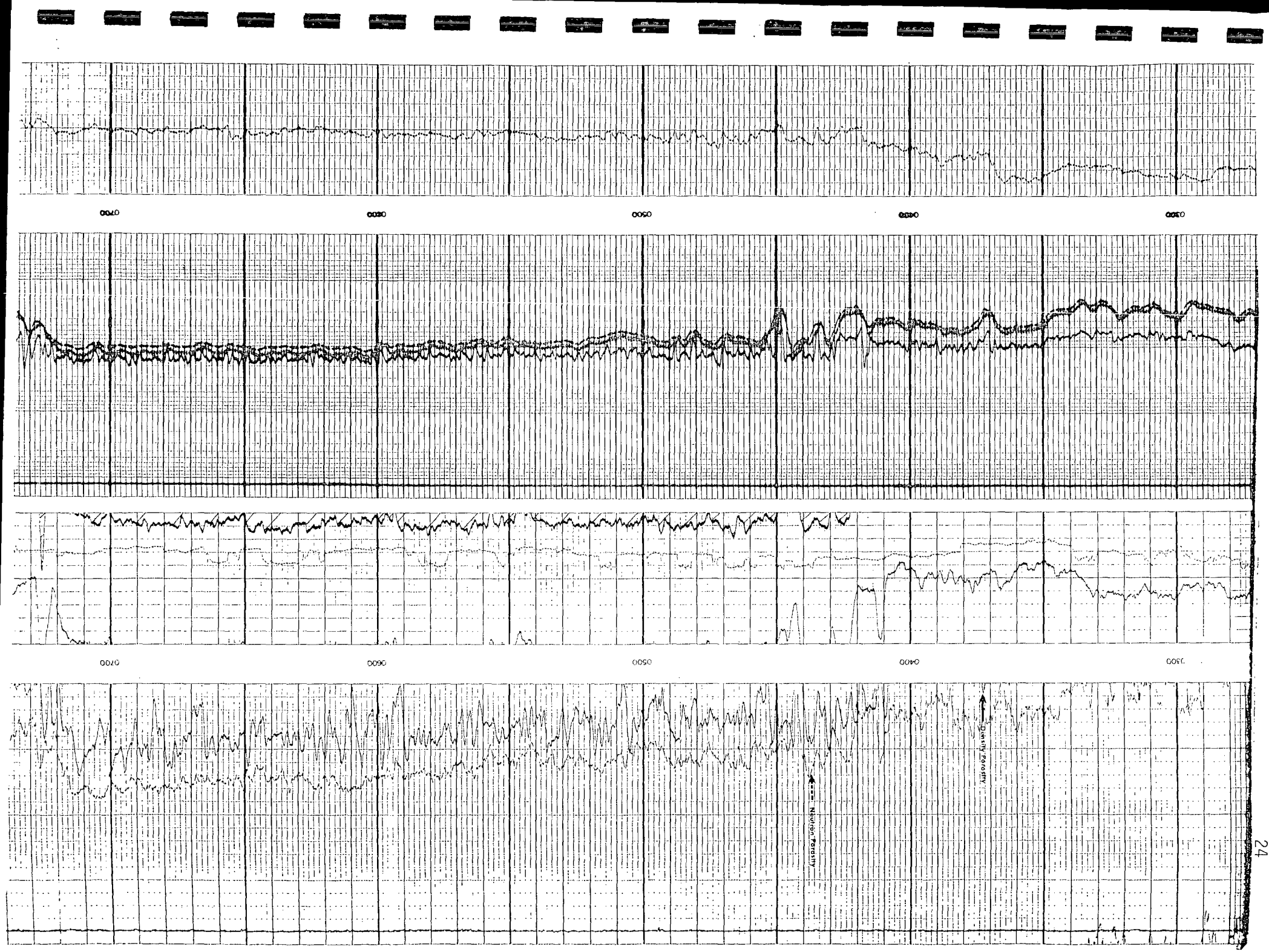
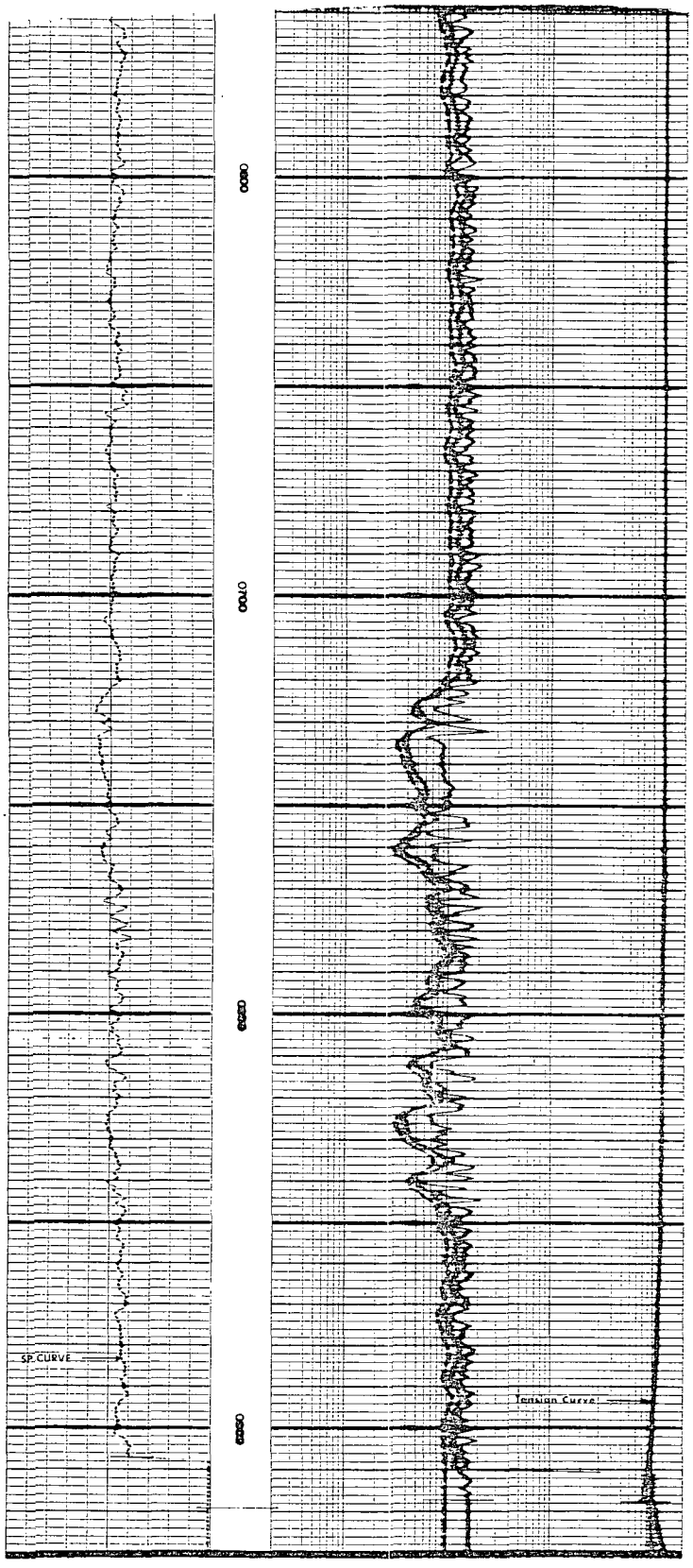
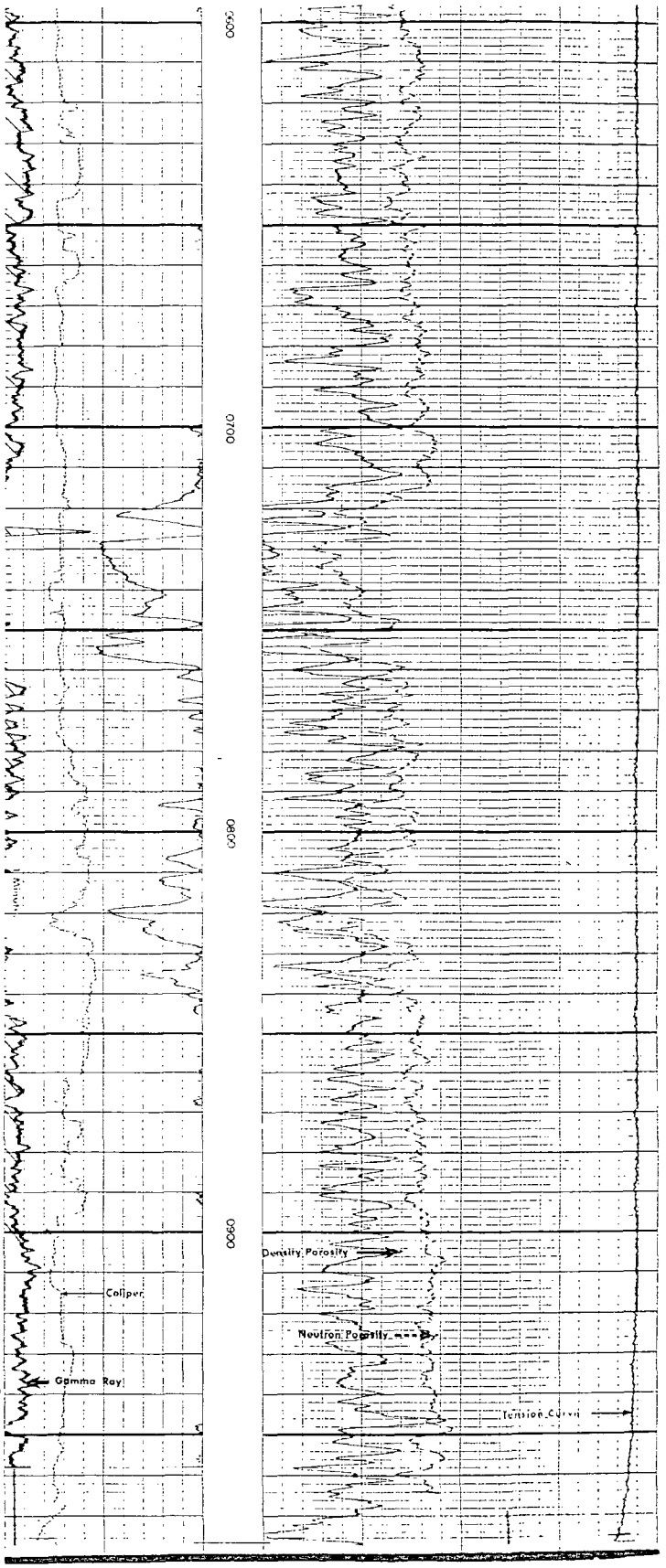


Fig. 8. Geophysical Logs of NMSU-DG-2


SP CURVE
3200
3100
3000
2900
2800
Density Porosity
Neutron Porosity


Neutron Porosity
Density Porosity


SP CURVE
Tension Curve


Caliper
Gamma Ray
Density Porosity
Neutron Porosity
Tension Curve