Department of Energy
Chicago Operations Office
Salt Repository Project Office
505 King Avenue
Columbus, Ohio 43201-2693
Commercial (614) 424-5916
FTS 976-5916

(Precopy sent to PLK 9/6/85)

August 12, 1985

John J. Linehan, Section Leader
Salt Section
Repository Projects Branch
Division of Waste Management, MS 623-SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Linehan:

SUBJECT: TRANSMITTAL OF AUGUST 5-8, 1985, NRC/DOE PERMIAN BASIN CORE EXAMINATION

Enclosed are the meeting record and meeting handouts for the subject meeting.

We look forward to continued positive and productive interactions.

Sincerely,

J.O. Neff

J.O. Neff
Program Manager
Salt Repository Project Office

SRPO:JS:max:8393B

Enclosures:
Meeting record with attachments:
1) Participant List
2) Agenda
3) Handouts and copies of viewgraphs. Material is keyed to names and dates given on the agenda.

   a) Peck/Murphy, August 5, 1985
   b) Murphy, August 5, 1985
   c) Ruppel, August 5, 1985
   d) Kreitler, August 6, 1985
   e) Senseny, August 6, 1985
   f) Sherwin, August 7, 1985
   g) Washer, August 8, 1985
   h) Murphy, August 7, 1985
   i) Gustavson, August 7, 1985 (4 pieces)
   j) Kreitler, August 7, 1985

1215

cc: L. Olsen, DOE-RL, w/encl.
D. Vieth, DOE-NV, w/encl.
R. Johnson, NRC, w/encl.
C. Head, DOE-HQ, w/encl.
A. La Sala, USGS, w/encl.
SRPO Staff, w/encl., w/o attachment
D. Dawson, ONWI, w/encl.

GS# 481-85

NRC/DOE PERMIAN BASIN CORE EXAMINATION SUMMARY

Date/Location

August 5-9, 1985
Texas Bureau of Economic Geology Offices
Austin, Texas

Attendees/Organizational Affiliation

A list of attendees and their organizational affiliations is attached as Enclosure 1.

Background/Facts

The primary purpose of this data review was to obtain a familiarization with the Palo Duro Basin stratigraphy and lithofacies through core examination and presentations of interpretations of core, logs, and cross sections. Also discussed were structural framework core observations and interpretations relating to dissolution, groundwater flow and engineering properties. An overview was given of ongoing work being conducted by Stone & Webster and the Texas Bureau of Economic Geology which aided in discussions of future data reviews and technical meetings. The agenda (Enclosure 2) gives a more detailed listing of the topics discussed and the activities during the course of this data review. Enclosure 3 consists of all of the handouts and copies of viewgraphs presented; each package is identified by the person making the presentation and date shown on the agenda. A representative of the Governor's Office of the State of Texas (see Enclosure 1) was present during the first day and did not make any observations for this summary.

Observations

The NRC general observations are given below. More detailed observations on geology, hydrogeology, rock mechanics, and quality assurance are included in the review sheets completed by NRC during the course of the data review and will be transmitted to SRP in a follow-up package. No specific geochemistry observations were made.

1. Interactions such as this core examination serve as one kind of excellent mechanism to transfer current information (data interpretations, methods, etc.) on SRP programs to NRC in a timely fashion. Such information transfer and exchange of ideas is greatly enhanced by including all the key investigators involved with the work as was done for this data review. The ability of NRC to comment in a timely manner to SRP on the various plans being developed is dependent on keeping current with the work in certain key technical areas. NRC noted that keeping up with current work using published reports in some cases is difficult and large time lags have and do exist for release of subcontractor reports (with their QA review completed) due to the additional technical review process.

2. Detailed lithologic logging of the DOE core by TBEG appears to be of extremely high quality.

3. Correlation of major units between DOE wells appears to be well established and documented by TBEG.

4. Correlation of minor units between DOE wells by TBEG appears reasonable. Continued efforts to strengthen the correlations by using geophysical logs from intermediate petroleum exploration wells is encouraged.

5. The core appears to be well treated within the TBEG facilities. Storage appears to be well organized and preservation techniques appear to be adequate.

6. The characteristics of the San Andres salts are such that considerable variation in their properties on the size scale of a repository is expected. Vertical and lateral lithologic variations probably will be present.

7. The preliminary investigation of the Dockum Group appears to be well thought out and focused. Information developed by this study should be integrated with hydrologic and structural geologic studies by others.

8. The structural framework of the basin is well known with respect to major structures. Minor structures are not as well known.

9. Significant work still remains to be done to understand dissolution phenomena. Problems still remain on understanding the relationship of interior to peripheral dissolution, timing of dissolution episodes, relationship to structural features, dissolution rates, and effects on waste isolation.

10. SWEC and TBEG are preparing several types of lithologic and geotechnical logs based on different classification schemes. A method of relating all classification schemes to each other should be developed.

11. Basin-wide correlations of individual stratigraphic units, based on the cyclicity interpreted from the core, provides a powerful means of interpreting the stratigraphic details between widespread drill holes. Further resolution of the extent and importance of sabkha-like versus marine influences would enhance the ability to predict the likely magnitude of local anomalies.

12. The DOE has not published information on the Quaternary Blackwater Draw formation, an eolian-lacustrine deposit. The extent and characteristics of this formation are important to the resolution of issues such as Quaternary dissolution and warping and ages of latest movement on faults. Information on this unit is also needed for foundation engineering.

13. The existing seismic network, as described in this meeting, does not appear to be properly deployed to accurately locate events within potentially seismogenic areas such as the Oldham Nose, Matador Arch, Amarillo Uplift and eastern New Mexico.

14. The nature and extent of fracturing that may have been induced by interior dissolution needs to be determined and its influence on hydrologic properties of strata above the base of dissolution assessed.

15. The geophysical logs appear to be sufficient to aid in stratigraphic correlations and geotechnical studies. The influence of halite cement on the values of geotechnical parameters so obtained is not yet fully understood.

16. At present, there is no document that synthesizes and integrates the stratigraphic, structural and hydrogeologic research by all DOE contractors.

17. With respect to quality assurance, SRP should improve their overview of TBEG work in the areas of surveillance, records management, TBEG QA organization, and supplier control. It is believed that these concerns would be surfaced and corrected in a timely manner if the SRP implemented a planned, disciplined program of surveillance and monitoring of work activities as well as the audit which is conducted annually.

18. NRC Rock Mechanics/Design staff and contractors observed core custody, core storage, and protection procedures pertinent to several borings within the Palo Duro Basin. In addition discussions with representatives of SWEC and RE/SPEC addressed such topics as core protection, rationale for selection of samples for testing, representativeness of samples, sample transportation, type of tests and documentation of core selection, handling procedures, test procedures and results. Observations relative to these activities will be part of the follow-up material to be provided by NRC.

19. NRC, SRP, ONWI, and TBEG discussed ideas for future interactions in the areas of geology, hydrogeology, geochemistry, and rock mechanics. NRC and SRP discussed the advantages and disadvantages to having large meetings covering many topics/issues versus meetings more focused on issues and the information pertinent to understanding the issue. NRC in general favors the more focused approach to interactions. The following summarizes NRC's current ideas on interactions for fiscal year 1986:.

Geology:

1. The only presently scheduled interaction between SRP and NRC is the surface based test plan. The NRC needs to discuss with the SRP contact the general philosophy which will be used in preparation of this plan prior to NRC and SRP setting a firm date for interaction.

2. Specific topical meetings are needed in the fields of structural geology, near surface stratigraphic units and dissolution.

3. The specific topical meetings while focused must be broad enough so that all disciplines which have input are represented.

Hydrogeology:

The following are topics to be included in one or more interactions.

1. Hydrogeologic conceptual model(s) - integration of current interpretations of all aspects of the existing data base including structure, stratigraphy, hydrochemistry, isotopes, and hydrogeologic properties.

2. Explanation and examination of hydrochemical and isotopic data.

3. Core data - how will core data be used to develop hydrogeologic properties?

4. Potentiometric head data

   a) error estimation
   b) fluid density variations with respect to head

5. Hydrogeologic properties of evaporite section including unit 4 dolomite.

Geochemistry:

The most immediate need is to read a draft of the geochemistry program plan when it becomes available. This will provide a better understanding of the geochemistry program which will allow NRC and SRP to more intelligently plan technical meetings as soon as possible.

Rock Mechanics:

Between now and January 1986, three interactions have already been agreed to by NRC and SRP. These are for exploratory shaft construction and sealing, repository design, and in situ testing. No additional interactions are needed during this time period.

20. NRC stressed the importance of having staff members, while assigned to the NRC on-site representative, read and understand program plans and detailed hierarchies (milestones charts) being developed by SRP/ONWI. This background should be very useful in mutually planning out an effective and timely series of interactions.

21. The NRC is of the opinion that this data review was extremely useful to their understanding of the present basis of stratigraphic studies in the Palo Duro Basin and has provided an excellent springboard from which other more focused topical workshops can be developed. The open discussion by all parties, especially in the core examination area, was extremely helpful. The NRC wishes to thank all personnel involved, and especially TBEG for hosting this review.

Agreements and Open Items

1. NRC and SRP agreed to further discuss ways (in addition to those currently in place) for enhancing the transfer of new interpretative information. A possibility suggested by the NRC is to open-file draft reports produced by contractors and subcontractors.

2. NRC will continue discussions with SRP on the topics, schedules and most effective approach to future interactions.

3. NRC will send SRP follow-up material within one month. This material will consist of the specific observations and any concerns developed during the meeting.

Robert L Johnson 8/9/85
Robert L. Johnson, NRC/WMRP

Jo-Ann Sherwin, DOE/SRP

John Trapp 8/9/85
John Trapp, NRC/WMGT

Enclosure 1

Participants

NRC Core Workshop
August 5-8, 1985
Austin, Texas

Sam Panno	DOE HQ/Weston	
Jo-Ann Sherwin	DOE-SRPC	
Steve Frishman	Office of the Governor, Texas	
Don McReynolds	High Plains Water District	806/762-0181
Dick Berry	NRC/Lawrence Livermore	
David W. Carpenter	NRC/Lawrence Livermore	415/422-3976
Robert Cummings	NRC/Engineers International	602/884-8818
Jaak Daemen	NRC/University of Arizona	602/621-2501
Claudia Hackbarth	NRC	301/427-4639
Dale Hedges	NRC	
John Imse	NRC/Weston Geophysical Corp.	617/366-9191
Gary K. Jacobs	NRC/ORNL	615/576-0567
Robert Johnson	NRC/WMPP	301/327-4785
Walt Kelly	NRC/NMSS	301/427-4571
Richard Lee	NRC	
Larry McKague	NRC/Lawrence Livermore	415/422-6494
Jerome Pearring	NRC/WMEG	301/427-4648
Fred Ross	NRC/Williams & Associates	
Jack Sharp	NRC/Williams & Assoc./Univ. Texas	
John S. Trapp	NRC/WMGT	301/428-4545
Tilak (Teek) Verma	NRC/Columbus	
Roy E. Williams	NRC/Williams & Associates	208/883-0153
Gerry Winter	NRC/Williams & Associates	
Ernst G. Zurflueh	NRC	617/427-4343
Walter E. Newcomb	ONWI	614/424-7685
Owen E. Swanson	ONWI	
Francis D. Hansen	RE/SPEC	605/394-6400
Paul Senseny	RE/SPEC	605/394-6400
Tom Lamb	SWEC	
John Peck	SWEC	
Philip J. Murphy	SWEC	617/589-2173
Ev Washer	SWEC	

Ed Bingler	TBEG	
Roy T. Budnik	TBEG	
Dow Davidson	TBEG	
Alan Dutton	TBEG	
Steve Fisher	TBEG	
Mike Fracasso	TBEG	
Thomas C. Gustavson	TBEG	
Susan Hovorka	TBEG	
David A. Johns	TBEG	
Charles Kreitler	TBEG	
H. S. Nance	TBEG	
Steve Ruppel	TBEG	
Jerry Wermund	TBEG	
Margaret Hart	Texas Dept. of Water Resources	512/463-7797

Enclosure 2

AGENDA
PERMIAN BASIN CORE EXAMINATION

August 5

1:00 p.m.	Introductions	J. Sherwin (SRPO) E. Bingler (TBEG)
1:30 p.m.	Opening remarks and expectations of meeting.	J. Sherwin (SRPO) J. Trapp (NRC) R. Johnson (NRC) Steve Scott
2:00 p.m.	Overview of the Palo Duro Basin, current understandings of structural and sedimentological history.	~~TBD (SWEC)~~ J. Peck (SWEC) P. Murphy (SWEC) Steve Ruppel TBEG
3:00 p.m.	Origin of the Permian evaporites, with emphasis on LSA 4.	~~TBD (SWEC)~~
4:00 p.m.	Core storage/handling/cur Palo Duro Basin stratigraphic section, locations of DOE test holes, regional correlations of major units, major hydrostratigraphic divisions.	Paul Davidson (TBEG) S. Hovorka (TBEG)

August 6

8:15 a.m.	Reconvene	
8:30 a.m.	Geologic logging of DOE drill holes, detailed logs of repository horizon (Lower San Andres Unit 4), geologic cross-sections, correlation of formations and units, description of rocks present in the core, (incl. mineralogic, petrologic, geochemical characteristics), with emphasis on evaporite section and host salt beds.	S. Hovorka (TBEG)
9:30 a.m.	Description of features noted in core from "dissolution wells," regional implications	C. Kreitler (TBEG)
10:00 a.m.	Presentation on available material related to DOE drill hole logs: lithologic logs; geophysical logs; applicable reports and data; correlations of geophysical logs with core; applications of geophysical logging to stratigraphic analysis.	~~G. Adams (ONWI)~~ T. Lamb (SWEC)
11:00 a.m.	Development of geotechnical logs based on mechanical properties, geophysical logging and visual core logging-correlated with test results performed on drill core; index of laboratory testing for mechanical properties of rock mass; in-situ stress measurements.	T. Lamb (SWEC) ~~TBD~~ (RE/SPEC) P. Sensenay
12:00 - 1:00 p.m.	LUNCH	

PERMIAN BASIN CORE EXAMINATION
PLANNED AGENDA
(Continued)

August 6 (Continued)

1:15 p.m.	Reconvene at Balcones Research Center and proceed to core repository. Core examination: Grabbe #1 J. Friemel #1 Zeeck #1 - LSA Unit 4 One dissolution well - TBD	
	* There is not enough table space for all listed core sections to be laid out simultaneously; over two days all core will be available.	
	Concurrent Quality Assurance discussions	

August 7

8:15 a.m.	Reconvene at Balcones Research Center Proceed to core repository.	
8:30 a.m.	Core examination continues. Tour of TBEG research and core storage/handling facilities	
12:00 - 1:00 p.m.	LUNCH	
1:15 p.m.	Review of status of Palo Duro Studies; published references; on-going work; data availability.	TBEG (Gustavson, Kreitler) SWEC (Washer, Hanby, Lamb) ONWI SRPO (Sherwin)

August 8

8:15 a.m.	Propose topics/agenda for Permian Basin data review.	
10:15 a.m.	Prepare summary of meeting.	J. Sherwin (SRPO) J. Trapp (NRC)

LIST OF SRP EXPECTED PARTICIPANTS

DOE

J. Sherwin

ONWI

W. Newcomb
C. Kuntz
H. Hume
A. Funk
S. Adams

SWEC

E. Washer
J. Peck
P. Murphy
T. Lamb

TBEG

E. Bingler
S. Hovorka
D. Davidson
C. Kreitler
S. Ruppel
S. Nance
D. Johns
S. Fisher
R. Budnik
T. Gustavson
A. Dutton
M. Fartasso

NRC

W. Kelly
G. Jacobs
F. Ross
R. Williams
G. Winters
J. Parring
J. Canon
R. Cummings
S. Bilhorn
D. Hedges
E. Zurflueh
C. Hackbarth
J. Trapp
R. Lee
R. Berry
L. McKeague
D. Carpenter
J. Imse
R. Johnson
T. Verma

Enclosure 3

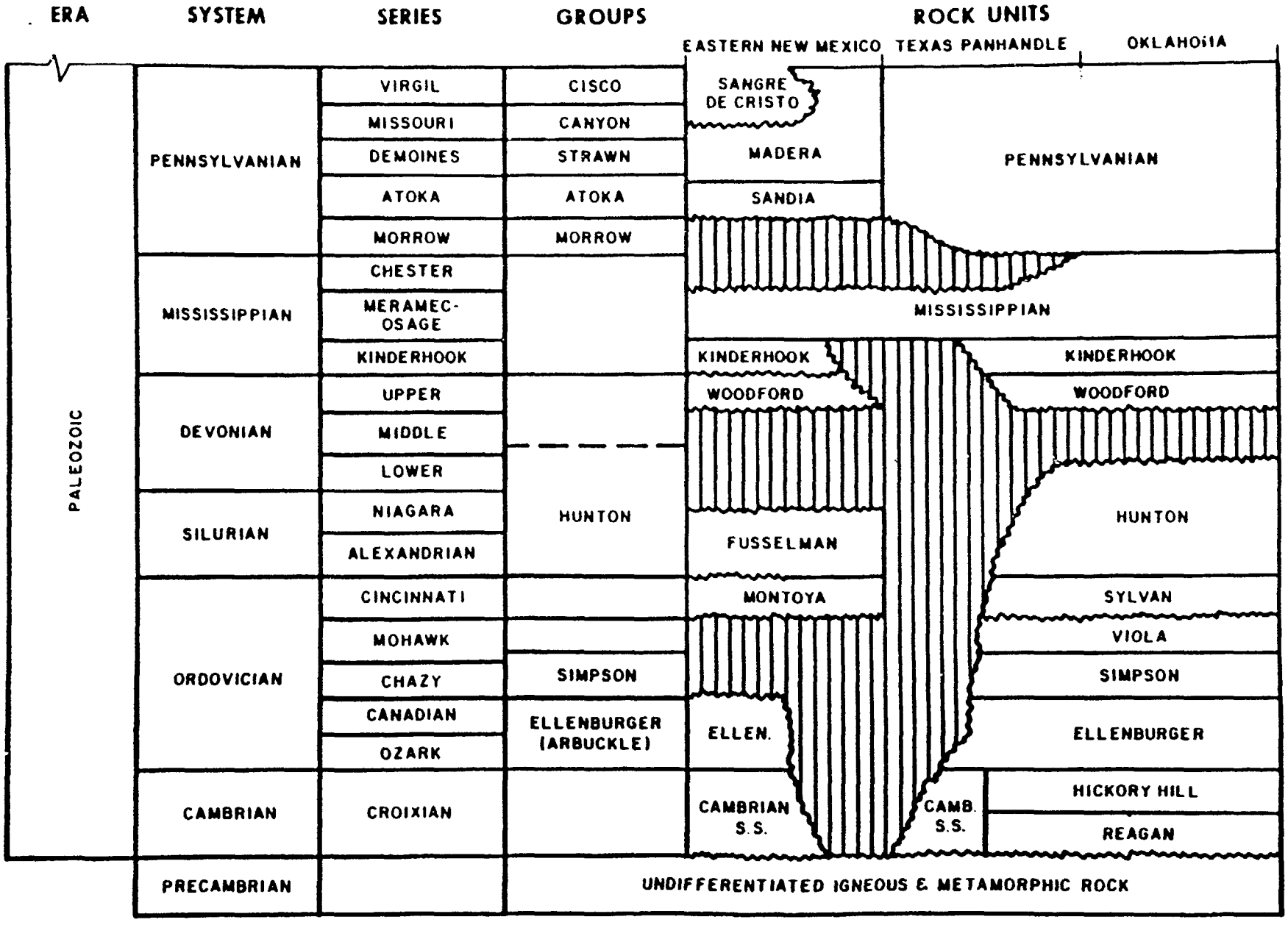
Handouts and copies of viewgraphs

Material is keyed to names and dates given on the agenda (Enclosure 2).

Peck / Murphy 5/5

STRATIGRAPHIC SECTION CONT.

PRECAMBRIAN TO PENNSYLVANIAN



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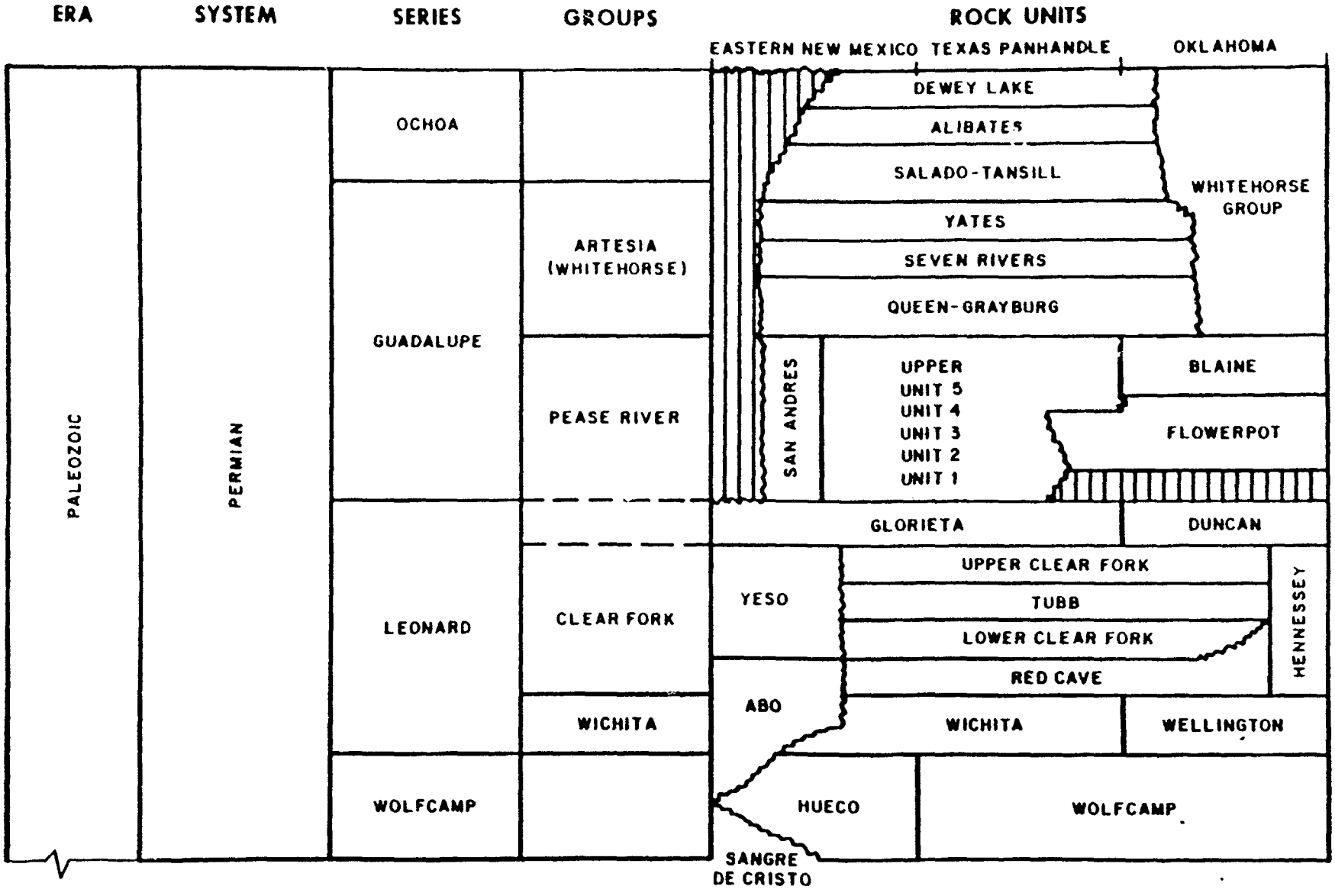
STRATIGRAPHIC SECTION CONT.

PERMIAN SYSTEM



STRATIGRAPHIC SECTION
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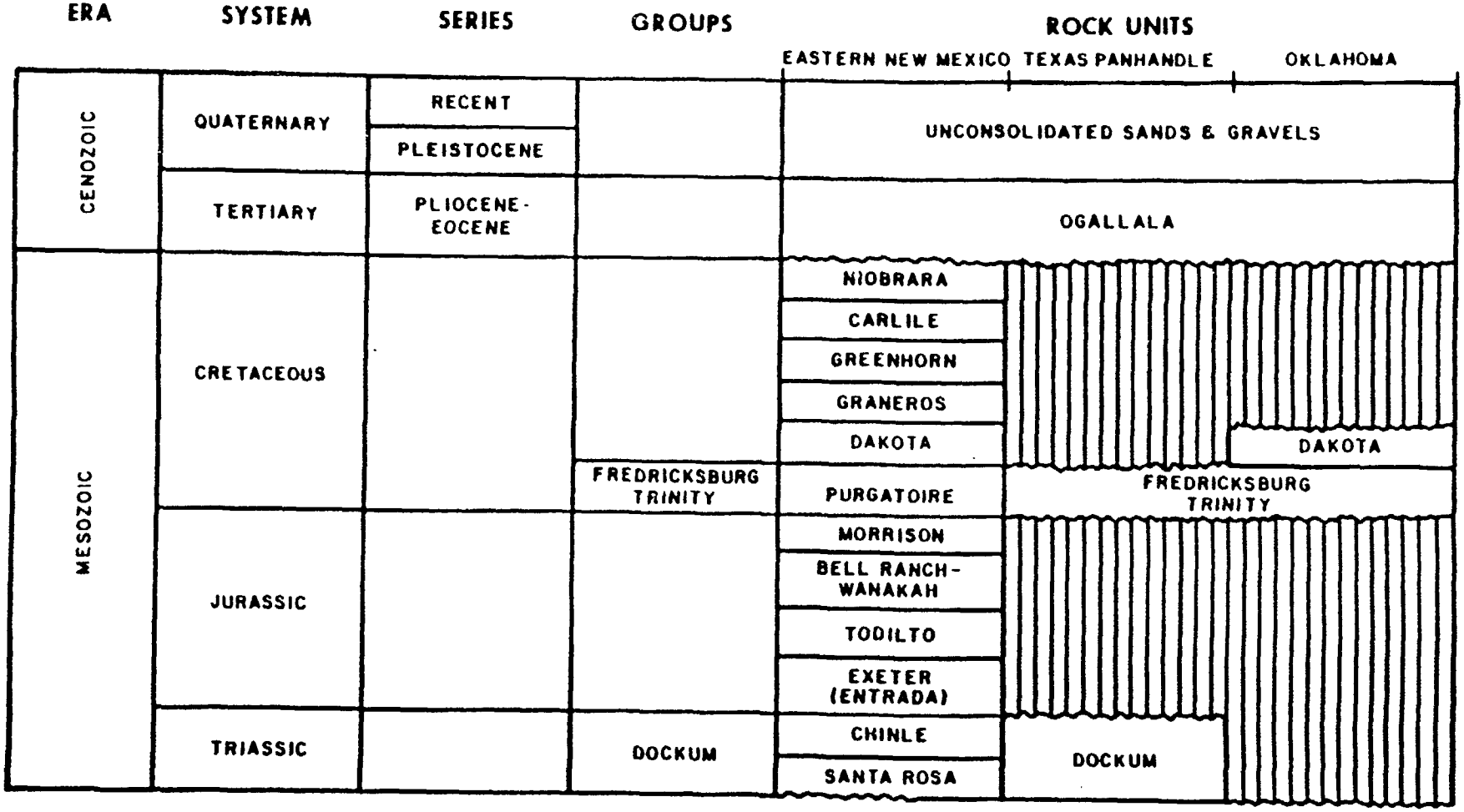
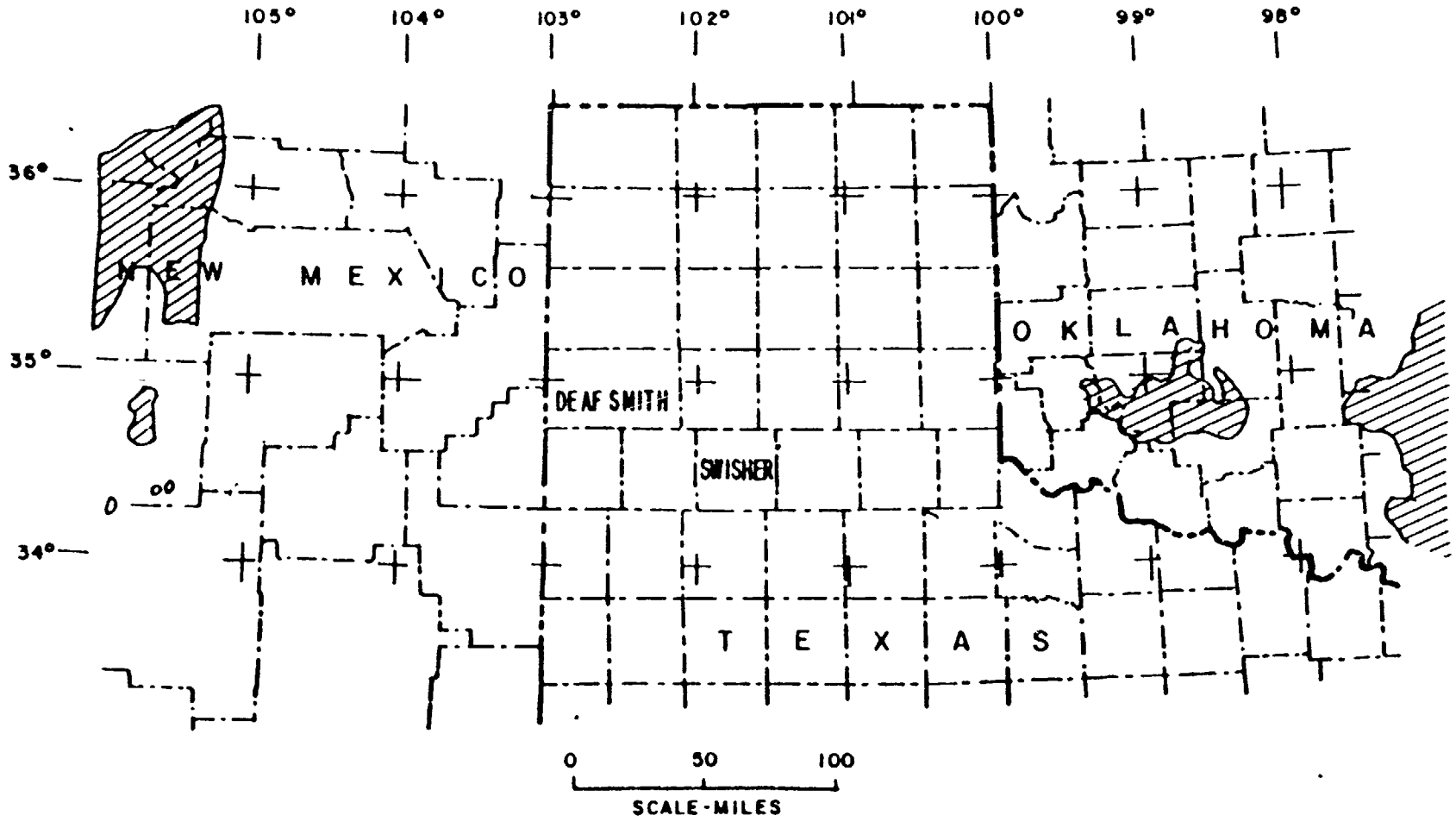


LOCATION OF PRECAMBRIAN-PENNSYLVANIAN OUTCROPS



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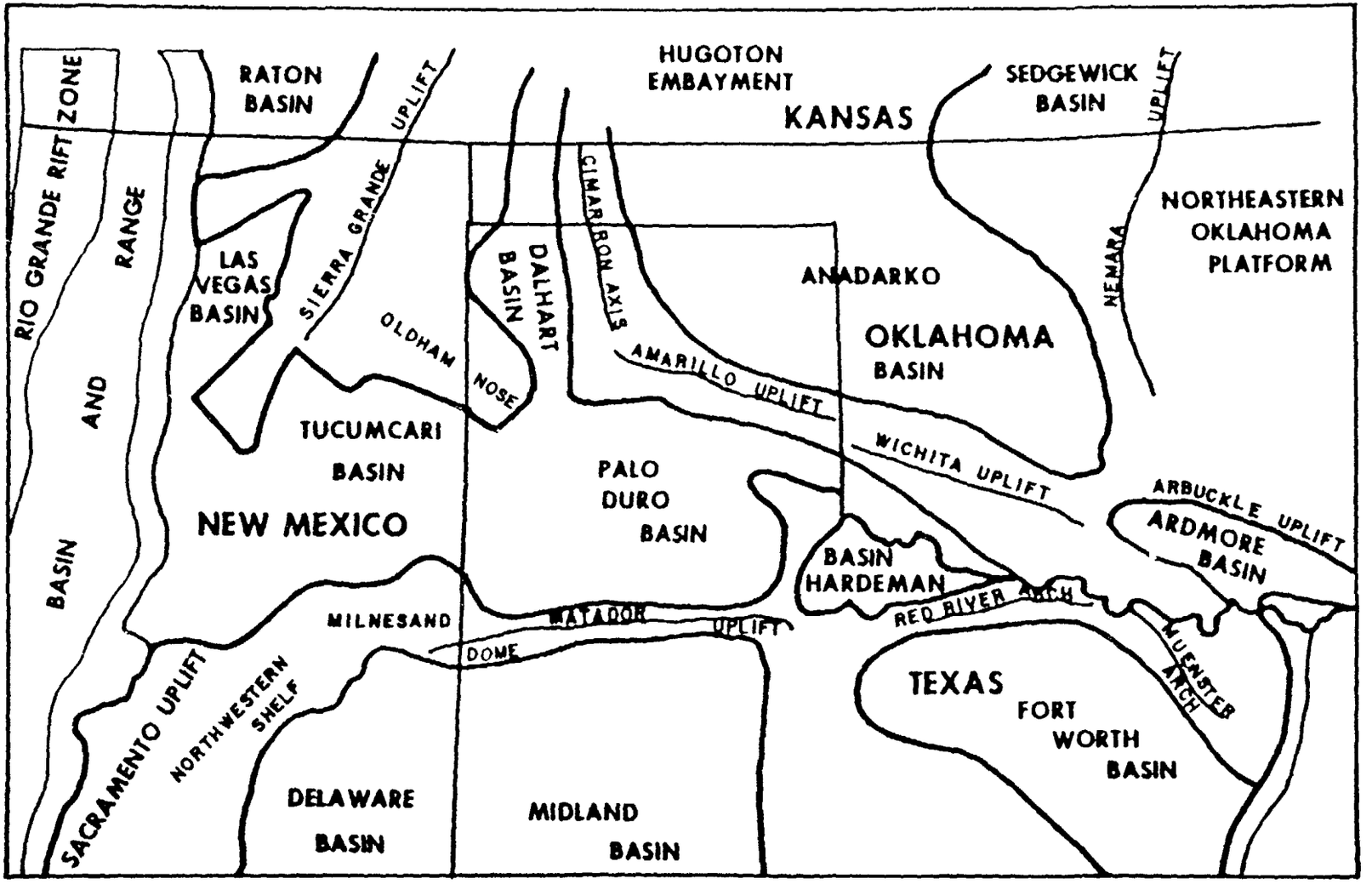

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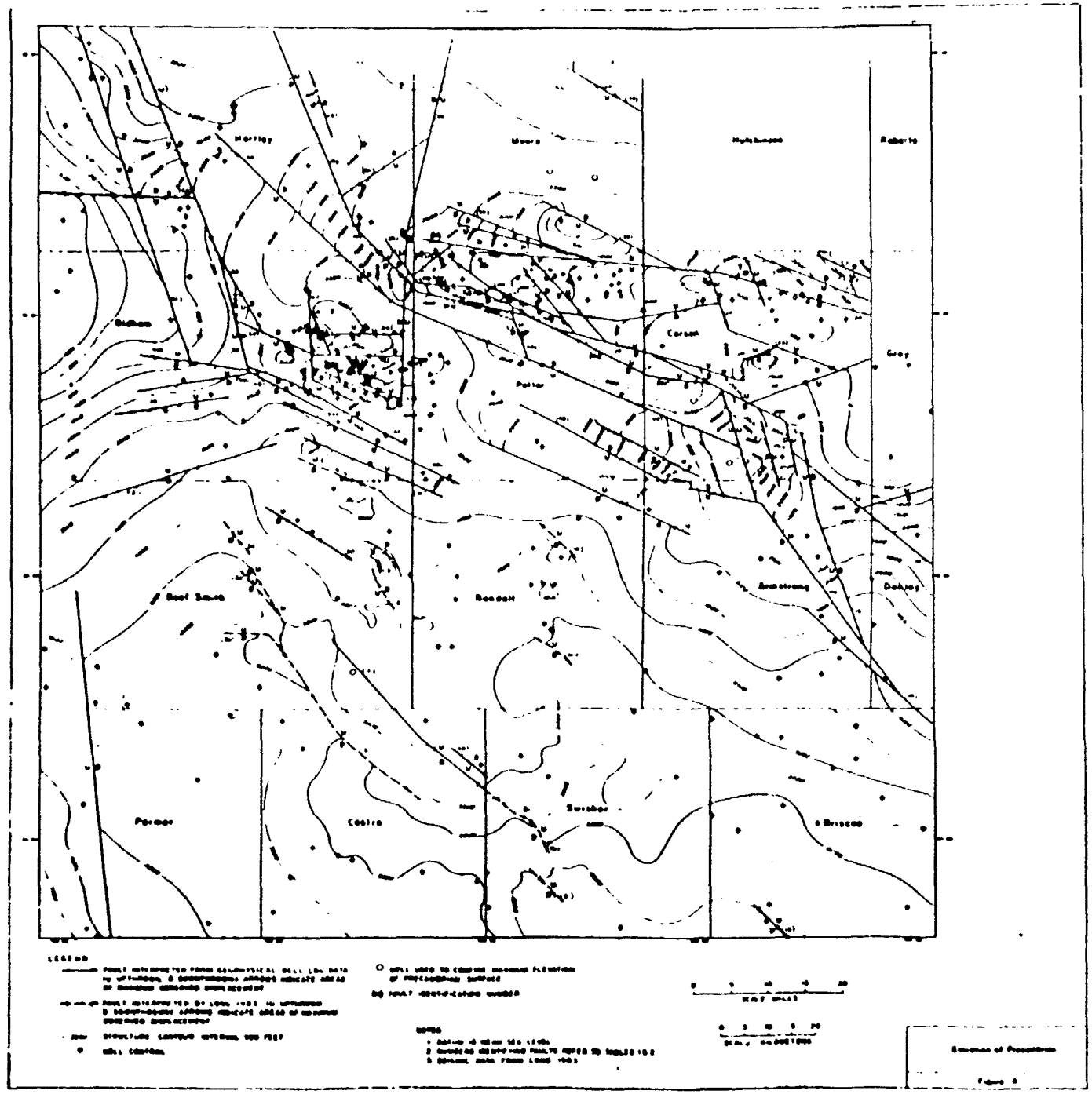
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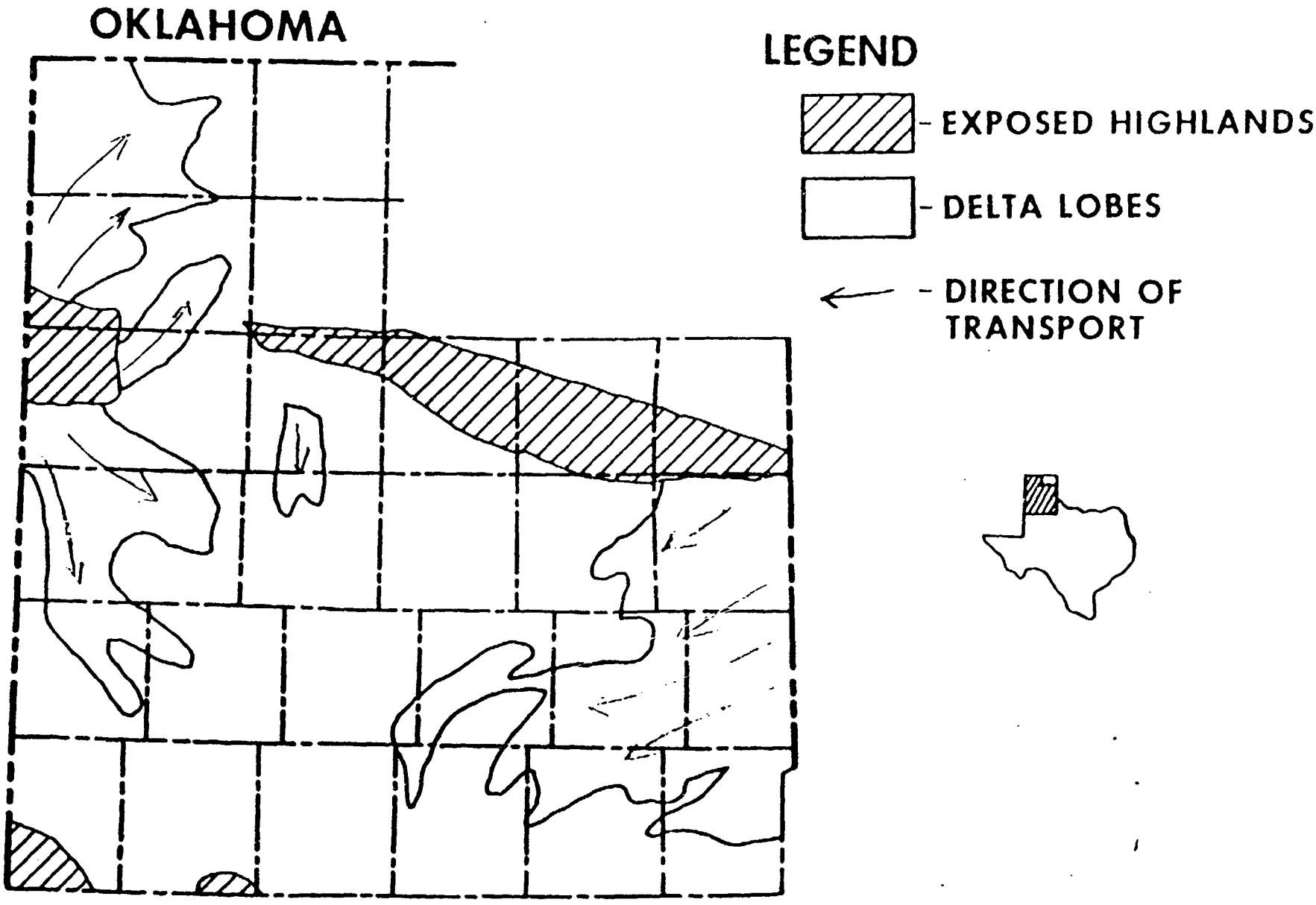
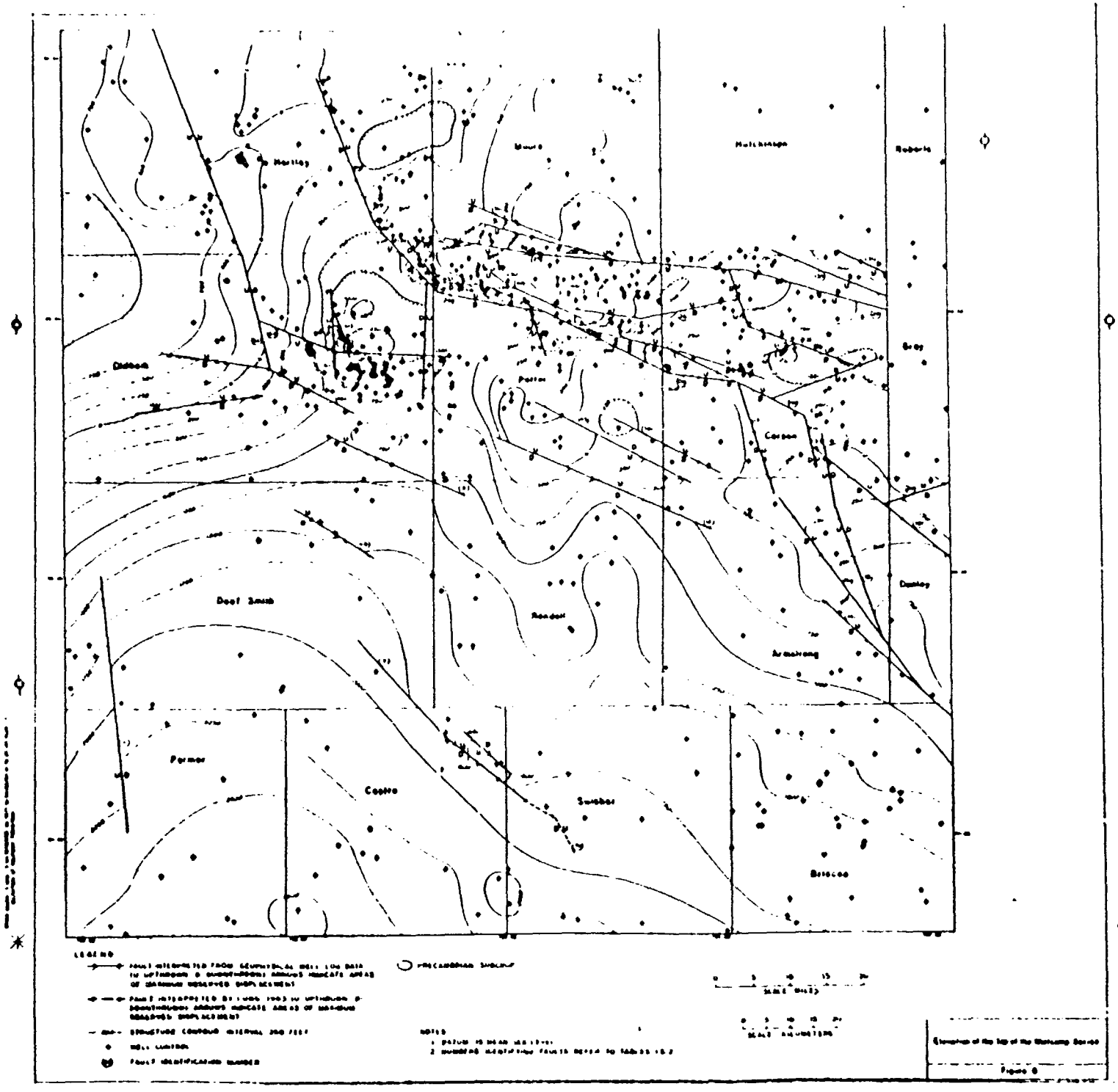
PENNSYLVANIAN DELTAS

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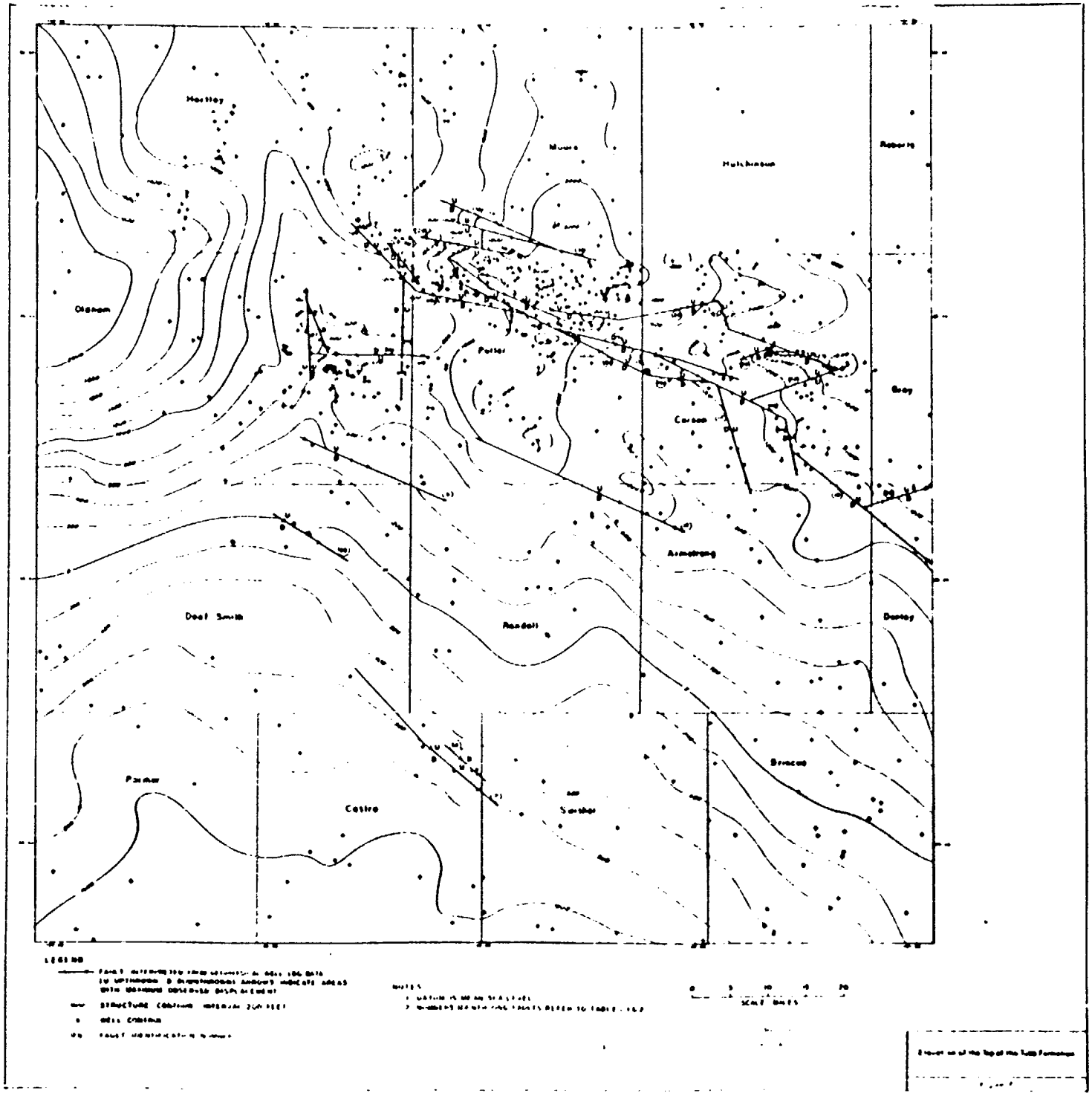
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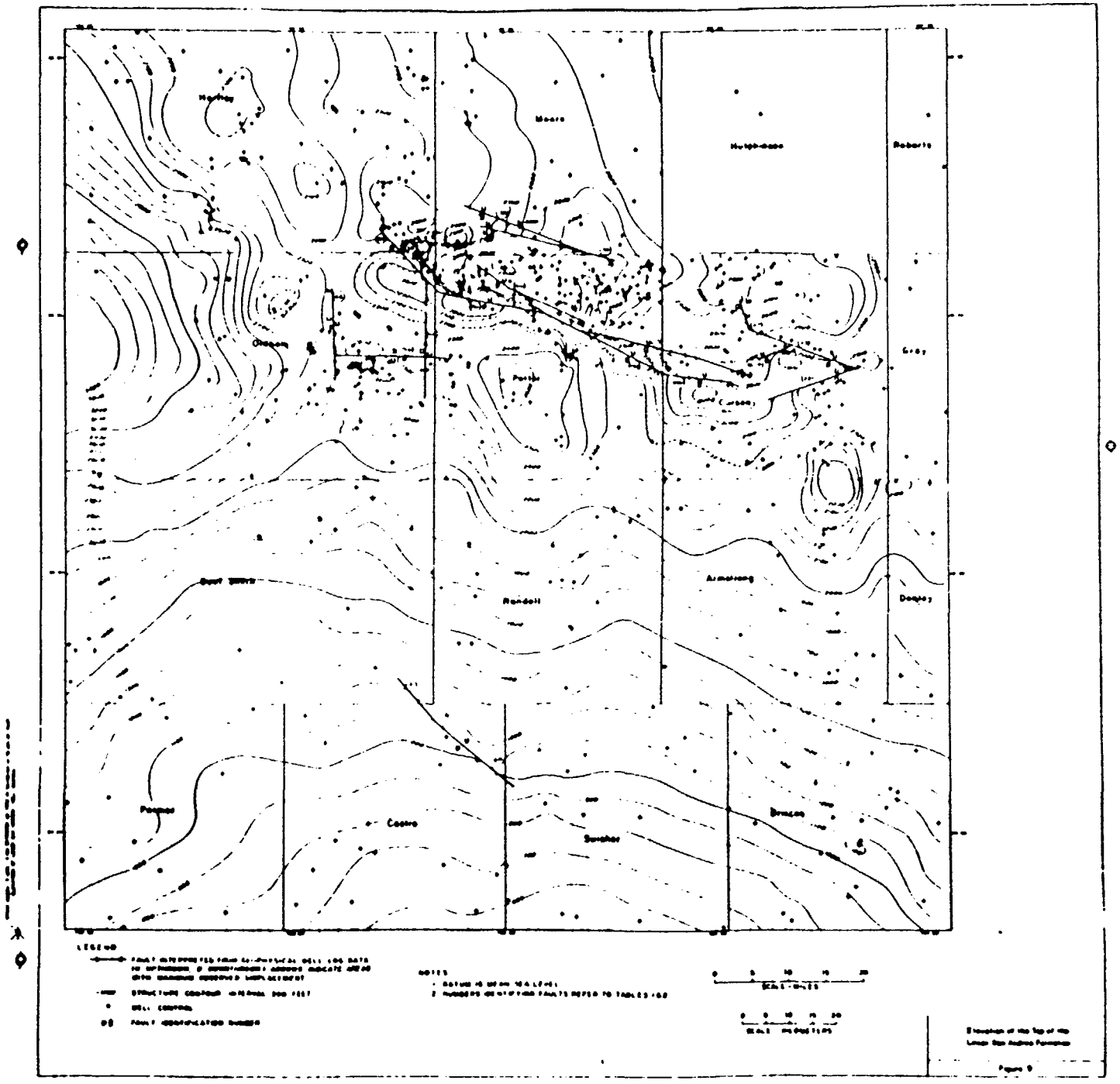
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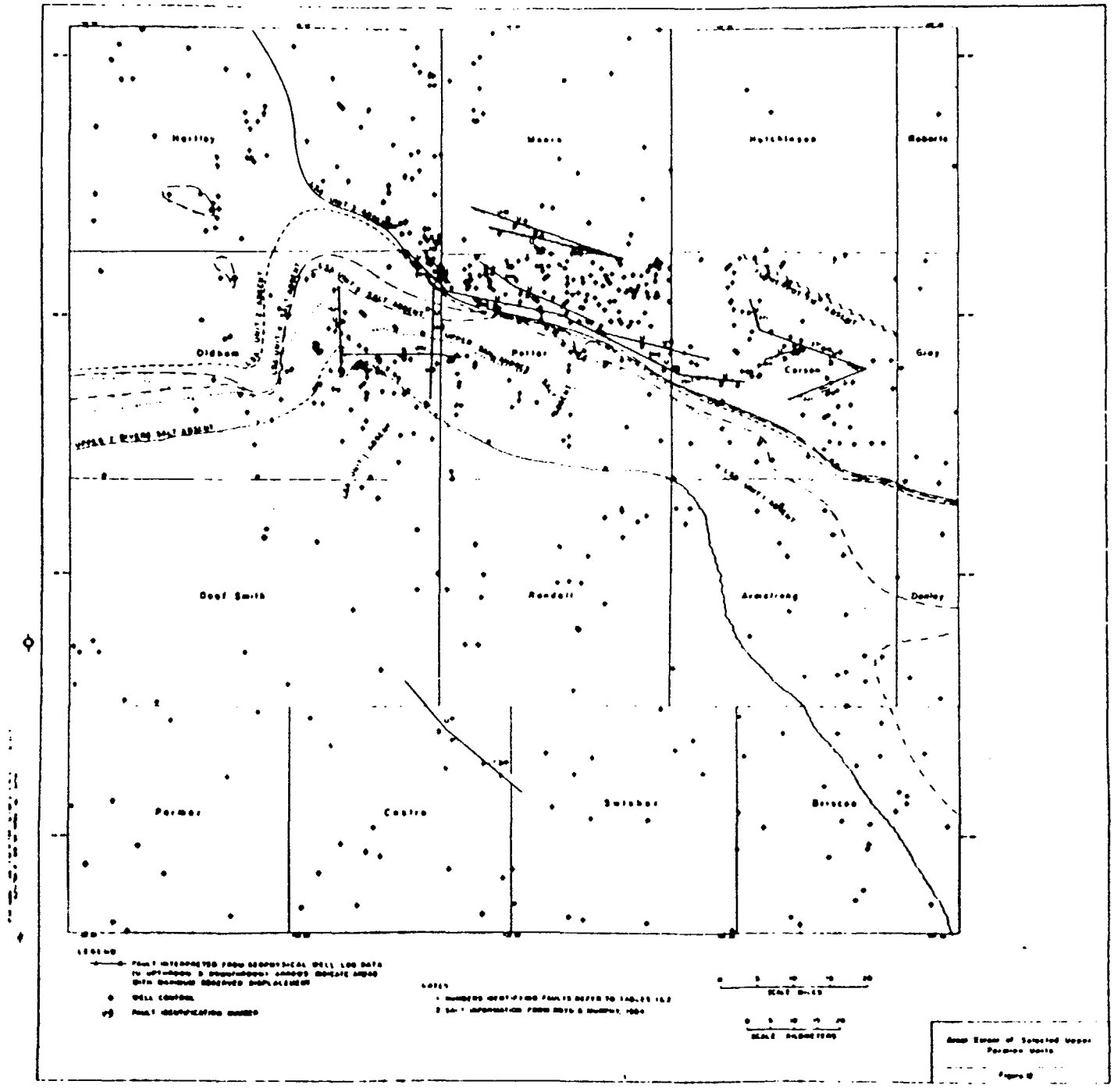
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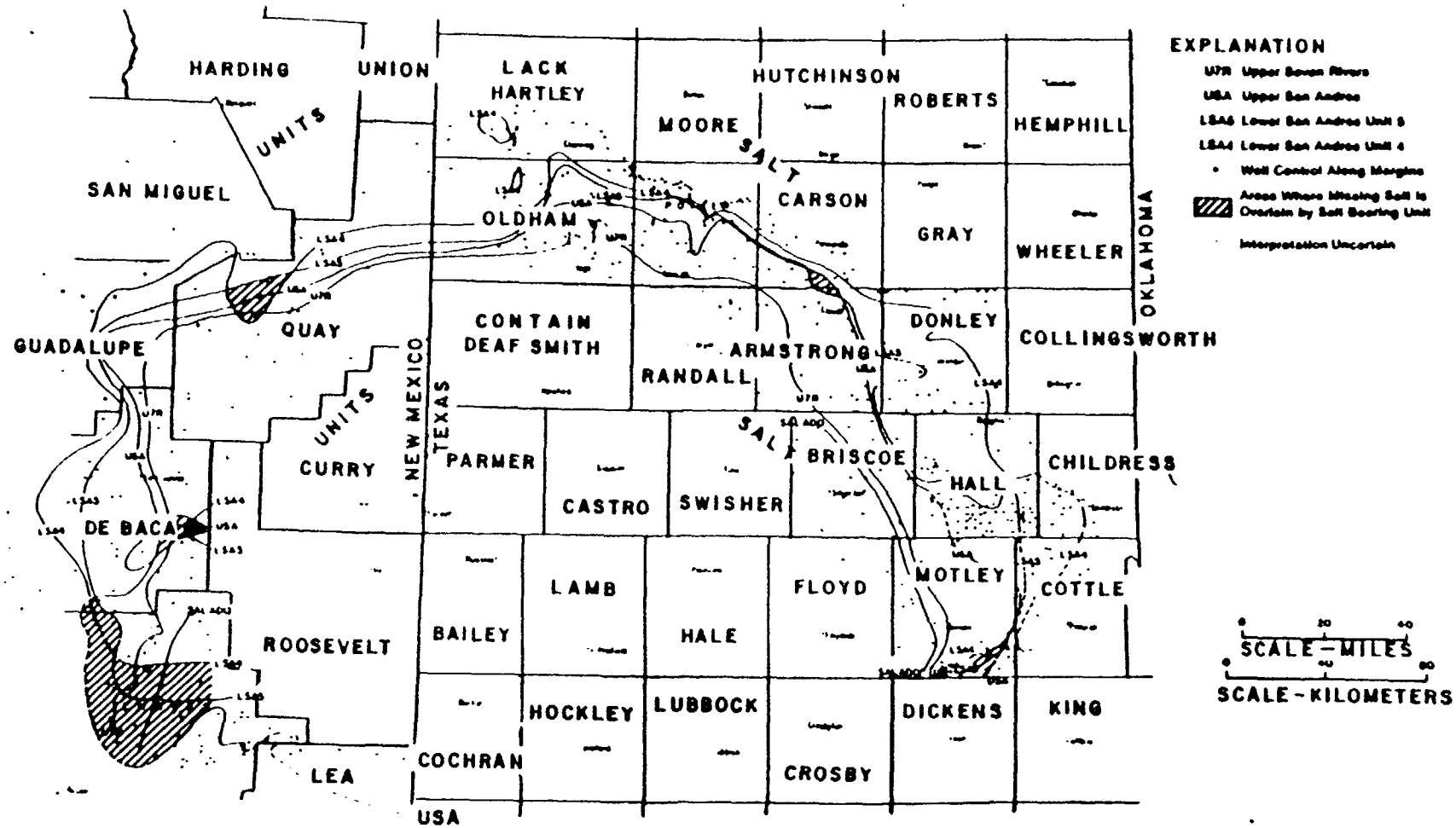
SALT MARGINS



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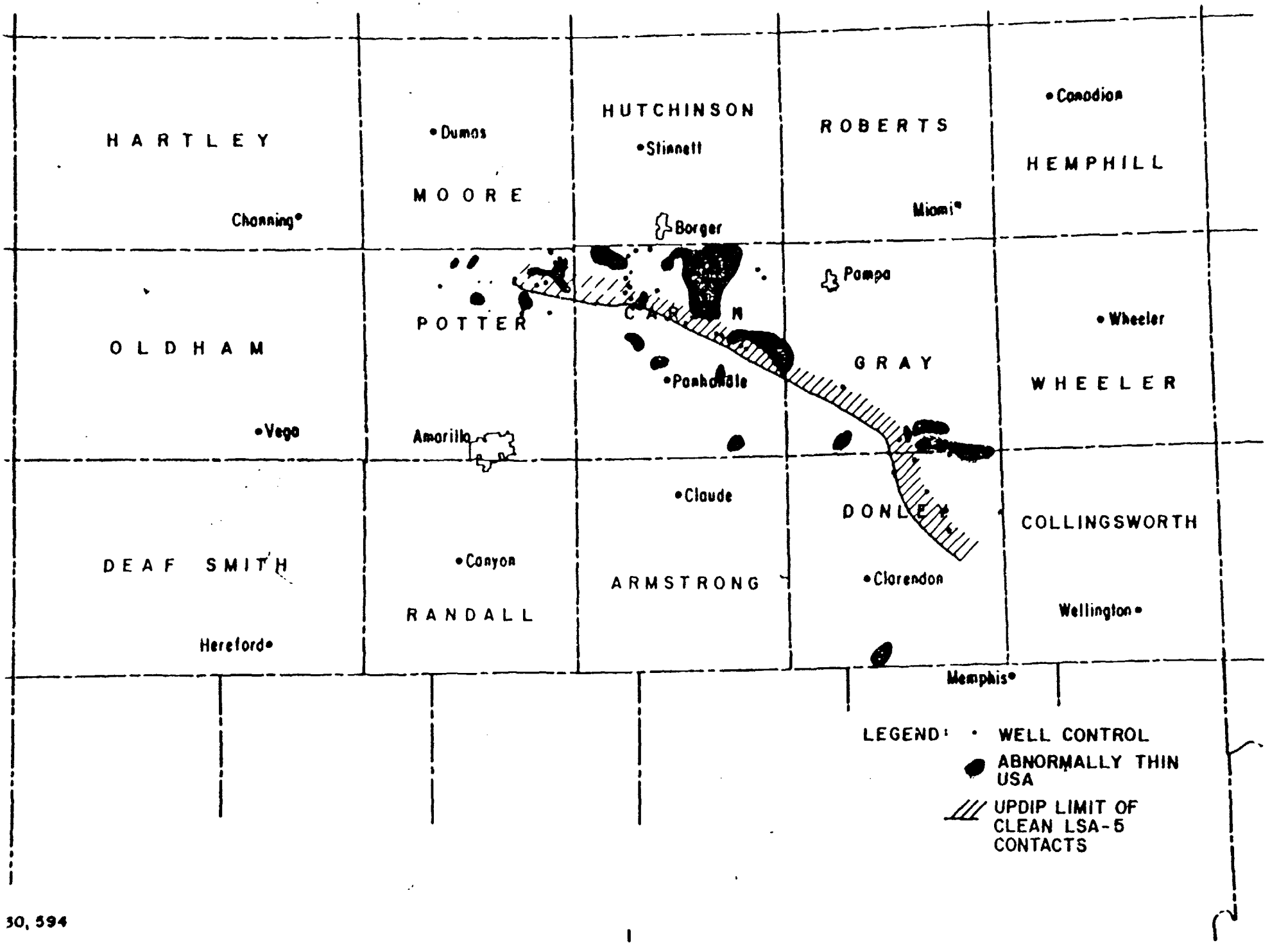
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POTTER
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GRAY
Wheeler
WHEELER
Claude
DONLEY
COLLINGSWORTH
DEAF SMITH
Hereford
Canyon
RANDALL
ARMSTRONG
Clarendon
Wellington
Memphis
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WELL CONTROL
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UPDIP LIMIT OF CLEAN LSA-5 CONTACTS

SHORT VS. AVERAGE
USA NON SALT SECTION

CITIES SERVICE
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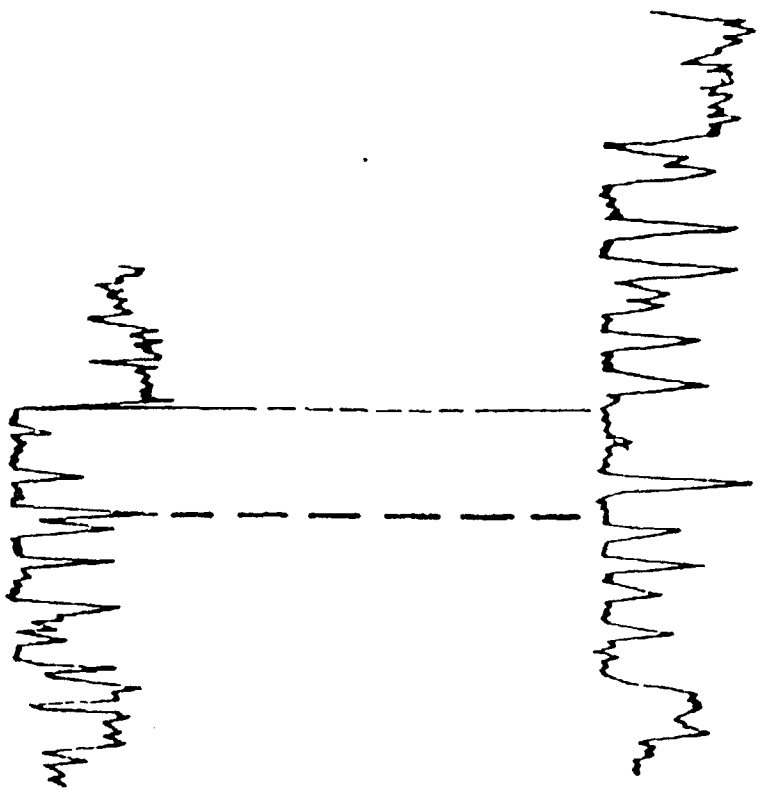
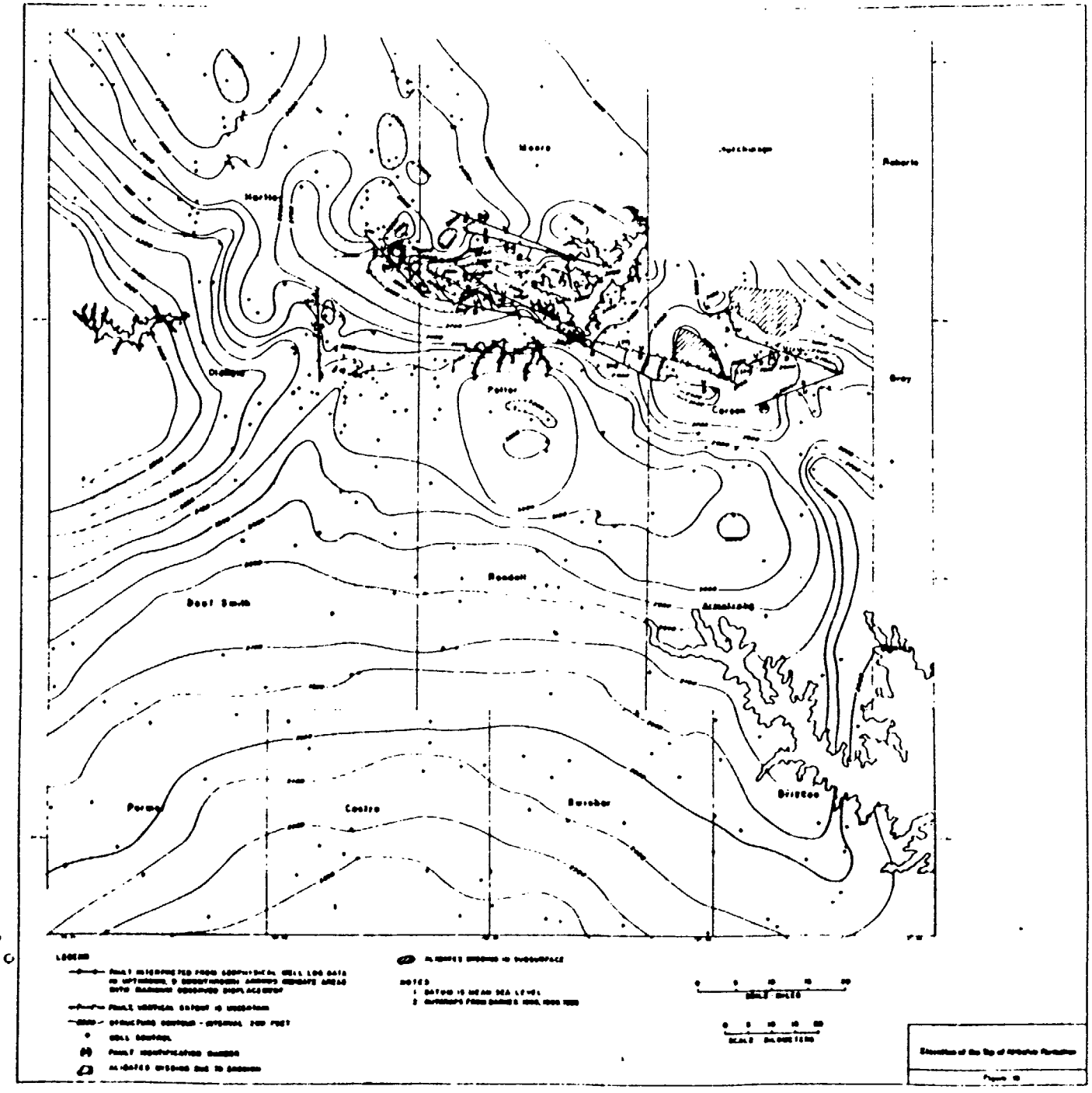
TEXAS GULF
BOBBITT # 1



BOTH WELLS IN CARSON CO.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CROSS SECTION H

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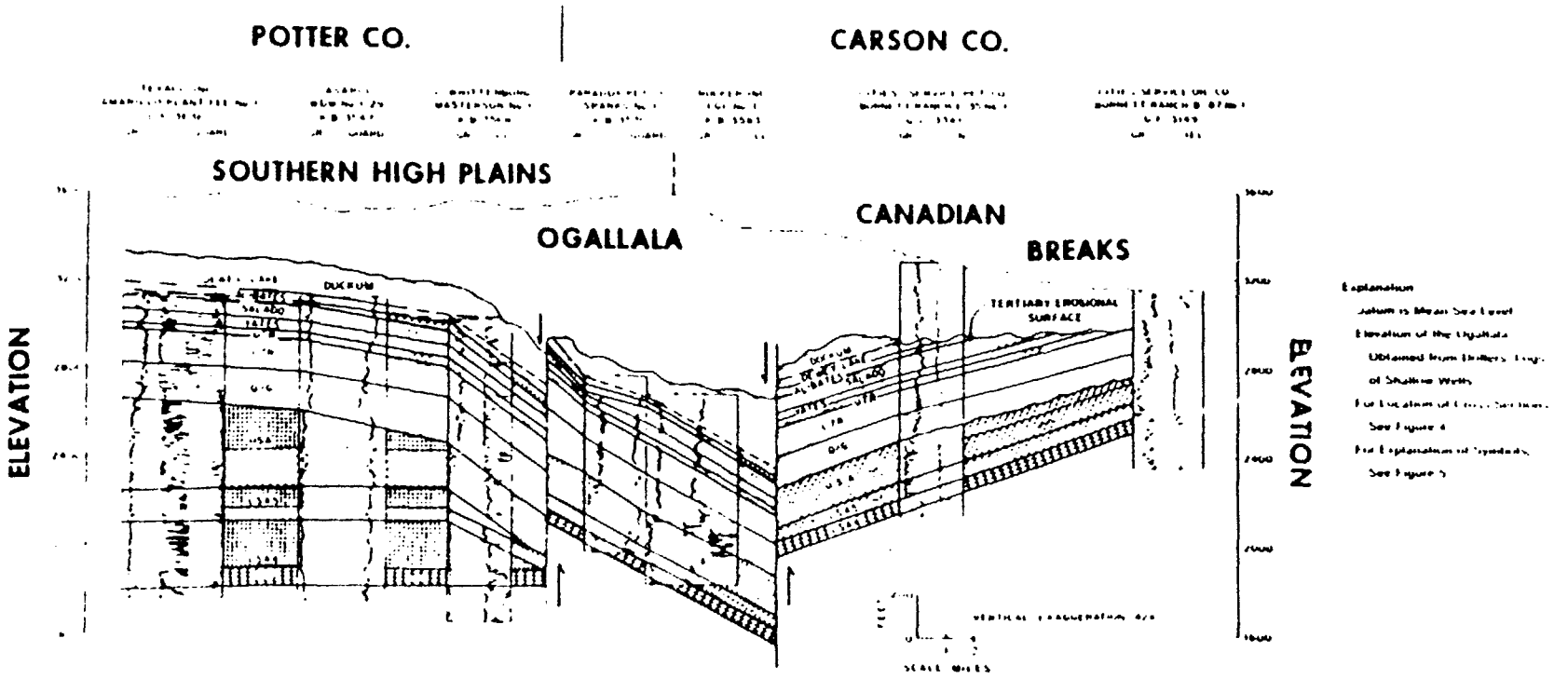
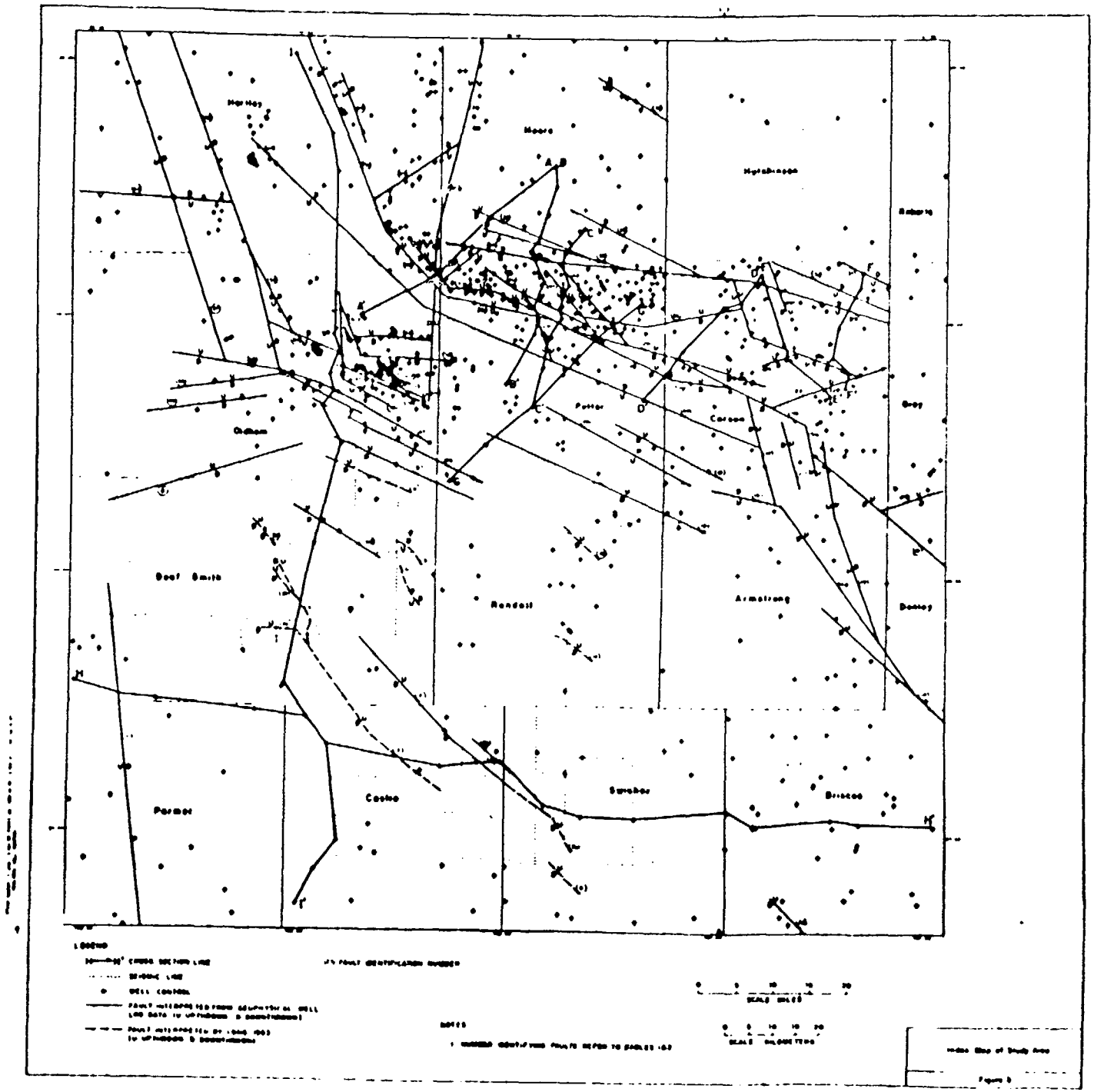
NORTHEAST

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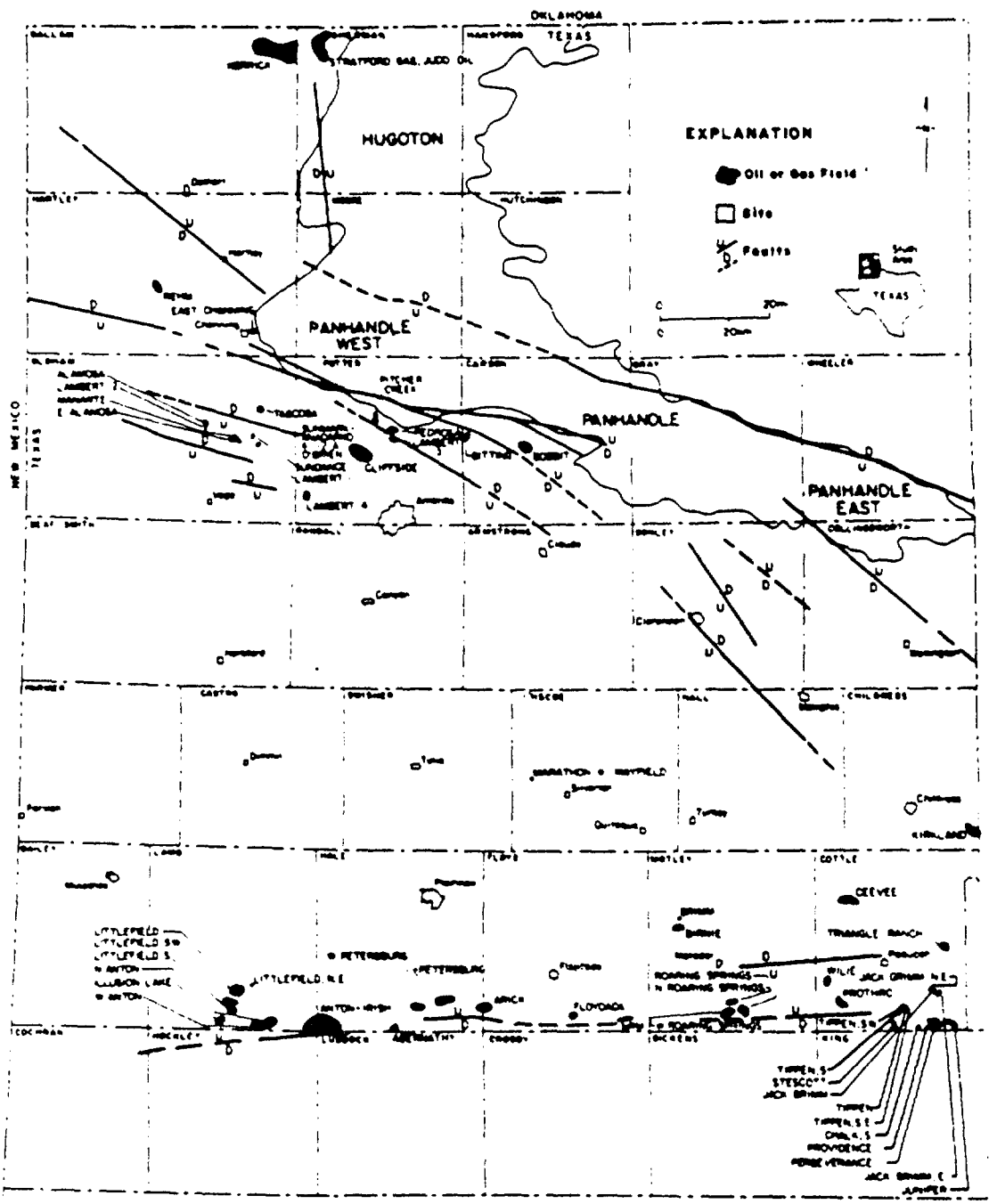
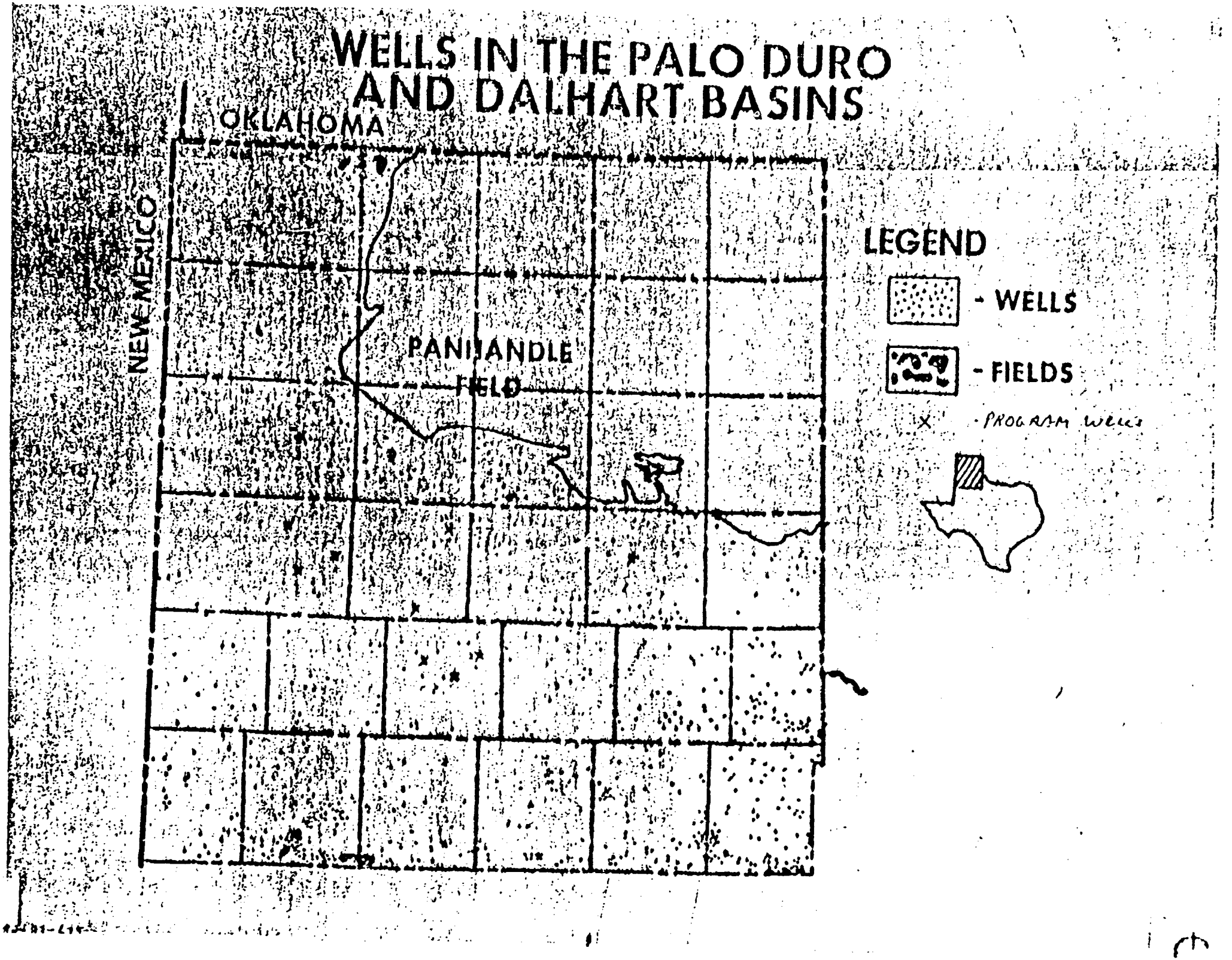


Location of Oil and Gas Fields in the Palo Duro Basin and Surrounding Areas.

Source: Dutton, Goldstein and Ruppel, 1982

Figure 3-3


WELLS IN THE PALO DURO AND DALHART BASINS
OKLAHOMA
NEW MEXICO
PANHANDLE FIELD
LEGEND
- WELLS
- FIELDS
X - PROGRAM WELLS

Murphy 8/5

SUMMARY OF WELLS DRILLED AND TESTED BY SWEC

1. Sawyer No. 1, Donley County, started June 23, 1981, completed October 15, 1981. T.D.: 4806 ft. Present status: Final plugged.

a. Casing Program - 13 3/8 in. conductor to 66 ft, 9 5/8 in. surface to 337 ft, 5 1/2 in. production to 3938 ft, 4 in. liner from 3938 ft to 4806 ft.

b. Rock Coring (all 4 in. OD core) - Total of 3872 ft, from 66 ft to 3938 ft, Yates through Pennsylvanian.

MAJOR SALT SECTION

o	Upper San Andres	438 ft to 652 ft, thickness	214 ft
o	LSA - Unit 5	652 ft to 756 ft, thickness	104 ft
o	LSA - Unit 4	756 ft to 840 ft, thickness	84 ft
o	LSA - Unit 3	840 ft to 894 ft, thickness	54 ft
o	LSA - Unit 2	894 ft to 947 ft, thickness	53 ft

Unusual features - Fault zone at 756-762 ft - 155 ft of missing section.

c. Drill Stem Tests (DSTs)

No. 1 2950 ft to 3123 ft - Wolfcamp, PI = 816 psi, k = 0.15 md

d. Geophysical Logging - Complete suites of cased and open hole logs.

e. Long-Term Pump Testing and Fluid Sampling

Zone 1 - Ellenburger Sand, 4716 ft - 4746 ft, unable to obtain data to determine PI or K, 4 downhole and 2 surface samples.

Zone 2 - Ellenburger Top, 4604 ft - 4640 ft, PI = 1390 psi, K = 0.3 md., 4 surface samples.

Zone 3 - Penn. Limestone, 4500 ft - 4535 ft, PI = 1531 psi, K = 5.4 md., 4 downhole and 2 surface samples.

Zone 4 - Penn. Limestone, 4258 ft-4342 ft, PI = 1350 psi, K = 2.7 md., 7 downhole and 10 surface samples.

Zone 5 - Wolfcamp, 3189 ft - 3172 ft, PI = 977 psi, K = 6.1 md., 3 downhole and 20 surface samples.

f. Dissolution Zone Water Well

Sawyer No. 2, 784 ft, 20 ft screen section at bottom of hole in LSA Unit 4. Testing by TBEG scheduled to begin April 1983.

2. Mansfield No. 1, Oldham County, started October 19, 1981, completed December 19, 1982. T.D. 4995 ft by SWEC, 7409 ft by Baker & Taylor (dry hole). Present status: Final plugged.

a. Casing Program - 13 3/8 in. conductor to 41 ft, 9 5/8 in. surface to 1212 ft, 5 1/2 in. tubing to 5180 ft.

b. Rock Coring (All 4 in. OD core) - Total of 4196 ft.

- 46 ft to 3540 ft - Dockum to Red Cave
- 4023 ft to 4123 ft - Wichita
- 4393 ft to 4995 ft - Wichita and Wolfcamp

MAJOR SALT SECTION

o	Upper San Andres	985 ft to 1373 ft, thickness	388 ft
o	LSA - Unit 5	1373 ft to 1546 ft, thickness	173 ft
o	LSA - Unit 4	1546 ft to 1815 ft, thickness	269 ft
o	LSA - Unit 3	1815 ft to 1940 ft, thickness	125 ft
o	LSA - Unit 2	1940 ft to 1978 ft, thickness	38 ft
o	LSA - Unit 1	1978 ft to 2001 ft, thickness	23 ft

c. Drill Stem Tests (DSTs)

No. 1	4800 ft - 4996 ft -	Wolfcamp PI = 1322 psi K = 26.6 md.
No. 2	4550 ft - 4650 ft -	Wolfcamp - Did not produce sufficient fluid.
No. 3	4550 ft - 4650 ft -	Wolfcamp - Did not produce sufficient fluid.
No. 4	4550 ft - 4650 ft -	Wolfcamp - Unable to set packers.
No. 5	6994 ft - 7409 ft -	Granite Wash - Did not produce sufficient fluid.
No. 6	6612 ft - 6640 ft -	Penn. Carbonates, PI = 2230, K = 21.4 md.
No. 7	4812 ft - 4840 ft -	Wolfcamp, PI = 1404, K = 30.22 md.

d. Geophysical Logging - Complete suites of cased and open hole logs.

e. Long-Term Pump Testing and Fluid Sampling

Zone 1 - Wolfcamp, 4818-4890, PI = 1470 psi, K = 3.3 md., 8 downhole and 24 surface samples.

Zone 2 - Wolfcamp, 4514-4638, PI = 1150 psi, K = 0.6 md., 9 downhole and 8 surface samples.

f. Dissolution Zone Water Well

Mansfield No. 2, 780 ft, 30 ft screen at bottom in Queen/Grayburg. Testing by TBEG scheduled to begin May 1983.

3. Detten No. 1 - Deaf Smith County, started February 26, 1982, completed May 5, 1982. T.D. 2839.3 ft. Status: Final plugged.

a. Casing Program - 13 3/8 in. conductor to 53 ft, 9 5/8 in. surface to 1122 ft.

b. Rock Coring (all 4 in. OD core) - Total of 1249 ft

- o 1129.2 ft to 1423.0 ft - Salado, Yates, Upper Seven Rivers
- o 1884 ft to 2839.3 ft - Upper San Andres, Lower San Andres to Unit 3

MAJOR SALT SECTION

o	Upper San Andres	1866 ft to 2374 ft, thickness	508 ft
o	LSA - Unit 5	2374 ft to 2575 ft, thickness	201 ft
o	LSA - Unit 4	2575 ft to 2830 ft, thickness	255 ft

c. Drill Stem Tests (DSTs)

No. 1	1160 ft - 1360 ft -	Upper Seven Rivers - Unsuccessful - Poor packer seat.
No. 2	1299 ft - 1366 ft -	Upper Seven Rivers - Unsuccessful - Poor packer seat.
No. 3	2749 ft - 2839 ft -	LSA Unit 4 Dolomite, P.I. = 1150 psi, K = 0.16 md.

d. Geophysical Logging - Complete suites of cased and open hole logs.

e. Long-Term Pump Testing and Fluid Sampling - None.

f. Dissolution Zone Water Well

Detten No. 2, 1325 ft, 20 ft of screen at bottom in Yates. Testing by TBEG scheduled to begin May 1983.

4. G. Friemel No. 1 - Deaf Smith County, started February 23, 1982, completed March 31, 1982. T.D. 2710 ft. Present status: Final plugged.

a. Casing Program - 13 3/8 in. conductor to 50 ft, 9 5/8 in. surface to 1058 ft.

b. Rock Coring (all 4 in. OD core) - Total of 1121.7 ft

- 1191.5 ft to 1312.0 ft - Yates, Upper Seven Rivers
- 1709.0 ft to 2710.2 ft - Queen/Grayburg, Upper San Andres, and Lower San Andres to Unit 3

MAJOR SALT SECTION

o	Upper San Andres	1742 ft to 2331 ft, thickness	589 ft
o	LSA - Unit 5	2331 ft to 2435 ft, thickness	104 ft
o	LSA - Unit 4	2435 ft to 2688 ft, thickness	253 ft

c. Drill Stem Tests (DSTs)

No. 1 2600 ft - 2710 ft, LSA Unit 4 Dolomite, P.I. = 975 psi, K = 0.07 md.

d. Geophysical Logging - Complete suites of cased and open hole logs.

e. Long-Term Pump Testing and Fluid Sampling - None.

f. Dissolution Zone Water Well None.

5. Zeeck No. 1 - Swisher County, started April 9, 1982, completed August 12, 1982. T.D. 7652 ft. Scheduled completion of pump testing is April 1983. Well will be final plugged at completion of pump testing.

a. Casing Program - 13 3/8 in. conductor to 26 ft, 9 5/8 in. surface at 1024 ft, 5 1/2 in. to 7421 ft.

b. Coring (all 4 in. OD core) - Total of 1993 ft

- o 1035 ft to 1144 ft - Salado
- o 1885 ft to 3102 ft - Queen/Grayburg, Upper San Andres, Lower San Andres Units 5, 4, 3, and Upper Section of Unit 2.
- o 5309 ft to 5780 ft - Wichita/Wolfcamp Contact and Upper Wolfcamp
- o 5910 ft to 6058 ft - Wolfcamp
- o 7300 ft to 7387 ft - Pennsylvanian Carbonates

MAJOR SALT SECTION

o	Upper San Andres	2014 ft to 2574 ft, thickness	560 ft
o	LSA - Unit 5	2574 ft to 2732 ft, thickness	158 ft
o	LSA - Unit 4	2732 ft to 3014 ft, thickness	282 ft
o	LSA - Units 3,2,&1	3014 ft to 3188 ft, thickness	174 ft

c. Drill Stem Tests (DSTs)

No. 1	1019 ft - 1044 ft -	Salado, Unsuccessful.
No. 2	1019 ft - 1044 ft -	Salado, Did not produce sufficient fluid.
No. 3	3035 ft - 3103 ft -	LSA, Unit 3, Did not produce sufficient fluid.
No. 4	2932 ft - 3103 ft -	LSA Unit 3, Unsuccessful.
No. 5	2927 ft - 3103 ft -	LSA Unit 4 Dolomite, P.I. = 1250 psi, K = 0.25 md.
No. 6	5365 ft - 5542 ft -	Upper Wolfcamp, PI = 1875 psi, K = 6.77 md.
No. 7	7146 ft - 7225 ft -	Pennsylvanian, PI = 2559 psi, K = 2.83 md.

d. Geophysical Logging - Complete suites of open and cased hole logs.

e. Long-Term Pump Testing and Fluid Sampling

Zone 1 - Penn. Carbonates, 7140 ft - 7230 ft, P.I. = 2500 psi, K = 15 md., 7 downhole and 33 surface samples.

Zone 2 - Wolfcamp, 5603 ft - 5640 ft, PI = 1960 psi, K = 1 md., 8 downhole samples.

Zone 3 - Wolfcamp, 5470 ft - 5550 ft, P.I. = 1890 psi, K = 7 md., 8 downhole and 4 surface samples.

Zone 4 - LSA Unit 4 Dolomite, 2930 Ft - 2970 ft, P.I. = 1300 psi, pumping and sampling in progress.

f. Dissolution Zone Water Well - None.

5. Harmon No. 1 - Swisher County, started July 29, 1982, completed September 7, 1982. T.D. 3052 ft, hole completed as Shallow Dissolution Zone Water Well (see below).

a. Casing Program - 13 3/8 in. conductor to 40 ft, 9 5/8 in. surface to 1063, cement to plug 1220 ft ± to 1400 ft ±.

b. Rock Coring (all 4 in. OD core) - Total of 1481 ft

- o 1070 ft to 1303 ft - Alibates, Salado, Yates, and Upper Seven Rivers
- o 1804 ft to 3052 ft (T.D.) - Queen/Grayburg, Upper San Andres, and Lower San Andres into Unit 2.

MAJOR SALT SECTION

o	Upper San Andres	1949 ft to 2446 ft, thickness	517 ft
o	LSA - Unit 5	2466 ft to 2651 ft, thickness	185 ft
o	LSA - Unit 4	2651 ft to 2931 ft, thickness	280 ft
o	LSA - Unit 3	2931 ft to 3012 ft, thickness	81 ft

c. Drill Stem Tests (DSTs)

No. 1 2840 ft - 3050 ft - Unit 4 Dolomite, P.I. = 1203 psi, K = 0.011 md., minor leakage noted around packers.

No. 2 2830 ft - 3050 ft (T.D.) - Unit 4 Dolomite, P.I. 1315, K = 0.186 md.

d. Geophysical Logging - Complete suites of cased and open hole logs.

e. Long-Term Pump Testing and Fluid Sampling - None.

f. Dissolution Zone Water Well

Installed in existing borehole with open hole section from bottom of surface casing at 1064 ft ± to top of cement plut at 1220 ft ±. Gravel packed screen (30 ft long) set in Yates. Pump tests and fluid sampling by TBEG scheduled to start late spring 1983.

7. J. Friemel No. 1 - Deaf Smith County, started October 15, 1982, completed March 18, 1983. T.D. 8283 ft, pump testing scheduled to start June 1983..

a. Casing Program - 22 in. conductor to 48 ft, 16 in. surface to 1210 ft, 10 3/4 in. intermediate salt string to 4695 ft, 5 1/2 in. to 8283 ft.

b. Rock Coring (all 4 in. OD core) - Total of 3043 ft

- o 352 ft to 1464 ft - Dockum, Dewey Lake, Alibates, Salado, Yates, and Upper Seven Rivers
- o 1846 ft to 2830 ft - Upper San Andres, LSA Units 5, 4, and Upper Section of Unit 3
- o 5519 ft to 6032 ft - Wolfcamp
- o 6421 ft to 6537 ft - Penn. Carbonates
- o 7698 ft to 7780 ft - Granite Wash.
- o 8047 ft to 8283 ft (T.D.) - Granite Wash

MAJOR SALT SECTION

o	Upper San Andres	1880 ft to 2372 ft, thickness	492 ft
o	LSA - Unit 5	2372 ft to 2560 ft, thickness	188 ft
o	LSA - Unit 4	2560 ft to 2822 ft, thickness	262 ft
o	LSA - Units 3,2,&1	2822 ft to 3018 ft, thickness	196 ft

c. Drill Stem Tests (DSTs)

No. 1	958 ft - 1216 ft -	Santa Rosa - Too high Producer..
No. 2	787 ft - 850 ft -	Santa Rosa - Unsuccessful.
No. 3	1279 ft - 1464 ft -	Upper Seven Rivers - Did not Produce Sufficient Fluid.
No. 4	1279 ft - 1464 ft -	Upper Seven Rivers - Did not Produce Sufficient Fluid.
No. 5	2753 ft - 2830 ft -	LSA Unit 4 Dolomite - Did not Produce Sufficient Fluid.
No. 6	5630 ft - 5909 ft -	Wolfcamp, PI = 1756 psi, K = 10.3 md.
No. 7	Penn. Carbonates and Granite Wash - Unsuccessful, tool stuck.	

d. Geophysical Logging - Complete suites of open and cased hole logs.

e. Long-Term Pump Testing and Fluid Sampling

Scheduled to start June 1983. Propose testing Granite Wash, Penn. Carbonates, Wolfcamp, and LSA Unit 4 Dolomite.

8. Holtzclaw No. 1 - Randall County, started February 28, 1983, scheduled completion April 1983. Planned T.D. 2800 ft ±. Present status: Coring Lower San Andres.

a. Casing Program - 20 in. conductor to 41 ft, 10 3/4 in. surface to 1400 ft ±.

b. Rock Coring (All 4 in. OD)

1080 ft - 1401 ft - Salado, Yates, and Upper Seven Rivers

Planned - Contact of LSA Unit 5 into LSA Unit 3.

MAJOR SALT SECTION

Unavailable at present.

c. Drill Stem Tests (DSTs)

No. 1	1276 ft - 1322 ft -	Upper Seven Rivers
No. 2	1140 ft - 1186 ft -	Salado
No. 3	702 ft - 748 ft -	Santa Rosa

Planned - LSA Unit 4 Dolomite. If indication of porosity contact of LSA 4 and 5, contact U.S.A. and Unit 5, and upper contact of U.S.A.

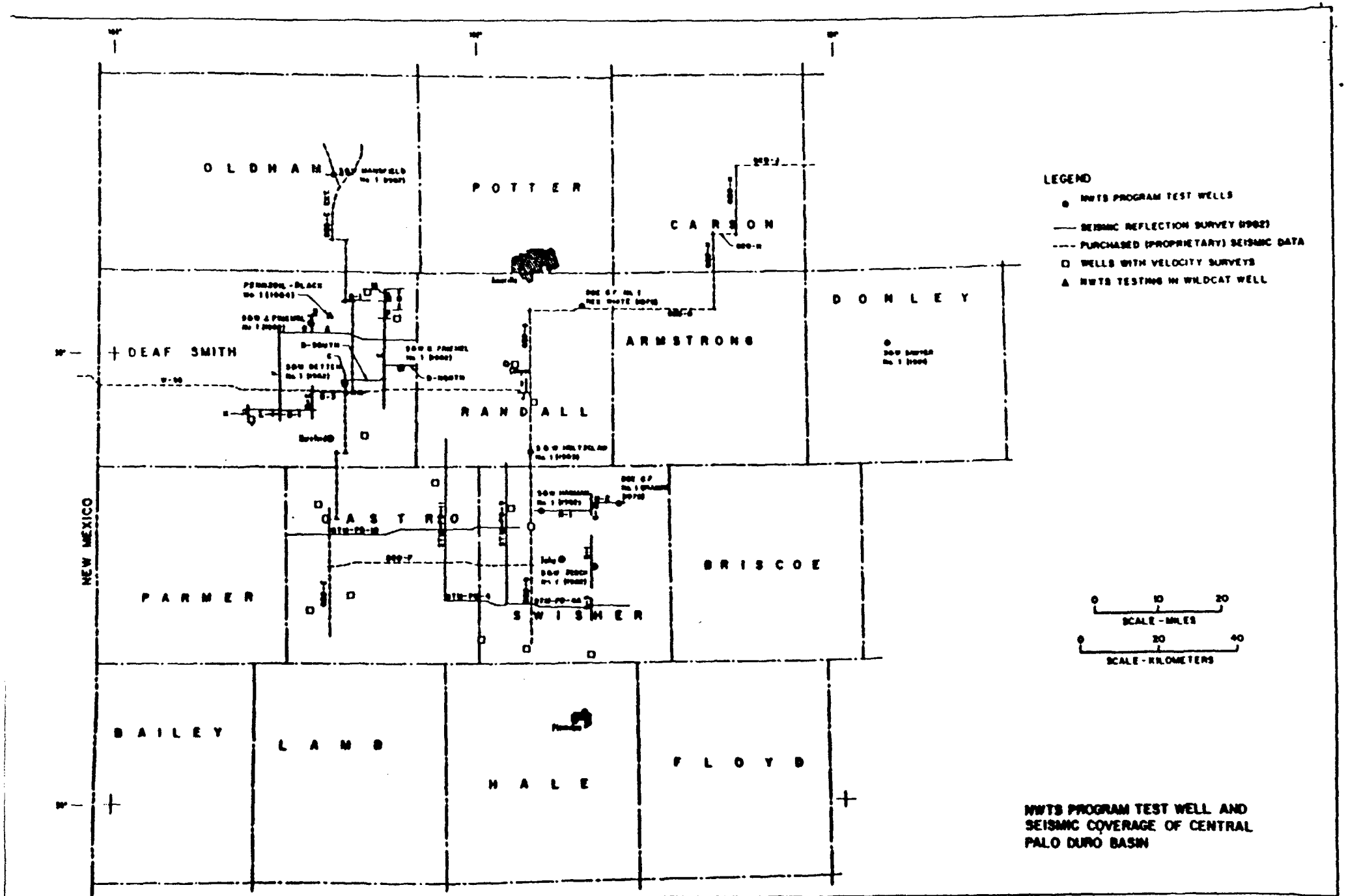
d. Geophysical Logging - Complete suites to T.D. planned.

e. Long-Term Pump Testing and Fluid Sampling

None presently planned.

f. Dissolution Zone Water Well

None presently planned.



NWTS PROGRAM TEST WELL AND SEISMIC COVERAGE OF CENTRAL PALO DURO BASIN

Ruppel 8/5

PALO DURO BASIN STRATIGRAPHIC STUDIES

BUREAU OF ECONOMIC GEOLOGY

UNIT	MAJOR CONTRIBUTORS
Precambrian	Flawn, Budnik
Cambrian, Ordovician	Ruppel
Mississippian	Ruppel
Pennsylvanian	Dutton, S.
Permian	
Wolfcamp	*Handford, Dutton, S., *Herron, Conti, Hovorka, Posey
Wichita	Hovorka
Red Cave	*Handford
Lower Clear Fork	*Handford
Tubb	*Presley
Upper Clear Fork	*Presley, *McGinnis
Glorietta	*Presley, *McGinnis
San Andres	*Presley, *Ramonoetta, *Bein, Hovorka, Fracasso
Queen-Grayburg	*Kolker, Hovorka, Nance
Seven Rivers	*Kolker, Hovorka, Nance
Yates	*Kolker, Hovorka, Nance
Tansill-Salado	*McGillis, *Presley, *Kolker, Nance
Alibates	*McGillis, *Presley, Nance
Dewey Lake	*Kolker, Fracasso, Johns
Triassic	
Dockum	*McGowen, *Granata, Seni, Johns
Teritary	
Ogallala	Seni, Gustavson
Quaternary	
Blackwater Draw, Etc.	Caran, Baumgardner, Gustavson

* No longer with the Bureau of Economic Geology

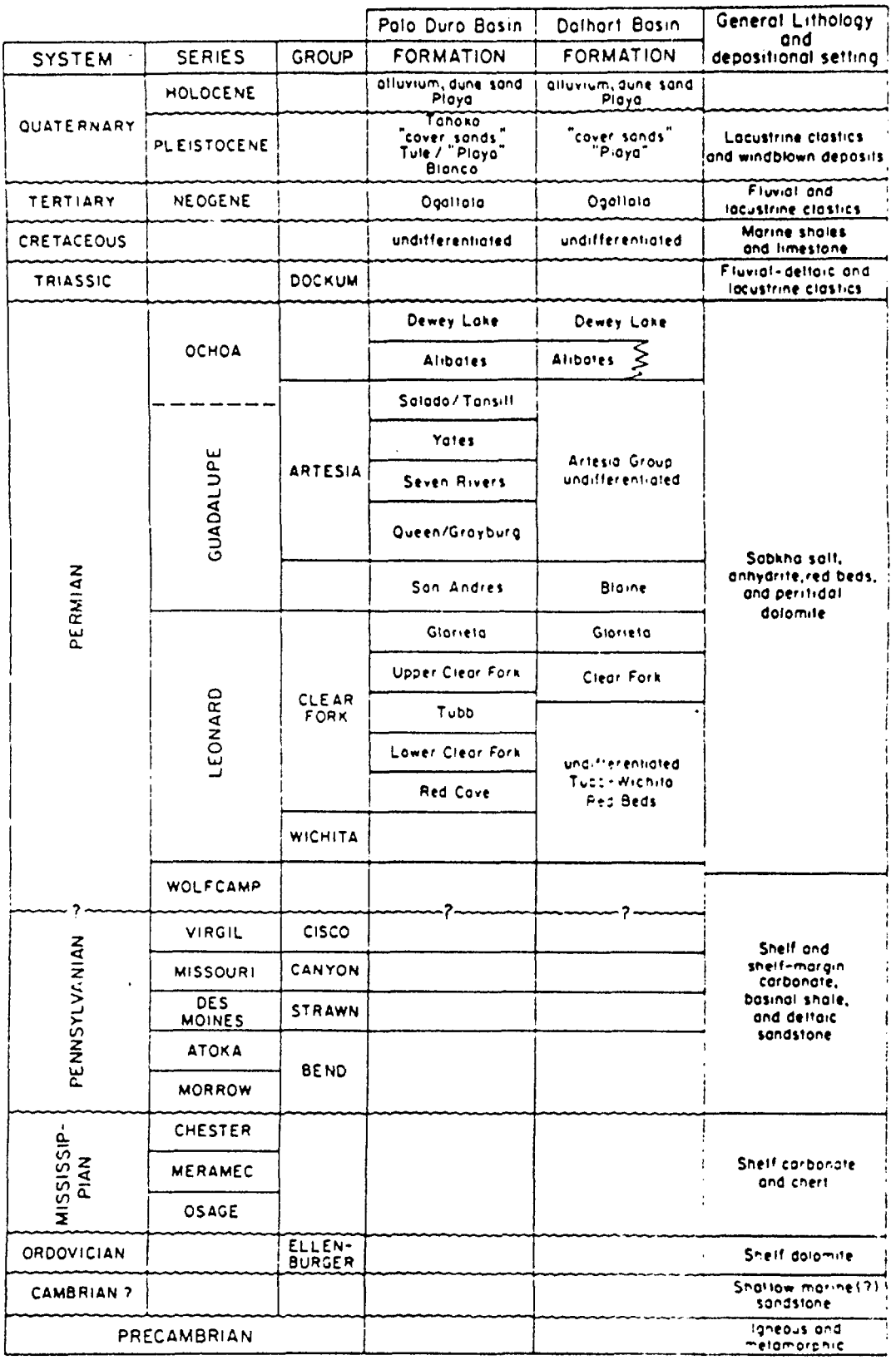


Figure 26. Stratigraphic column and general lithology of the Palo Duro and Dalhart Basins. After Handford and Dutton (1980).

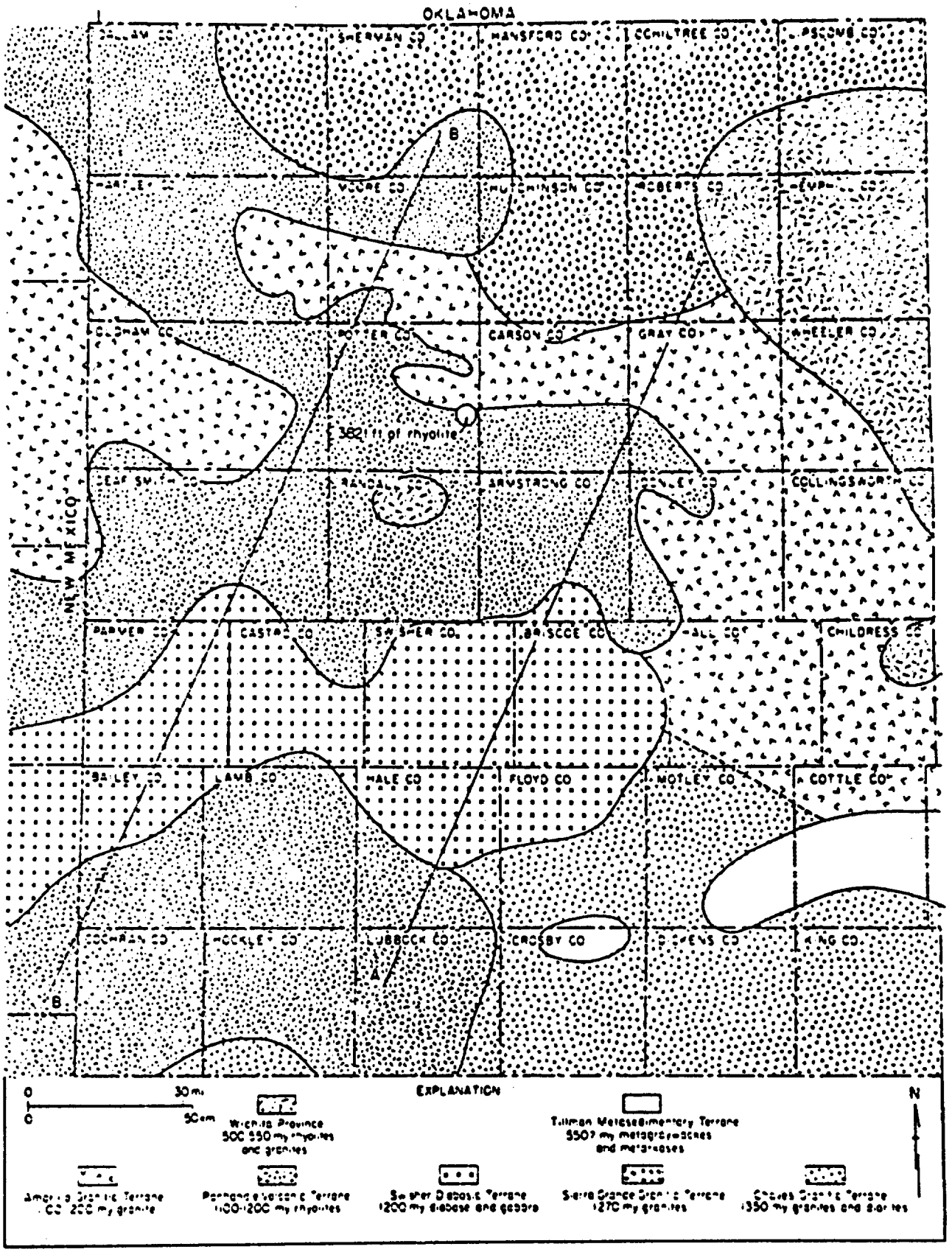
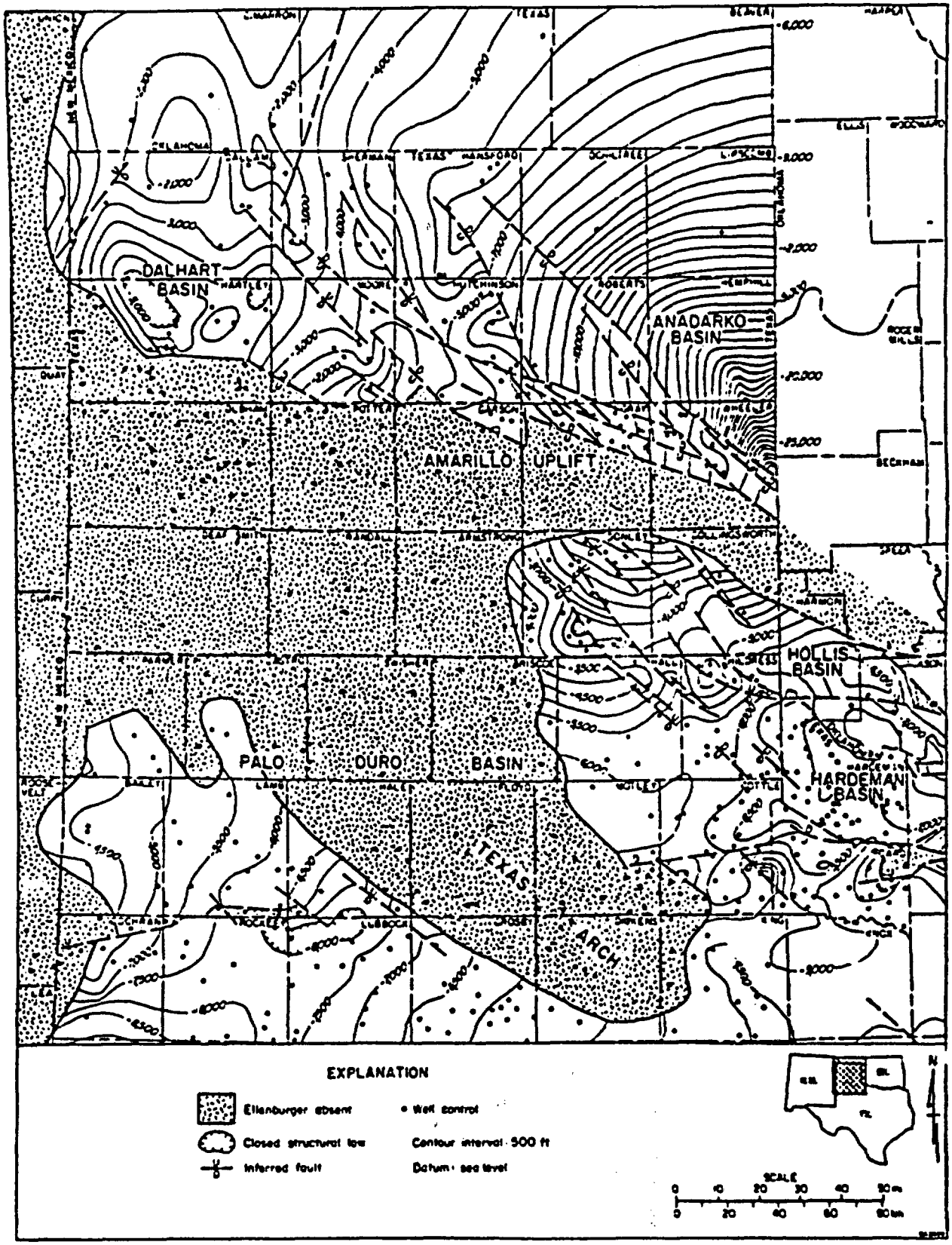
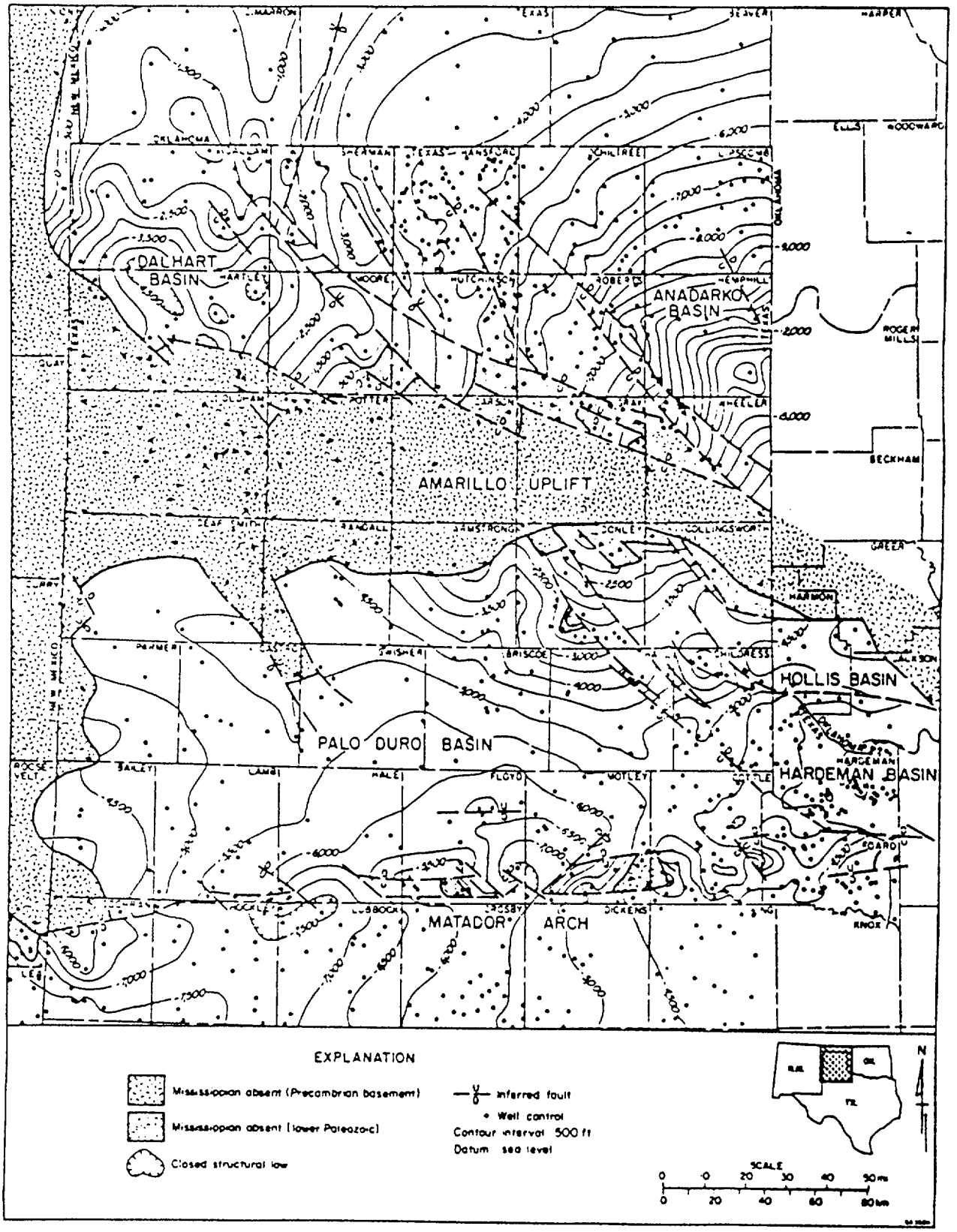


Figure 42. Basement lithologic provinces in the Texas Panhandle (from Muehlberger and others, 1967). A-A' and B-B' are locations of gravity models discussed in this report (see figs. 43 and 44).

ORDOVICIAN ELLENBURGER GROUP: STRUCTURE MAP



MISSISSIPPIAN SYSTEM: STRUCTURE MAP



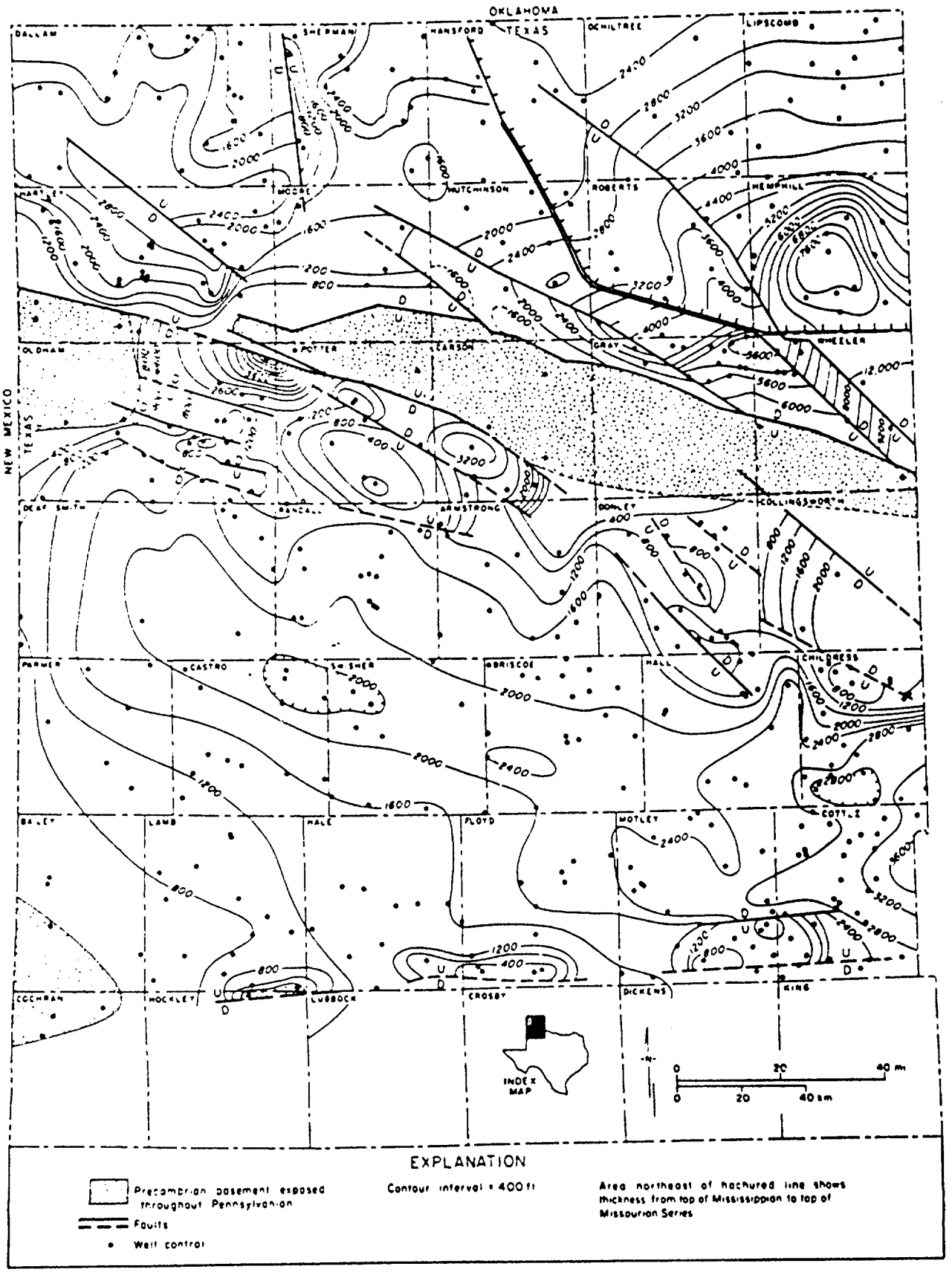


Figure 14. Isopach map of Pennsylvanian System, Texas Panhandle. Sediments thin onto uplifts that were exposed during Pennsylvanian Period.

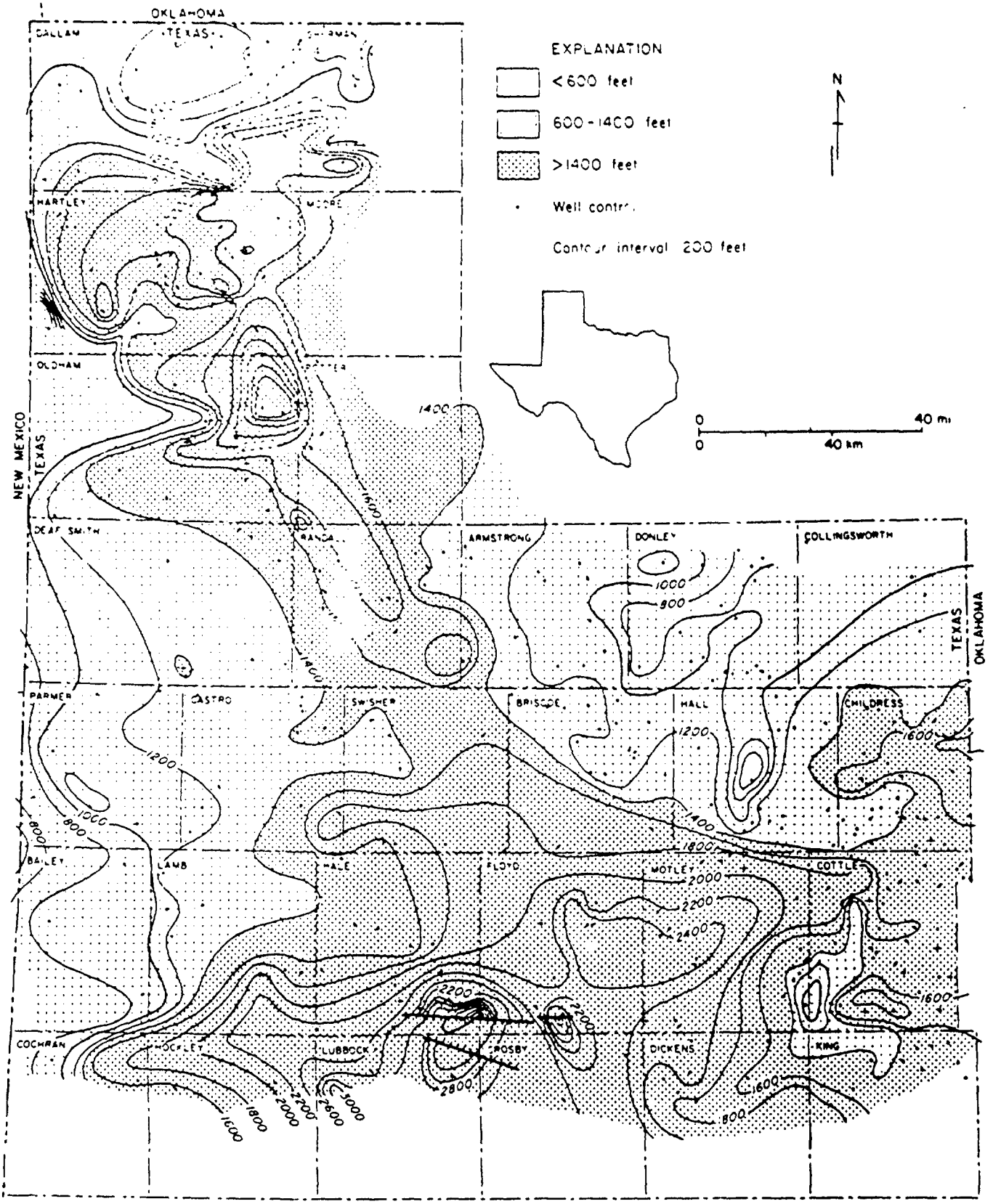


Figure 16. Isopach map of Wolfcampian Series, Palo Duro Basin (Handford, unpublished data).

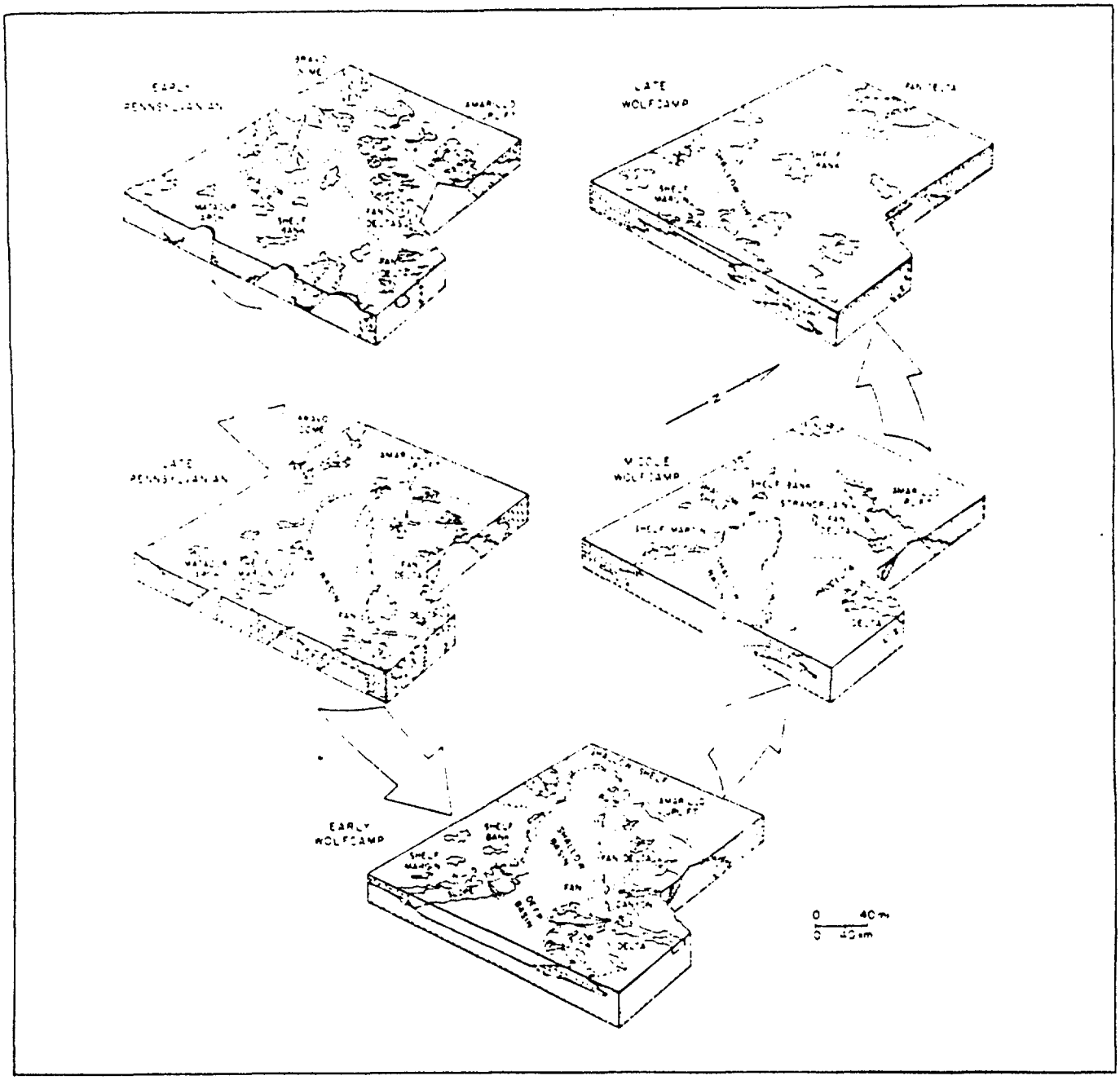


Figure 23. Block diagrams of paleogeographic evolution of Palo Duro Basin during Pennsylvanian and Wolfcampian time (from Handford and Dutton, 1980).

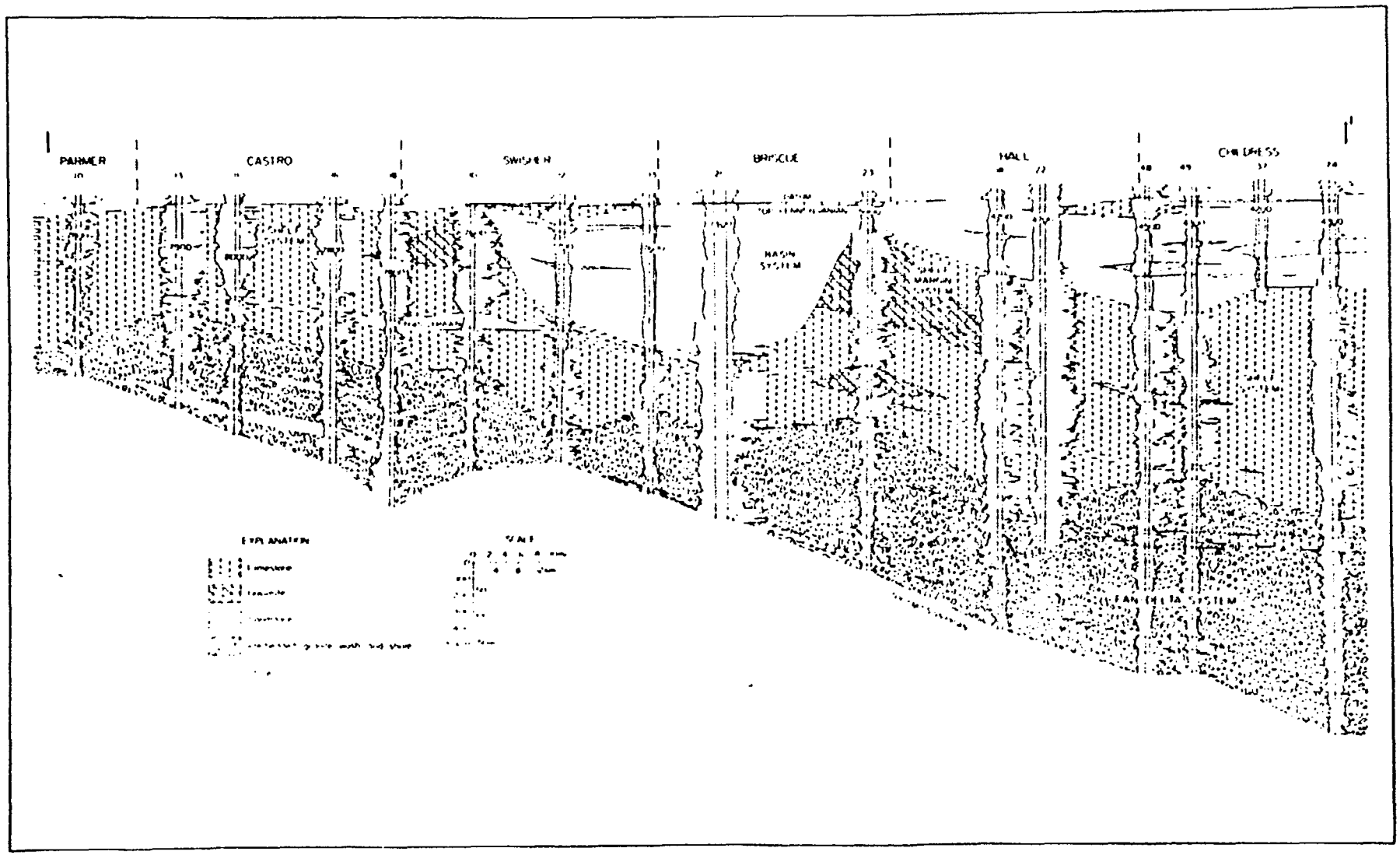


Figure 25. East-west cross section I-I' of Pennsylvanian strata, Parmer to Childress Counties (see fig. 3 for location).

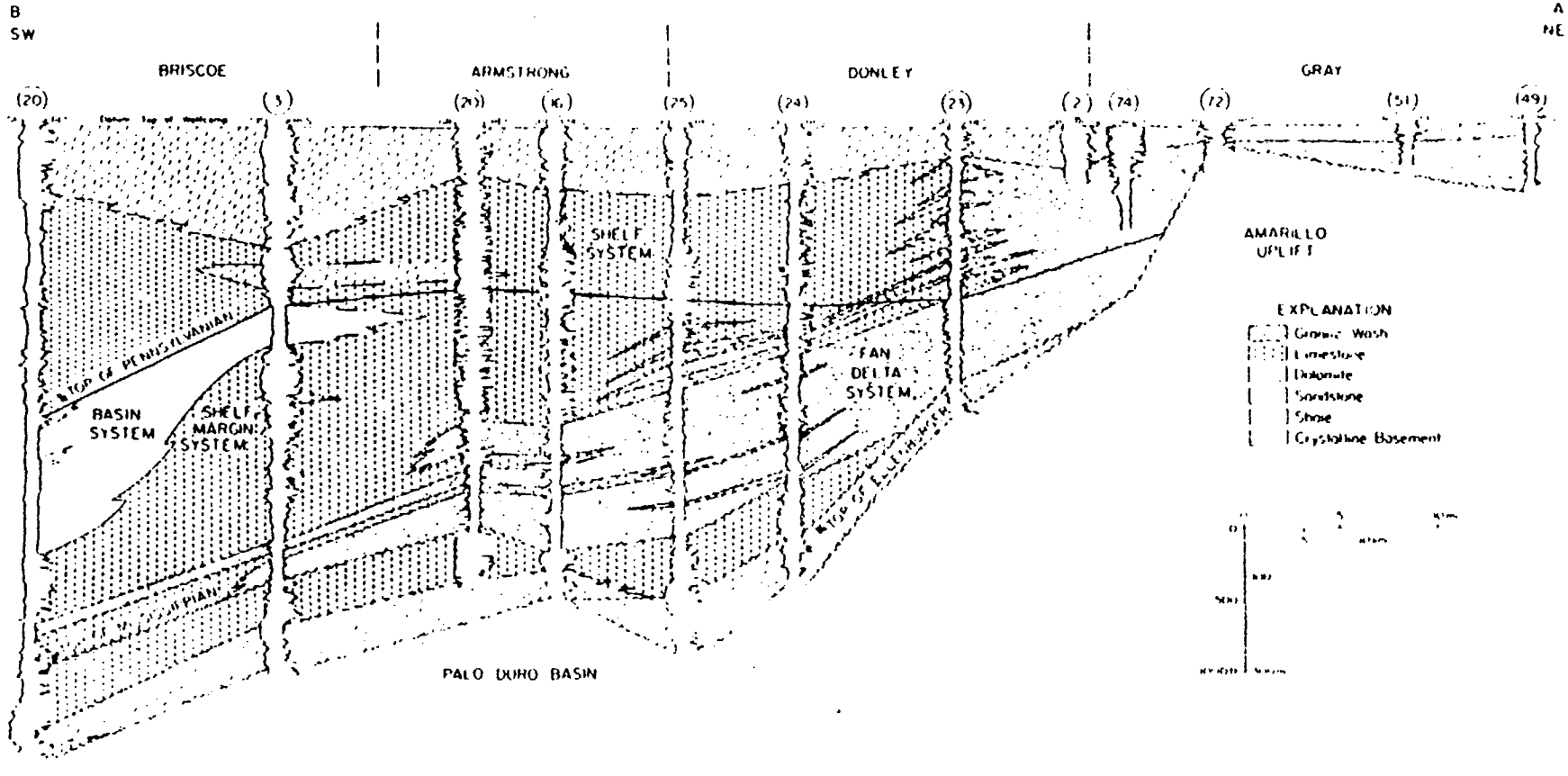


Figure 59. North-south regional cross section A-B from the central Palo Duro Basin to the Amarillo Uplift. Line of section shown in figure 57.

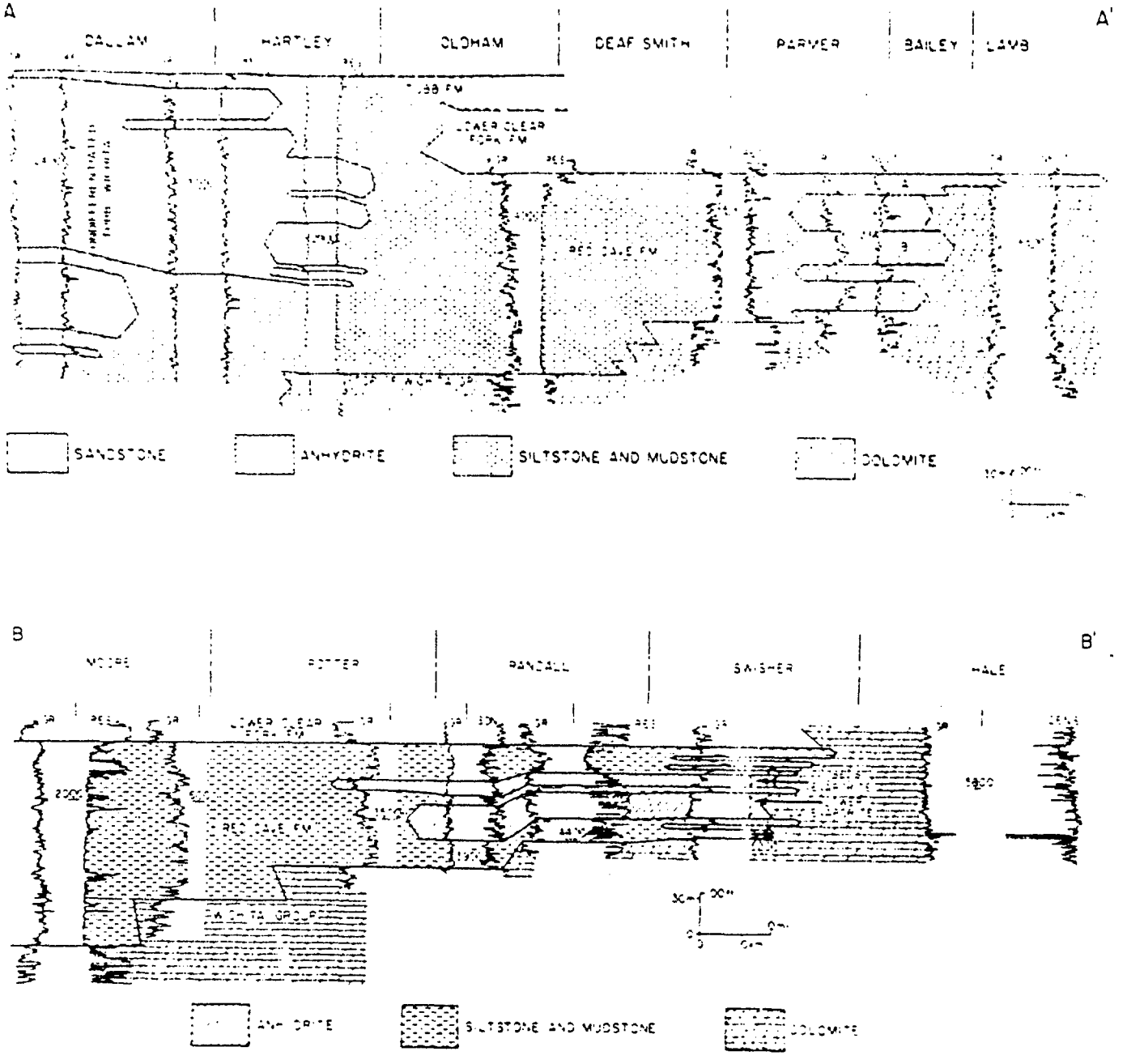


Figure 3. North-south cross sections A-A' and B-B' through the Red Cave Formation.

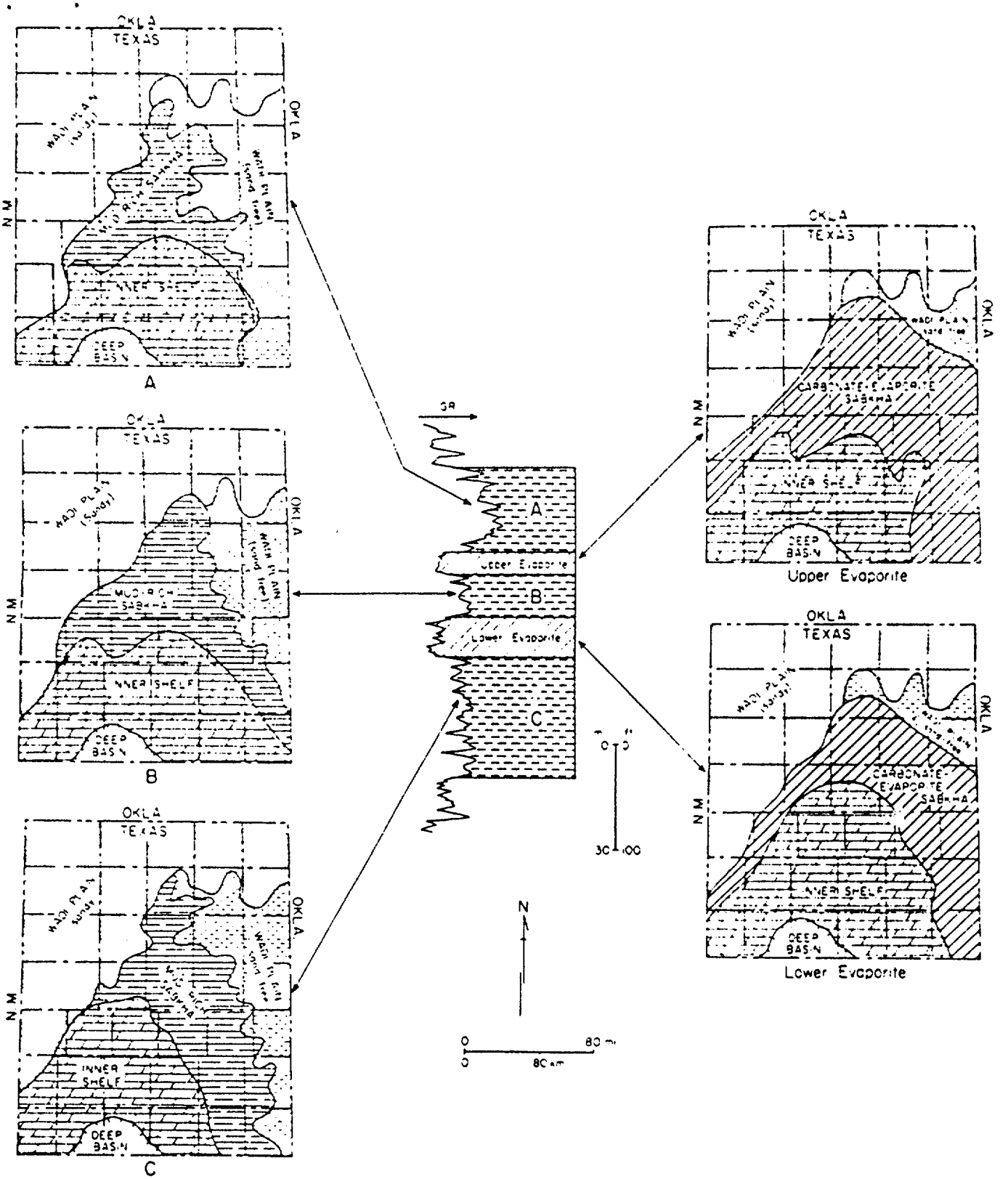


Figure 19. Paleogeography of the Red Cave Formation. Cyclic clastic and carbonate-evaporite facies reflect alternating styles of sabkha deposition that were brought on by the periodic availability and supply of clastics to sabkha environments.

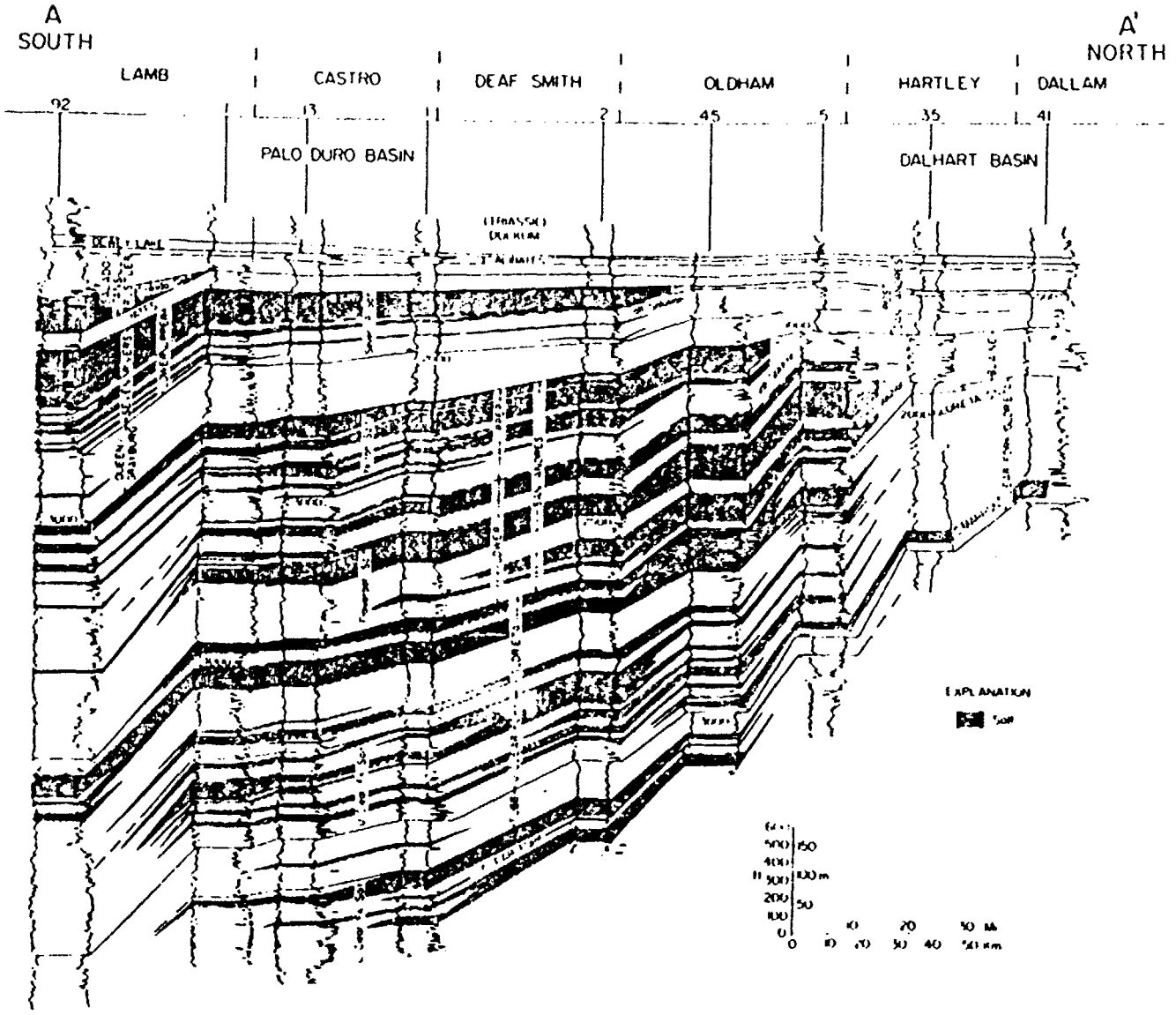


Figure 5. North-south cross section, Upper Permian salt-bearing strata, Texas Panhandle. Generalized salt units are correlated. Location of section in figure 4.

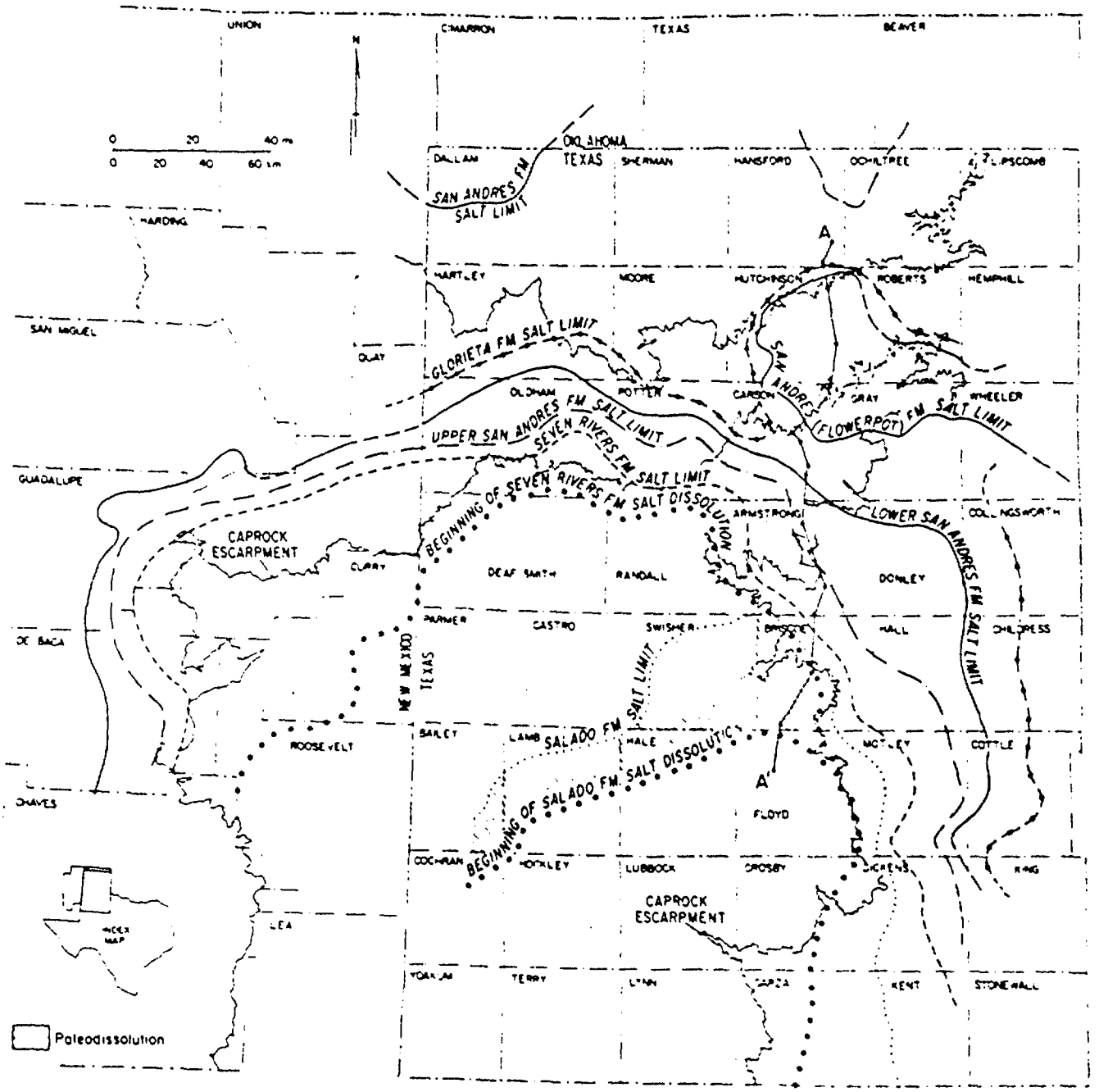


Figure 72. Salt dissolution zones, Texas Panhandle and eastern New Mexico. Except for the Seven Rivers and Salado Formations, where both the beginning of salt dissolution and the limit of salt are shown, the limit of salt for the younger formation marks the approximate beginning of salt dissolution for the next older formation (from Dutton and others, 1979).

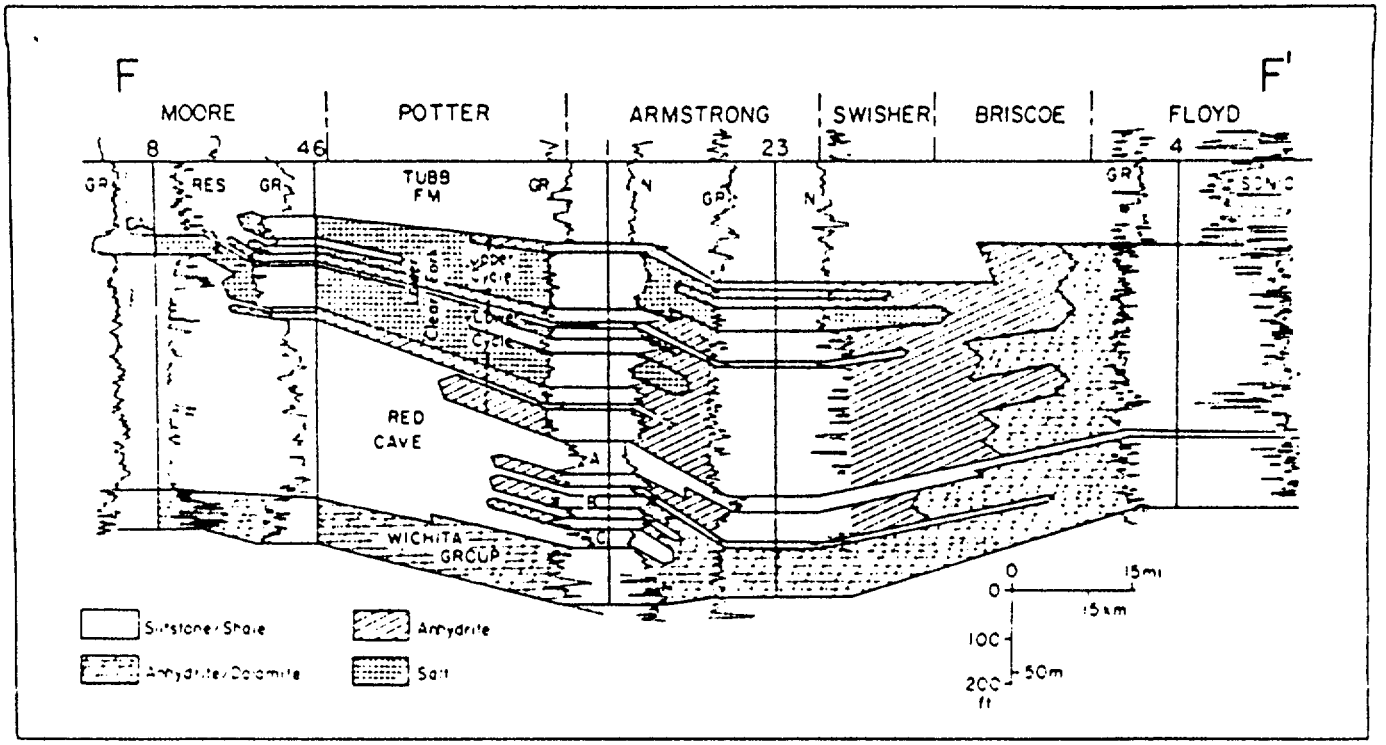


Figure 34. North-south cross section F-F' of lower Clear Fork Formation. See figure 3 for location (from Handford, 1981).

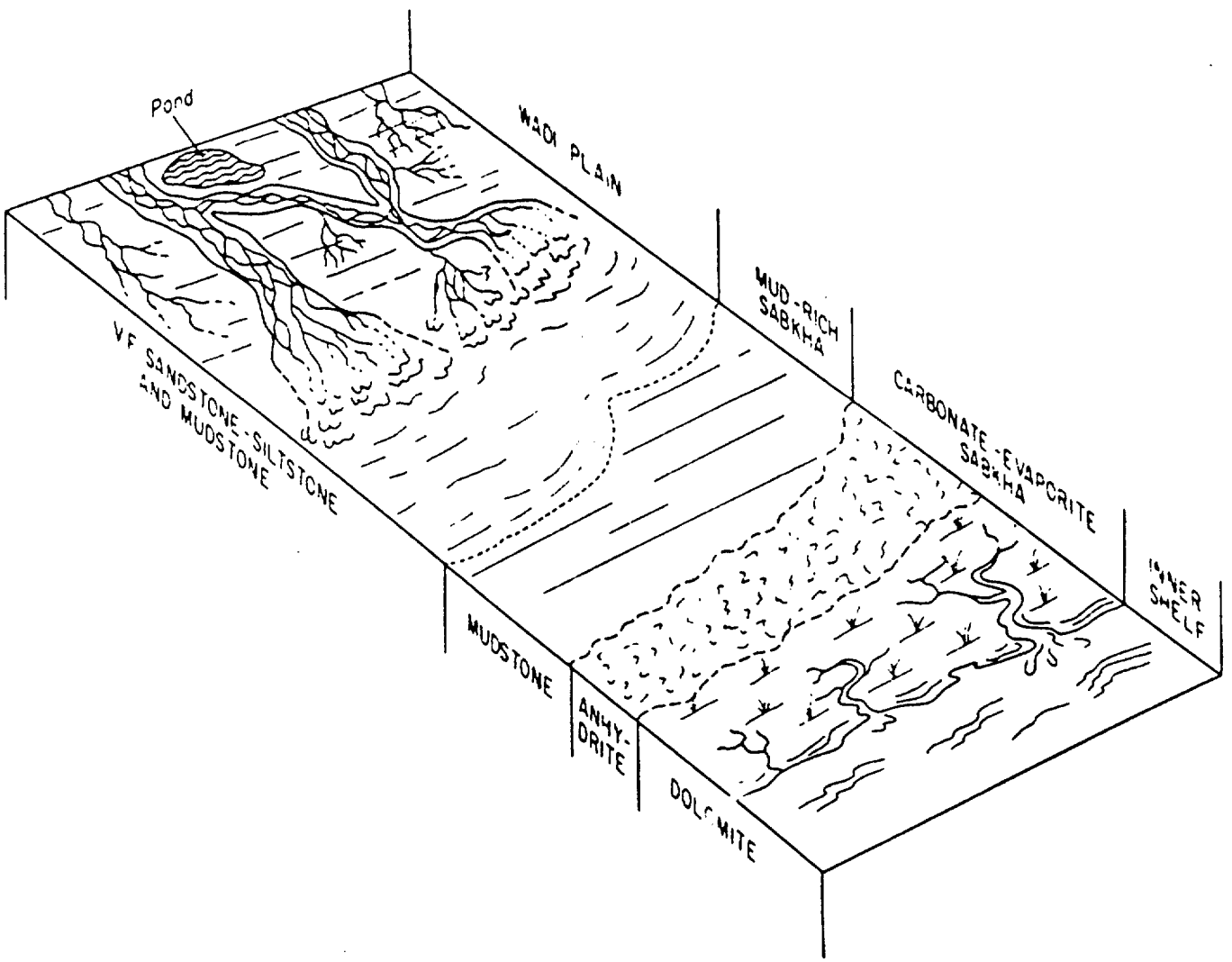


Figure 17. Composite depositional model for Red Cave carbonate, evaporite, and clastic facies.

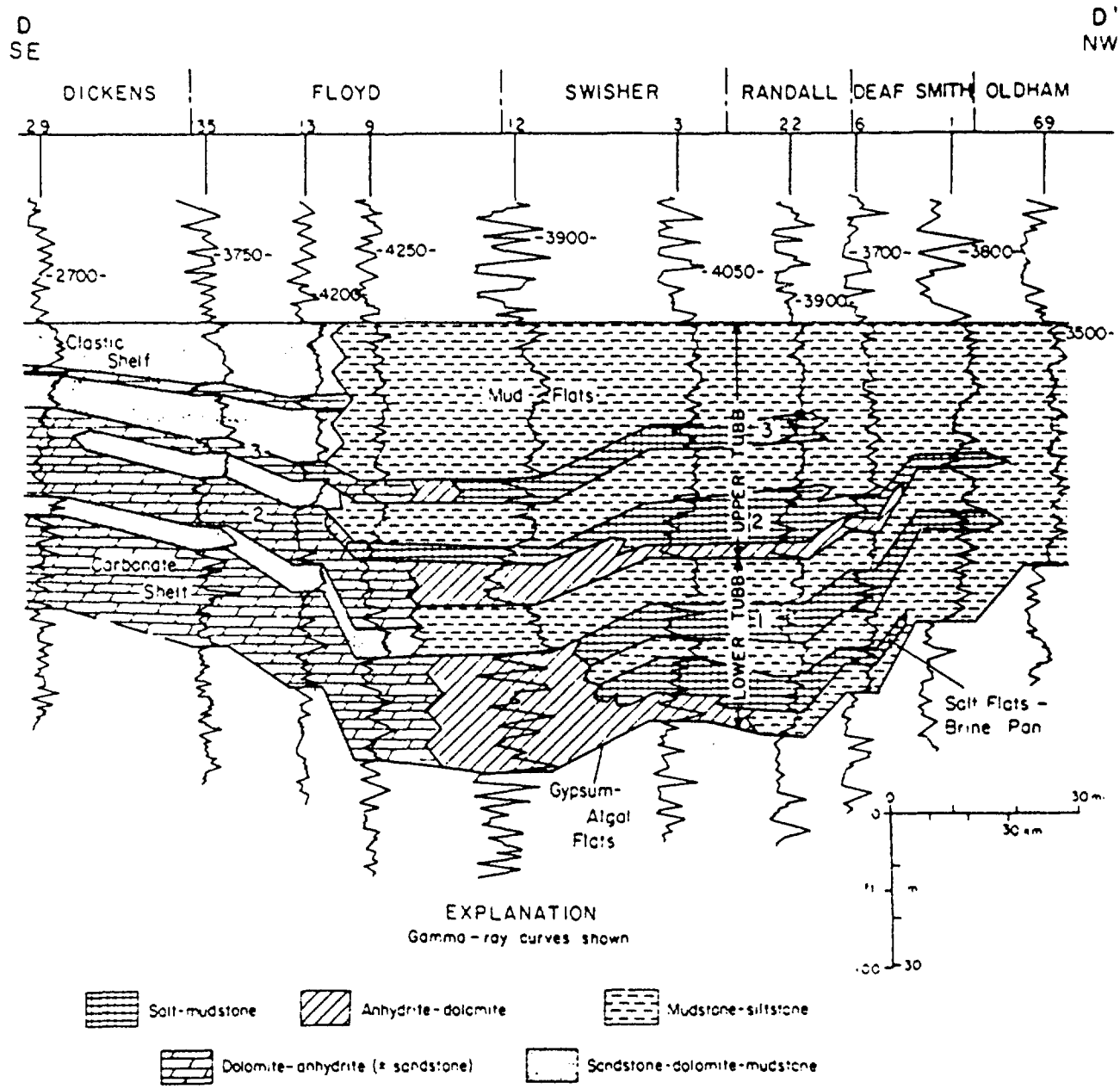


Figure 41. Northwest-southeast cross section, Tubb Formation, Palo Duro Basin. Line of cross section is indicated in figure 87. From Presley (1980b).

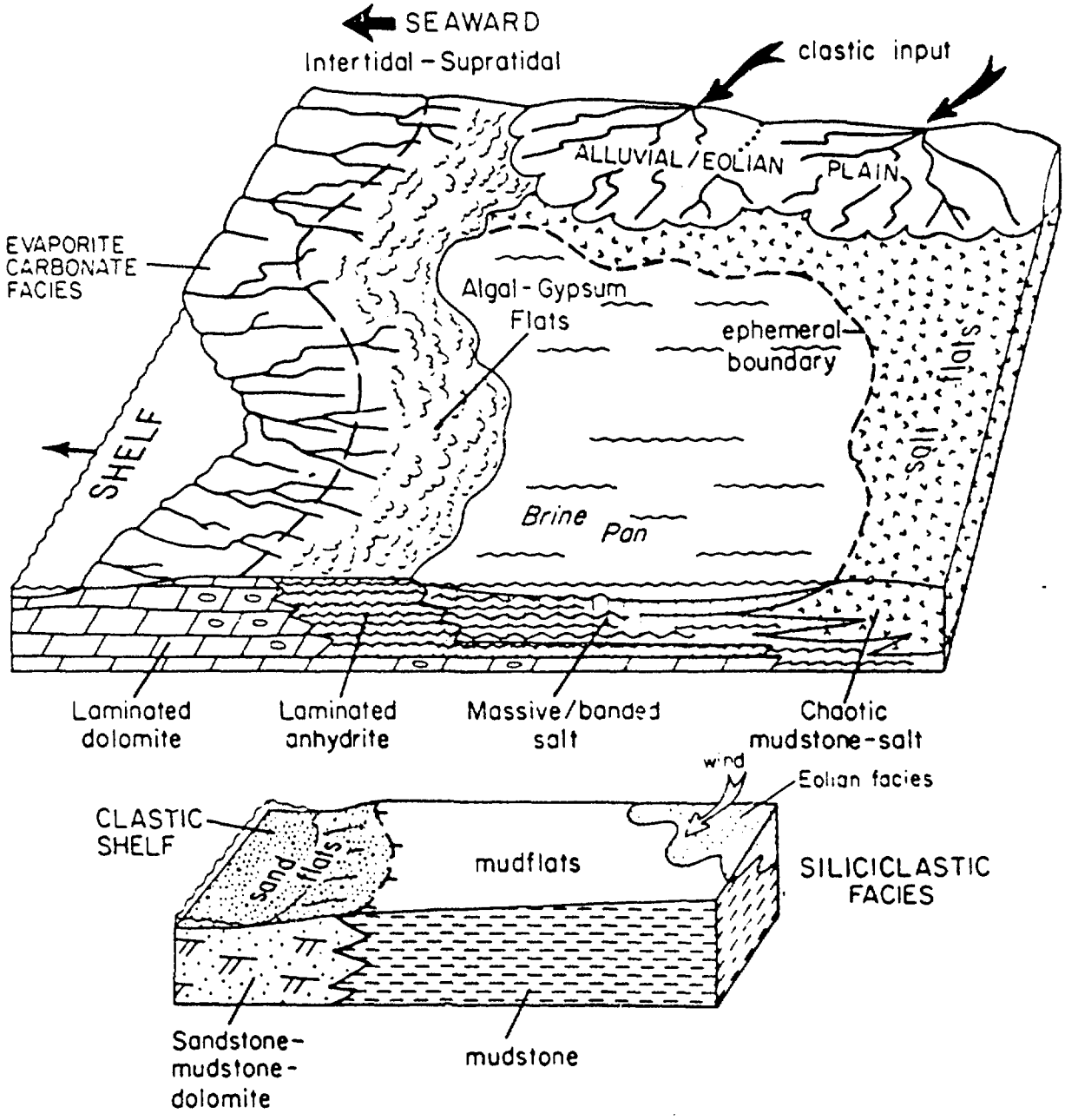


Figure 40. Facies and environments recorded in Tubb strata of the Palo Duro and Dalhart Basins. Evaporite-carbonate facies record a gradual basinward shift in environments. Siliciclastic (red-bed) facies dominate the Tubb sequence, and were deposited in tidal mud flats, which graded basinward into tidal sand flats. From Presley (1980b).

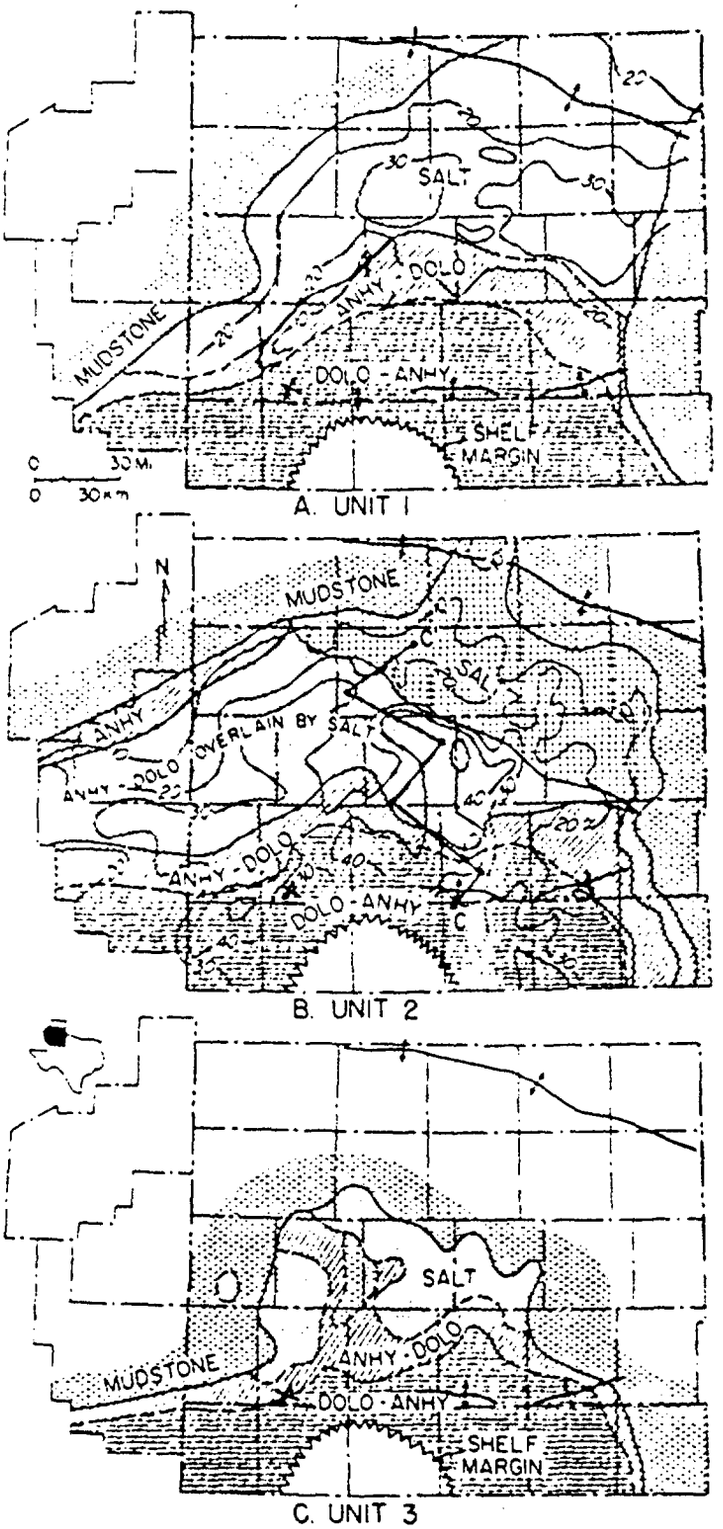


Figure 42. Facies maps of evaporite-carbonate units 1, 2, and 3 (oldest to youngest) of the Tubb Formation. Salt is dominant in updip regions to the north; carbonate is dominant to the south. These units show progressive southerly migration of evaporite-carbonate facies. From Presley (1980b).

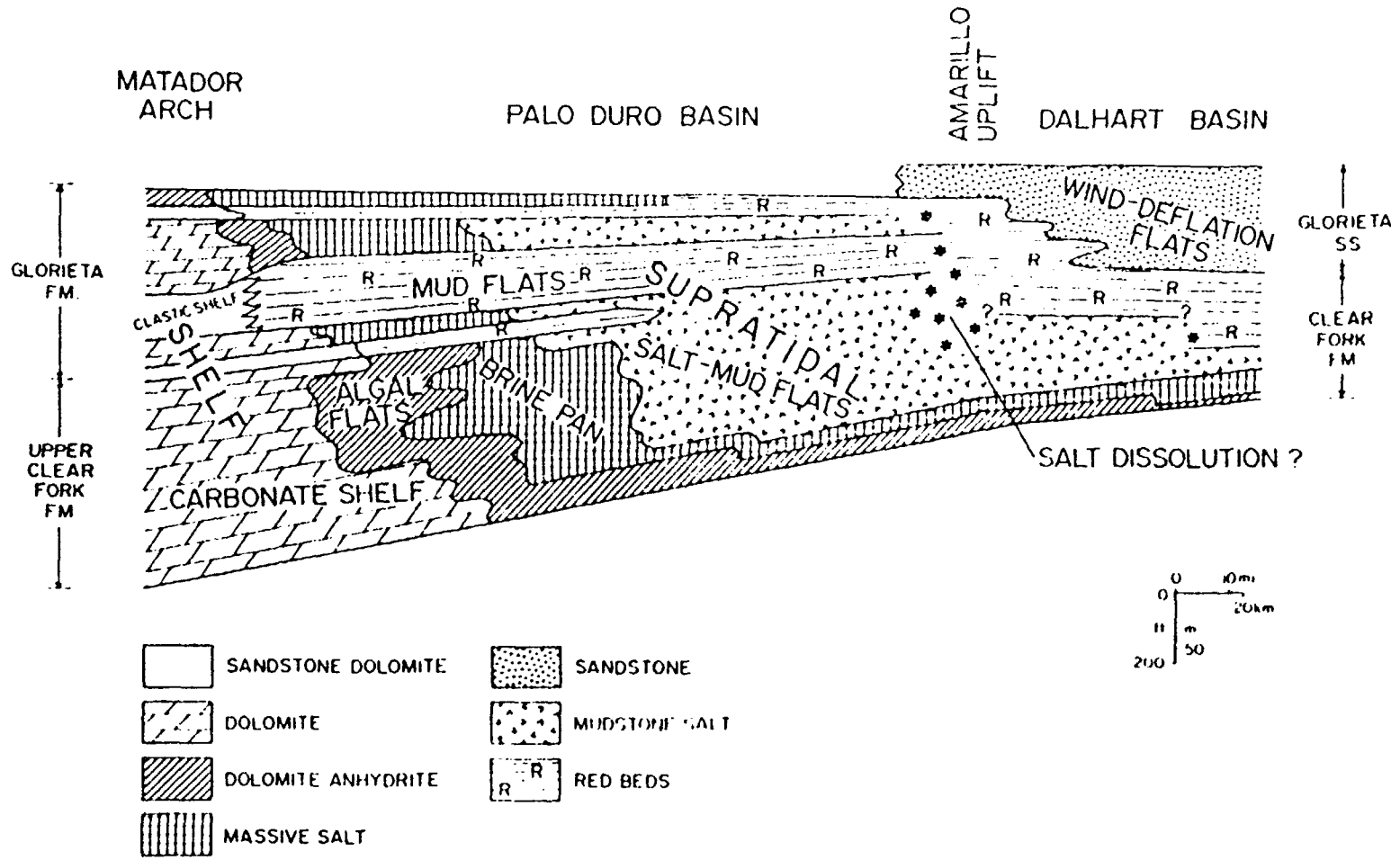


Figure 43. North-south facies cross section through Palo Duro and Dalhart Basins showing relation of environments for the upper Clear Fork and Glorieta Formations. From Presley (unpublished data).

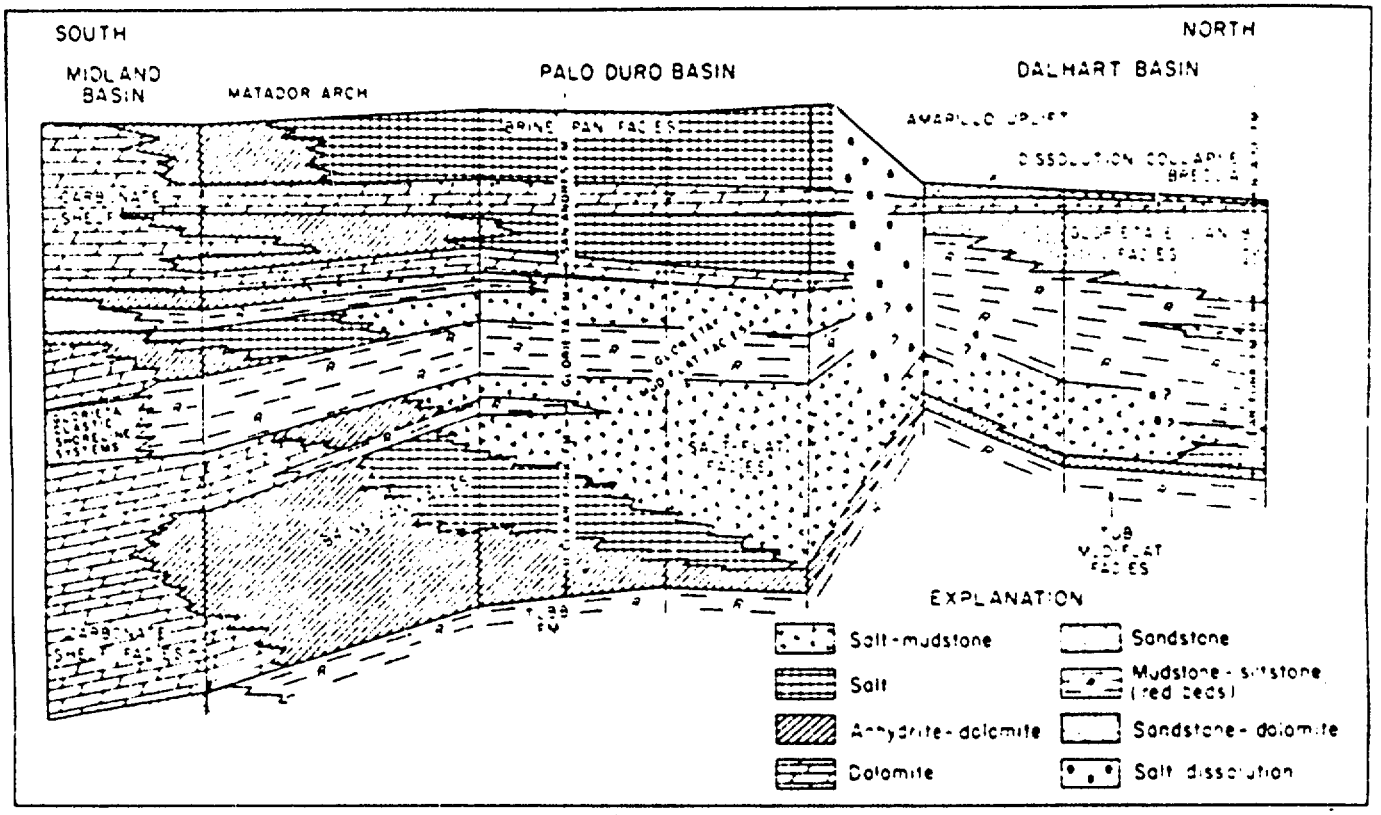


Figure 2. Diagrammatic north-south cross section of upper Clear Fork and Glorieta Formations and underlying and overlying units in Texas Panhandle. Generalized facies interpretations are shown. Location generally follows line of section A-A' in figure 1.

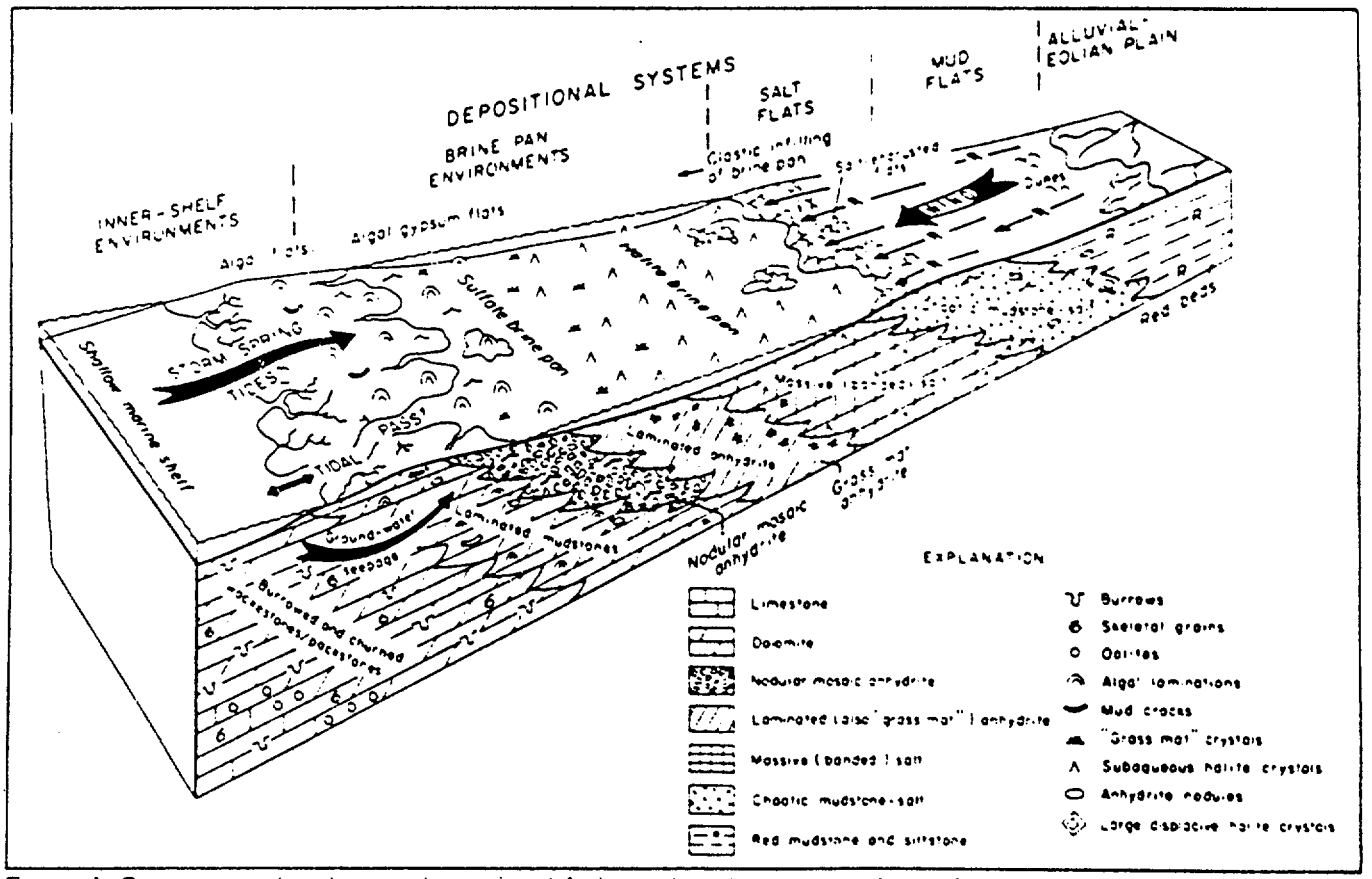


Figure 3. Evaporite and carbonate depositional facies and environments inferred for upper Clear Fork and Glorieta rocks.

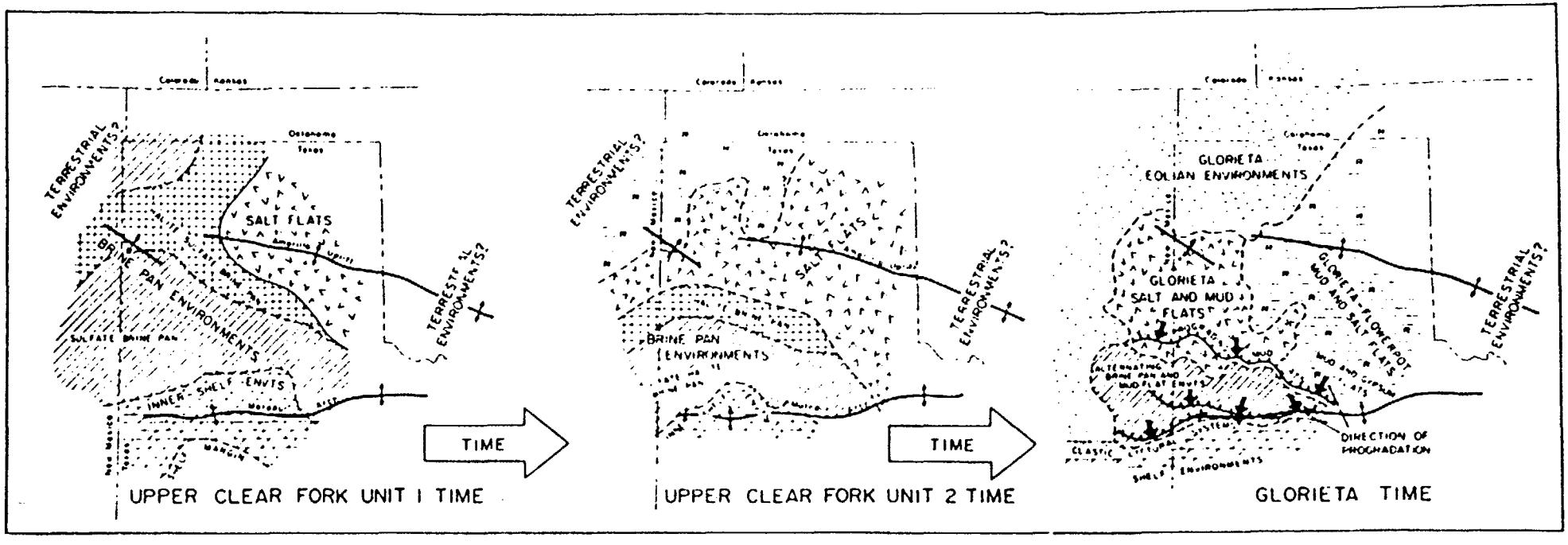


Figure 5. Paleogeography at the time of deposition of the upper Clear Fork and Glorieta Formations.

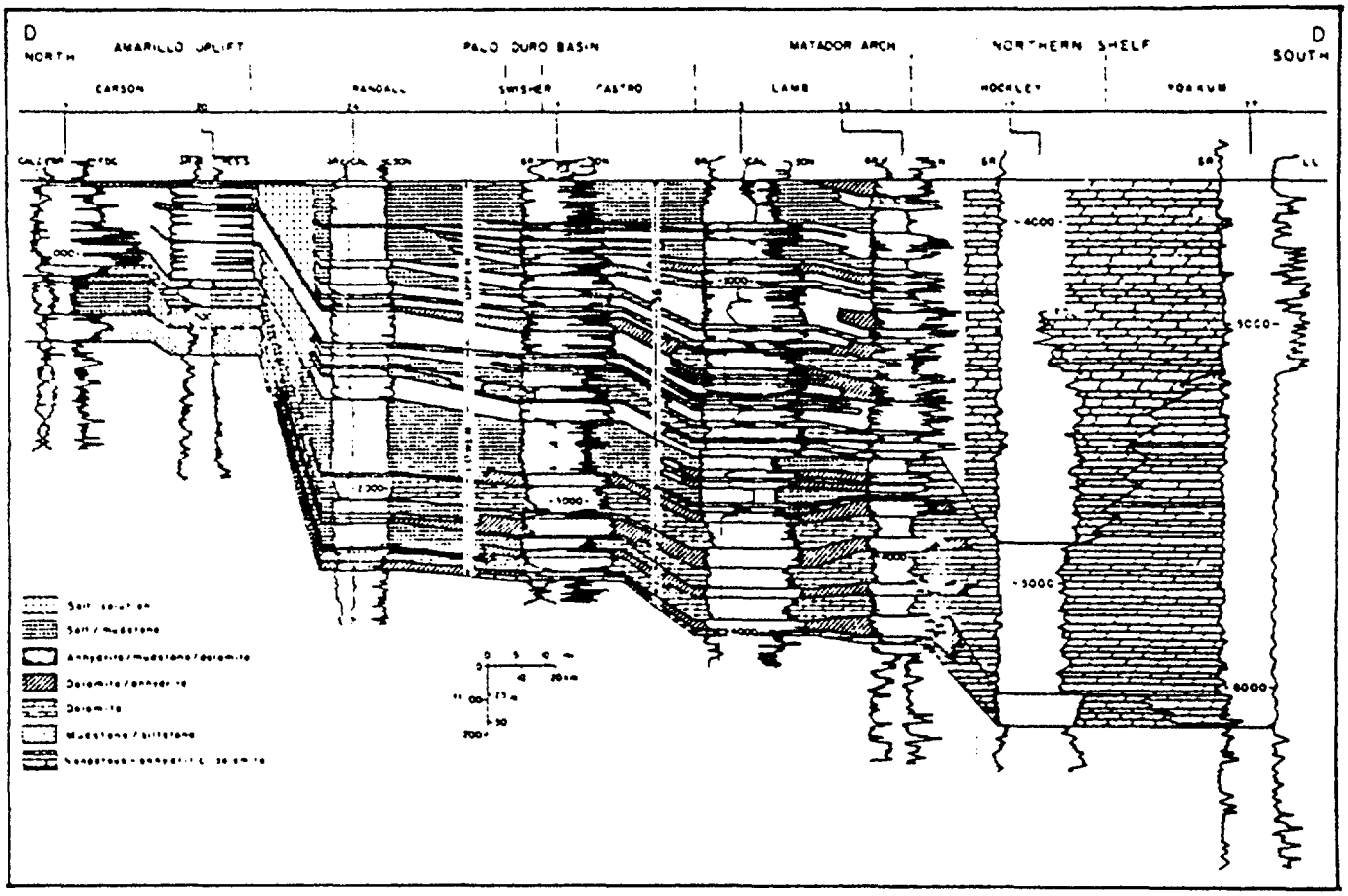
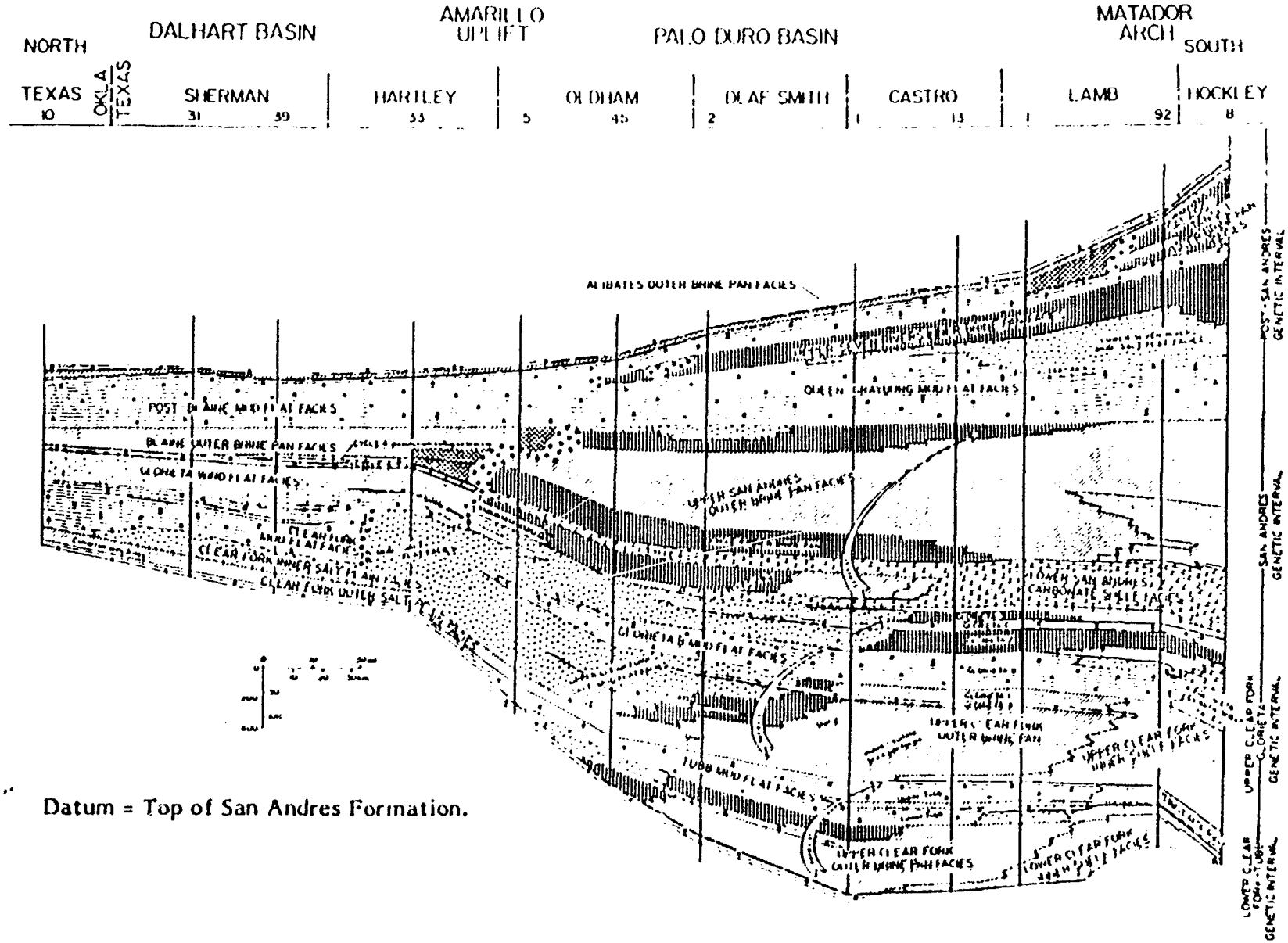


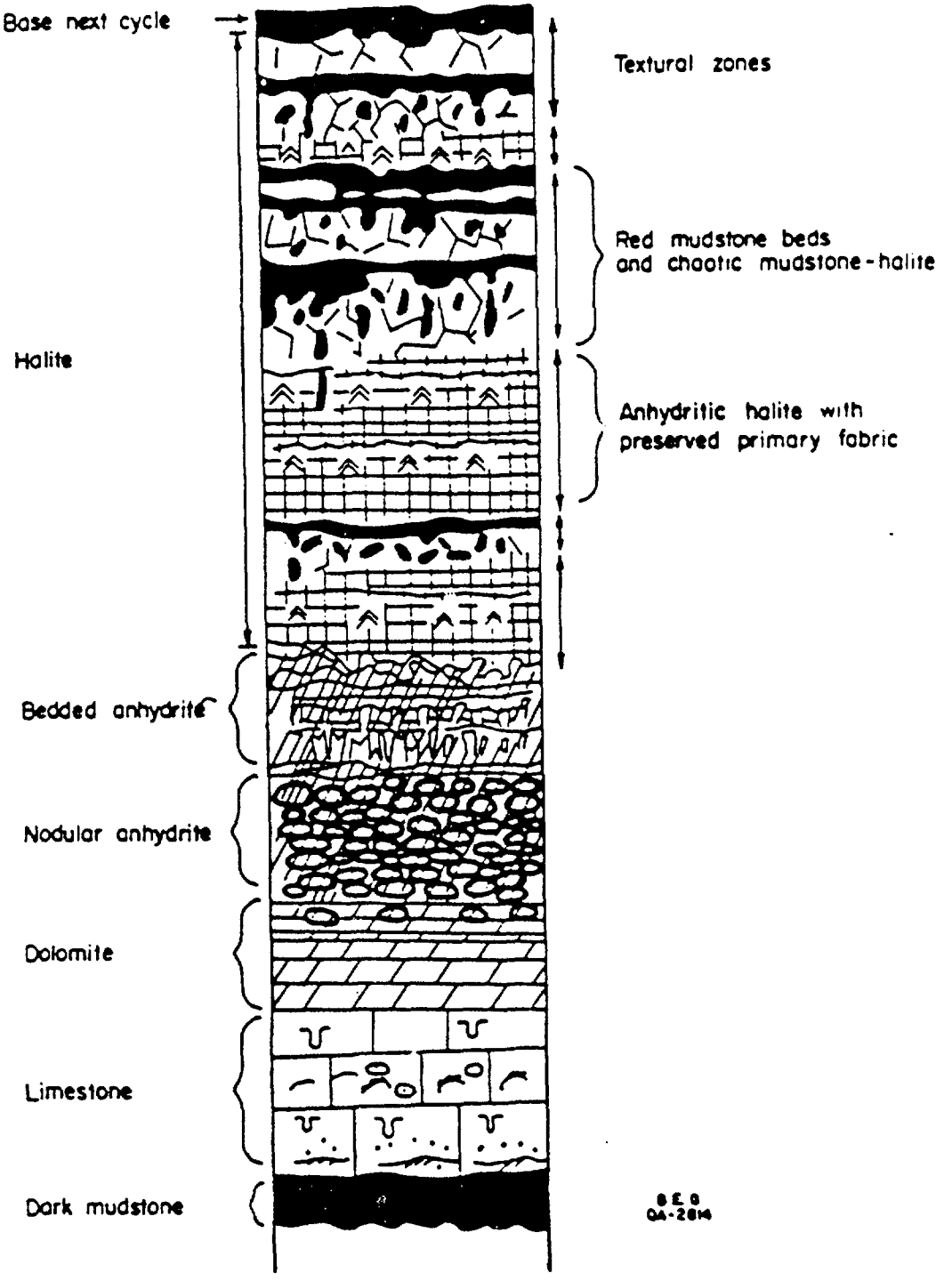
Figure 2. North-south cross section through the study area (after Presley, 1979, and P. Ramondetta, personal communication, 1981). Pinch-out of salt and anhydrite preclude detailed log correlation to the south. Datum: Top San Andres. See figure 1 for line of section.

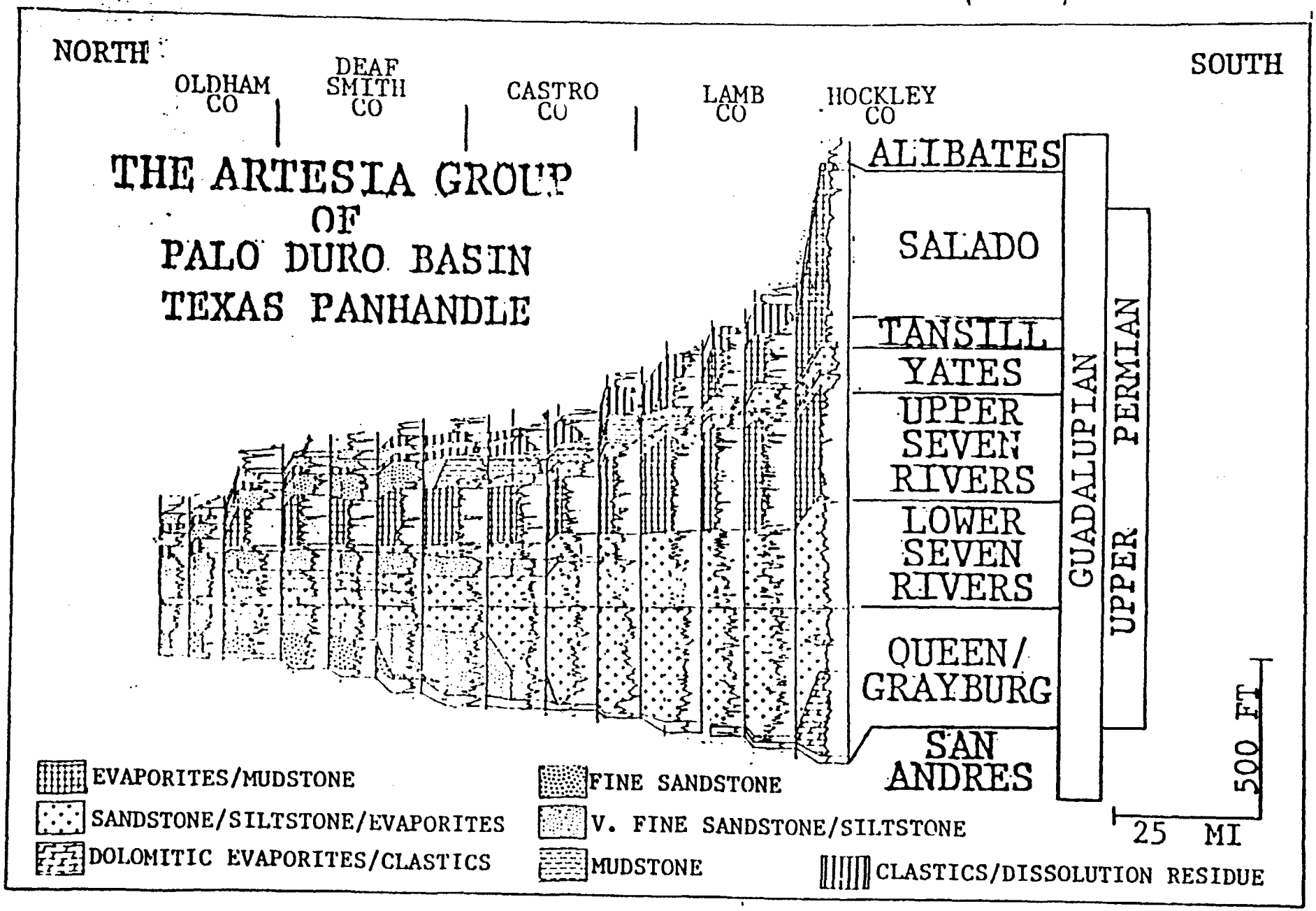
Figure 2



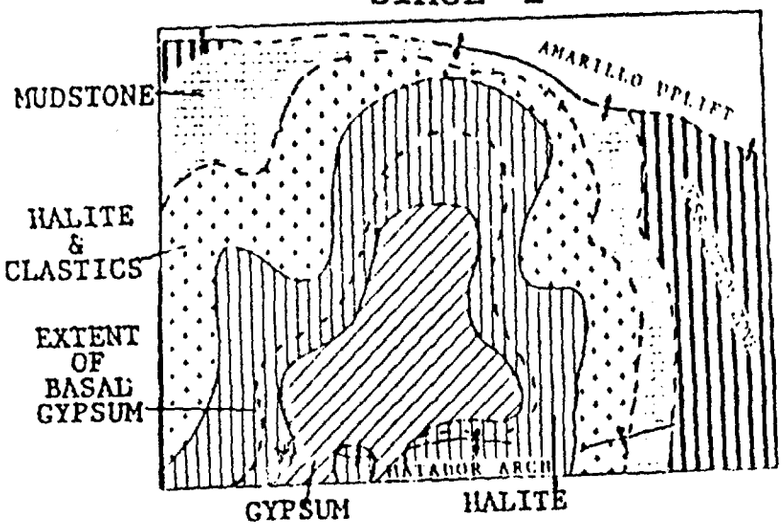
Datum = Top of San Andres Formation.

TYPICAL SAN ANDRES CYCLE

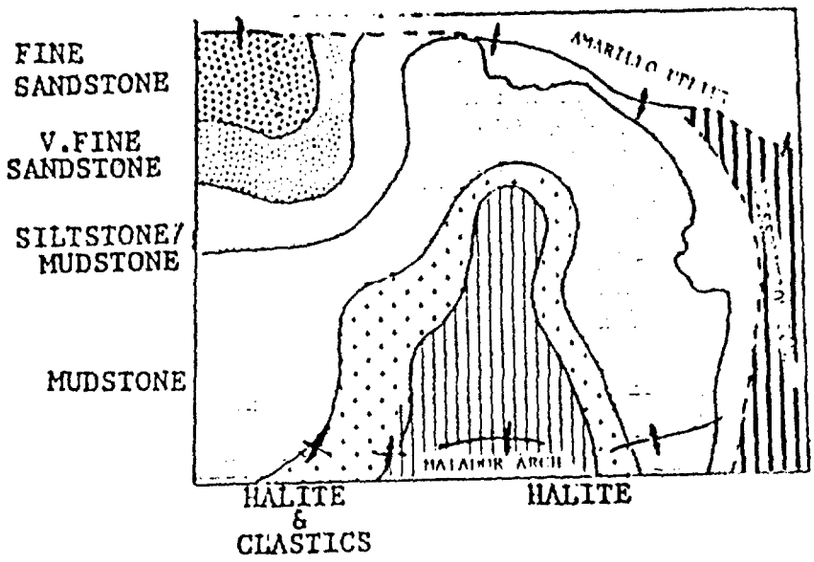



NORTH
SOUTH
OLDHAM CO
DEAF SMITH CO
CASTRO CO
LAMB CO
HOCKLEY CO
THE ARTESIA GROUP
OF
PALO DURO BASIN
TEXAS PANHANDLE
ALIBATES
SALADO
TANSILL
YATES
UPPER SEVEN RIVERS
LOWER SEVEN RIVERS
QUEEN/ GRAYBURG
SAN ANDRES
GUADALUPIAN
UPPER PERMIAN
500 FT
25 MI
EVAPORITES/MUDSTONE
SANDSTONE/SILTSTONE/EVAPORITES
DOLOMITIC EVAPORITES/CLASTICS
FINE SANDSTONE
V. FINE SANDSTONE/SILTSTONE
MUDSTONE
CLASTICS/DISSOLUTION RESIDUE

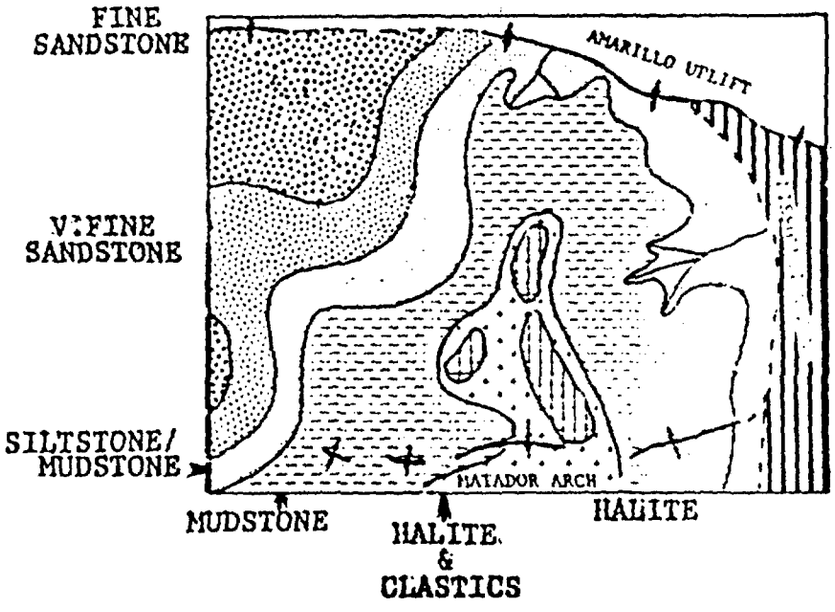
STAGE I



STAGE II



STAGE III



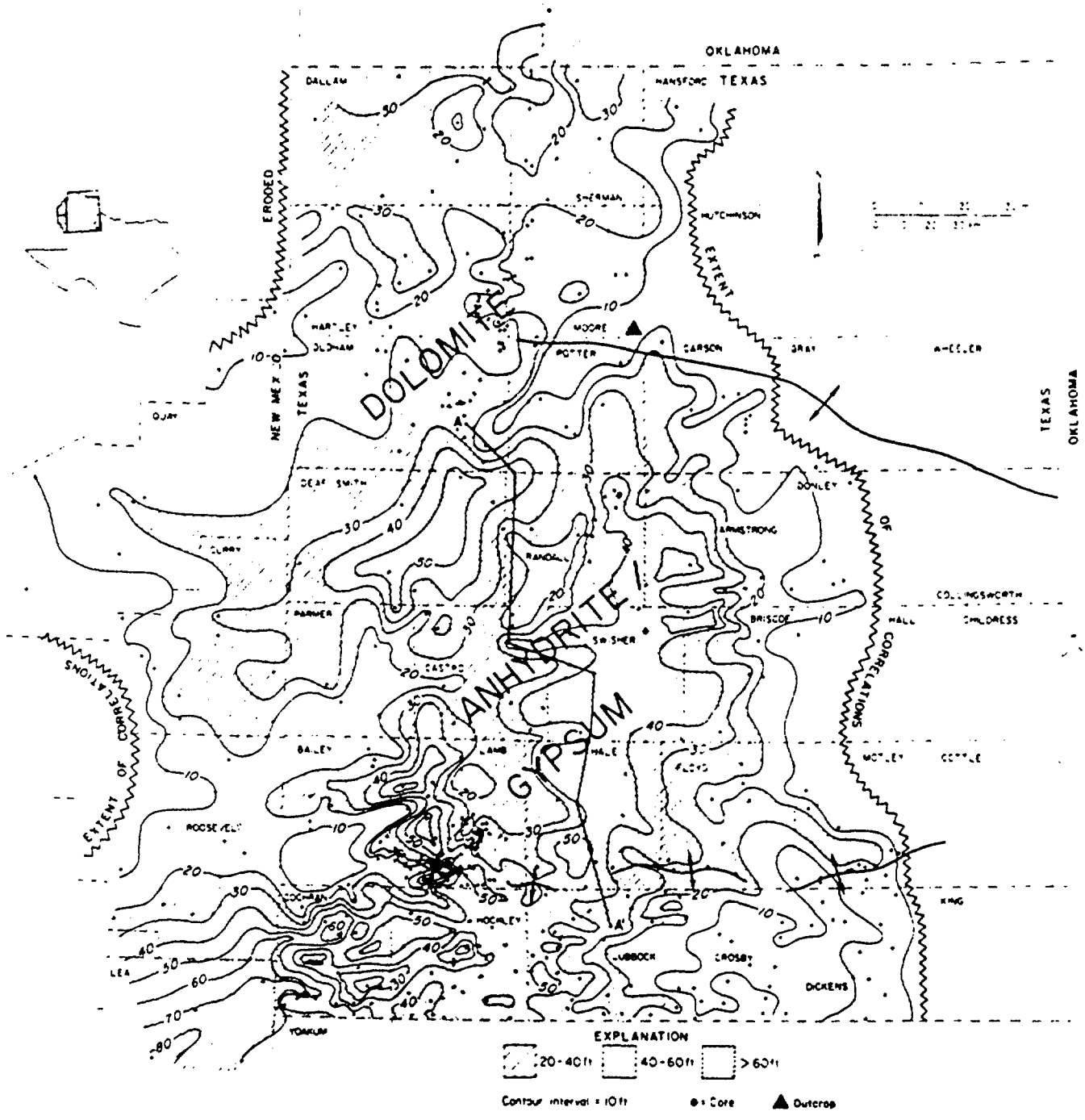


Figure 10. Isopach map, Alibates Formation. Serrate lines mark limit of correlation and erosional boundaries. Outcrop shown in Moore County. Maximum thickness in central and southern Palo Duro Basin.

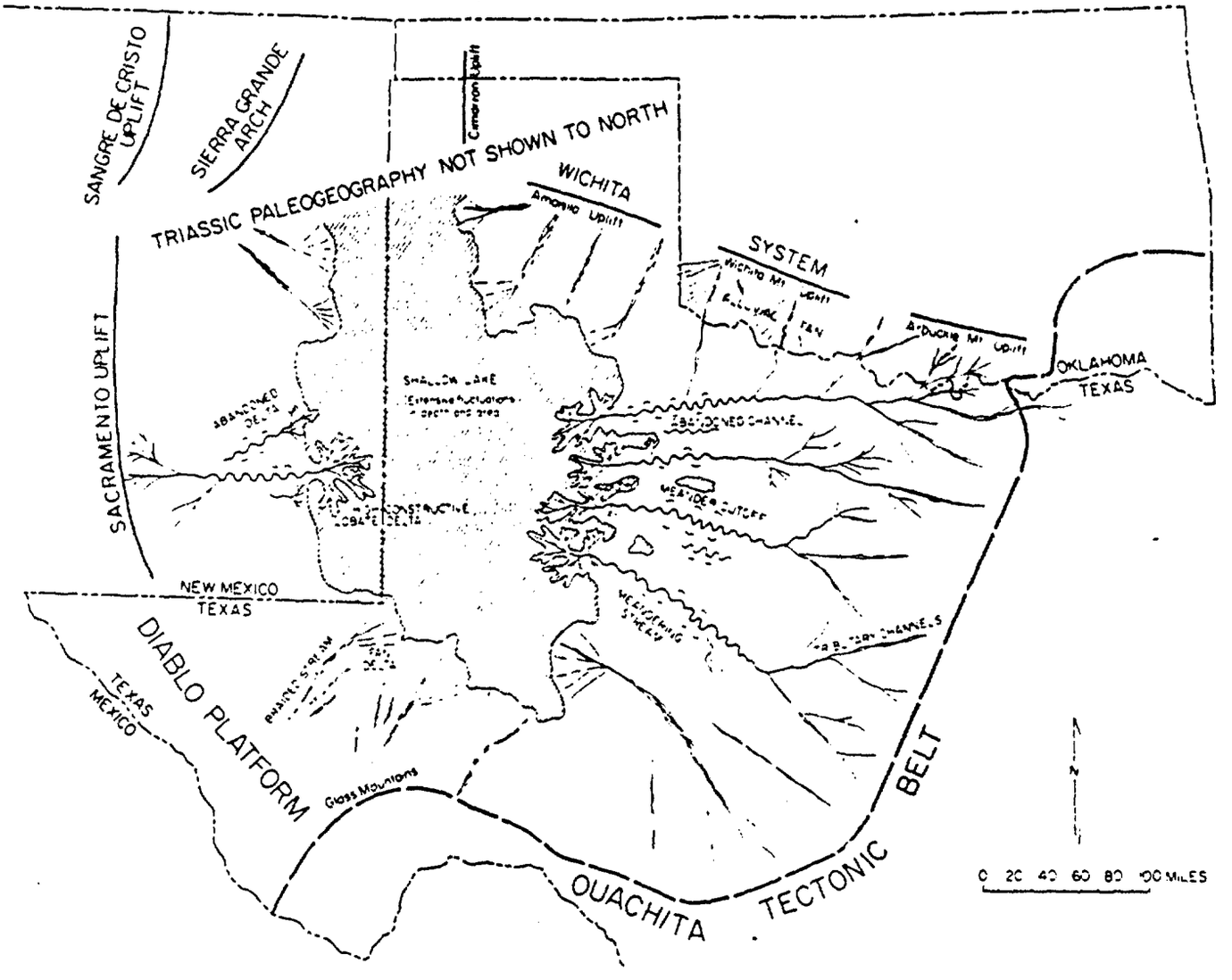


Figure 5. Inferred paleogeography during the initial stage of Dockum sedimentation in the area south of Amarillo Uplift - Bravo Dome. Depositional elements are braided streams, alluvial fans, fan deltas, meandering streams, distributary deltas, and shallow lakes.

Kreitler 8/6

DISSOLUTION CONSIDERATIONS

Process: Shallow ground water dissolving salt

Types: "Peripheral" and "Interior" ?

Controls: Hydraluic gradient, evaporite geology, overlying geology

Extent: Geographic and stratigraphic

Rates: Rates of dissolution for different types

Timing: Ongoing or relict process

Implications to nuclear repository

TYPES OF DATA

Geologic data: Stratigraphic, structural, geomorphic

Hydrologic-hydrochemical data: dissolution wells saline springs

Core data: DOE stratigraphic and hydro wells

HYDROLOGIC-HYDROCHEMICAL DATA

Well locations

Mansfield and Sawyer well results ("peripheral")

1. Hydrologic Testing
2. Chemical composition
3. Stable isotope composition
4. C^{14} Concentrations

Harmon and Detten wells ("interior")

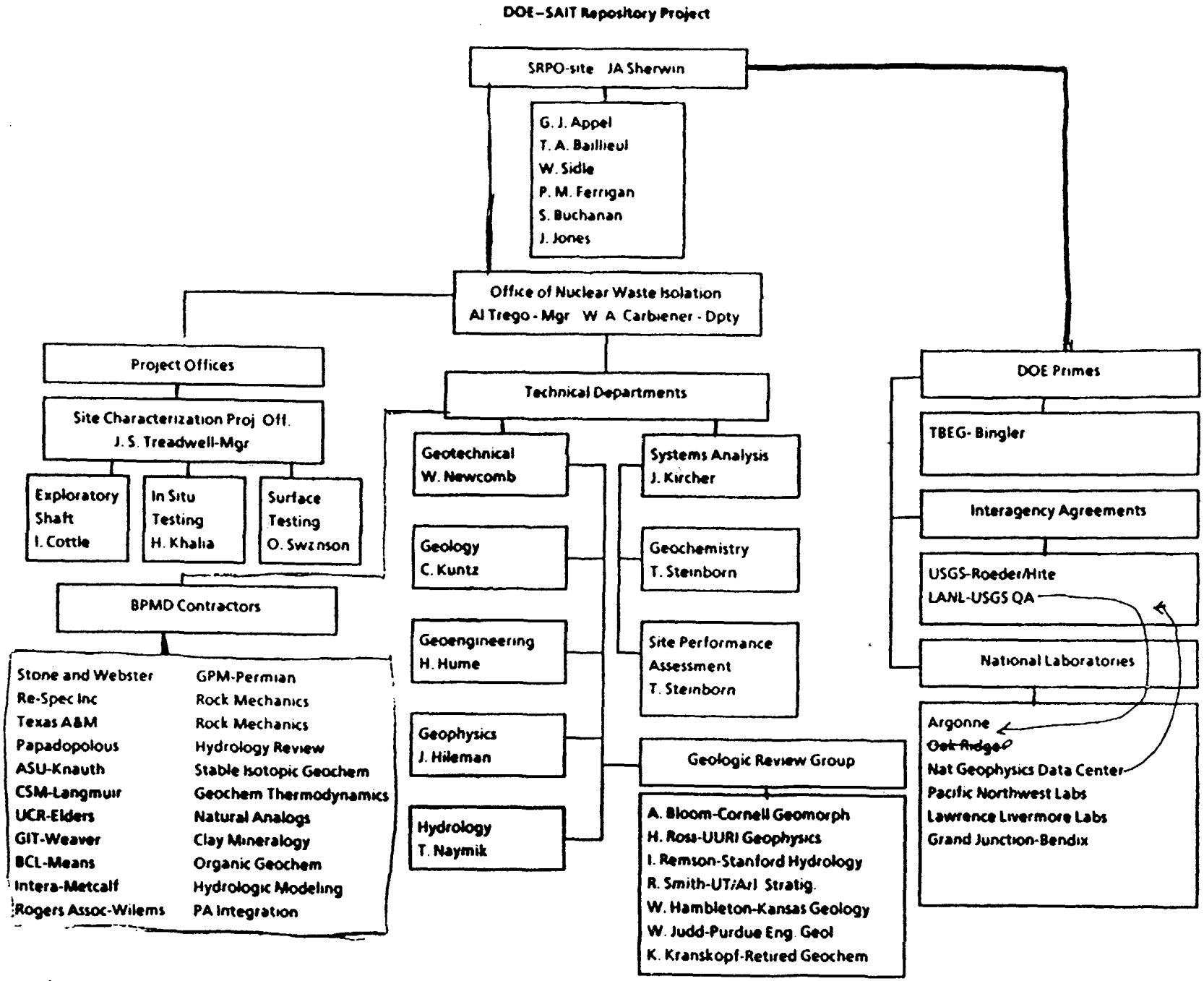
1. Hydrologic testing
2. Chemical composition
3. Stable isotope composition

CORE DESCRIPTION

Well locations for core in dissolution zone

Diagnostic features of dissolution

Geographic distribution of dissolution features


DOE–SAIT Repository Project
SRPO-site JA Sherwin
G. J. Appel
T. A. Baillieul
W. Sidle
P. M. Ferrigan
S. Buchanan
J. Jones
Office of Nuclear Waste Isolation
Al Trego - Mgr W A Carbiener - Dpty
Project Offices
Site Characterization Proj Off.
J. S. Treadwell-Mgr
Exploratory Shaft
I. Cottle
In Situ Testing
H. Khalia
Surface Testing
O. Swanson
BPMD Contractors
Technical Departments
Geotechnical
W. Newcomb
Geology
C. Kuntz
Geoengineering
H. Hume
Geophysics
J. Hileman
Hydrology
T. Naymik
Systems Analysis
J. Kircher
Geochemistry
T. Steinborn
Site Performance Assessment
T. Steinborn
Geologic Review Group
A. Bloom-Cornell Geomorph
H. Ross-UURI Geophysics
I. Remson-Stanford Hydrology
R. Smith-UT/Arl Stratig.
W. Hambleton-Kansas Geology
W. Judd-Purdue Eng. Geol
K. Kranskopf-Retired Geochem
Stone and Webster GPM-Permian
Re-Spec Inc Rock Mechanics
Texas A&M Rock Mechanics
Papadopolous Hydrology Review
ASU-Knauth Stable Isotopic Geochem
CSM-Langmuir Geochem Thermodynamics
UCR-Elders Natural Analogs
GIT-Weaver Clay Mineralogy
BCL-Means Organic Geochem
Intera-Metcalf Hydrologic Modeling
Rogers Assoc-Wilems PA Integration
DOE Primes
TBEG- Bingler
Interagency Agreements
USGS-Roeder/Hite
LANL-USGS QA
National Laboratories
Argonne
Oak Ridge
Nat Geophysics Data Center
Pacific Northwest Labs
Lawrence Livermore Labs
Grand Junction-Bendix

Sherwin 1/1

GEOENGINEERING TASKS

TASK .13 LABORATORY TESTING

TASK .36 SUBCONTRACTED LABORATORY TESTING (F.Y. 1985)

TASK .62 GEOTECHNICAL STUDIES

TASK .63 ENGINEERING DESIGN SUPPORT (F.Y. 1983)

TASK .67 GEOTECHNICAL FIELD TESTS (F.Y. 1984)

THESE STUDIES SUPPORT THE FOLLOWING ACTIVITIES:

- EA PREPARATION
- SITE CHARACTERIZATION PLANNING
- PRELIMINARY DESIGN DEVELOPMENT

Lamb 8/6

FY 1985 ACTIVITIES – GEOENGINEERING

LABORATORY TESTING

- COMPLETE TESTING BEGUN IN FY 1984
- COMPLETE SELECTED TESTS - J. FRIEMEL AND HOLTZCLAW WELLS
- COMPLETE PETROGRAPHIC ANALYSIS
- UPDATE TESTING DATA BASE
- ANALYSIS OF LAB DATA

GEOTECHNICAL STUDIES

- COMPLETE FIELD TEST REPORT
- GEOTECHNICAL LOGS - J. FRIEMEL, G. FRIEMEL, DETTEN
- VELOCITY STUDIES - ZEECK AND J. FRIEMEL, DEAF SMITH COUNTY
- DYNAMIC PROPERTIES STUDY
- GEOPHYSICAL LOG INTERPRETATION
- DEAF SMITH COUNTY CROSS SECTIONS

LABORATORY TESTING - OBJECTIVES

- **SITE SELECTION**
  - CHARACTERIZATION AT ALL PERTINENT SOIL AND ROCK UNITS FROM GROUND SURFACE TO BASEMENT
  - DEVELOPMENT OF A DATA BASE FOR ENGINEERING PROPERTIES OF PERMIAN BASIN ROCKS
  - ASSESS VARIATIONS IN PROPERTIES OF LITHOLOGIC UNITS FROM WELL TO WELL
  - ASSESS CHANGES IN ENGINEERING PROPERTIES WITH LITHOLOGIC CHANGES
  - ASSESS PREDICTABILITY OF ENGINEERING PROPERTIES
  - CHARACTERIZE DISCONTINUITIES AND BOUNDAIES
- **SUPPORT SHAFT DESIGN STUDIES**

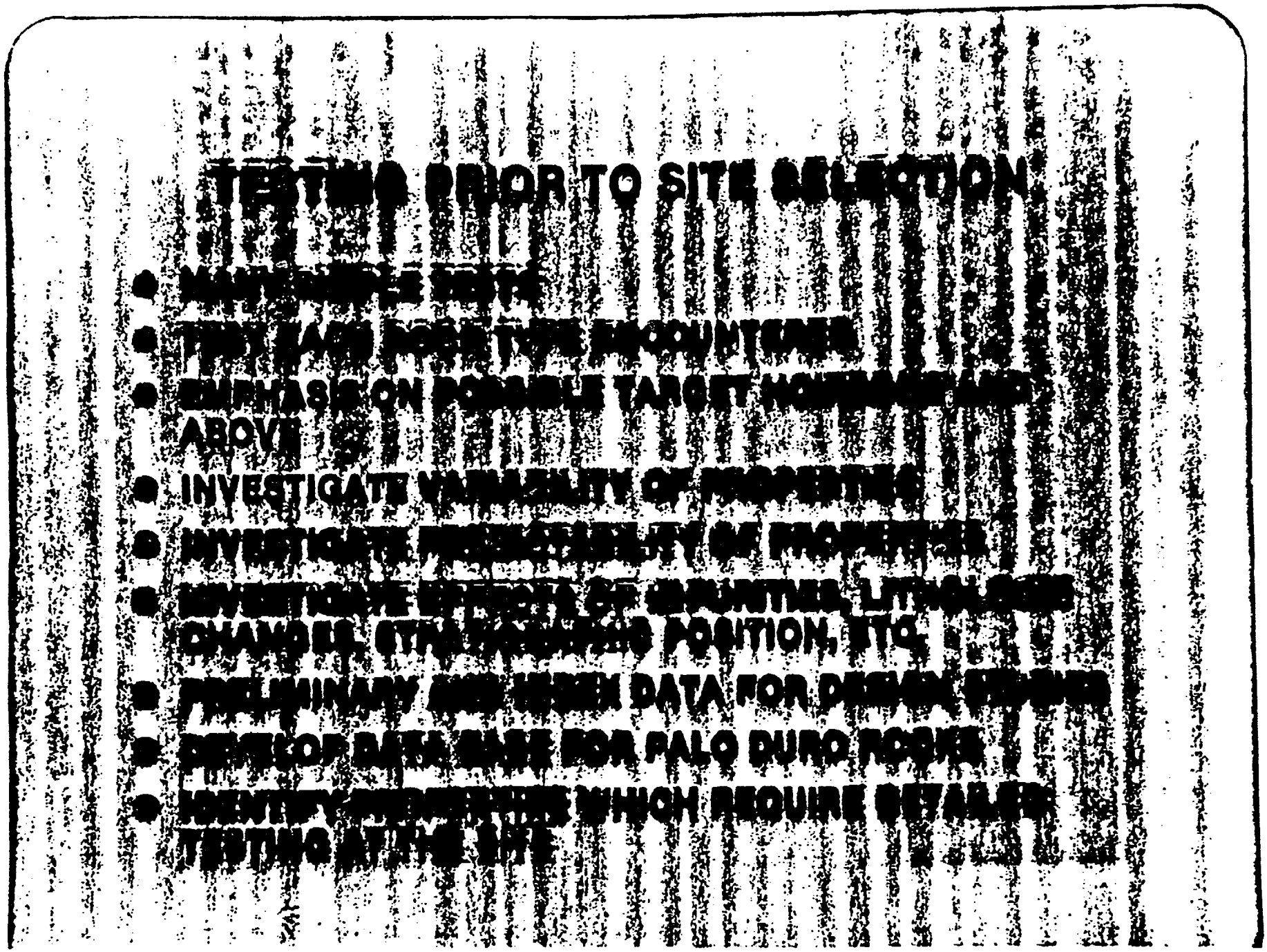
  DEVELOP AVERAGE VALUES AND RANGES OF VALUES OF PHYSICAL AND MECHANICAL PROPERTIES PERTINENT TO:
  - EXCAVATION
  - SUPPORT AND LINING
  - SHAFT SEALING

LABORATORY TESTING - OBJECTIVES
(CONT.)

- SUPPORT REPOSITORY DESIGN STUDIES
  - PROVIDE DATA ON ANTICIPATED RANGE OF VALUES
  - PROVIDE DATA ON PREDICTABILITY OF UNITS
  - PROVIDE DATA BASE FOR COMPARISON WITH SITE SPECIFIC DATA
- SUPPORT MODELING AND PERFORMANCE ASSESSMENT
  - CONSTRUCTION OF MODELS
    - PREDICTABILITY
    - VARIABILITY
    - ENGINEERING UNITS
  - ANALYSES
    - AVERAGE VALUES
    - RANGES OF PROPERTIES
    - DATA BASE

LABORATORY TESTING - APPROACH

- TESTING REQUIREMENTS BECAME MORE SPECIFIC AND SOPHISTICATED AS A SITE IS SELECTED AND CHARACTERIZATION PROGRESSES
- PRIOR TO SITE SELECTION
- SITE CHARACTERIZATION AND LICENSING
- FACILITY DESIGN



TESTING FOR SITE CHARACTERIZATION AND LICENSING

- FEWER, MORE SOPHISTICATED TESTS
- CAREFUL SELECTION AND PRESERVATION OF SAMPLES
- DETERMINE PROPERTIES IMPORTANT FOR [illegible] AND [illegible]
- COMPLEMENT FIELD TESTS
- COMPARE WITH DATA FROM OTHER WELLS
- DEVELOP [illegible]

TYPES OF TESTS

- PHYSICAL PROPERTIES
- INDEX PROPERTIES
- MECHANICAL PROPERTIES
- THERMAL PROPERTIES
- HYDROLOGIC PROPERTIES
- GEOLOGIC DOCUMENTATION

LABORATORY TESTING - ROCK CORE FROM PERMIAN BASIN

TEST	RESPONSIBILITY	PURPOSE
Physical/Index Properties Test		
Density	SWEC	Aid in interpretation of other tests.
Porosity (effective)	SWEC	Develop data base. Correlate with
Water Content	SWEC, SWEC Sub	stratigraphy and geophysical logs.
Hardness (Taber, Schmidt)	SWEc, SWEC Sub	Estimate construction behavior. Assess variability.
Slake/Swell	SWEC	
Velocity	SWEC Sub	Correlate geophysical and static data.
Mechanical Properties Tests		
Unconfined Strength	SWEC Sub/RE/Spec	Intact rock strength and stress/strain
Elastic Constants	SWEC Sub/RE/Spec	behavior.
Triaxial & Elevated Temperature	RE/Spec	Variation in properties with temp. and c
Dynamic Properties	SWEC Sub	Intact rock properties under dynamic loads.
Creep Rate	RE/SPEC	Predict creep rate.
Direct Shear on Joints	SWEC	Joint shear strength.
Thermal Tests		
Coefficient of Thermal Expansion	ONWI Sub	Thermal Properties of rocks.
Specific Heat	ONWI Sub	
Thermal Conductivity	ONWI Sub	
Descrepitation Temp.	ONWI Sub	Maximum allowable salt temp.
Hydrologic Tests (Lab)		
Permeability	SWEC, SWEC Subs	Intact rock permeability.
Porosity	SWEC, SWEC Subs	Assess effective porosity.
Total Porosity	SWEC Subs	Interpretation of Geophysical Logs, DSTs, pump tests.
Geologic Documentation		
Thin Sections	SWEC/TBEG/BFEC	Provide detailed data to assist
Clay Mineralogy	SWEC Sub, BFEC	in interpretation of other tests
L.O.W. on Heating	SWEC Sub	and as input to geologic studes.
Insoluble Residue	SWEC/TBEG	
Salt Water Content	SWEC/TBEG	

Rock Mechanics Data Summary - Permian Basin

Testing Laboratory (Contract No.)	Type of Test	Test Data Included in Laboratory Testing Reports
SWEC Geotechnical Laboratory, Boston	Water Content	Results for each sample
	Density and Effective Porosity	Results for each sample
	Rebound Hardness (Schmidt)	Hardness index (average of 10 highest readings) for each sample
	Brazilian Tensile Strength	Results for each sample
	Slake Durability Index	Results of each cycle for each sample
	Atterberg Limits	Results of each sample
	Direct Shear on Discontinuities	Plot of shear stress vs horizontal displacement, Plot of stress ratio vs horizontal displacement Calculated peak and residual friction angle Photograph and cross section of shear surface
	Liquid Permeability	Results for each sample for each set of test conditions
	Unconfined Swell, Confined Swell	Plot of swelling strain vs time
	Swelling Pressure	Plot of pressure vs time
Applied Research Assoc. Inc. S. Royalton, Vermont (G-110D)	Triaxial Compression and Sonic Velocity	Plots of: Displacement vs time Deviatoric Stress vs axial strain Radial strain vs axial strain Loading History Velocity traces (at progressively higher stresses) Vp vs stress Vs vs stress

Rock Mechanics Data Summary - Permian Basin (cont'd)

Testing Laboratory (Contract No.)	Type of Test	Test Data Included in Laboratory Testing Reports
		E(Dynamic) vs stress G(Dynamic) vs stress P.R.(Dynamic) vs stress Photos Specimen dimensions and index properties Bulk Modulus (dynamic) at various confining pressures Fracture strength or maximum stress Summary Data (picks from plots)
Applied Research Assoc. Inc. S. Royalton, Vermont, (G-110D)	Unconfined Compression and Sonic Velocity	Plots of: Displacement vs time Stress vs strain Radial strain vs axial strain Velocity traces (typical) Vp vs stress Vs vs stress E(Dynamic) vs stress G(Dynamic) vs stress P.R.(Dynamic) vs stress Photos Specimen dimensions and index properties Fracture strength or maximum stress Summary Data (picks from plots)
Resource Engineering Inc. Waltham, Mass (G-110M)	Bulk Density, Apparent Density, Specific Gravity, Effective Porosity, Total Porosity	Results for each sample, sample description,
Applied Research Assoc. Inc. S. Royalton, Vermont (G-110J)	Unconfined Compression Rebound hardness Abrasion hardness	Plots of: Displacement vs time Deviatoric stress vs axial strain Radial strain vs axial strain Specimen Summary Page containing: Density, Moisture Content, Specimen dimensions, Fracture Strength Taber abrasion hardness (avg. of two determinations) Rock abrasiveness (avg. of

Rock Mechanics Data Summary - Permian Basin (cont'd)

Testing Laboratory (Contract No.)	Type of Test	Test Data Included in Laboratory Testing Reports
		two determinations) Total Hardness Schmidt rebound hardness (radial) (average and std. deviation of 10 highest readings) Schmidt rebound hardness (axial) (average and std. deviation of 10 highest readings)
Prof. R. C. Reynolds Dartmouth College Hanover, NH (G-111E)	Clay Mineralogy	Photos, Results for each sample, Sample description, X-Ray diffraction charts, Data reduction program
Terra Tek Inc. Salt Lake City, Utah (G-110Y)	-Salt Index- Water content insoluble residue clay mineralogy Thermal fracture	Work in progress
Applied Research Assoc. Inc. S. Royalton, Vermont (G-111M)	Gas Permeability	Work in progress

SUMMARY OF ROCK MECHANICS LABORATORY TESTS
BY WELL

(xx) indicates number of additional scheduled tests.

Test	Mansfield	Detten	G.Friemel	Zeeck	Harman	J.Friemel	Holtzclaw
Density, Porosity & W/C	22	14	9	36	(30)	61 (20)	(39)
Total Porosity	41	5	6	31	(30)	(81)	(39)
Swelling Index	2	5	1	4	(26)	10 (2)	(11)
Slake Durability	15	6	8	6	(14)	25	(12)
Permeability	9	(6)	(4)	(32)	(25)	7 (60)	(42)
Direct Shear	1	2	2	8	(16)	(4)	(8)
Brazilian	4	12	6	8	(16)	17	(37)
Rebound Hardness	7	7	6	31	6 (9)	5	(85)
Petrographic Analysis	16 (11)	1 (15)	(14)	(31)	(26)	(43)	(35)
Taber Hardness	-	-	-	10	6	9	-
Unconfined Compression	10	8	11	11	19	22	17
Traxial Compression	14	9	11	13	35	55	7 (30)
Gas Permeability	-	-	-	5 (1)	(2)	3 (7)	(7)
Clay Mineralogy	8	6	5	7	(11)	22	(6)
Salt Index	-	-	-	(9)	(9)	(13)	(10)

SUMMARY OF ROCK MECHANICS LABORATORY TESTS
BY FORMATION

(xx) indicates number of tests to be performed in FY 85.

Test	Dockum	Dewey Lake	Alibates	Salado	Yates	Upper 7-Rivers	Lower 7-Rivers	Queen/ Grayburg
Density, Porosity & W/C	11	3 (3)	4 (6)	5 (4)	13 (6)	5 (2)	2	6
Total Porosity	4 (18)	(6)	(7)	1 (6)	4 (11)	(6)	1	3 (2)
Swelling Index	6	2		1 (4)	4 (4)	2 (3)	1	1
Slake Durability	8	1	1	2	9	3	2	5
Permeability	2 (15)	(6)	(6)	(8)	(13)	(7)	-	(5)
Direct Shear	-	(2)	(1)	2 (2)	1 (2)	-	-	-
Brazilian	1	(3)	2 (4)	1 (2)	4 (6)	3 (1)	1	3
Rebound Hardness		(10)	1 (8)	2 (6)	4 (12)	1 (2)	1	4
Petrographic Analysis	9	(3)	4 (12)	(15)	(13)	(7)	(3)	(12)
Taber Abrasion	-	-	2	2	-	1	-	6
Unconfined Compression		1	8	-	9	12	1	2
Triaxial Compression	8	3 (2)	7 (3)	4 (2)	10 (4)	3 (2)	1	6
Gas Permeability	-	-	(1)	-	(1)	(3)	-	-

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Test	Dockum	Dewey Lake	Alibates	Salado	Yates	Upper 7-Rivers	Lower 7-Rivers	Queen/ Grayburg
Clay Mineralogy	10	1	1 (1)	5 (1)	8 (1)	3	2	2
Salt Index	-	-	-	(1)	-	(6)	-	-

SUMMARY OF ROCK MECHANICS LABORATORY TEST
BY FORMATION

(xx) indicates number of tests to be performed in FY 85.

Test	USA	LSA-5	LSA-4	LSA-3	LSA-2	LSA-1	Glorieta	Wichita	Wolfcamp	Pennsylvanian
Density, Porosity & W/C	19 (3)	8 (12)	19 (19)	3	-	1	3	4	22 (25)	2 (13)
Total Porosity	8 (10)	2 (15)	8 (14)	2	-	-	-	3	31 (25)	2 (13)
Swelling Index	6	2	1		-	-	-	-	-	-
Slake Durability	9	2	6	1	-	1	2	-	-	-
Permeability	(15)	(16)	(19)	(3)	-	-	-	-	7 (25)	4 (13)
Direct Shear	5 (1)	-	5		-	-	-	-	(3)	-
Brazilian	16 (8)	7 (11)	8 (13)		-	-	-	-	-	-
Rebound Hardness	7 (8)	2 (22)	6 (22)	2	-	-	2	3	6 (25)	(13)
Petrographic Analysis	(28)	(21)	(25)		-	-	-	-	(25)	(10)
Taber Abrasion	8	1	1		1	-	-	-	2	1
Unconfined Compression	26	16	11		-	-	-	-	6	2
Triaxial Compression	37 (2)	16 (13)	22 (7)		-	-	-		11	5
Gas Permeability	(4)	(4)	(5)		-	-	-	-	-	-
Clay Mineralogy	3 (1)	1 (1)	4 (1)	1	-	-	1	-	2	2

Test	USA	LSA-5	LSA-4	LSA-3	LSA-2	LSA-1	Glorieta	Wichita	Wolfcamp	Pennsylvanian
Salt Index	(12)	(13)	(12)		-	-	-	-	-	-

GEOPHYSICAL LOG INTERPRETATION

- BOTH MANUAL AND COMPUTER AIDED ANALYSIS
- DEFINE ZONES OF SIMILAR LITHOLOGY
- CALCULATE ENGINEERING PROPERTIES OF INTEREST
- DEFINE ZONES OF SIMILAR ENGINEERING PROPERTIES
- ESTIMATE VALUES AND RANGES OF PERTINENT PROPERTIES
- PROGRAM WELLS ONLY

VELOCITY ANALYSIS - PURPOSE

- DERIVE DYNAMIC ELASTIC CONSTANTS FROM GEOPHYSICAL LOGS
- USE DYNAMIC PROPERTIES AS AN INDEX FOR STATIC PROPERTIES
- COMPARE SIMILAR LITHOLOGIES WITHIN A WELL
- COMPARE TRACEABLE LITHOLOGIC UNITS FROM WELL TO WELL
- ASSESS PREDICTABILITY OF PROPERTIES
- SUPPORT DESIGN AND MODELING
- EVALUATE VARIOUS SONIC TOOLS

VELOCITY ANALYSIS - APPROACH

- PRELIMINARY STUDIES - MANUAL INTERPRETATION
- PHASE II STUDIES - COMPUTER AIDED
- USE LAB DATA TO ESTIMATE VP / VS FOR EACH LITHOLOGY
- CALCULATE ENGINEERING PROPERTIES FROM SONIC TOOLS
- STATISTICAL ANALYSIS OF RESULTS
- CIRCUMVENT PROBLEMS WITH PICKING SHEAR WAVE ARRIVALS

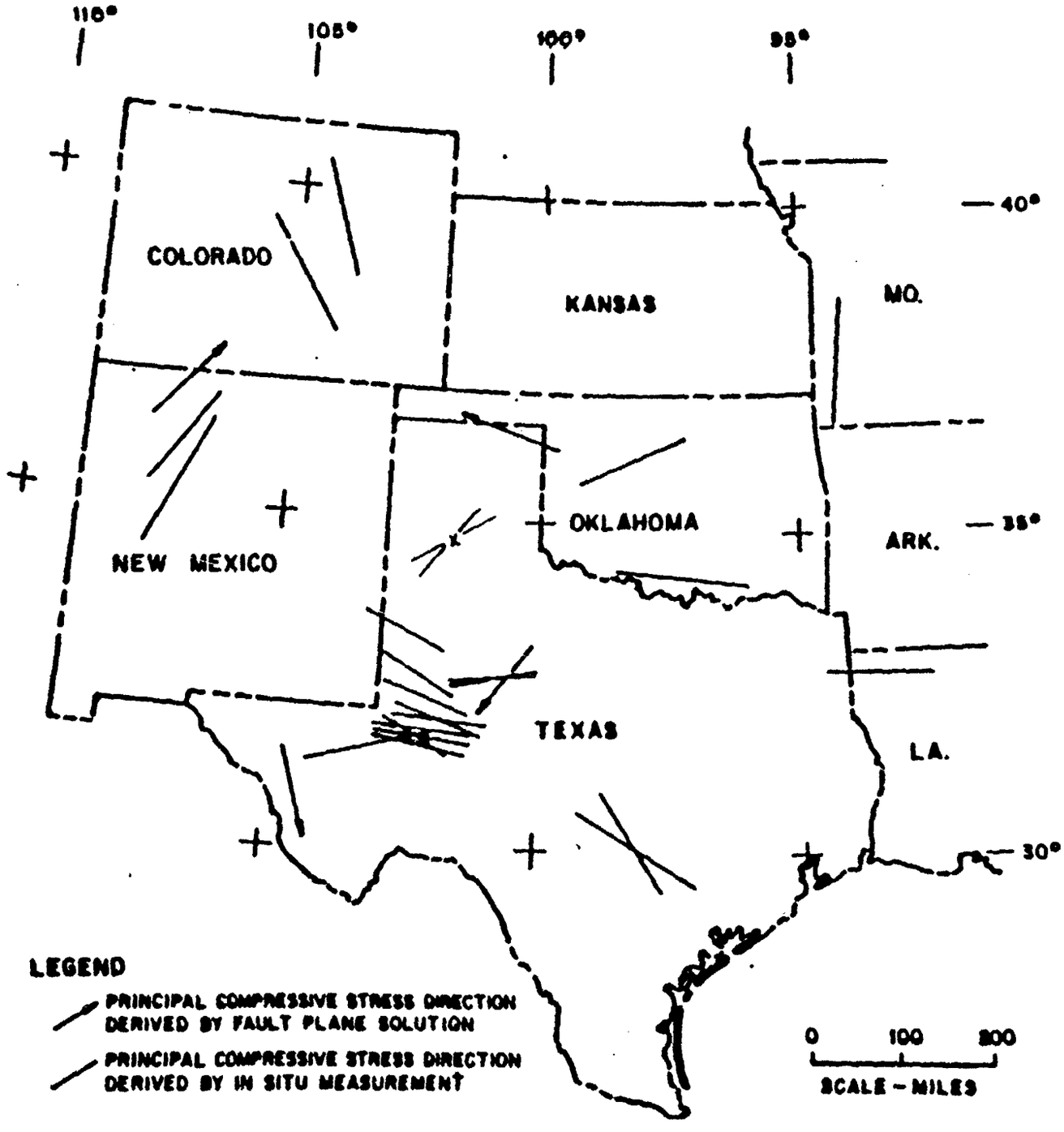
FIELD GEOTECHNICAL TESTING HOLTZCLAW NO. 1 WELL

PROPOSED TEST	PURPOSE	RESULTS
CALIPER & TEMP. LOGS PRIOR TO CLEANING WELL	1.) EVALUATE SALT CREEP 2.) DETERMINE AMBIENT DOWNHOLE TEMPERATURES	UNSUCCESSFUL HOLE CONDITIONS PRECLUDE RUNNING LOGS
GEOPHYSICAL LOGS (GAMMA RAY CALIPHER BHC)	CONFIRM TEST ZONES	SUCCESSFUL ESSENTIALLY THE SAME AS PREVIOUS LOGS
REPEAT FORMATION TESTER IN ZONES TO BE FRACTURED	1.) CONFIRM ZONES ARE TIGHT 2.) ESTIMATE PORE PRESSURES	VERY LITTLE PRESSURE BUILDUP
BOREHOLE TELEVIEWER PRIOR TO HYDRAULIC FRACTURE	1.) CONFIRM TEST ZONES 2.) IDENTIFY INTERBEDS	SUCCESSFUL RESOLUTION OF INTERBEDS GREATER THAN 6 IN.
HYDRAULIC FRACTURE		
2790 - 2798.5	DETERMINE MAXIMUM AND MINIMUM HORIZONTAL STRESS	SUCCESSFUL - 4 CYCLES
2581 - 2588.5		SUCCESSFUL - 4 CYCLES
2430 - 2438.5		SUCCESSFUL - 5 CYCLES
2330 - 2338.5		EXTENDED PAST PACKER
1885 - 1858.5		SUCCESSFUL - 5 CYCLES
BOREHOLE TELEVIEWER AFTER HYDRAULIC FRACTURE	DETERMINE FRACTURE ORIENTATION	UNSUCCESSFUL NO FRACTURE SEEN
IMPRESSION PACKERS		
2790 - 2798.5	DETERMINE ORIENTATION OF FRACTURES (FRACTURE PARALLEL TO MAX. HORIZONTAL STRESSES)	SUCCESSFUL - N 45 E
2581 - 2588.5		SUCCESSFUL - N 60 E
2430 - 2438.5		SUCCESSFUL - N 60 E
2330 - 2338.5		SUCCESSFUL - N 40 E & N 80 W
1850 - 1858.5		SUCCESSFUL - N 30 E & N 40 W

Table 9-1. Summary of Calculated Stresses

Formation (Rock Type)	Depth (ft)	Vertical Stress (psi)	Horizontal Stress Min (psi)	Horizontal Stress Max (psi)	σ_v/Depth (psi/ft)	σ_{HMin}/Depth (psi/ft)	σ_{HMax}/Depth (psi/ft)	$\sigma_{HMax}/\sigma_{HMin}$
Queen/Grayburg (Siltstone)	1,850-1,858.5	1,835[a]	1,110	1,260	0.99	0.60	0.68	1.14
Upper San Andres (Anhydrite)	2,330-2,338.5	2,335[a]	(d)	(d)	1.00	-	-	-
Lower San Andres (Unit 5 Salt)	2,430-2,438.5	2,445[a] 2,780[b]	2,915	(d)	1.00 1.14	- 1.20	- -	- -
Lower San Andres (Unit 4 Salt)	2,581-2,589.5	2,600[a] 2,950[b][c]	3,500[e]	(d)	1.01 1.14	- 1.36	- -	- -
Lower San Andres (Unit 4 Limestone)	2,790-2,798.5	2,810[a]	1,940	2,650	1.01	0.69	0.95	1.37

(a) Weight of overburden by integrating Lithodensity Log. (Calculation 13697-G(B)-29.)
(b) Calculated from hydraulic fracture data.
(c) This may be the minimum horizontal stress. Refer to text.
(d) Not determinable from the data obtained. Refer to text.
(e) Refer to Note (c).



PRINCIPAL COMPRESSIVE STRESS DIRECTIONS

DETERMINED BY IN-SITU MEASUREMENTS AND FAULT PLANE FAULT PLANE SOLUTIONS

SOURCES:

Zoback and Zoback, 1980
Voss and Herrmann, 1980
Herrmann, 1979
Hooker and Johnson, 1969
Raleigh, 1974
Heinson, 1977

X Data from Holtzclaw No. 1

GEOTECHNICAL LOGS

- GRAPHICAL FORMAT
- PREPARED FOR SELECTED PROGRAM WELLS
- SUMMARIZES DATA AVAILABLE
- INTEGRATES LAB AND FIELD DATA
- DOCUMENTS ANALYSIS OF GEOPHYSICAL LOGS
- DOCUMENTS OUR CURRENT UNDERSTANDING OF GEOTECHNICAL PROPERTIES
- WORKING DOCUMENTS - USED AS A STARTING POINT FOR ADDITIONAL STUDIES

GEOTECHNICAL PROFILES

- PREPARED AS CROSS SECTIONS
- GENERALIZED LITHOLOGIC GROUPINGS & CORRELATIONS
- SELECTED GEOPHYSICAL LOGS
- SELECTED DRILLING DATA
- SELECTED FIELD TEST DATA
- SELECTED LAB DATA
- UPDATED AS DATA BECOMES AVAILABLE AND AS WELLS ARE DRILLED

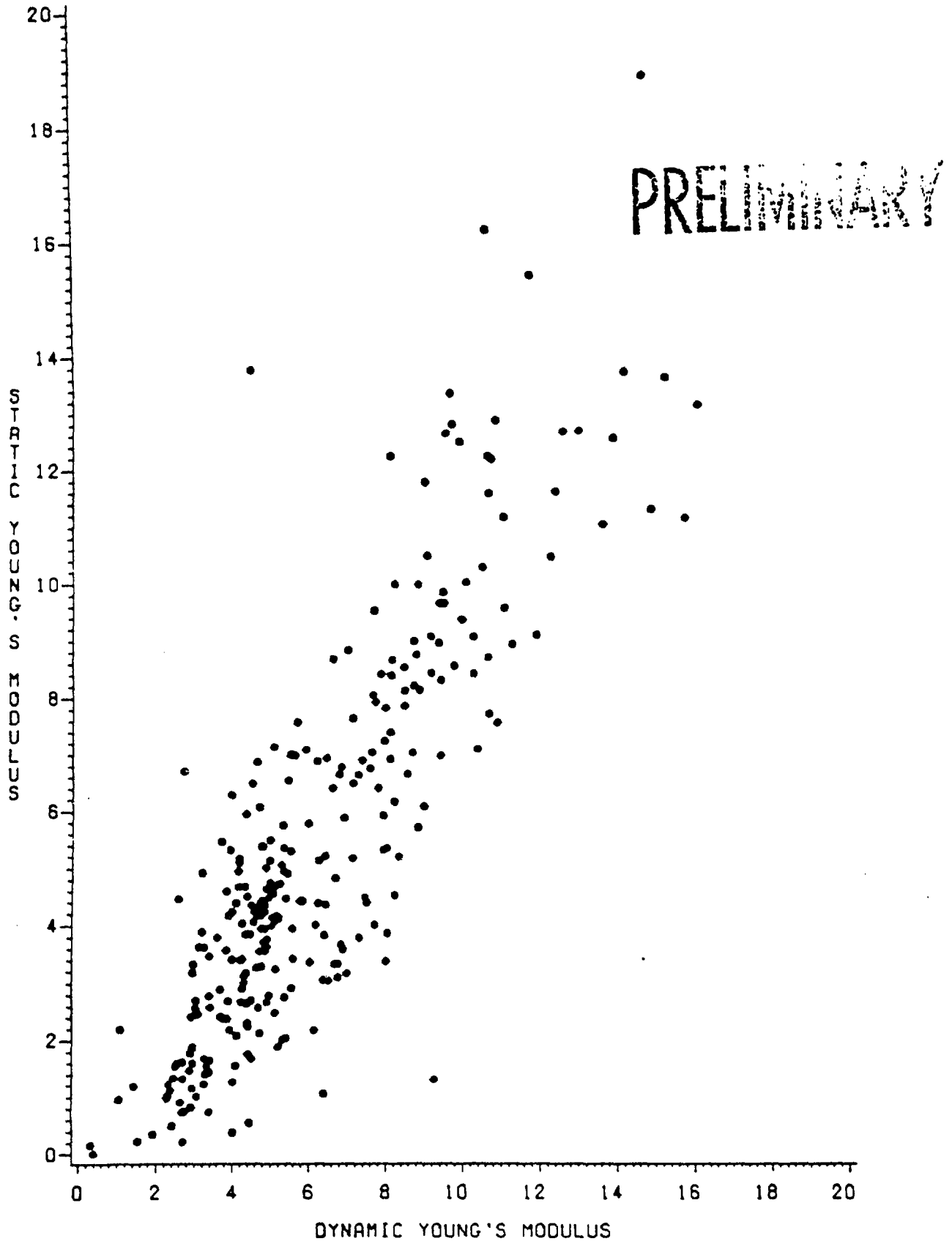
LAB TESTING DATA SUMMARY

FORMATION (LITHOLOGY)	GRAIN DENSITY	POROSITY	STRENGTH	YOUNG'S MODULUS	P-WAVE VELOCITY
DOCKUM (CLASTICS)	2.66 (2.64-2.68)	24 (15-38)	100-5600	1.14 (.004-2.86)	8206 (3700-15220)
DEWEY LAKE (CLASTICS)	2.7 (2.69-2.70)	19 (18-21)	1200-8300	0.98 (.22-1.75)	10920 (9100-14840)
ALIBATES (CLASTICS)	2.69	18 (17-20)	2930-5600	1.51 (.73-3.63)	11617 (10440-12760)
SALADO (CLASTICS)	2.62 (2.51-2.73)	14 (2-27)	4150-6985	1.55 (1.04-2.54)	15472 (1100-2370)
YATES (CLASTICS)	2.66 (2.64-2.69)	22 (3-29)	950-9000	1.63 (.81-2.73)	12845 (10330-15000)
USR (CLASTICS)	2.72	19 (3-25)	1050-3825	1.79 (.81-2.75)	13007 (9640-15820)
LSR (CLASTICS)	2.68	23 (21-25)	2400-3800	1.07 (.97-1.18)	10045 (9450-10640)
QUEEN-GRAY (CLASTICS)	2.5 (2.41-2.58)	6 (1-22)	1300-10200	3.74 (.49-6.71)	14555 (9280-17170)

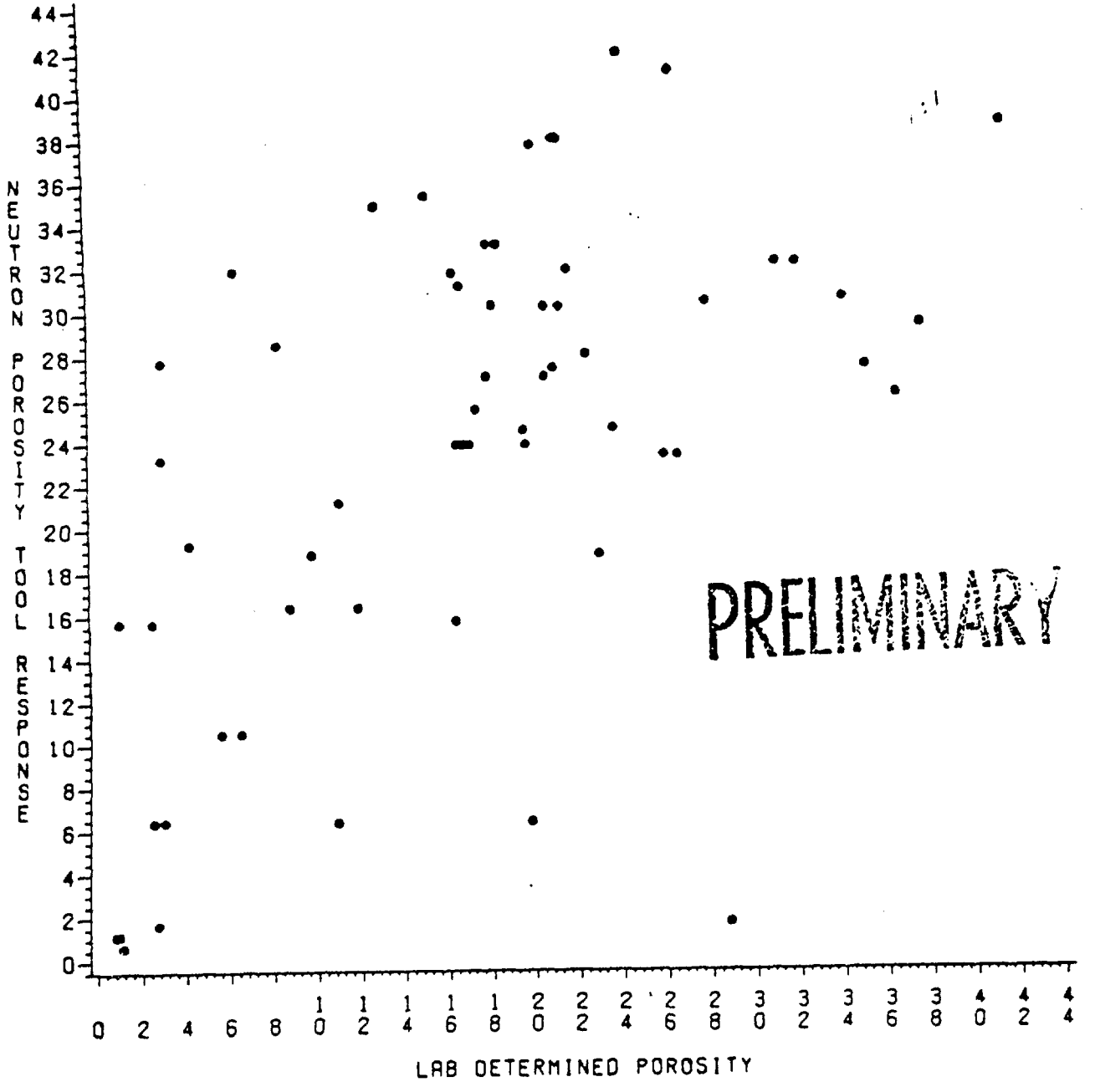
LAB TESTING DATA SUMMARY

FORMATION (LITHOLOGY)	GRAIN DENSITY	POROSITY	STRENGTH	YOUNG'S MODULUS	P-WAVE VELOCITY
USA					
(SALTS)	*2.2		- 1855-9526#	3.71 (.38-5.38)	14568 (10075-16700)
(CLASTICS)	2.54 (2.34-2.69)	14 (1-28)	15932**	6.7**	19100**
(ANHYDRITES)	2.83 (2.68-2.94)	1.2 (0-5.7)	4740-28000	8.94 (3.62-18.94)	19100 (11500-24540)
(CARBONATES)	2.7 (2.55-2.82)	11.5 (5.6-20.1)	5980-25070	4.8 (2.67-8.75)	17201 (13200-22700)
LSA-5					
(SALTS)	*2.17 (2.16-2.21)		- 2542-9062#	4.47 (3.47-6.49)	14902 (13560-16680)
(ANHYDRITES)	*2.84 (2.52-2.96)	0.7	5170-25210	10.28 (6.76-16.23)	19965 (15320-24800)
(CARBONATES)	2.7 (2.59-2.76)	19.3	6873-25300	4.2 (2.56-7.73)	15084 (11600-20200)
LSA-4					
(SALTS)	*2.17 (2.14-2.21)		- 2575-9236#	4.07 (2.56-7.73)	14868 (14300-15440)
(ANHYDRITES)	*2.80 (2.46-2.94)	2.75 (2.5-3.0)	5000-23620	10.66 (7.04-12.25)	18837 (16680-21400)
(CARBONATES)	2.64 (2.53-2.73)	5.6 (.5-19.2)	2965-25091	6.53 (3.33-10.0)	17585 (11380-19980)

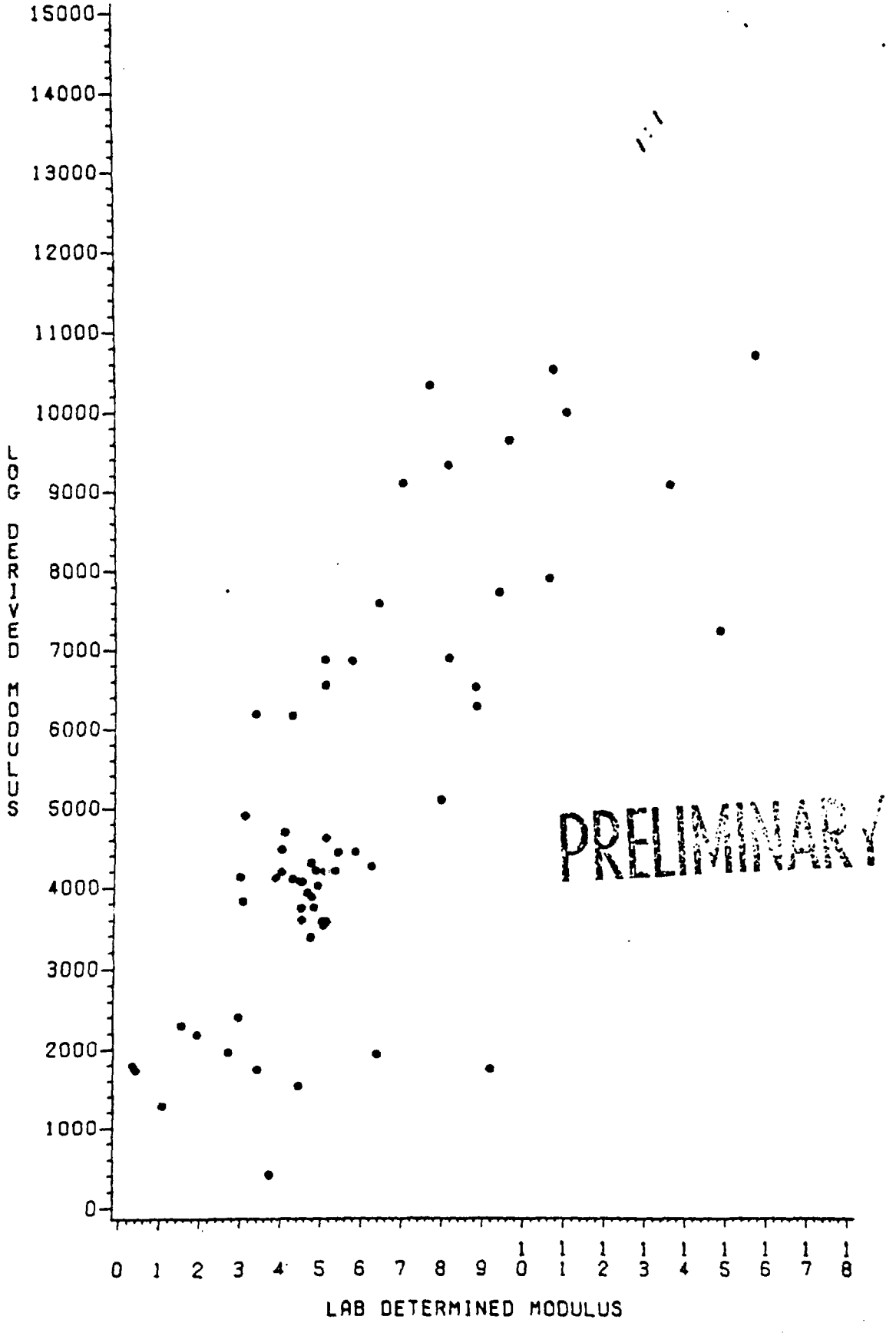
STATIC VS DYNAMIC MODULI CORRELATION

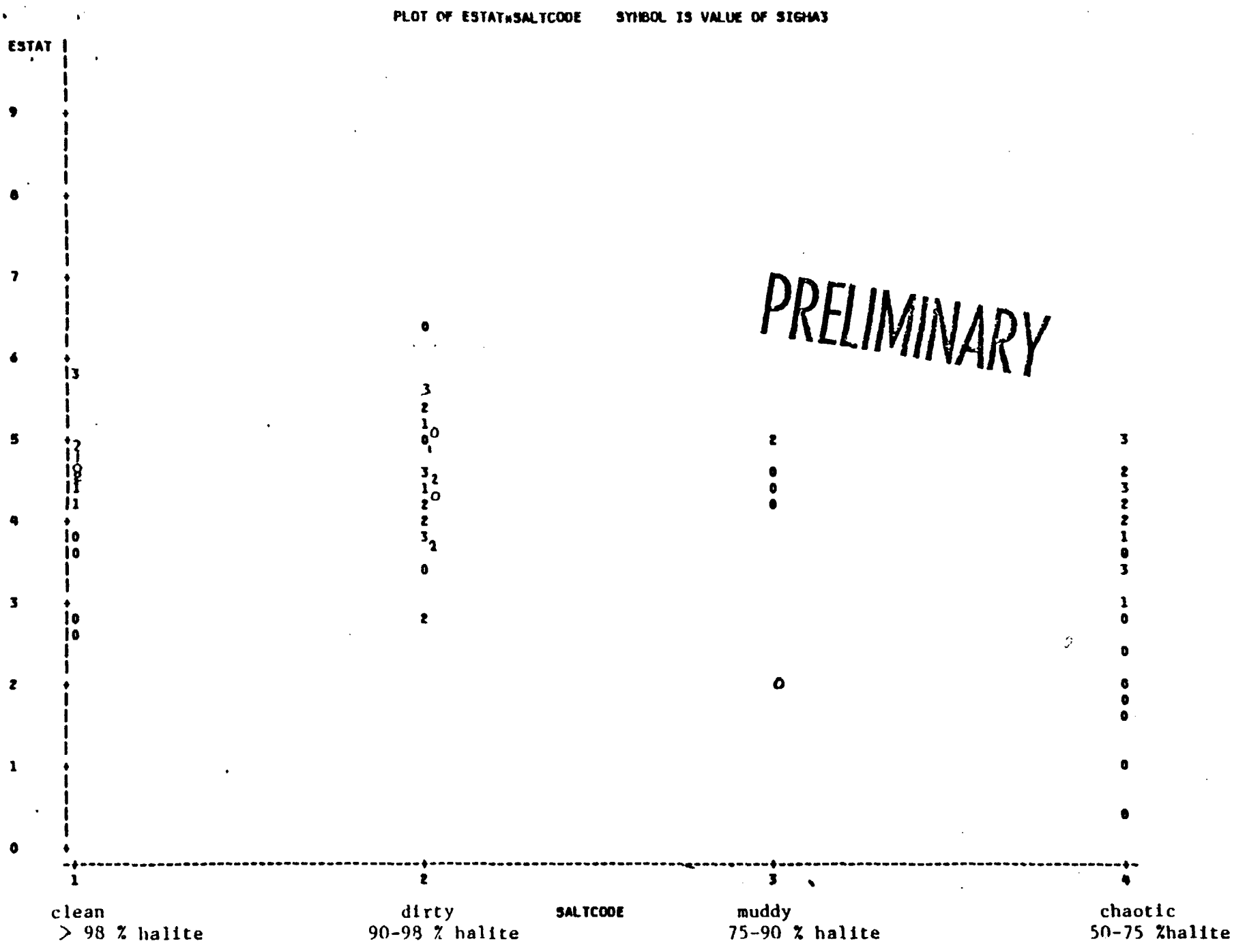


LAB VS LOG CORRELATIONS



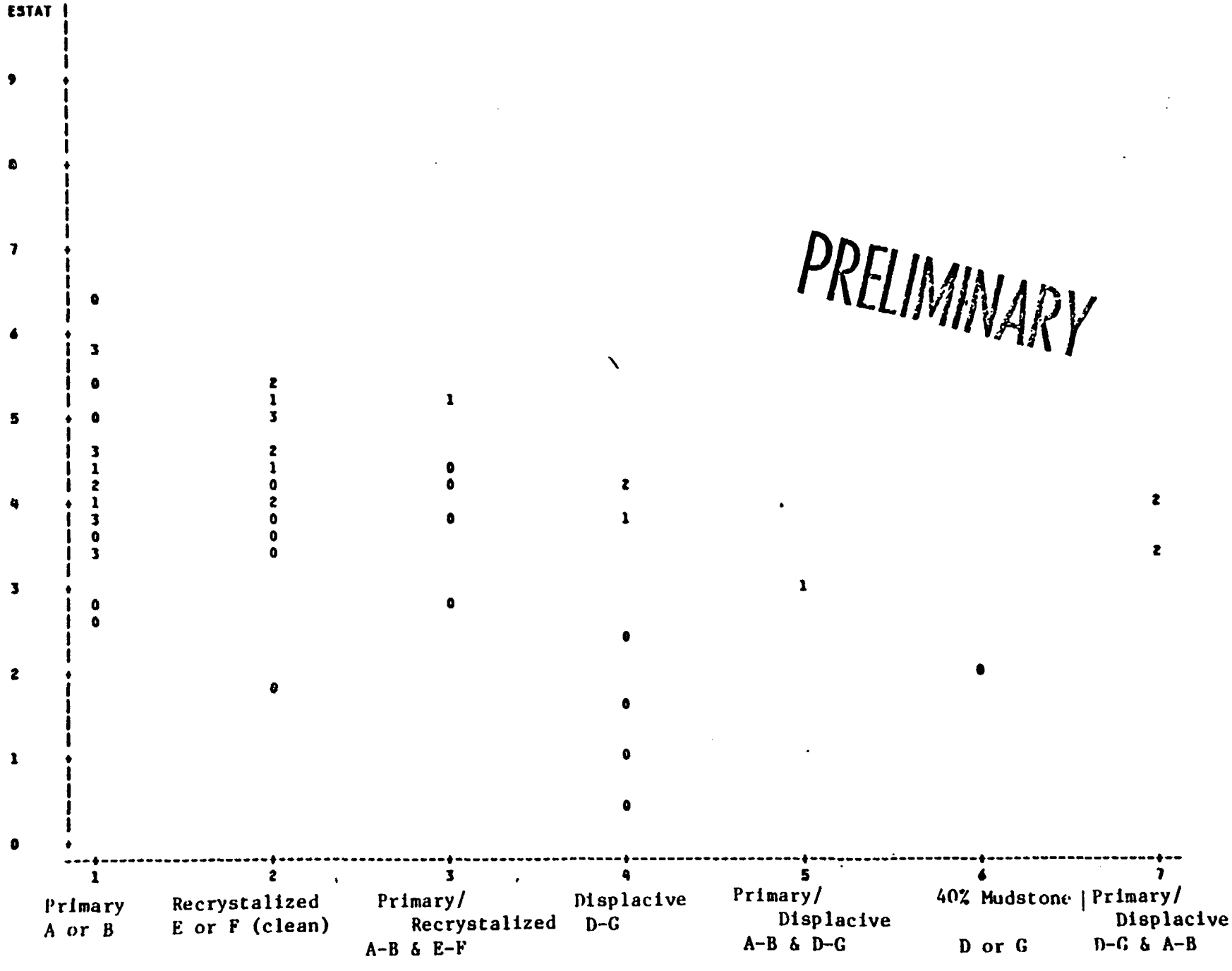
LAB VS LOG CORRELATIONS




PLOT OF ESTAT*SALTCODE SYMBOL IS VALUE OF SIGMA3
ESTAT
PRELIMINARY
clean
> 98 % halite
dirty
90-98 % halite
SALTCODE
muddy
75-90 % halite
chaotic
50-75 %halite

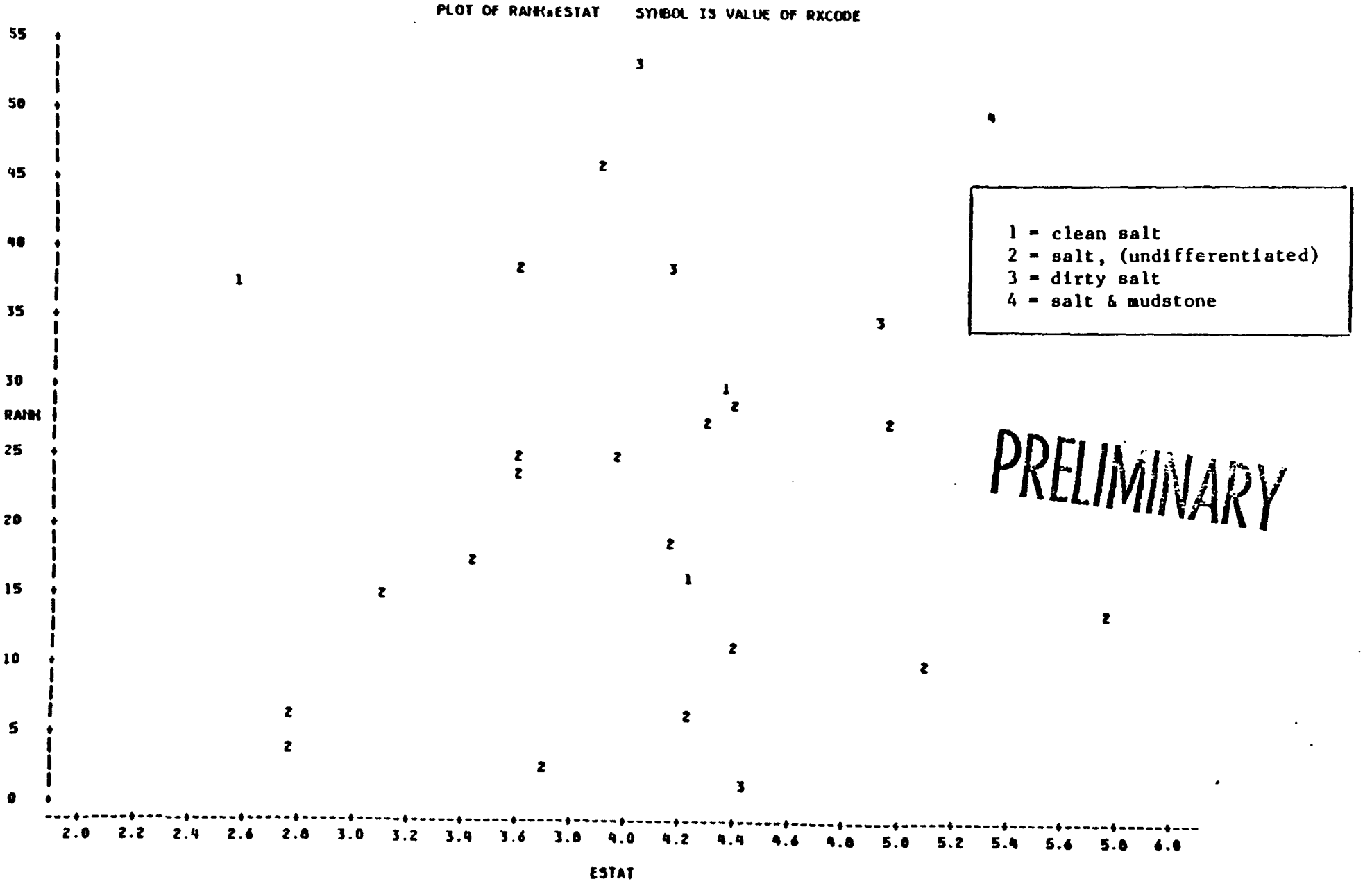
ALL SALTS, (CLEAN, DIRTY & CHAOTIC) TESTED BY ARA

PLOT OF ESTAT*TYPE SYMBOL IS VALUE OF SIGMA3



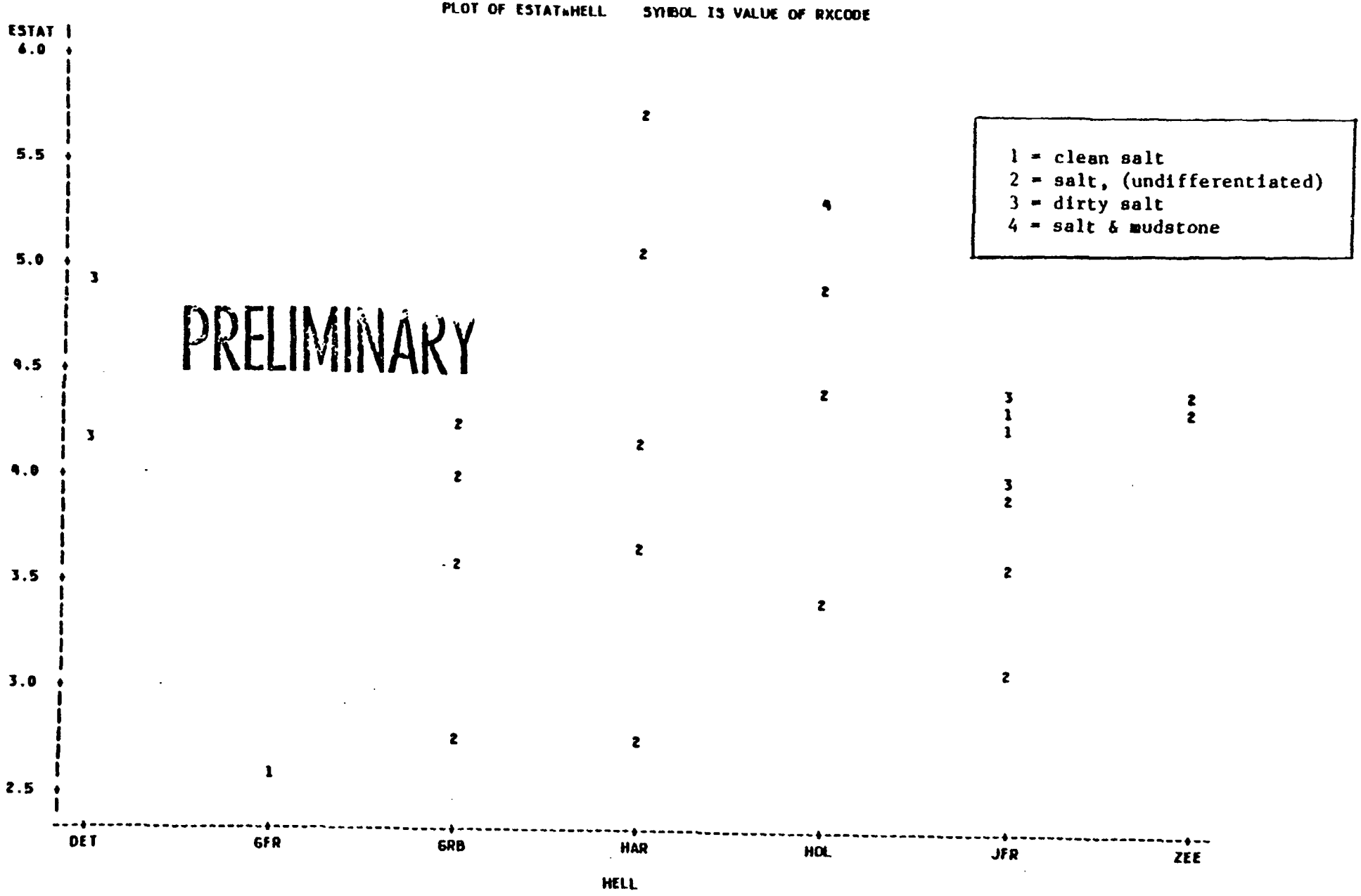
PRELIMINARY

LOWER SAN ANDRES CYCLE 4 - SALTS
MECHANICAL PROPERTIES LABORATORY TESTS
(AMBIENT TEMPERATURE ONLY)
FROM THE PALO DURO BASIN



PRELIMINARY

LOWER SAN ANDRES CYCLE 4 - SALTS
MECHANICAL PROPERTIES LABORATORY TESTS
(AMBIENT TEMPERATURE ONLY)
FROM THE PALO DURO BASIN



PRELIMINARY

Senseny 8/6

SAMPLE SELECTION

IMPORTANT HORIZONS

- Repository Salt
- Adjacent Units
- Thick Units
- Stiff Units
- Aquifers

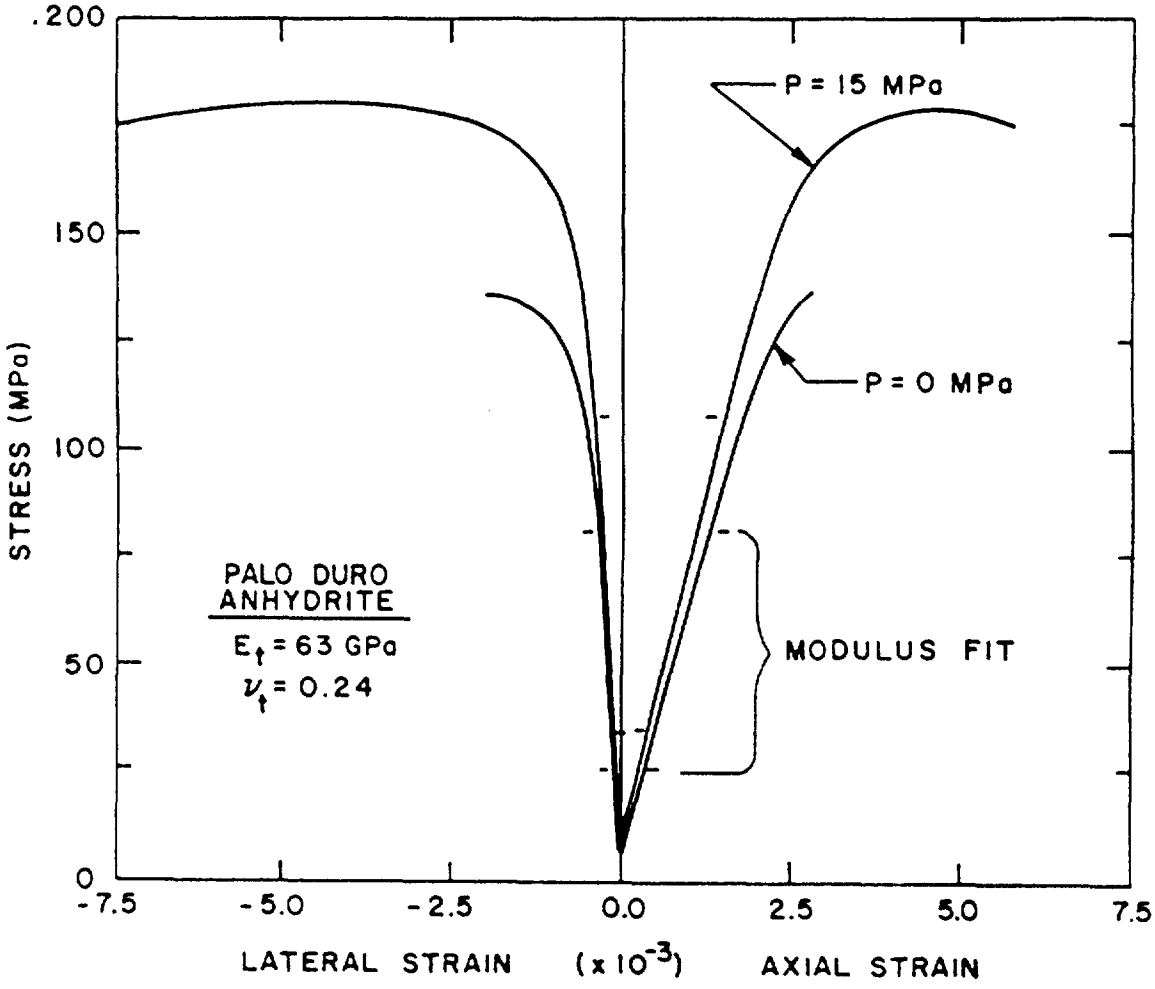
SAMPLING

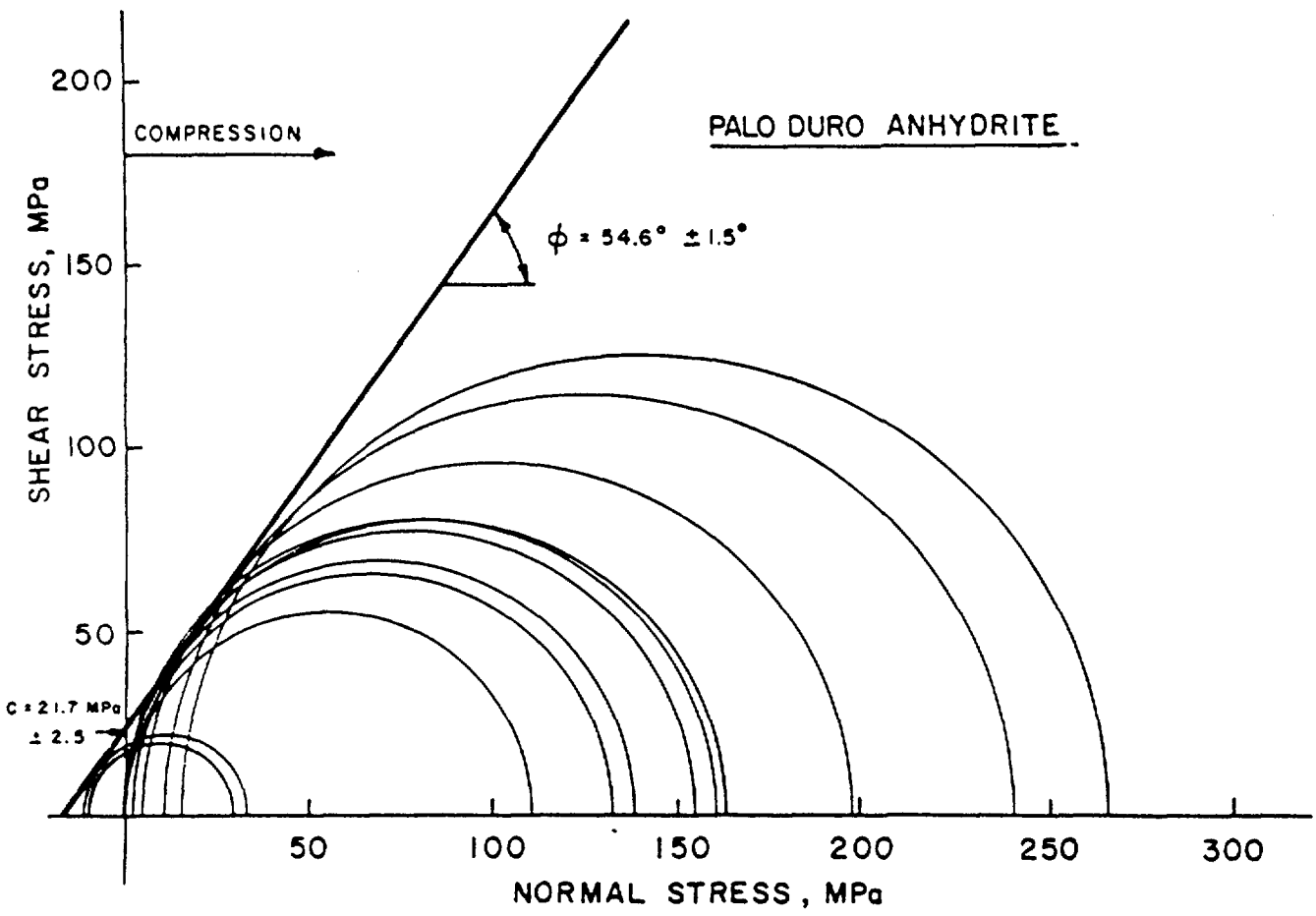
- Somewhat Random
- Representative
- Testable

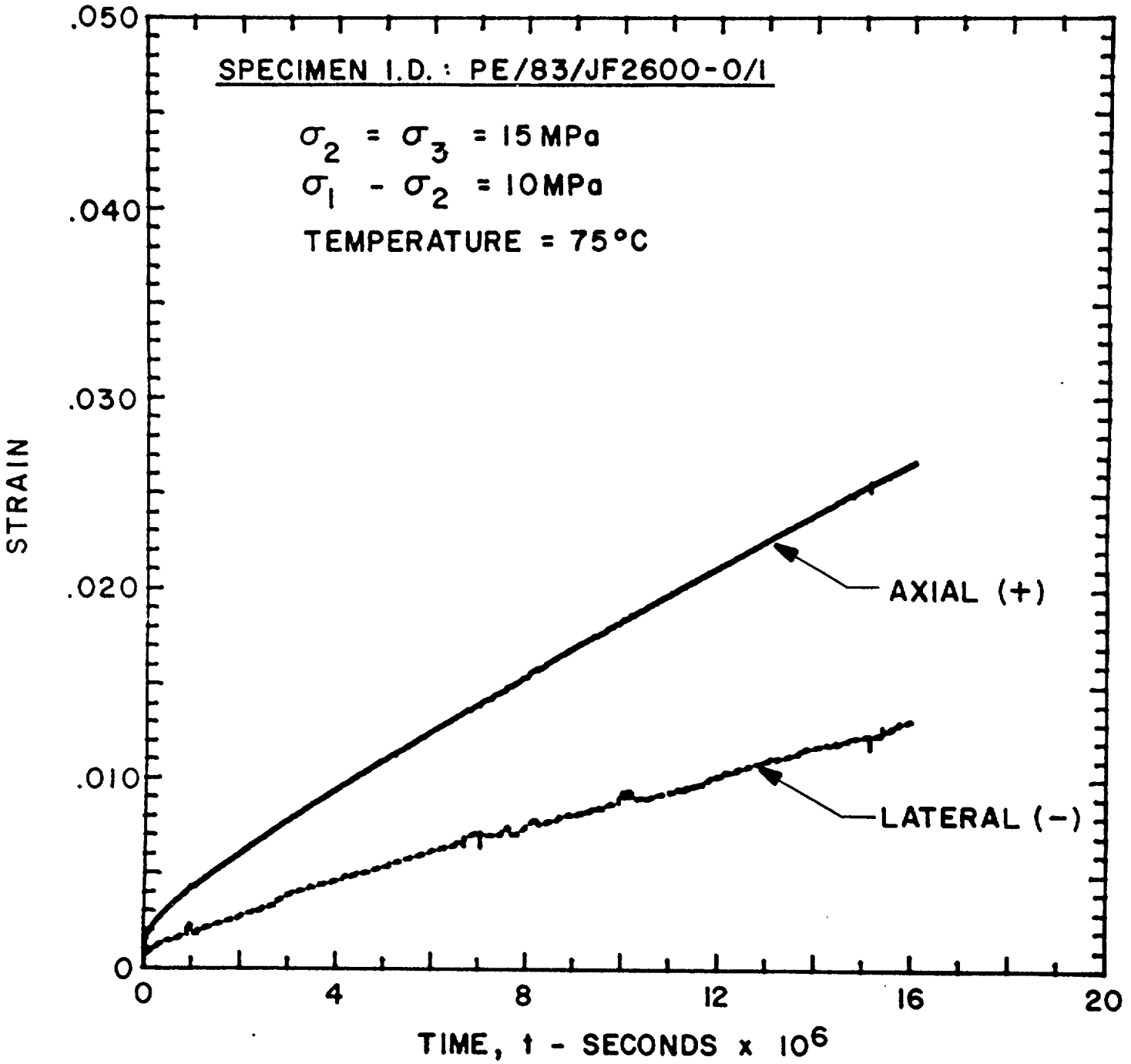
TESTING

BRAZILIAN:	Tensile Strength
UNCONFINED COMPRESSION:	Compressive Strength; Elastic Constants
TRIAXIAL COMPRESSION:	Envelope of Compressive Strengths Elastic Constants
CREEP:	Time-Dependent Deformation

RSI DWG 001-83-194






SPECIMEN I.D. : PE/83/JF2600-0/1
$\sigma_2 = \sigma_3 = 15$ MPa
$\sigma_1 - \sigma_2 = 10$ MPa
TEMPERATURE = 75°C
AXIAL (+)
LATERAL (−)
STRAIN
.050
.040
.030
.020
.010
0
0
4
8
12
16
20
TIME, t - SECONDS x 10^6

GRABBE #1

Rock Type	Recovery Depth m (Feet)	Test Type
Mudstone	335.1 — 337.4 (1099.4 — 1107.0)	B, U
Chaotic Mudstone/Salt	390.3 — 397.8 (1280.6 — 1306.2)	B, U
Siltsotne	503.2 — 505.8 (1650.9 — 1659.3)	B, U
Anhydrite	652.4 — 654.9 (2140.3 — 2148.5)	B, U
Unit 4 Salt	770.1 — 801.7 (2526.5 — 2630.2)	B, T, C
Dolomite	829.2 — 831.7 (2720.4 — 2728.6)	B, U
Mudstone	975.2 — 980.3 (3199.5 — 3216.1)	B, U
Chaotic Mudstone/Salt	1034.8 — 1037.4 (3395.0 — 3403.5)	B, U

MANSFIELD #1

Rock Type	Recovery Depth m (Feet)	Test Type
Unit 5 Salt	446.1 — 451.6 (1463.7 — 1481.6)	B, T, C

REXWHITE #1

Rock Type	Recovery Depth m (Feet)	Test Type
Unit 4 Salt	572.0 — 572.8 (1876.7 — 1879.3)	B, T

DETTEN #1

Rock Type	Recovery Depth m (Feet)	Test Type
Anhydrite	348.0 — 350.1 (1141.7 — 1148.5)	B, T
Siltstone	369.9 — 372.4 (1213.55 — 1221.7)	B, T
Sandstone	393.9 — 396.5 (1292.3 — 1300.7)	B, T
Siltstone	401.62 — 402.9 (1317.65 — 1322.0)	B, T
Salt	578.3 — 581.5 (1897.2 — 1907.8)	B, T
Anhydrite	637.9 — 639.4 (2092.8 — 2097.9)	B, T
Salt	670.5 — 672.7 (2199.9 — 2207.0)	B, T
Shale	678.47 — 680.73 (2225.95 — 2233.35)	B, T
Salt	683.9 — 686.4 (2243.7 — 2252.0)	B, T
Dolomite	694.9 — 696.5 (2280.0 — 2285.15)	B, T
Anhydrite	700.9 — 715.7 (2299.4 — 2348.0)	B, T
Unit 5 Salt	735.6 — 751.9 (2413.4 — 2466.7)	B, T
Dolomite	762.9 — 765.0 (2503.0 — 2510.0)	B, T

ZEECK #1

Rock Type	Recovery Depth m (Feet)	Test Type
Argillaceous Dolomite	814.1 — 816.7 (2670.8 — 2679.6)	B, T
Anhydrite	825.9 — 828.3 (2709.5 — 2717.5)	B, T
Unit 4 Salt	845.2 — 886.6 (2773.0 — 2908.8)	B, T
Dolomite	887.9 — 894.4 (2913.0 — 2934.3)	B, T
Limestone	899.4 — 909.9 (2950.7 — 2985.0)	B, T
Argillaceous Dolomite	926.9 — 940.6 (3041.0 — 3086.0)	B, T
Argillaceous Dolomite	1618.5 — 1628.9 (5310.0 — 5344.0)	B, T
Fossiliferous Limestone	1649.9 — 1656.3 (5413.0 — 5434.0)	B, T

G. FRIEMEL #1

Rock Type	Recovery Depth m (Feet)	Test Type
Unit 5 Salt	683.13 — 690.1 (2241.25 — 2264.1)	C
Unit 5 Salt	784.03 — 786.3 (2300.55 — 2307.2)	C

J. FRIEMEL #1

Rock Type	Recovery Depth m (Feet)	Test Type
Unit 4 Salt	789.8 — 825.9 (2591.2 — 2709.6)	C

WOODS-HOLTZCLAW #1

Rock Type	Recovery Depth m (Feet)	Test Type
Unit 5 Salt	746.7 — 751.3 (2449.8 — 2464.6)	C
Unit 4 Salt	783.4 — 809.3 (2570.0 — 2655.0)	C

REPORTS

ONWI-450	Preliminary Constitutive Properties for Salt and Nonsalt Rocks From Four Potential Repository Sites
BMI/ONWI-549	Constitutive Parameters for Salt and Nonsalt Rocks From the Detten, G. Friemel, and Zeeck Wells in the Palo Duro Basin, Texas
RSI-0252	Exponential-Time Constitutive Law for Palo Duro Unit 4 Salt From the J. Friemel #1 Well
RSI-0259	Influence of Impurities on the Creep of Salt From the Palo Duro Basin

Table 2-1. Nominal Impurity Content of Specimens

Specimen ID	Depth (feet)	Nominal Impurity Content
PE/84/WH 2450-0/1	2,449.8 - 2,450.7[a]	Pure Salt
PE/84/WH 2453-0/1	2,452.7 - 2,453.5[a]	Pure Salt
PE/84/WH 2509-0/1	2,508.9 - 2,509.7[a]	Pure Salt
PE/84/WH 2383-0/1	2,382.8 - 2,383.6[a]	10% Anhydrite
PE/84/WH 2448-0/1	2,447.2 - 2,448.0[a]	10% Anhydrite
PE/84/WH 2468-0/1	2,467.5 - 2,468.3[a]	10% Anhydrite
PE/84/WH 2376-0/1	2,375.5 - 2,376.3[a]	10% Mud
PE/84/WH 2443-0/1	2,442.9 - 2,443.8[a]	10% Mud
PE/84/WH 2464-0/1	2,463.8 - 2,464.6[a]	10% Mud
PE/84/WH 2570-0/1	2,570.0 - 2,570.9[b]	20% Mud
PE/84/WH 2578-0/1	2,577.2 - 2,578.1[b]	20% Mud
PE/84/WH 2655-0/1	2,654.2 - 2,655.0[b]	20% Mud

(a) Unit 5 Salt
(b) Unit 4 Salt

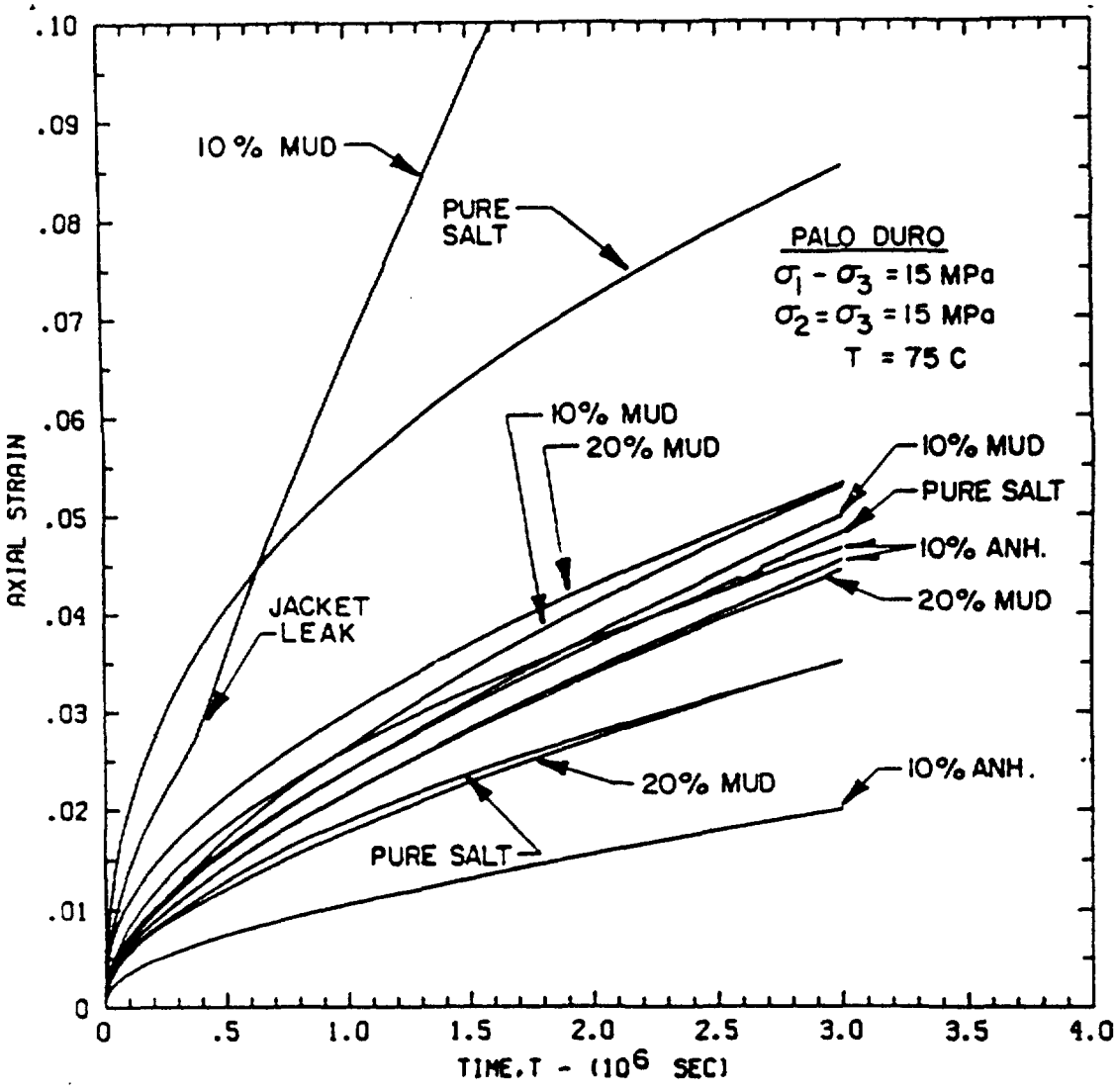
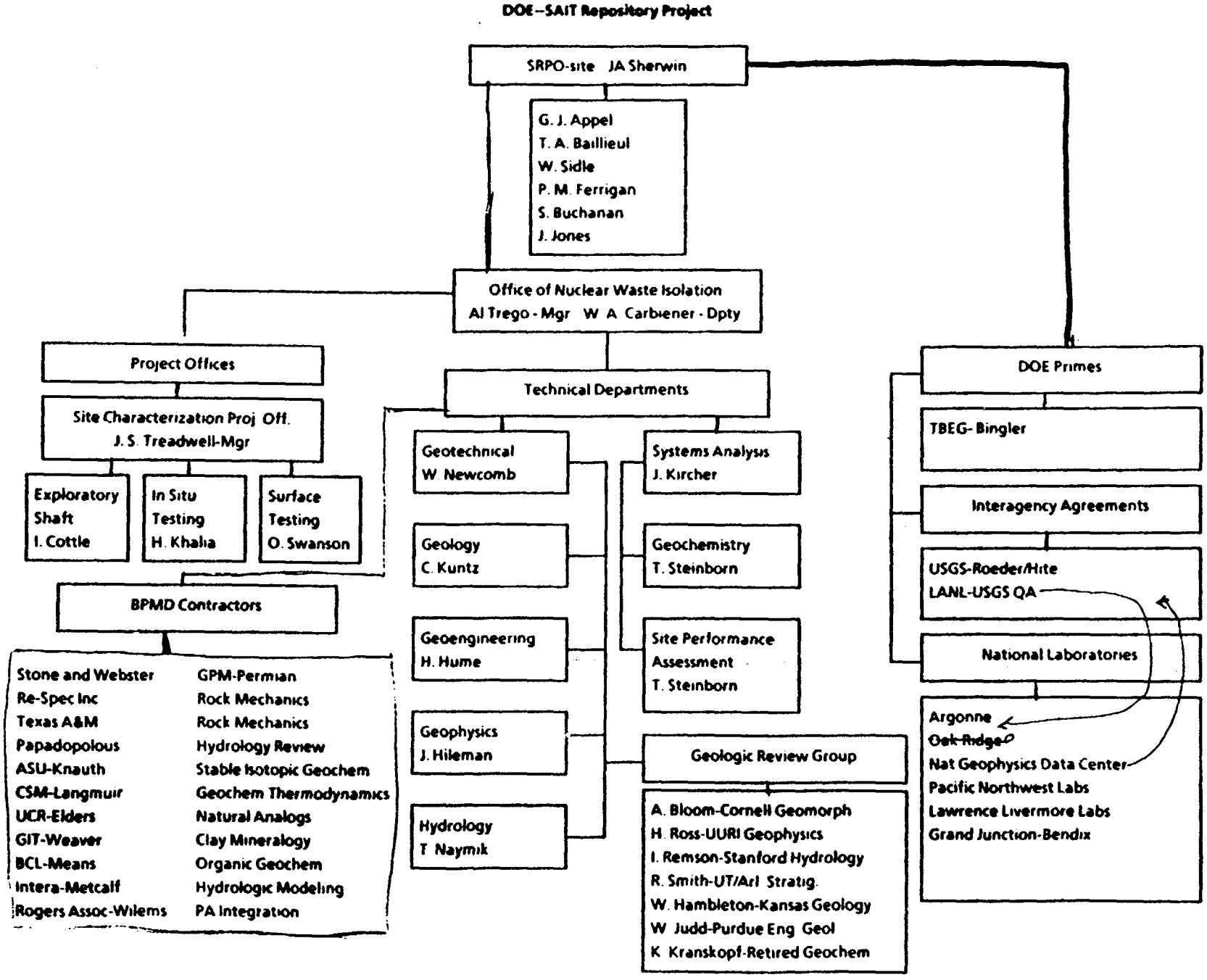

.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
AXIAL STRAIN
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TIME, T - (10^6 SEC)
10 % MUD
PURE SALT
PALO DURO
σ1 - σ3 = 15 MPa
σ2 = σ3 = 15 MPa
T = 75 C
10% MUD
20% MUD
10% MUD
PURE SALT
10% ANH.
20% MUD
JACKET LEAK
20% MUD
10% ANH.
PURE SALT

Table 4-2. Comparison of Current and Previous[a] Quasi-Static Parameter Values for Palo Duro Unit 5 Salt

Parameter	Currrent Value	Previous Value
Indirect Tensile[b] Strength, T_o (MPa)	-1.6 ± 0.4	-1.6 ± 0.4
Young's Modulus, E (GPa)[b]	28.8 ± 2.1	29.1 ± 4.0
Poisson's Ratio, ν[b]	0.26 ± .01	0.33 ± 0.01
Linear Failure Envelope[b]		
C (MPa)	5.7 ± 2.4	4.7 ± 2.0
ϕ (degrees)	40.1 ± 4.8	39.4 ± 4.0
Nonlinear Failure Envelope[b]		
K (MPa)	1.1 ± 1.8	1.1 ± 0.8
α (MPa)	46.0 ± 5.0	43.5 ± 2.6
β (MPa^{-1})	0.015 ± .004	0.015 ± .002

(a) Unit 5 from the Mansfield #1 borehole in Oldham County, Texas.

(b) 20 C data for current values; 24 C data for previous values.


DOE--SAIT Repository Project
SRPO-site JA Sherwin
G. J. Appel
T. A. Baillieul
W. Sidle
P. M. Ferrigan
S. Buchanan
J. Jones
Office of Nuclear Waste Isolation
Al Trego - Mgr W A Carbiener - Dpty
Project Offices
Site Characterization Proj Off.
J. S. Treadwell-Mgr
Exploratory Shaft
I. Cottle
In Situ Testing
H. Khalia
Surface Testing
O. Swanson
BPMD Contractors
Stone and Webster
Re-Spec Inc
Texas A&M
Papadopolous
ASU-Knauth
CSM-Langmuir
UCR-Elders
GIT-Weaver
BCL-Means
Intera-Metcalf
Rogers Assoc-Wilems
GPM-Permian
Rock Mechanics
Rock Mechanics
Hydrology Review
Stable Isotopic Geochem
Geochem Thermodynamics
Natural Analogs
Clay Mineralogy
Organic Geochem
Hydrologic Modeling
PA Integration
Technical Departments
Geotechnical
W. Newcomb
Geology
C. Kuntz
Geoengineering
H. Hume
Geophysics
J. Hileman
Hydrology
T Naymik
Systems Analysis
J. Kircher
Geochemistry
T. Steinborn
Site Performance Assessment
T. Steinborn
Geologic Review Group
A. Bloom-Cornell Geomorph
H. Ross-UURI Geophysics
I. Remson-Stanford Hydrology
R. Smith-UT/Arl Stratig.
W. Hambleton-Kansas Geology
W Judd-Purdue Eng Geol
K Kranskopf-Retired Geochem
DOE Primes
TBEG- Bingler
Interagency Agreements
USGS-Roeder/Hite
LANL-USGS QA
National Laboratories
Argonne
Oak Ridge
Nat Geophysics Data Center
Pacific Northwest Labs
Lawrence Livermore Labs
Grand Junction-Bendix

Sherwin 8/7

CONTRACT E512-05000
STONE & WEBSTER ENGINEERING CORPORATION

ONGOING TECHNICAL TASKS
FY1985 - FY1986

HYDROGEOLOGY
- EXTEND REGIONAL 2D MODEL INTO SW OKLAHOMA
- BEGIN 3D MODEL FOR 20 MI RADIUS OF SITE
- ANALYSIS OF PUMP TEST DATA, ZEECK AND J. FRIEMEL WELLS

GEOLOGY
- STRUCTURAL ANALYSES OF PALO DURO BASIN
- HYDROGEOLOGIC SUBDIVISIONS OF PALO DURO BASIN
- SALT DISSOLUTION IN THE INTERIOR OF THE PALO DURO BASIN

GEOPHYSICS
- MAINTAIN AND UPGRADE THE SEISMIC NETWORK

GEOTECHNICAL ENGINEERING
- GEOTECHNICAL PROFILES - DEAF SMITH COUNTY
- GEOPHYSICAL LOG ANALYSIS / ROCK MECHANICS LAB DATA
- COMPLETE LAB TESTING OF ROCK CORE

Washer 8/7

COMPUTER DATA BASES MAINTAINED BY STONE & WEBSTER

- OGALLALA WELL DATA FILE
- DOCKUM WELL DATA FILE
- DEEP BASIN DST FILES: PRESSURE, PERMEABILITY
- FORMATION FLUID CHEMISTRY FILE
- FORMATION TOPS, MAJOR SALT UNIT TOPS
- HYDROGEOLOGIC UNIT TOPS
- ROCK MECHANICS LAB TESTING DATA
- TEST SAMPLE DESCRIPTIONS
- GEOPHYSICAL LOG DATA (SWEC WELLS) REFORMATTED FOR IBM

STONE & WEBSTER TECHNICAL REPORTS

REPORT NO.	DATE	REPORT TYPE	TITLE	
G82-16	11/23/82	Characterization Report	Area Geological Characterization Report (AGCR)	1.13
T-1	03/22/83	Topical Report	Ogallala Aquifer Mapping Report	1.17
			Revised 10/21/83 (T-16)	1.18
T-2	03/07/83	Topical Report	Maps of Selected Formations	1.22
			Deaf Smith County (Draft)	1.23
T-3	02/23/83	Well Completion Report	Detten Final Core Log and Core	1.27
			Photographs	1.28
T-4	04/12/83	Well Completion Report	G. Friemel Final Core Log	1.32
			and Core Photographs	1.33
T-5	04/25/83	Well Completion Report	Sawyer No. 1 Pumping Test	1.37
			and Fluid Sampling Report	1.38
			Revised 9/7/84 (T-25)	1.39
T-6	05/26/83	Well Completion Report	Zeeck No. 1 Final Core Log	1.42
			and Core Photographs	1.43
T-8	06/17/83	Topical Report	Major Salt Beds (Revision of	1.45
			Report G82-12, 10/29/82)	1.46
T-9	08/01/83	Well Completion Report	Mansfield No. 1 Pumping Test	1.48
			and Fluid Sampling Report	1.49
			Revised 7/25/84 (T-26)	1.50
T-10	07/07/83	Well Completion Report	Dissolution Zone Water	1.52
			Wells	1.53
T-11	12/29/83	Well Completion Report	J. Friemel No. 1 (PD-9) Well	1.56
			Completion Report	1.57
T-12	12/15/83 and 12/16/83	Well Completion Report	Holtzclaw No. 1 Well (PD - 10)	2.3
			Completion Report	2.4
T-14	05/29/84	Topical Report	Hydrogeologic Investigations Based	2.8
			On Drill-Stem Tests	2.9
T-15	08/01/83	Well Completion Report	Harman No. 1 Final Core Log and	2.13
			Core Photographs	2.14
T-16	10/21/83	Topical Report	Ogallala Aquifer Mapping Program	2.17
T-17	09/14/83	Topical Report (Draft)	Geoengineering Evaluation for the	2.21
			Intermediate Shaft Liner Seal	2.22

STONE & WEBSTER TECHNICAL REPORTS

REPORT NO.	DATE	REPORT TYPE	TITLE	
T-18	11/16/83	Well Completion Report	Sawyer No. 1 Well (PD-3) Replaces draft of 3/8/82	2.25 2.26
T-19	11/18/83	Well Completion Report	Mansfield No. 1 Well (PD-4) Replaces draft of 6/24/82	2.28 2.29
T-20	04/05/84	Well Completion Report	G. Friemel No. 1 Well (PD-5)	2.31
T-21	07/19/84	Well Completion Report	Detten No. 1 Well (PD-6) Revision 1	2.33 2.34
T-22	06/29/84	Well Completion Report	Zeeck No. 1 Well (PD-7) Revision 1	2.37 2.38
T-23	08/20/84	Well Completion Report	Harman No. 1 Well (PD-8) Revision 1	2.42 2.43
T-24	12/22/83	Well Completion Report	Dissolution Zone Water Wells (PD-8, 11, 12, 13) Revision 1	2.47 2.48 2.49
T-25	09/07/84	Well Completion Report	Sawyer No. 1 Well (PD-3) Pumping Test and Fluid Sampling Report Revision 1	2.52 2.53 2.54 2.55
T-26	07/25/84	Well Completion Report	Mansfield No. 1 Well (PD-4) Pumping Test Revision 1	2.58 2.59
T-27	11/09/84	Topical Report	Origin of the Salado, Seven Rivers, and San Andres Salt Margins in Texas and New Mexico	3.4 3.5 3.6 3.7
T-28	12/04/84	Topical Report	Geotechnical Borehole Testing Report, Holtzclaw No. 1 Well	3.11 3.12 3.13
T-29	05/15/85	Well Completion Report	Zeeck No. 1 Well (PD-7) Pumping Test and Fluid Sampling Report	3.17 3.18 3.19
T-30	11/16/84	Topical Report	Structural Analysis of the Northern Palo Duro Basin	3.23 3.24
T-31	08/85	Well Completion Report	J. Friemel No. 1 Well (PD-9) Pumping Test and Fluid Sampling Report	3.27 3.28 3.29

STONE & WEBSTER TECHNICAL REPORTS

REPORT NO.	DATE	REPORT TYPE	TITLE	
T-32	12/21/84	Topical Report	Regional Permeability Determinations	3.33 3.34
T-33	01/03/85 Revised 07/85	Topical Report	Historical Seismicity of the Texas Panhandle from an Examination of Lubbock Station Records	3.38 3.39 3.40 3.41
T-34	01/03/85 Revised 04/85	Topical Report	Palo Duro Microearthquake Network Operation Report for April-July 1984	3.45 3.46 3.47
T-35	04/26/85	Topical Report	A Preliminary Simulation Model to Determine Ground-Water Flow and Ages Within the Palo Duro Basin Hydrogeologic Province	3.51 3.52 3.53 3.54 3.55 3.56
T-36	04/08/85	Field Test Activities Report	Black No. 1 Well, Deaf Smith County, Texas	4.1 4.2
T-37	04/01/85	Topical Report	Velocity Study: J. Friemel No. 1 and Zeeck No. 1 Wells	4.6 4.7
T-38	06/10/85	Topical Report	Geologic Database Management and Computer Mapping	4.10 4.11
T-39	08/85	Topical Report	Pumping Test Analyses - Sawyer No. 1 and Mansfield No. 1 Wells	4.14 4.15
T-40	04/22/85	Topical Report	Palo Duro Microearthquake Network Operation Report August-December 1984	4.19 4.20 4.21
T-41	06/12/85	Topical Report	Hydrogeologic Subdivision of the Wolfcamp Series and Pennsylvanian System of Eastern New Mexico	4.25 4.26 4.27 4.28
T-42	06/10/85	Topical Report	Hydrodynamic Investigations in the Texas Panhandle Area	4.32 4.33
T-43	Sept 85	Topical Report	A Report on Fracturing in the Deaf Smith Area	4.37 4.38
T-44	[illegible]	Topical Report	Hydrogeologic Subdivision of the Wolfcamp Series and Pennsylvanian System of the Deaf Smith County Area, Texas	4.42 4.43 4.44 4.45

ROCK MECHANICS LABORATORY TESTING REPORTS

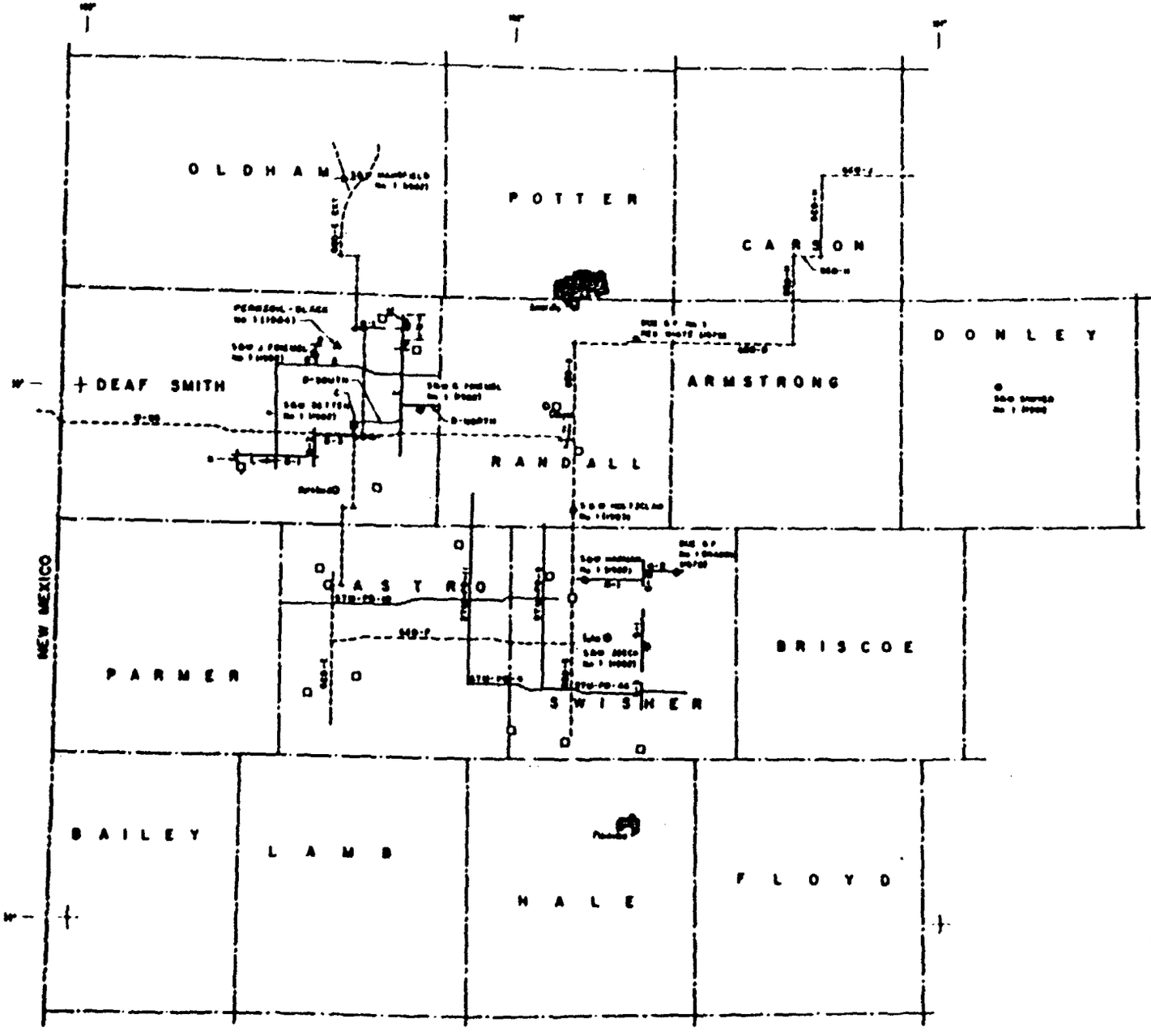
Report Title	Testing Lab	Report No. and Date	Presents Results of:
Laboratory Testing on Rock Core Samples from Mansfield No. 1 Well, Permian Basin Project	SWEC	13A-1 1-6-84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the Mansfield No. 1 Well
Laboratory Testing on Rock Core Samples from Detten No. 1 Well, Permian Basin Project	SWEC	13A-2 5-22-84 BMI/SRP 5023 Aug 84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the Detten No. 1 Well
Laboratory Testing on Rock Core Samples from G. Friemel No. 1 Well, Permian Basin Project	SWEC	13A-3 6-14-84 BMI/SRP 5025 Aug 84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the G. Friemel No. 1 Well
Laboratory Testing on Rock Core Samples from Zeeck No. 1 Well, Permian Basin Project	SWEC	13A-4 9-21-84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the Zeeck No. 1 Well
Laboratory Testing on Rock Core Samples from J. Friemel No. 1 Well Permian Basin Project	SWEC	13A-5 2-25-85	Density Porosity, Water Content, Rebound Hardness Tensile Strength, Slake Durability and Atterberg Limits Testing from the J. Friemel No. 1 Well
Report of Direct Shear Testing on Rock Core Samples from Mansfield No. 1 Well, Permian Basin Project	SWEC	13A-11 6-14-84 BMI/SRP 5027 Aug 84	Shear Strength Determinations of Naturally Occurring Discontinuities from the Mansfield No. 1 Well
Report of Direct Shear Testing on Rock Core Samples form Detten No. 1 Well Permian Basin Project	SWEC	13A-12 6-14-84 BMI/SRP 5026 Aug 84	Shear Strength Determinations of Naturally Occurring Discontinuities from the Detten No. 1 Well

Report Title	Testing Lab	Report No. and Date	Presents Results of:
Report of Direct Shear Testing on Rock Core Samples from Zeeck No. 1 Well Permian Basin Project	SWEC	13A-13 11-30-84	Shear Strength Determination of Naturally Occurring Discontinuities from the Zeeck No. 1 Well
Report of Liquid Permeability Measurements on Rock Core Samples from Mansfield No. 1 Well - Permian Basin Project	SWEC	13A-21 2-26-85	Measurement of permeability of selected samples from the Mansfield No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 1 7-26-83 BMI/SRP 5015 Sept 84	Unconfined Compression and Pulse Velocity Measurements for Samples from the Mansfield No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 2 7-26-84 BMI/SRP 5015 Sept 84	Unconfined Compression and Pulse Velocity Measurements for Samples from the Detten No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 3 7-26-84 BMI/SRP 5015 Sept 84	Unconfined Compression and Pulse Velocity Measurements for Samples from the G. Friemel No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 4 2-7-84 BMI/SRP 5015 Sept 84	Triaxial Compression and Pulse Velocity Measurements for Samples from the G. Friemel No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 5 2-7-84 BMI/SRP 5015 Sept 84	Triaxial Compression and Pulse Velocity Measurements for Samples from the Mansfield No, 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 6 2-7-84 BMI/SRP 5015 Sept 84	Triaxial Compression and Pulse Velocity Measurements for Samples from the Detten No. 1 Well

Report Title	Testing Lab	Report No. and Date	Presents Results of:
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 7 4-4-84 BMI/SRP 5015 Sept 84	Unconfined Compression and Pulse Velocity Measurements for Samples from the Zeeck No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli and Triaxial Compressive Strength	ARA	Vol. 8 4-4-84 BMI/SRP 5015 Sept 84	Triaxial Compression and Pulse Velocity Measurements for Samples from the Zeeck No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli Dynamic Moduli & Triaxial	ARA	Vols. 9-15 11-16-84	Unconfined and Triaxial Compression and Pulse Velocity Measurements for Samples from the J. Friemel No. 1 Well
Laboratory Testing of Rock and Salt Samples for Static Moduli, Dynamic Moduli & Triaxial	ARA	Vols. 16-20 1-10-85	Unconfined and Triaxial Compression and Pulse Velocity Measurements for Samples from the Harman No. 1 Well
Laboratory Testing of Rock and Salt Samples for the Determination of Rebound Hardness, Abrasion Hardness and Unconfined Compressive Strength	ARA	Vol. 1 7-23-84 BMI/SRP 5029 Nov. 84	Schmidt Rebound Hardness, Taber Abrasion Hardness and Unconfined Compressive Strength for Samples from the Zeeck No. 1 Well
Laboratory Testing of Rock and Salt Samples for the Determination of Rebound Hardness, Abrasion Hardness and Unconfined Compressive Strength	ARA	Vol. 2 7-23-84 BMI/SRP 5029 Nov. 84	Schmidt Rebound Hardness, Taber Abrasion Hardness and Unconfined Compressive Strength for Samples from the J. Friemel No. 1 Well
Laboratory Testing of Rock and Salt Samples for the Determination of Rebound Hardness, Abrasion Hardness and Unconfined Compressive Strength	ARA	Vol. 3 7-23-84 BMI/SRP 5029 Nov. 84	Schmidt Rebound Hardness, Taber Abrasion Hardness and Unconfined Compressive Strength for Samples from the Harman No. 1 Well

Report Title	Testing Lab	Report No. and Date	Presents Results of:
Laboratory Testing of Rock and Salt Samples for the Determination of Rebound Hardness, Abrasion Hardness and Unconfined Compressive Strength	ARA	Vol. 4 2-4-85	Schmidt Rebound Hardness, Taber Abrasion Hardness and Unconfined Compressive Strength for Samples from the Lower portion of the J. Friemel No. 1 Well
Laboratory Testing of Rock Samples for the Determination of Clay Mineralogy	Dartmouth College	Vol. 1 1-10-84 BMI/SRP 5018 Sept 84	Clay Mineralogy Determinations of Selected Samples from the Mansfield, Detten and G. Friemel Wells
Laboratory Testing of Rock Samples for the Determination of Clay Mineralogy	Dartmouth College	Vol. 2 7-12-84 BMI/SRP 5018 Sept 84	Clay Mineralogy Determinations of Selected Samples from the Zeeck No. 1. Well
Laboratory Testing of Rock Samples for the Determination of Clay Mineralogy	Dartmouth College	Vol. 3 1-1-85	Clay Mineralogy Determinations of Selected Samples from the J. Friemel No. 1 Well
Laboratory Testing of Rock and Salt Samples for Determination of Specific Gravity and Total Porosity	REI	1 9-20-83 BMI/SRP 5022 July 84	Water Content, Bulk Density, Apparent Specific Gravity, Specific Gravity, Effective Porosity and Total Porosity Determinations from the Mansfield No. 1 Well
Laboratory Testing of Rock and Salt Samples for Determination of Specific Gravity and Total Porosity	REI	2 7-12-84	Water Content, Bulk Density, Apparent Specific Gravity, Specific Gravity, Effective Porosity and Total Porosity Determinations from the G. Friemel and Detten Wells
Laboratory Testing of Rock and Salt Samples for Determination of Specific Gravity and Total Porosity	REI	3 5-7-84 BMI/SRP 5021 July 84	Water Content, Bulk Density, Apparent Specific Gravity, Specific Gravity, Effective Porosity and Total Porosity Determinations from the Zeeck No. 1 Well
Suspected Presence of Solid Hydrocarbon in Bedded Salt Samples from the Permian Basin	REI	4 3-5-84	Laboratory Efforts to Identify Material Previously Suspected to be Hydrocarbons

Report Title	Testing Lab	Report No. and Date	Presents Results of:
Suspected Presence of Solid Hydrocarbon in Bedded Salt Samples from the Permian Basin	RE1	4 (rev. 1) 11-28-84	Laboratory Efforts to Identify Material Previously Suspected to be Hydrocarbons



LEGEND

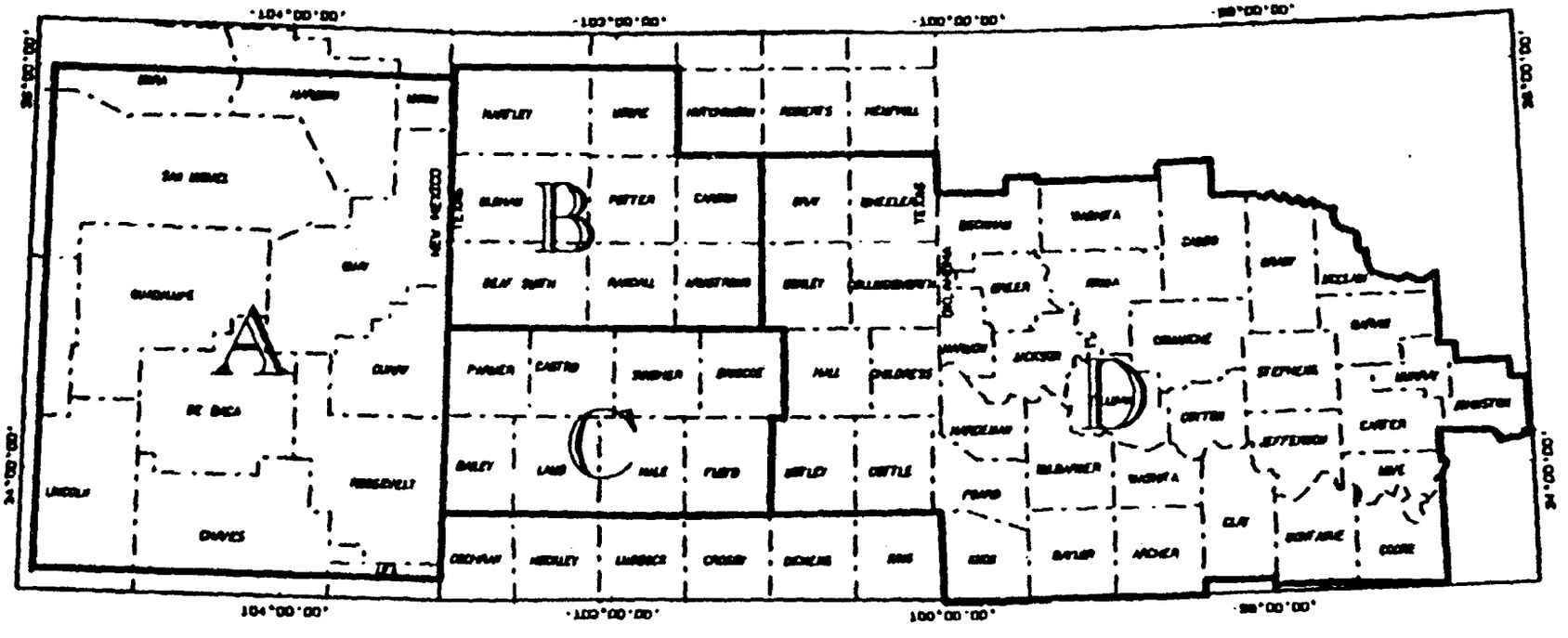
- NWTS PROGRAM TEST WELLS
- SEISMIC REFLECTION SURVEY (1982)
- PURCHASED (PROPRIETARY) SEISMIC DATA
- WELLS WITH VELOCITY SURVEYS
- NWTS TESTING IN WILDCAT WELL

0 10 20
SCALE - MILES
0 20 40
SCALE - KILOMETERS

NWTS PROGRAM TEST WELL AND SEISMIC COVERAGE OF CENTRAL PALO DURO BASIN

Murphy 8/7

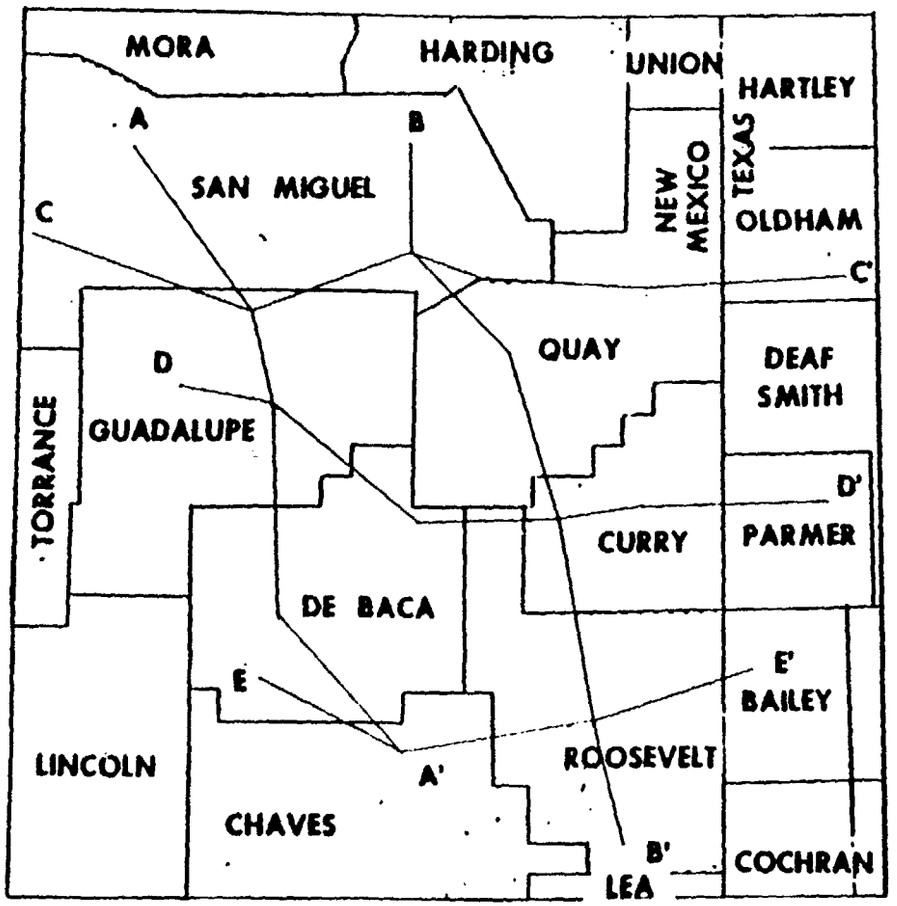
HYDROGEOLOGIC STUDY AREAS



A Eastern New Mexico (Task .31)
B Dent Smith (Task .32)
C Selsher (Task .33)
D Eastern Panhandle and Oklahoma (Task .34)

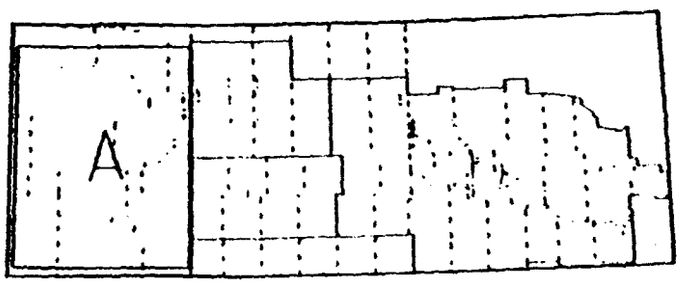
-44,158

LOCATION OF STUDY AREA AND LINES OF CROSS SECTION



Legend.

- Well Control
- Cross Section Line

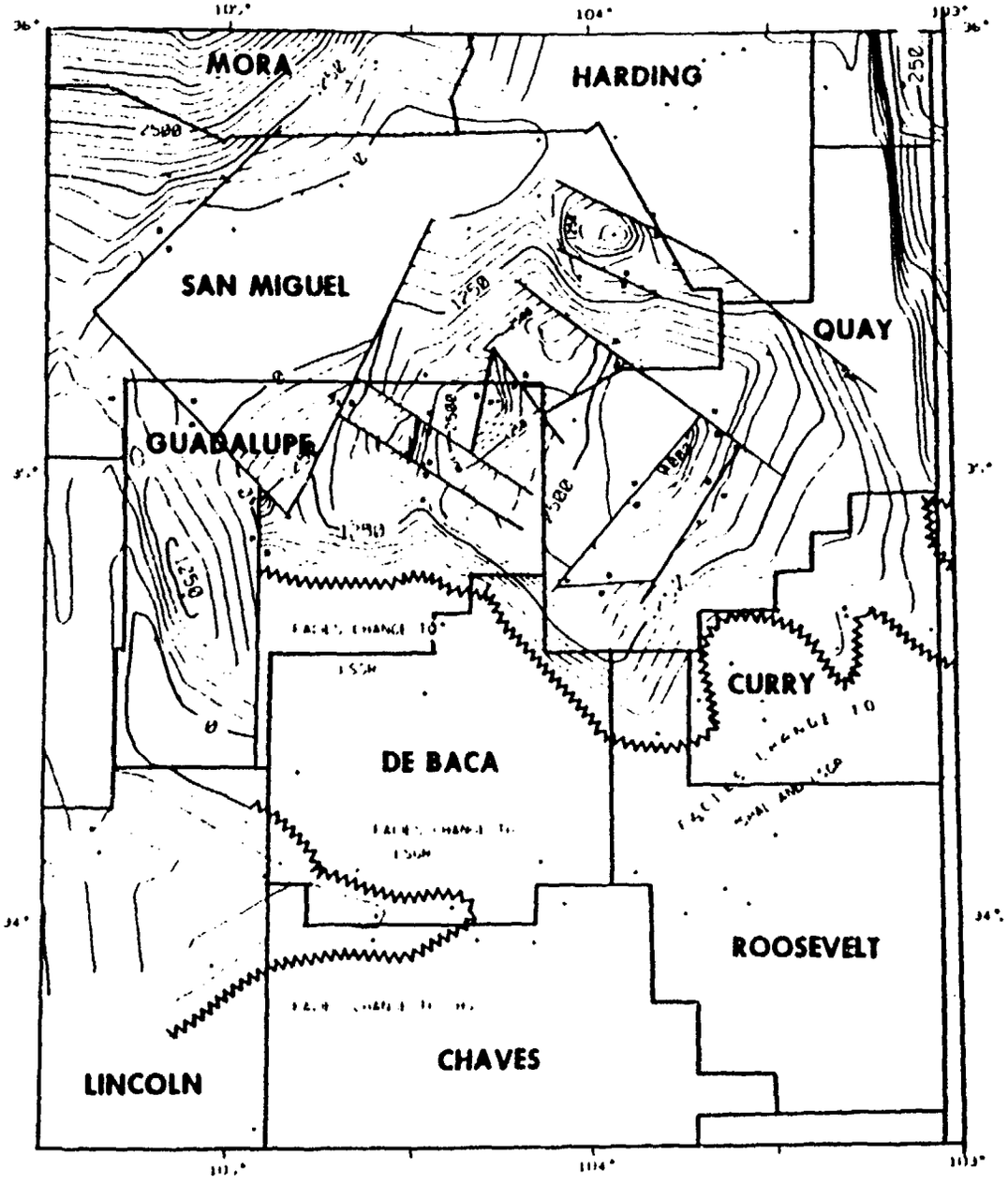


Hydrogeologic Study Areas

- A Eastern New Mexico
- B Deaf Smith
- C Switsher
- D Eastern Panhandle and Oklahoma

85-44,037

THICKNESS OF GRWA HYDROGEOLOGIC UNIT



LEGEND:

- Well Control
- Fault, U = Upthrown, D = Downthrown
- Facies Change

Datum: Mean Sea Level

Contour Interval 250 Feet

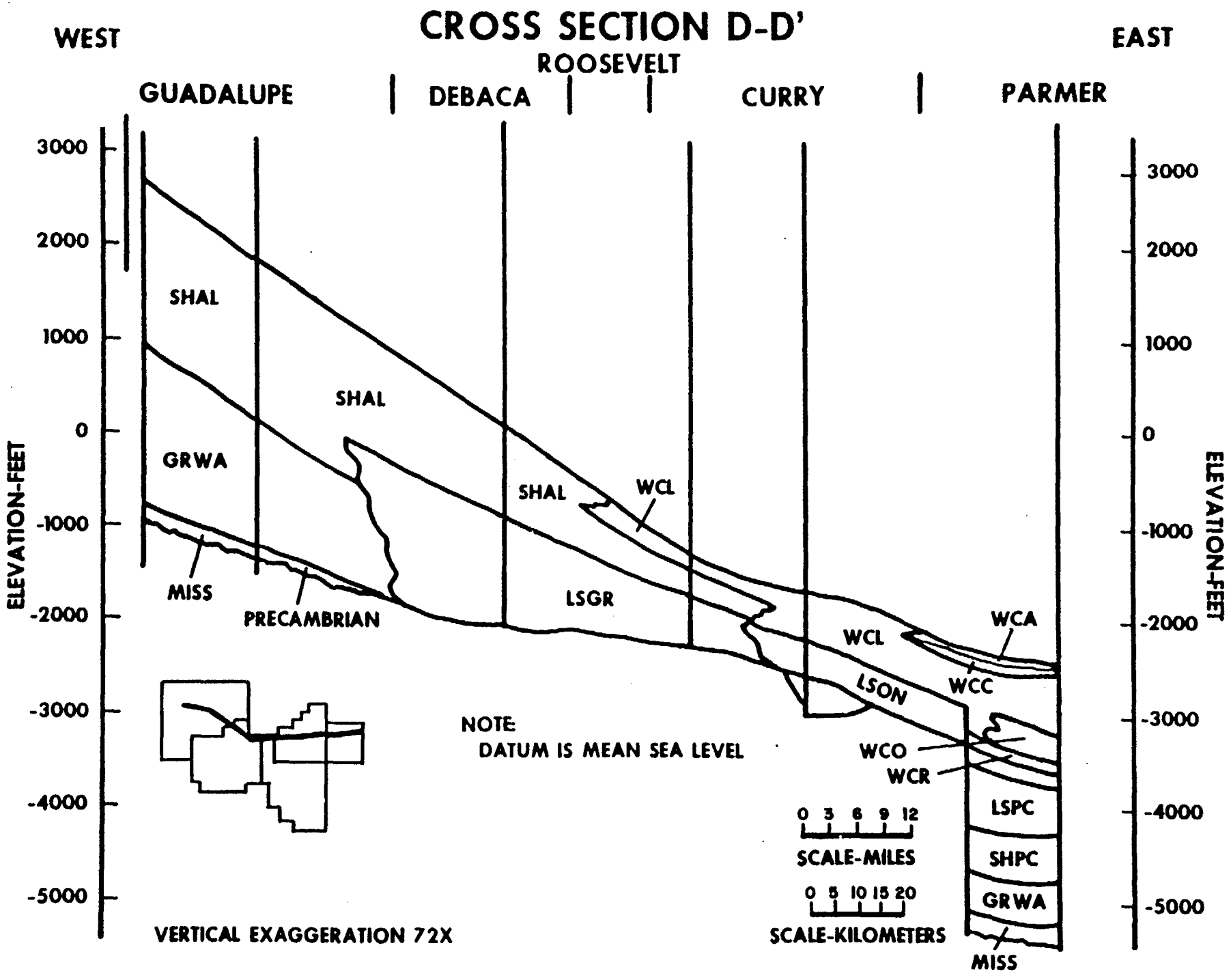
0 20 40 60

SCALE-MILES

0 20 40 60

SCALE-KILOMETERS

85-44,167


CROSS SECTION D-D'
WEST
EAST
ROOSEVELT
GUADALUPE
DEBACA
CURRY
PARMER
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
ELEVATION-FEET
SHAL
SHAL
SHAL
GRWA
WCL
MISS
PRECAMBRIAN
LSGR
WCA
WCL
WCC
LSON
WCO
WCR
LSPC
SHPC
GRWA
MISS
NOTE:
DATUM IS MEAN SEA LEVEL
0 3 6 9 12
SCALE-MILES
0 5 10 15 20
SCALE-KILOMETERS
VERTICAL EXAGGERATION 72X

85-44,010

Gustavson 8/7

PERMIAN BASIN CORE EXAMINATION MEETING

TEXAS BUREAU OF ECONOMIC GEOLOGY

Review of status of Palo Duro Basin Studies

August 7, 1985

Surface/Subsurface Geology

A. Quaternary stratigraphy of the western Rolling Plains (Gustavson)

B. Paleoenvironmental and paleoclimatic reconstructiion (Caran)

C. Characterization of the Blackwater Draw and Ogallala Formations (Gustavson)

D. Characterization of Dockum Group strata (Johns)

E. Depositional systems analysies of post-San Andres strata (Permian) (Nance)

F. Effects of interior salt dissolution in post-San Andres strata (Nance)

G. Petrography of post-San Andres Formation evaporites (Hovorka)

H. Diagenesis of the San Andres Formation (Hovorka)

I. Porosity and permeability analyses of Wolfcampian strata (Conti)

J. Regional stratigraphy of the San andres Formation (Fracasso)

K. Regional stratigraphy early Paleozoic strata (Ruppel)

L. Structure and tectonic history, Palo Duro Basin (Budnik)

M. Interion and peripheral salt dissolution (Gustavson)

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BEG PUBLICATIONS

REQUESTS FOR REVIEW PENDING

West Texas Waste Isolation Project
Contract No. DE-AC97-83WM46651

1.	Draft: Bureau RI	"Hydrogeology and Hydrochemical Facies of the San Andres Formation in Eastern New Mexico, West-Central Texas, and the Texas Panhandle," by Dutton and Orr. Review requested 2/6/85.
2.	Draft: Bureau RI	"Numerical Modeling of Regional Ground-Water Flow in the Deep-Brine Aquifers of the Palo Duro Basin, Texas Panhandle," by Wirojanagud, Kreitler, and Smith. Review requested 4/18/85.
3.	Final: Contract Report	"The Internal Structure of Model and Natural Salt Domes - Experimental Modeling of Salt Diapirs: Final Report," by Jackson and Talbot. Review requested 4/29/85.
4.	Article: AAPG Bulletin	"Wolfcampian Series Porosity Distribution: Implications for Deep-Basin Ground-Water Flow in the Palo Duro Basin, Texas Panhandle," by Conti, Senger, Wirojanagud, and Herron. Review requested 5/17/85.
5.	Draft: Bureau RI	"Cyclicity in the Middle Permian San Andres Formation, Palo Duro Basin, Texas Panhandle," by Fracasso and Hovorka. Review requested 6/20/85.
6.	Draft: Bureau GC	"Fracture Analyses of the Palo Duro Basin Area, Texas Panhandle and Eastern New Mexico," by Collins and Luneau. Review requested 7/29/85.

BEG PUBLICATIONS

APPROVAL PENDING

1.	Draft: Contract Report Bureau GC	"Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle: A Report on the Progress of Nuclear Waste Isolation Feasibility Studies (1983)," by Gustavson and others. Review requested 10/2/84. Comments received 7/1/85. Extension to 8/15/85 requested.
2.	Article: Groundwater	"Geochemistry of Salt Water in the Rolling Plains, North-Central Texas," by Richter and Kreitler,

Review requested 10/10/84. Comments received 5/13/85 Responses submitted 6/13/85. Revised article submitted 7/3/85.

3. Article: Geology — "Geochemical and Textural Evidence of Primary and Altered Bedded Salt, Permian Lower San Andres Formation, Palo Duro Basin, Texas," by Fisher and Hovorka. Review requested 10/19/84. Comments received 5/13/85. Response period extended to 9/1/85.

4. Draft: Bureau RI — "Late Cenozoic Geomorphic Evolution of the Texas Panhandle and Northeast New Mexico - Case Studies of Structural Controls of Regional Drainage Development," by Gustavson and Finley. Review requested 12/21/84. Comments received 7/1/85. Extension to 8/15/85 requested.

5. Article: GSA Bulletin — "Structural Control of the Development of the Canadian River Valley, Texas Panhandle: An Example of Regional Salt Dissolution and Subsidence," by Gustavson. Review requested 3/7/85. Comments received 7/5/85. Extension to 8/31/85 requested.

6. Draft: Bureau RI — "The Pre-Pennsylvanian of the Palo Duro Basin, Texas Panhandle: Stratigraphy and Petroleum Potential," by Ruppel. Review requested 3/11/85. Comments received 7/15/85. Responses submitted 7/24/85.

7. Draft: Bureau RI — "Stratigraphy of Bedded Halite in the Permian San Andres Formation, Units 4 and 5, Palo Duro Basin, Texas," by Hovorka, Luneau and Thomas. Review requested 4/3/85. Comments received 7/3/85. Responses submitted 7/25/85.

8. Article: South Texas Geological Society — "Reinterpretation of the Internal Structure of Palangana Salt Dome, South Texas," by Jackson and Talbot. Review requested 4/23/85. Comments received 7/22/85.

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June 1985

PUBLICATIONS ASSOCIATED WITH RESEARCH IN THE PALO DURO AND DALHART BASINS

I. Bureau Publications

1979

Dutton, S. P., Finley, R. J., Galloway, W. E., Gustavson, T. C., Handford, C. R., and Presley, M. W., 1979, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle: a report on the progress of nuclear waste isolation feasibility studies (1978): The University of Texas at Austin, Bureau of Economic Geology Geological Circular 79-1, 99 p.

McGowen, J. H., Granata, G. E., and Seni, S. J., 1979, Depositional framework of the Lower Dockum Group (Triassic), Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 97, 60 p.

1980

Dutton, S. P., 1980, Depositional systems and hydrocarbon resource potential of the Pennsylvanian System, Palo Duro and Dalhart Basins, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-8, 49 p.

Dutton, S. P., 1980, Petroleum source rock potential and thermal maturity, Palo Duro Basin, Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-10, 48 p.

Finley, R. J., and Gustavson, T. C., 1980, Climatic controls on erosion in the Rolling Plains and along the Caprock Escarpment of the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-11, 50 p.

Gustavson, T. C., Finley, R. J., and McGillis, K. A., 1980, Regional dissolution of Permian salt in the Anadarko, Dalhart, and Palo Duro Basins of the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 106, 40 p.

Gustavson, T. C., Presley, M. W., Handford, C. R., Finley, R. J., Dutton, S. P., Baumgardner, R. W., Jr., McGillis, K. A., and Simpkins, W. W., 1980, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle: a report on the progress of nuclear waste isolation feasibility studies (1979): The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-7, 99 p.

Handford, C. R., and Fredericks, P. E., 1980, Facies patterns and depositional history of a Permian sabkha complex: Red Cave Formation, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 80-9, 38 p.

Handford, C. R., and Fredericks, P. E., 1980, Lower Permian facies of the Palo Duro Basin, Texas: depositional systems, shelf-margin evolution, paleogeography, and petroleum potential: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 102, 31 p.

Seni, S. J., 1980, Sand-body geometry and depositional systems, Ogallala Formation, Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 105, 36 p.

1981

Finley, R. J., and Gustavson, T. C., 1981, Lineament analysis of the Texas Panhandle using Landsat imagery: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 81-5, 37 p.

Gustavson, T. C., Bassett, R. L., Finley, R. J., Goldstein, A. G., Handford, C. R., McGowen, J. H., Presley, M. W., Baumgardner, R. W., Jr., Bentley, M. E., Dutton, S. P., Griffin, J. A., Hoadley, A. D., Howard, R. C., McGookey, D. A., McGillis, K. A., Palmer, D. P., Ramondetta, P. J., Roedder, E., Simpkins, W. W., and Wiggins, W. D., 1981, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle: a report on the progress of nuclear waste isolation feasibility studies (1980): The University of Texas at Austin, Bureau of Economic Geology Geological Circular 81-3, 173 p.

Handford, C. R., Dutton, S. P., and Fredericks, P. E., 1981, Regional cross sections of the Texas Panhandle: Precambrian to mid-Permian: The University of Texas at Austin, Bureau of Economic Geology Cross Sections, 8 p.

McGillis, K. A., and Presley, M. W., 1981, Tansill, Salado, and Alibates Formations: Upper Permian evaporite/carbonate strata of the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 81-8, 31 p.

Presley, M. W., 1981, Middle and Upper Permian salt-bearing strata of the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Cross Sections, 10 p.

Simpkins, W. W., Gustavson, T. C., Alhades, A. B., and Hoadley, A. D., 1981, Impact of evaporite dissolution and collapse on highways and other cultural features in the Texas Panhandle and eastern New Mexico: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 81-4, 23 p.

1982

Baumgardner, R. W., Jr., Hoadley, A. D., and Goldstein, A. G., 1982, Formation of the Wink Sink, a salt dissolution and collapse feature, Winkler County, Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 114, 38 p.

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BUREAU OF ECONOMIC GEOLOGY C 2

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-1	A Comparison of the Depositional Environment of the San Andres Formation in the Palo Duro Basin to Recent Evaporitic Environments (332 FJ) Geochemistry (6.0) and (332 FJ) Natural Analogs (6.4) Chapman	4-27-84	5-7-84	5-25-84
OF-WTWI-1984-2 32 p @ 3.20 + ship	Uplift, Tilting and Subsidence of the Palo Duro Basin Area (3.3.2.2 A,C,E,I) Tectonic History McGookey	5-15-84	5-15-84	5-25-84
OF-WTWI-1984-3 36 pages $3.60 + ship	Salt Dissolution: Examples from Beneath the Southern High Plains (3.3.2.2 G) Geomorphic Processes and (3.3.2.2 R) Salt Dissolution Gustavson & Budnik	5-15-84	5-15-84	5-25-84
OF-WTWI-1984-4 19 p @ 1.40 + ship	Active Stress Field in the Texas Panhandle (3.3.2.2 B) Tectonic History Budnik	5-21-84	5-21-84	5-28-84
OF-WTWI-1984-5	Status of Borehole Sealing Research and Its Application to the Palo Duro Basin (332 FI) Relationships Among Hydrogeologic Units (5.6.2) Simpkins	1-30-84	5-24-84	5-28-84
OF-WTWI-1984-6	Investigation of Underpressuring in the Deep-Basin Brine Aquifer, Palo Duro Basin, Using Pressure/Depth Profiles (332 FI) Relationships Among Hydrogeologic Units (5.6.2) Orr	1-30-84	5-23-84	5-28-84

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
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OF-WTWI-1984-8 182 pg x .10 = 64 pg x .20 = $31.00 + shipping	Numerical Modeling of Regional Ground-Water Flow in the Deep-Basin Aquifers of the Palo Duro Basin, Texas Panhandle (332 FI) Regional Ground-Water Flow System (5.7) and (332 FI) Principal Ground-Water Flowpaths (5.7.2) Wirojanagud, Kreitler & Smith	2-24-84	6-1-84	6-1-84
OF-WTWI-1984-9	Structural Control of Physiography, Geomorphic Processes, and Lithofacies, Texas Panhandle (332 FH) Geomorphology (3.1) and (332 FH) Physiography and Topography (3.1.1) Gustavson & Budnik	3-12-84	5-23-84	5-29-84
OF-WTWI-1984-10	Late Quaternary Paleoclimatology of the Southern High Plains of Texas -- Implications for Disposal of Nuclear Waste (332 FJ) Long-Term Climate Assessment (7.2), (332 FJ) Paleoclimatology (7.2.1) and (332 FJ) Future Climatic Variation (7.2.2) Caran & Neck	3-12-84	5-23-84	5-29-84
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OF-WTWI-1984-12 9 p. $0.90 + ship	Quaternary Faulting in Southeastern Briscoe County, Texas (332 FH) Geomorphic Units (3.1.2) Baumgardner & Caran	3-21-84	5-23-84	5-29-84
OF-WTWI-1984-13	Stratigraphy of a Significant Quaternary Alluvial Sequence, Briscoe, Floyd, Hall, and Motley Counties, Texas (332 FH) Geomorphic Units (3.1.2) Caran & Baumgardner	3-21-84	5-23-84	5-29-84
OF-WTWI-1984-14	Historic Seismicity In and Around the Texas Panhandle (332 FH) Long-Term Regional Stability with Respect to Tectonic and Geologic Processes (3.5) Pennington & Davis	3-28-84	5-23-84	5-31-84
OF-WTWI-1984-15	Long-Term Rates of Denudation Based on Hypsometric Analysis of Drainage Basins and Underlying Salt Beds in the Texas Panhandle and Northeast New Mexico (332 FH) Geomorphic Processes (3.1.3) Baumgardner	4-4-84	5-31-84	5-31-84
OF-WTWI-1984-16	Modern Eolian Processes on the Southern High Plains (332 FH) Geomorphic Processes (3.1.3) Machenberg & Caran	4-4-84	5-23-84	5-31-84
OF-WTWI-1984-17	Analysis of Dust Trap Sediments Collected on the Southern High Plains (332 FH) Geomorphic Processes (3.1.3) Machenberg	4-4-84	5-23-84	5-31-84

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-18	Statistical Analysis of Erosion Pin Measurements: I. Description of Erosion and Deposition at Six Stations in the Texas Panhandle (332 FH) Geomorphic Processes (3.1.3) Simpkins	4-4-84	5-31-84	5-31-84
OF-WTWI-1984-19	Statistical Analysis of Erosion Pin Measurements: II. Calculation and Projection of Erosion and Deposition Rates at Six Stations in the Texas Panhandle (332 FH) Geomorphic Processes (3.1.3) Simpkins	4-4-84	5-31-84	5-31-84
OF-WTWI-1984-20	Jointing History of the Palo Duro Basin (3.3.2.2 M) Tectonic History - Jointing History Collins	6-11-84	6-11-84	N/A
OF-WTWI-1984-22 22 p * 2.20 + ship	Geostatistical Analysis of Potentiometric Surface of the San Andres Formation, Texas Panhandle (3.3.2.4 A) Hydrogeologic Units Dutton & Orr	6-21-84	6-21-84	N/A
Of-WTWI-1984-23 3 pgs x.10 = .30 9 ft x 1.15/ft = 10.35 10.65 + ship.	Chemical Composition of Dockum Group Ground Water, Texas Panhandle (3.3.2.4 A) Hydrogeologic Units Dutton & Simpkins	6-21-84	6-21-84	N/A
OF-WTWI-1984-24 8 p. * 0.80 + ship	Determination of Chemical Composition of San Andres Brine at the Zeeck No. 1 Well near Tulia, Texas (3.3.2.4 A) Hydrogeologic Units Dutton	6-21-84	6-21-84	N/A

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OF-WTWI-1984-25	Status Report on Identification of Discharge Areas of Deep-Basin Brine Aquifers, Hardeman Basin, Texas (332GN D) Identification of Recharge-Discharge Areas Richter, Smith & Orr	6-25-84	6-25-84	N/A
OF-WTWI-1984-26 13p $1.30 + ship	Geochemical Environment of the Evaporite Aquitard and Deep-Basin Brine Aquifer, Palo Duro Basin, Texas (332GP A) Geochemical Stability Fisher	6-25-84	6-25-84	N/A
OF-WTWI-1983-4 30p * 3.00 + ship	Identification of Recharge-Discharge Areas of the Palo Duro Basin, Texas Panhandle (332 FI) Identification of Recharge-Discharge Areas (5.7.1) Senger & Richter	9-22-83	6-29-84	6-29-84
OF-WTWI-1983-5	Texas Panhandle Mineral Assessment: Summary Report (332 FH) Mineral and Hydrocarbon Resources (3.7) and (332 FH) Mineral Resources (3.7.1) Bureau of Business Research (for the Bureau of Economic Geology)	12-19-83	7-3-84	7-3-84
OF-WTWI-1983-6	Texas Panhandle Mineral Assessment: The Petroleum Industry (332 FH) Hydrocarbon Resources (3.7.2) Bureau of Business Research (for the Bureau of Economic Geology)	12-19-83	7-3-84	7-3-84

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OF-WTWI-1983-1	Tectonic History of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic History (3.3.2) Budnik	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-2	Tectonic Framework of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic Framework (3.3.1) Budnik	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-3	Fracture Studies of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic History (3.3.2) Collins	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-9	Hydrocarbon Resources of the Palo Duro Basin, Texas Panhandle (3.7.2) Hydrocarbon Resources (3.9.3) Dutton	1-5-83	7-9-84	7-9-84
OF-WTWI-1983-14	Hydrocarbon Resources of the Palo Duro Basin, Texas Panhandle (332 FH) Hydrocarbon Resources (3.7.2) Ruppel and Dutton	12-21-83	7-9-84	7-9-84
OF-WTWI-1982-1	Hydrology of the Palo Duro Basin, Texas Panhandle (5.6.1) Hydrogeologic Units (5.1 & 5.1.1); (5.6.2) Relationship Among Hydrogeologic Units (5.1.2); (5.6.3) Potentiometric Level (5.1.3); (5.6.4) Hydraulic Characteristics of Principal Hydrogeologic Units (5.1.4); (5.7.1) Identification of Recharge and Discharge Areas (5.2.1); (5.7.2) Principal Ground-Water Flow Paths (5.2 & 5.2.2); and (5.7.3) Isotopic and Regional Hydrochemistry (5.2.3, 5.3.2, 6.2A, 6.2D) WTWI Staff, The Bureau of Economic Geology	10-26-82	7-18-84	7-18-84

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OF-WTWI-1982-3	Use of Kriging to Estimate the Wolfcampian and San Andres Potentiometric Surfaces, Palo Duro Basin, Texas Panhandle (5.6.1) Hydrogeologic Units Smith & Orr	12-22-82	7-18-84	7-18-84
OF-WTWI-1983-8	Mineral Resources of the Palo Duro Basin and Surrounding Areas, Texas Panhandle (3.7.1) Mineral Resources (3.9); Surface Mining (3.9.1); Analysis of Resources-Determine Uranium Potential in the Ogallala Formation, Dockum Group, and Permian Rocks in the Palo Duro Basin (3.9.4E); and Host-Rock Geochemistry - Resource Investigation, Copper Sabkha Model, Uranium, Non-Metallic (6.1B) Kolker	1-5-83	7-18-84	7-18-84
OF-WTWI-1983-10	Geomorphic Processes of the Texas Panhandle (3.1.3) Geomorphic Processes (3.4.2.2) Baumgardner	1-20-83	7-18-84	7-18-84
OF-WTWI-1983-11	Surface Geology of the Palo Duro and Dalhart Basins Area, Texas (3.2.1) Surface Geology (3.5.7) Smith	1-27-83	7-18-84	7-18-84
OF-WTWI-1983-13 16p. $1.60 + ship	Hydrogeochemistry of the Palo Duro Basin, Texas Panhandle (3.3.2.5) Hydrogeochemistry (6.2) Fisher	6-28-83	7-18-84	7-18-84
OF-WTWI-1984-31 2p $0.20 + ship	Composition of Unit 4 Halite in Deaf Smith and Swisher Counties, Texas Panhandle Hovorka	7-23-84	7-23-84	N/A

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-27	Preliminary Results of Porosity and Permeability of Cores from DOE Wells in the Palo Duro Basin, Texas Panhandle (332GN C) Hydraulic Characteristics of Principal Hydrogeologic Units Senger, Smith & Conti	8-7-84	8-7-84	N/A
OF-WTWI-1984-28	Evaluation of the J. Friemel #1 Vertical Well Test, Deaf Smith County, Palo Duro Basin, Texas Panhandle (332GN C) Hydraulic Characteristics of Principal Hydrogeologic Units Smith	8-7-84	8-7-84	N/A
OF-WTWI-1984-32 66 p $6.60 + ship	Modeling the Effects of Regional Hydrostratigraphy and Topography on Ground-water Flow, Palo Duro Basin, Texas Technical Report Senger & Fogg	8-7-84	8-7-84	N/A
OF-WTWI-1984-34	Analysis of Dust Trap Sediments Collected on the Southern High Plains (332 GM G) Geomorphic Processes and (332GM N) Physiography and Topography Machenberg	8-15-84	8-15-84	N/A
OF-WTWI-1984-35	Drainage Density in Five Representative Drainage Basins, Texas Panhandle and Northeast New Mexico (332GM G) Geomorphic Processes and (332GM N) Physiography and Topography Baumgardner	8-15-84	8-15-84	N/A

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-29	Experimental Modeling of Diapirs: Initial Report (332HE C) Initial Report of Findings Jackson	8-17-84	8-17-84	N/A
OF-WTWI-1984-30	Stratigraphy of the Palo Duro Basin - A Status Report (332FH D1) Stratigraphy (3.2) Ruppel and others	8-21-84	8-17-84	N/A
OF-WTWI-1984-36 22 p. $2.20 + ship	Regional and Isotopic Hydrogeochemistry: Deep-Basin Brine Aquifer, Palo Duro Basin, Texas Panhandle (332GN B) Isotopic and Regional Hydrogeochemistry Fisher	8-23-84	8-22-84	N/A
OF-WTWI-1984-37	Regression Analysis of Erosion and Deposition at Six Stations in the Texas Panhandle (332GM G) Geomorphic Processes (332GM K) Erosion Rates Simpkins	8-24-84	8-24-84	N/A
OF-WTWI-1984-21 6 pg = 6.90 ? 505 pg x 1.15 = 1580 $6498 + ship	Cyclicity in the Middle Permian San Andres Formation, Palo Duro Basin, Texas Panhandle Technical Report Fracasso & Hovorka	8-30-84	8-30-84	N/A
OF-WTWI-1984-38	Potentiometric Level of the Deep-Basin Brine Aquifer - A Status Report (332GN E) Potentiometric Level Smith	9-6-84	8-28-84	N/A

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-39 84 p figs 8.05 $16.45 + ship	Late Cenozoic Geomorphic Evolution of the Texas Panhandle and Northeastern New Mexico: Case Studies of Structural Controls of Regional Drainage Development Technical Report Gustavson & Finley	9-14-84	9-14-84	N/A
OF-WTWI-1984-40	Saponite and Chlorite-rich Clay Assemblage in Permian Sabkha Evaporite/Red Bed Strata, Palo Duro Basin, Texas Panhandle Technical Report Palmer	9-14-84	9-14-84	N/A
OF-WTWI-1984-41 31 p $3.10 + ship	Chemical and Isotopic Composition of Waters from the Salina Ometepec, Baja California (332GP B) Natural Analogs Kreitler, Chapman & Knauth	9-14-84	9-14-84	N/A
OF-WTWI-1984-43	Stratigraphic Studies of the Palo Duro Basin: An Update (1984) (332GM L) Stratigraphic Framework of the Candidate Area Ruppel, Fracasso & Johns	9-19-84	9-19-84	N/A
OF-WTWI-1984-42	Hydrologic Test Data, J. Friemel #1 Well, Deaf Smith County, Palo Duro Basin, Texas Panhandle (332GN C) Hydraulic Characteristics of Principal Hydrogeologic Units Smith	9-21-84	9-21-84	N/A
OF-WTWI-1984-44	Vertical Hydraulic Conductivity, Flux, and Flow in the Deep-Basin Brine Aquifer, Palo Duro Basin, Texas (332GN F) Relationships Among Hydrogeologic Units Orr & Senger	9-21-84	9-21-84	N/A

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-45	Core and Sample Analysis of the Dockum Group, DOE-Gruy Federal #1 Grabbe, Swisher County, Texas Topical Report Johns & Hovorka	9-28-84	9-28-84	N/A
OF-WTWI-1984-48 15 p. $1.50 + ship	Textural and Chemical Zones in Bedded Halite, Permian Lower San Andres Formation, Palo Duro Basin, Texas (332GP D) Host-Rock Geochemistry Fisher & Hovorka	10-2-84	10-2-84	N/A
OF-WTWI-1984-46	Potential for Petroleum Resources in the Palo Duro Basin Area, Texas Panhandle (332GM U) Mineral Resources and (332GM V) Hydrocarbon Resources Ruppel & Dutton	10-9-84	10-9-84	N/A
OF-WTWI-1983-12 28 p 2.00 fig 13.00 $15.60 + ship	Supplemental Report for Pressure-Depth Relationships, Potentiometric Levels, and Hydrochemistry of the Palo Duro Basin, Texas Supplement to: (5.6.2) Relationships Among Hydrogeologic Units, (5.6.3) Potentiometric Level, (5.6.3.1) Potentiometric Level of the Deep-Basin Brine Aquifer, (5.7.3) Isotopic and Regional Hydrochemistry, (5.7.3.1) Isotopic and Regional Hydrochemistry of the Deep-Basin Brine Aquifer Orr, Senger, Smith & Fisher	2-28-83	10-9-84	10-9-84
OF-WTWI-1984-49	Quaternary Stratigraphy and Geologic Mapping, Western Rolling Plains of Texas (332GM F) Geomorphic Units and (332GM H) Surface Geology Caran & Baumgardner	10-11-84	10-11-84	N/A

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-47	Lower Permian (Wolfcampian) Stratigraphy and Paleogeography, Palo Duro Basin, Texas Topical Report Herron	10-18-84	10-17-84	N/A
OF-WTWI-1984-50	Amount and Nature of Occluded Water in Bedded Salt, Palo Duro Basin, Texas Topical Report Fisher	10-29-84	10-29-84	N/A
OF-WTWI-1984-51	Experimental Modeling of Salt Diapirs: Interim Report (332HE D) Interim Report of Conclusions Jackson	10-31-84	10-31-84	N/A
OF-WTWI-1984-33	Porosity Distribution Trends in Wolfcamp Strata of the Palo Duro Basin, Texas Panhandle--Implications for Ground-Water Flow through Lower Permian and Deep-Basin Aquifers Topical Report Conti & Wirojanagud	11-5-84	11-5-84	N/A
OF-WTWI-1984-52	Hydrology of an Evaporite Aquitard: Permian Evaporite Strata, Palo Duro Basin, Texas (332GP) Hydrogeochemistry Kreitler, Fisher, Senger, Hovorka & Dutton	11-15-84	11-15-84	N/A
OF-WTWI-1984-55	Structural Geology and Tectonic History of the Palo Duro Basin, Texas Panhandle (332GM) D. Tectonic History - Faulting History; O. Tectonic Framework; Q. Tectonic History - Folding History; S. Faulting History - Overview of Faulting; and T. Tectonic History - Long-Term Regional Stability with Respect to Tectonic and Geologic Processes	12-21-84	12-21-84	N/A

OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-54	Hydrodynamic Development of the Palo Duro Basin and Other Mechanisms Creating Possible Transient Flow Conditions (332GN G) Principal Ground-Water Flow Paths Senger	1-18-85	12-18-84	N/A
OF-WTWI-1984-53	Reconstruction of the Late Quaternary Paleoclimate of Northwestern Texas -- Progress Report, 1984 (332GM J) Paleoclimatology Caran	1-28-85	12-19-84	N/A
OF-WTWI-1985-1	Radiocarbon Age of Quarternary Deposits, Western Rolling Plains of Texas (332GM A.) Milestone Report Caran and Baumgardner	1-30-85	1-30-85	N/A
OF-WTWI-1985-2	Hydrogeology and Hydrochemical Facies of the San Andres Formation in Eastern New Mexico, West-Central Texas, and the Texas Panhandle Topical Report Dutton and Orr	2-6-85	2-6-85	N/A
OF-WTWI-1985-3	Hydrologic Testing in the Salt-Dissolution Zone of the Palo Duro Basin, Texas Panhandle Topical Report Dutton and others	2-13-85	2-13-85	N/A
OF-WTWI-1985-4	Evaluation of Numerical Codes for Fracture Flow Modeling (332GN A.) Milestone Report Senger	2-22-85	2-22-85	N/A

OPEN-FILED REPORTS

OF #	Title, Report Type, Author	Date Submitted to DOE	Date Open-Filed
OF-WTWI-1985-5	Initial Results of the Wolfcamp Pilot Study (332GP A.) Milestone Report Posey, Fisher and Tweedy	2/28/85	2/28/85
OF-WTWI-1985-7 31 pgs x .10 = 3.10 11 ft x 1.15/ft = 12.65 b 15.75 + ship	Structure Control of the Development of the Canadian River Valley, Texas Panhandle: An Example of Regional Salt Dissolution and Subsidence (332GM B.) Milestone Report Gustavson	3/7/85	3/7/85
OF-WTWI-1985-8	Summary Well Report Supplements (No. 1 Rex White, No. 1 Grabbe, No. 1 Sawyer, No. 1 Mansfield, No. 1 J. Friemel, No. 1 G. Friemel, No. 1 Detten, No. 1 Harman, No. 1 Zeeck, No. 1 Woods-Holtzclaw) (332FG H) Milestone Report WTWI Staff	3/8/85	3/8/85
OF-WTWI-1985-6	The Pre-Pennsylvanian of the Palo Duro Basin, Texas Panhandle: Stratigraphy and Petroleum Potential Topical Report Ruppel	3/11/85	3/11/85
OF-WTWI-1985-9 171 pgs x .10 17.10 57 ft x 1.15/ft 65.55 82.65	Stratigraphy of Bedded Halite in the Permian San Andres Formation, Units 4 and 5, Palo Duro Basin, Texas Topical Report Hovorka, Luneau and Thomas	4/3/85	4/3/85

OPEN-FILED REPORTS

OF #	Title, Report Type, Author	Date Submitted to DOE	Date Open-Filed
OF-WTWI-1984-8 Revision 1	Numerical Modeling of Regional Ground-Water Flow in the Deep-Brine Aquifers of the Palo Duro Basin, Texas Panhandle Topical Report Wirojanagud, Kreitler, and Smith	4-18-85	4-18-85
OF-WTWI-1985-10	The Internal Structure of Model and Natural Salt Domes - Experimental Modeling of Salt Diapirs: Final Report (332HE E) Final Report of Conclusions CSR Jackson and Talbot	4-23-85	4-23-85
OF-WTWI-1984-33 Revision 1	Wolfcampian Series Porosity Distribution: Implications for Deep-Basin Ground-Water Flow in the Palo Duro Basin, Texas Panhandle Topical Report FY85 Milestone (332GN, Subtask V, B) Conti, Senger, Wirojanagud, Herron	5-20-85	5-20-85
OF-WTWI-1984-21 Revision 1	Cyclicity in the Middle Permian San Andres Formation, Palo Duro Basin, Texas Panhandle Topical Report FY85 Milestone (332GP, Subtask II, A, Fracasso and Hovorka	6-20-85	6-20-85
OF-WTWI-1983-3 Revision 1	Fracture Analyses of the Palo Duro Basin Area, Texas Panhandle and Eastern New Mexico Topical Report Collins and Luneau	7-29-85	7-29-85

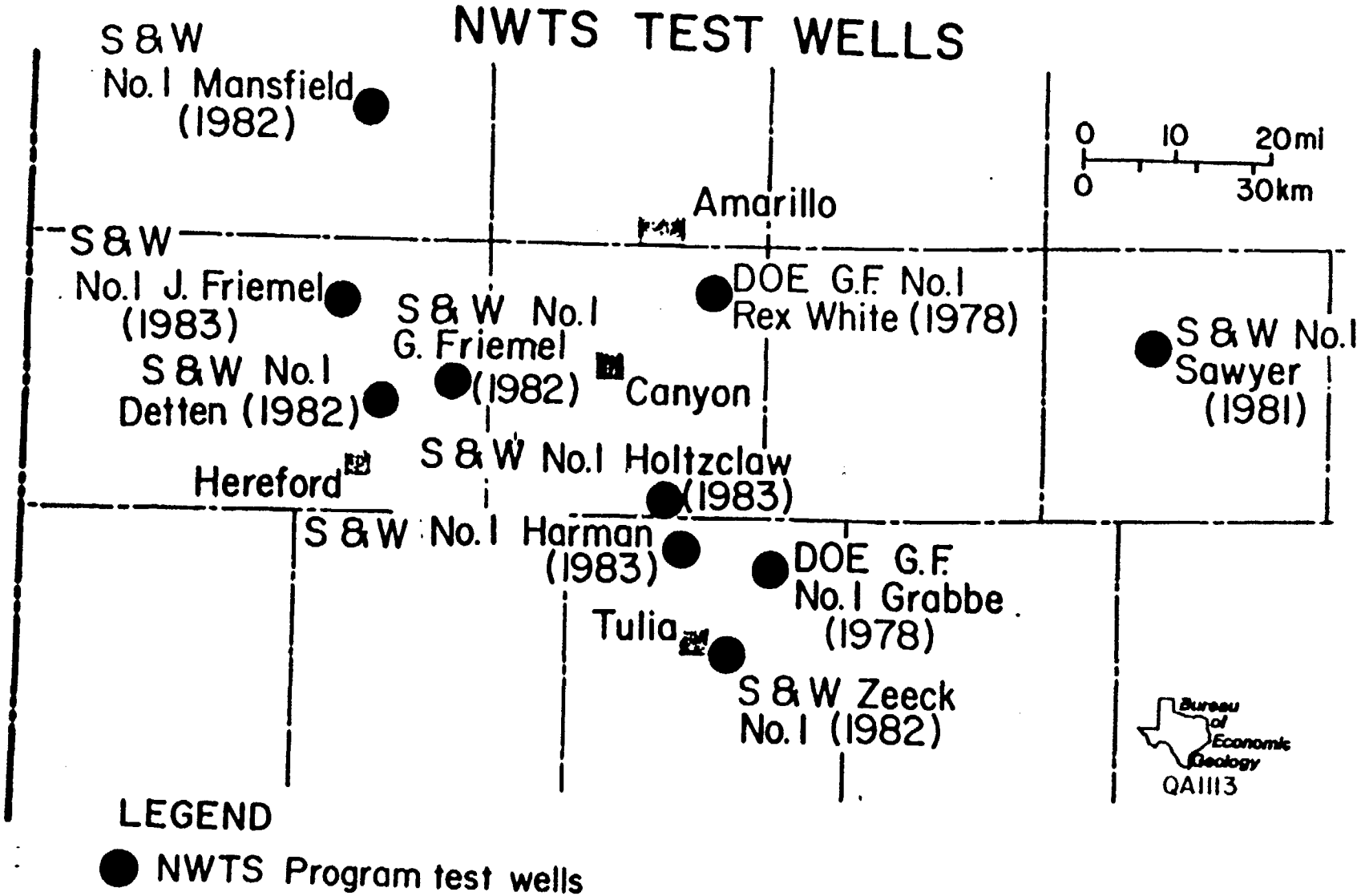
Kreitler 8/7

The Bureau of Economic Geology
The Univeristy of Texas at Austin

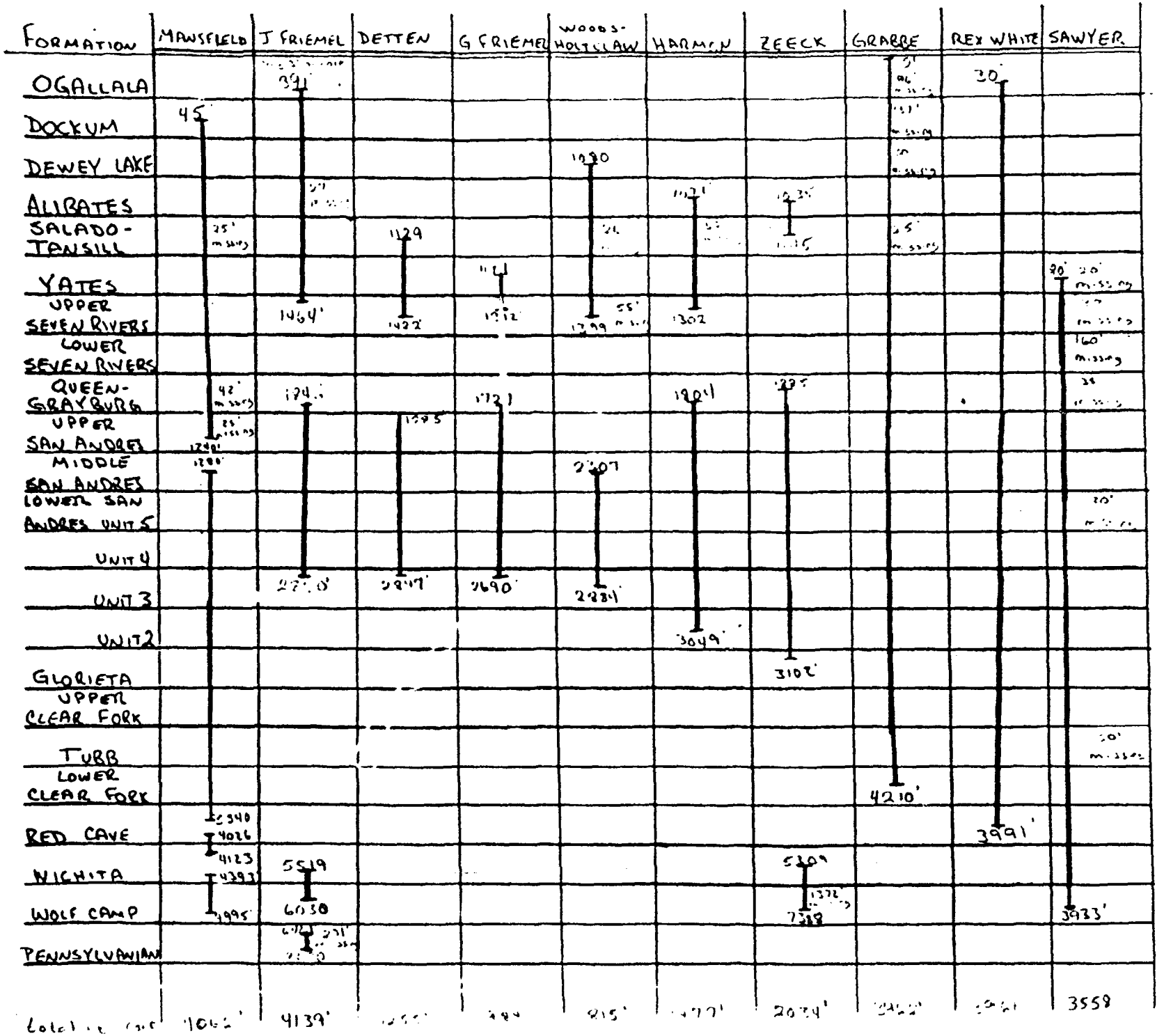
Status of Reports in Hydrology-Geochemistry,
West Texas Waste Isolation

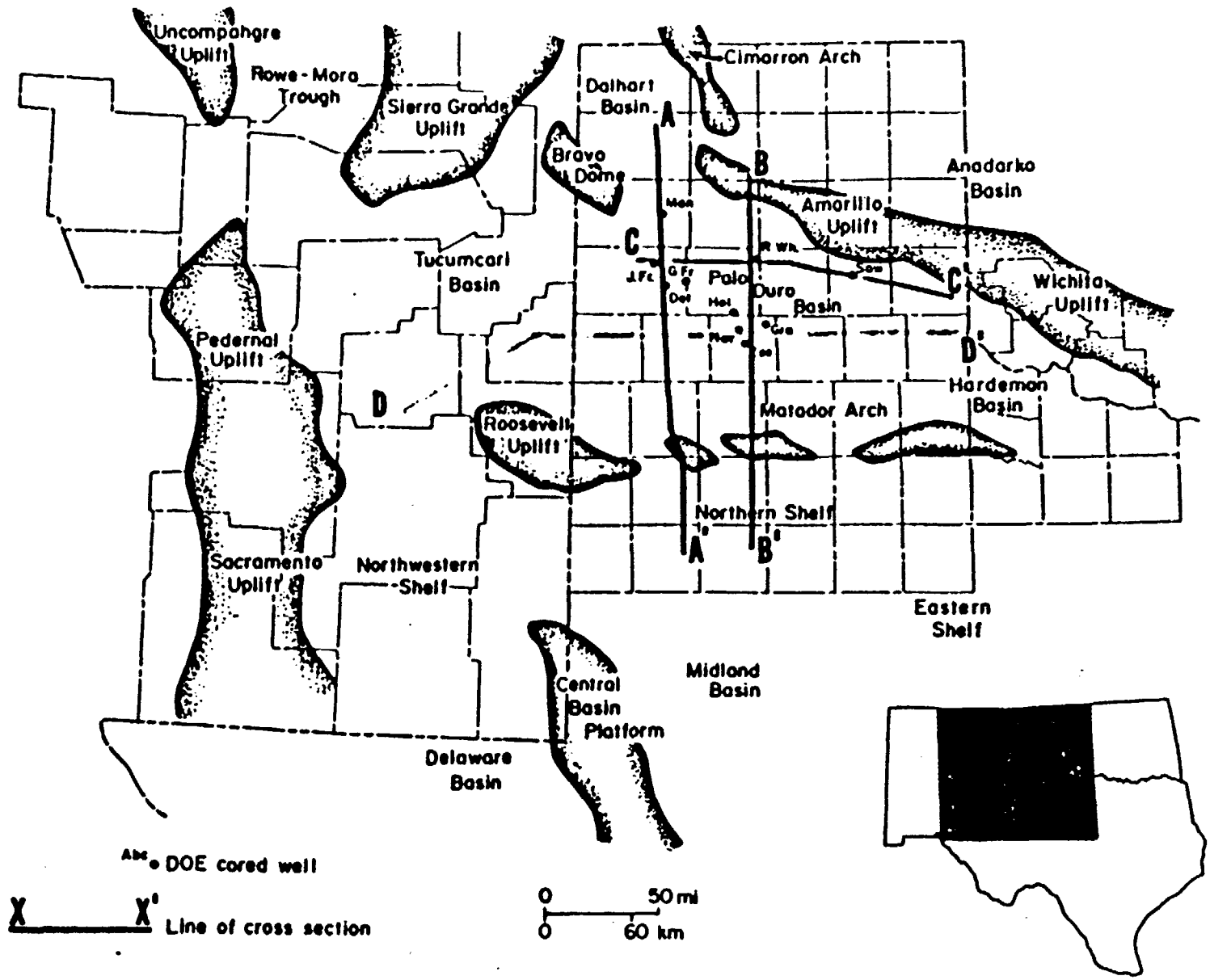
1. Modeling of hypothetical fracture flow, Palo Duro Basin, (Senger) in BEG review
2 Cross-sectional modeling of steady-state and transient ground water flow in the Palo Duro Basin, (Senger) In BEG review
3. Areal modeling of ground-water flow in the Deep-Basin Brine Aquifers, Palo Duro Basin, (Wirojanagud) In DOE review
4 Hyc ıogy of Deep-Basin Brine aquifer, (Smith) In BEG review
5. Geochemistry of Deep-Basin Brines, (Fisher) completed this fall
6. Pressure/Depth relationships within Deep-Basin Brine aquifer, (Orr) published, in press
7 Geochemistry of the Wolfcamp, (Posey) completed this fall
8 Permeability from core analysis, (Senger) ongoing
9 Geochemistry of San Andres Halite, (Br chemistry, water content)(Fisher) responding to DOE comments
10 Clay mineralogy in the evaporite strata (Palmer report, in TBEG review), (Fisher, completed this fall)
11 Hydrogeology of the San Andres Carbonates, (Dutton) DOE review
12 Hydrogeology of dissolution zone, Sawyer and Mansfield wells (Dutton) BEG Open-File Report
13 Hydrogeology of the Dockum aquifer, (Dutton) in TBEG review
14. Hydrogeology of the Ogallala aquifer, (Nativ) first year status report in TBEG review

Havorka handouts


NWTS TEST WELLS
S&W
No. 1 Mansfield
(1982)
0 10 20mi
0 30km
Amarillo
S&W
No. 1 J. Friemel
(1983)
S&W No. 1
G. Friemel
(1982)
DOE G.F. No. 1
Rex White (1978)
S&W No. 1
Sawyer
(1981)
S&W No. 1
Detten (1982)
Canyon
Hereford
S&W No. 1 Holtzclaw
(1983)
S&W No. 1 Harman
(1983)
DOE G.F.
No. 1 Grabbe
(1978)
Tulia
S&W Zeeck
No. 1 (1982)
Bureau of Economic Geology
QA1113
LEGEND
NWTS Program test wells

CORED INTERVALS




Uncompahgre Uplift
Rowe-Mora Trough
Sierra Grande Uplift
Cimarron Arch
Dalhart Basin
Bravo Dome
Anadarko Basin
Amarillo Uplift
Tucumcari Basin
Palo Duro Basin
Wichita Uplift
Pedernal Uplift
Hardeman Basin
Matador Arch
Roosevelt Uplift
Northern Shelf
Sacramento Uplift
Northwestern Shelf
Eastern Shelf
Midland Basin
Central Basin Platform
Delaware Basin
A
B
C
D
A'
B'
C'
D'
Abc DOE cored well
X X' Line of cross section
0 50 mi
0 60 km

SYSTEM	SERIES	GROUP	Palo Duro Basin FORMATION	Dalhart Basin FORMATION	General Lithology and depositional setting
QUATERNARY	HOLOCENE		alluvium, dune sand Playa	alluvium, dune sand Playa	
	PLEISTOCENE		Tahoka "cover sands" Tule Blanco	"cover sands"	Lacustrine clastics and windblown deposits
TERTIARY	NEOGENE		Ogallala	Ogallala	Fluvial and lacustrine clastics
CRETACEOUS			undifferentiated	undifferentiated	Marine shales and limestone
TRIASSIC		DOCKUM			Fluvial-deltaic and lacustrine clastics
PERMIAN	OCHOA		Dewey Lake	Dewey Lake	Cyclic sequences: shallow-marine carbonates; hypersaline-shelf anhydrite, halite; continental red beds
			Alibates	Alibates	
	GUADALUPE	ARTESIA	Salado/Tansill	Artesia Group undifferentiated	
			Yates		
			Seven Rivers		
			Queen/Grayburg		
			San Andres	Blaine	
	LEONARD	CLEAR FORK	Glorieta	Glorieta	
			Upper Clear Fork	Clear Fork	
			Tubb	undifferentiated Tubb-Wichita Red Beds	
			Lower Clear Fork		
			Red Cave		
		WICHITA			
	WOLFCAMP				
?			?	?	
PENNSYLVANIAN	VIRGIL	CISCO			Shelf and shelf-margin carbonate, basinal shale, and deltaic sandstone
	MISSOURI	CANYON			
	DES MOINES	STRAWN			
	ATOKA	BEND			
	MORROW				
MISSISSIPPIAN	CHESTER				Shelf carbonate and chert
	MERAMEC				
	OSAGE				
ORDOVICIAN		ELLENBURGER			Shelf dolomite
CAMBRIAN ?					Shallow marine(?) sandstone
PRECAMBRIAN					Igneous and metamorphic

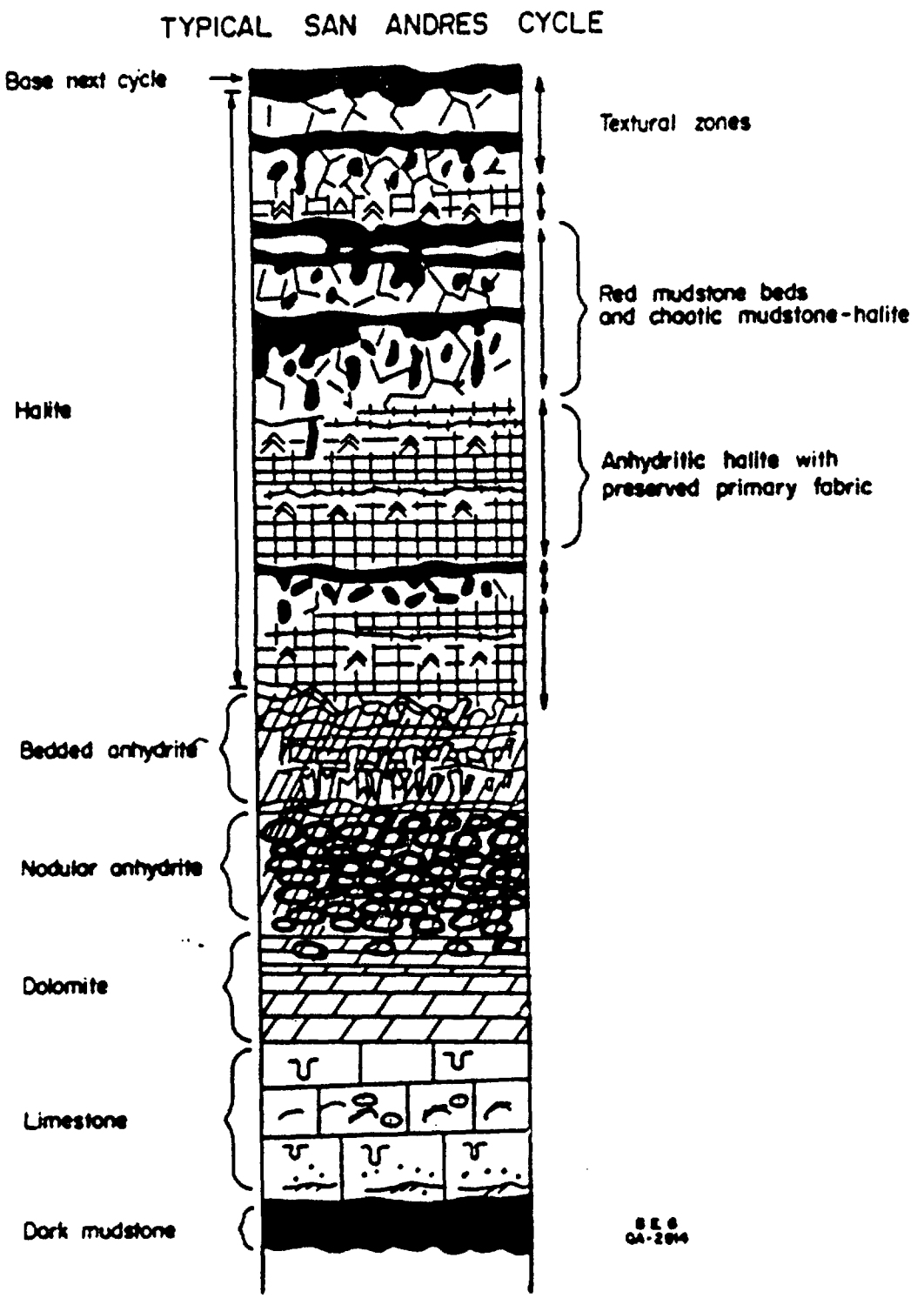
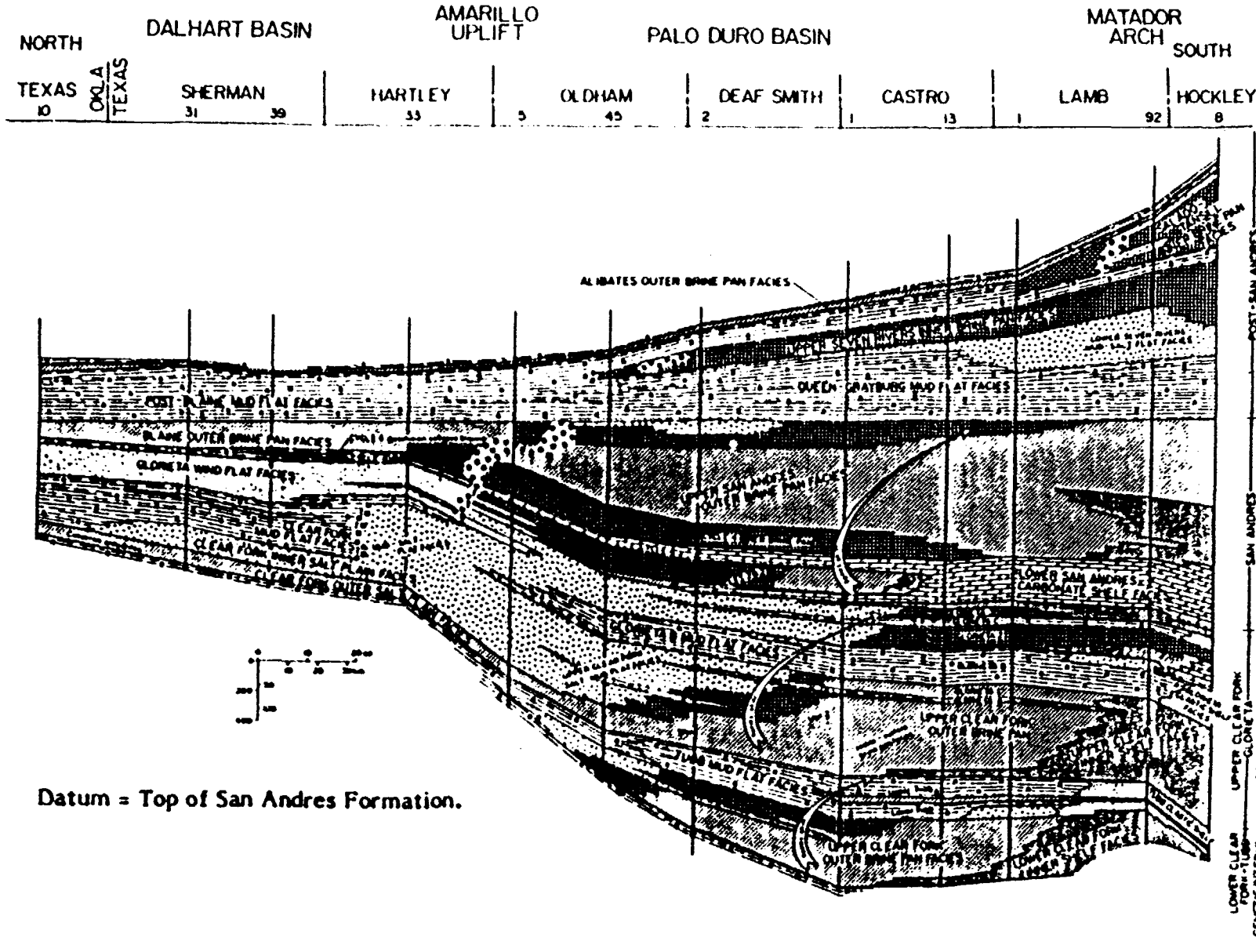
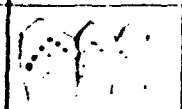
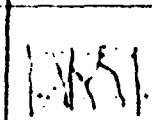
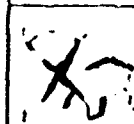
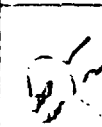
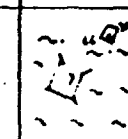
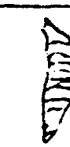

TYPICAL SAN ANDRES CYCLE
Base next cycle
Textural zones
Red mudstone beds and chaotic mudstone-halite
Halite
Anhydritic halite with preserved primary fabric
Bedded anhydrite
Nodular anhydrite
Dolomite
Limestone
Dark mudstone
BEG 0A-2914

figure 2



Datum = Top of San Andres Formation.

Table 3 Textural classification of halite with genetic significance.

Symbol		A	B	C	D	E	F	G	H	I
halite type		chevron halite rock	color banded/ vertically oriented halite rock	C reserved for another primary fabric not yet recognized	chaotic mudstone-halite rock	[illegible] muddy halite rock	[illegible] anhydritic halite rock	displacive halite in other sediments	halite cavity-filling cement	fibrous fracture-filling halite cement
halite crystal size		0.5-5 cm tall	0.5-5cm tall		0.1 to 1 cm	1-5 cm	1-5 cm	0.5-3 cm	1 to 20+ cm	.3 to 1 cm
halite crystal shape		subvertical mosaic; L:W= 3:2 to 4:1	subvertical mosaic; L:W= 3:2 to 4:1		equant anhedral to euhedral crystals	equant mosaic	equant mosaic	euhedral cubes or hopper shapes	equant mosaic	fibrous
impurities	composition	anhydrite common; mudstone possible	anhydrite, mudstone, organic-[illegible]		mudstone, minor anhydrite	mudstone, minor anhydrite	anhydrite	mudstone; also dolomite, anhydrite	cavity filling halite is clean but is associated with mudstone and anhydrite insoluble residues	trace of hematite present as coloring agent, otherwise pure halite
impurities	%	<1%-5%	1%-5%		10-50%	1-10%	1-25%	50-99%		
impurities	location	anhydrite on grain boundaries, partings, mudstone only in pipe fills	within and between grains, along partings, in pipes		in masses between halite crystals, some also within grains	within grains, minor between grains	along partings, grain boundaries	matrix for halite		
fluid inclusions		abundant, small define relict growth faces	varied		few	varied	varied	few	large and abundant	?
associated with halite types		F along crystal boundaries and pipes, H and/or D in pipes	F & E, H and/ or D in pipes		mudstone beds typically includes remnant B halite	may contain remnant A,B, possible H	may contain remnant A,B possible H	non-halite rocks	all halite types	in non-halite rocks
identifying characteristics		minute fluid inclusions along relict halite growth faces	bedding and/ or vertical orientation of crystals		10-50% mudstone in intercrystalline masses, chaotic texture	halite colored red brown or black by 1-10% impurities, no bedding	halite with 1-25% anhydrite, [illegible], no bedding	euhedral to subhedral halite crystals in sediments	exceptionally coarse clear crystals, fill cavity in other salt type	fibrous halite in fracture, many examples red colored
sketch										

Key to detailed logs, San Andres units 4 and 5 halite

Column 1 Depths in feet below kelly bushing

PC indicates point count of 100 points over 1 foot interval of slabbed core to check estimated percent lithology.

+ and * indicate sampled interval, core not available during detailed logging and checking.

* indicates sample logged by BEG and a detailed description available in BEG files.

+ indicates sample logged, but no detailed description.

Intervals sampled before BEG logging are labeled as "sampled" in column 2

Column 2 Estimated percent lithology

Mineral Composition

Carbonate Components

G Grainstone
P Packstone
W Wackestone
M Mudstone

Carbonate Components (continued)

- o oolites or coated grains
- intraclasts
- fossiliferous (general)
- molluscs
- o crinoids
- forams
- brachiopods
- A phylloid algae
- coral

Column 3 Structures

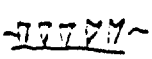
Sketch of structures in left half of column; interbeds of one lithology in another extend 3/4 of column width; boundaries between lithologies drawn across entire column width.

Halite

- chevrons
- vertically oriented crystals
- dark bands
- pipe, pits (show residue at bottom)
- anhydrite
- chaotic mud salt
- recrystallized halite
- exceptionally coarse halite
- mudstone interbed
- anhydrite interbed
- discontinuous mudstone interbed
- discontinuous anhydrite interbed
- nonhorizontal bedding

Column 3 Structures (continued)

Anhydrite

 gypsum pseudomorphs

 bedding (schematic)

 contorted bedding

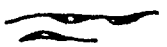
 nodular

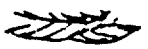
* crystallotopic

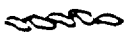
Carbonates

 bedding, scour surface

 wispy lamination

 ripple lamination

 cross beds

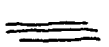
 intraclasts

: coarse grainstone

 burrows

 stylolites

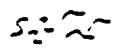
Clastics

 lamination

 burrows

 ripple lamination

 disturbed intraclastic fabric

 more disturbed

 cross bedding

 dissipation structures

Column 3 Structures (continued)

General

 boudinage

 mudcracks

 clasts

 faulting

 fractures

 birdseye-fabric

 contorted alminae.

 displacive halite hoppers

 skeletal displacive halite

 filled fracture

 nodules (note composition)

 crystallotopic anhydrite in other lithologies

Column 4 Comments

A. At left edge letters A through F indicate halite rock types.

Halite Types

A bedded halite with chevron fluid inclusions

B bedded halite with vertically oriented crystals

D chaotic mudsalt

E recrystallized muddy halite

F recrystallized halite with interstitial anhydrite

G displacive halite in sediment

H coarse recrystallized cavity fill halite

I fibrous fracture fill

See table and text for description of halite classification.

B. Location, irregularity and estimated continuity of mudstone and anhydrite interbeds in halite.

mudstone

anhydrite

irregular base, flat top

discontinuous beds

C. Comments on interbeds

M indicates mudstone

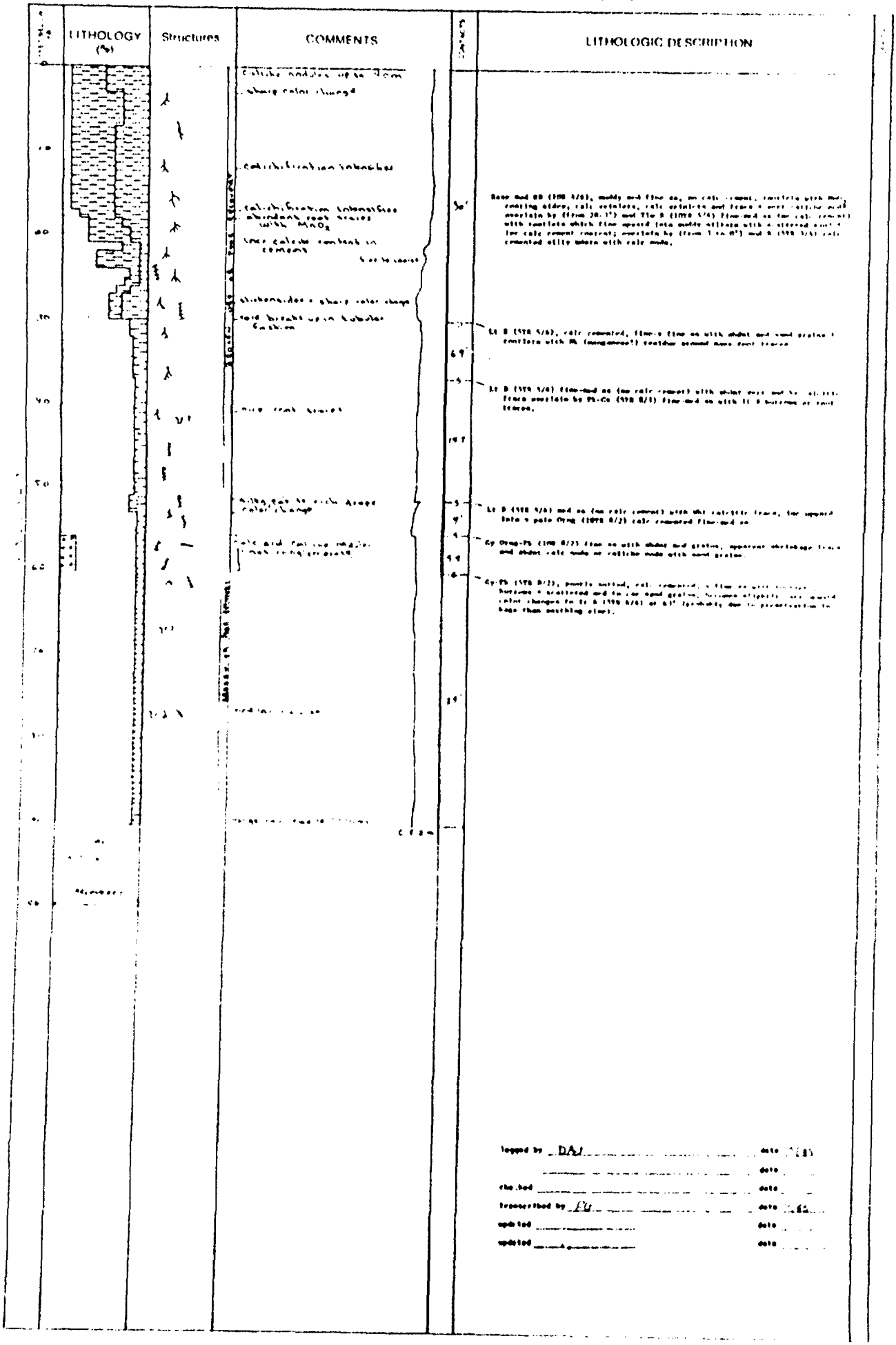
A indicates anhydrite ≠ indicates siltstone

bed thickness shown

5A indicates 5 anhydrite interbeds too closely spaced to show individually, estimated percent impurities shown.

WELL # 1 GRABBE COUNTY SUBLETTE DATE 5/85

INTERVAL 0 100 LOGGED BY DAJ



logged by DAJ date 5/85

date

checked date

transcribed by DJ date 5/85

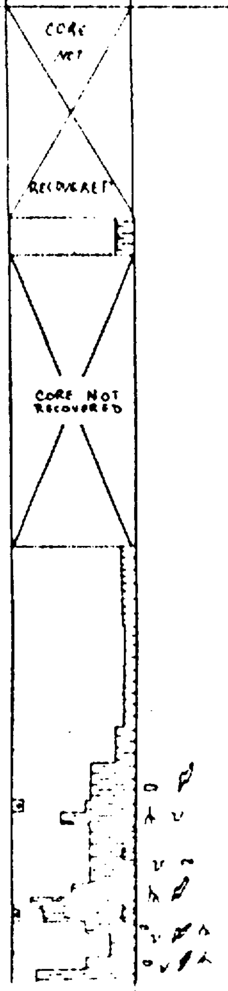
updated date

updated date

WELL #1 GRABBE | COUNTY SWISHER | DATE 5/85

INTERVAL 100 190 OGALLALA | LOGGED BY DAJ

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
100	CORE NOT RECOVERED				
110					
120			5.5 cm ls fragment	3'	Gy-Orng Pk (5YR 7/2) calc cemented ss, large (3.5 cm) rounded [illegible] to [illegible] at top with some of calichification surrounding it.
130	CORE NOT RECOVERED			24'	
140					Base of caliche and mud rich soil horizon overlain by Gy-Orng Pk (5YR 7/2) silty ss with opal-filled fracs, abdnt calc nods (up to 8 cm), better sorted upward.
150				21	
160			caliche nodules; abundant caliche nodules; [illegible]		
			[illegible]		
			calc nodules; clay [illegible]	6	[illegible] (5YR 5/6) [illegible] overlain by [illegible] (5YR 6/4), [illegible], a little bedding preserved, [illegible] clay clasts (possible [illegible] clasts), opal-filled [illegible], better sorting upward, soil horizon at about [illegible]
170			[illegible]		
			calc nodules	19	
180			[illegible]		



logged by DAJ date 5/85

date

checked date

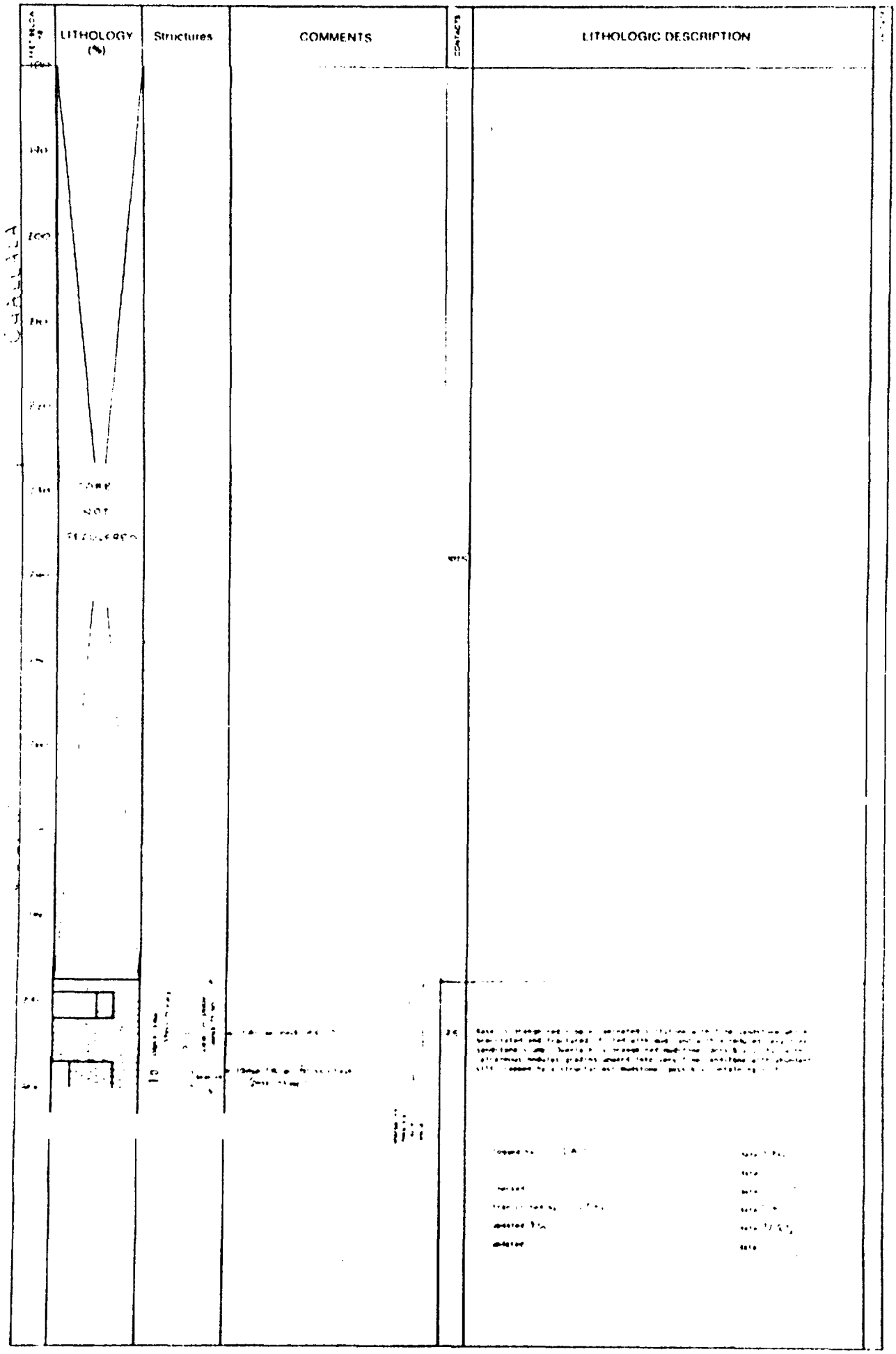
transcribed by [illegible] date [illegible]

updated date

updated date

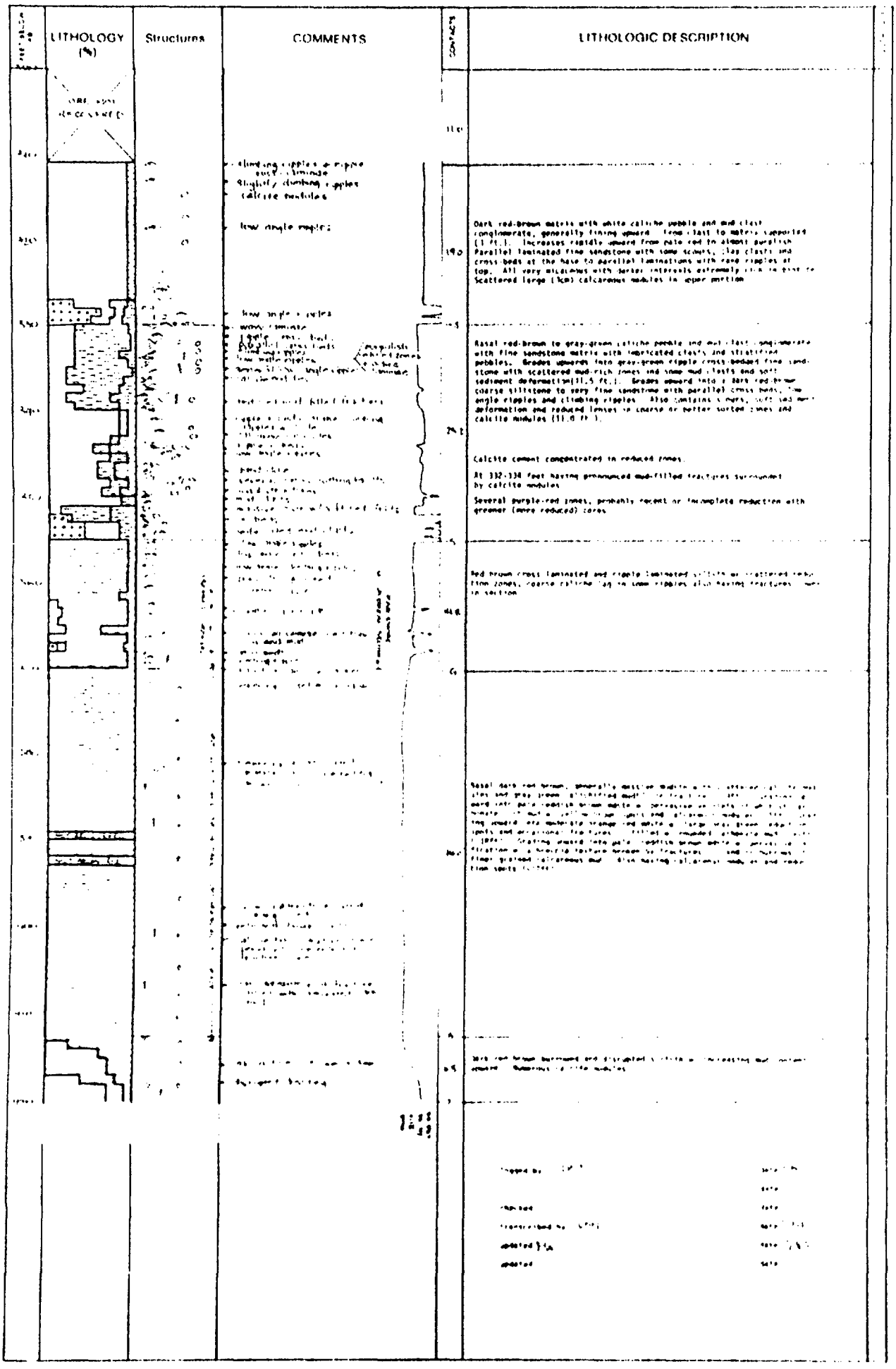
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 180-300' OGALLALA, DOCKUM LOGGED BY DAJ



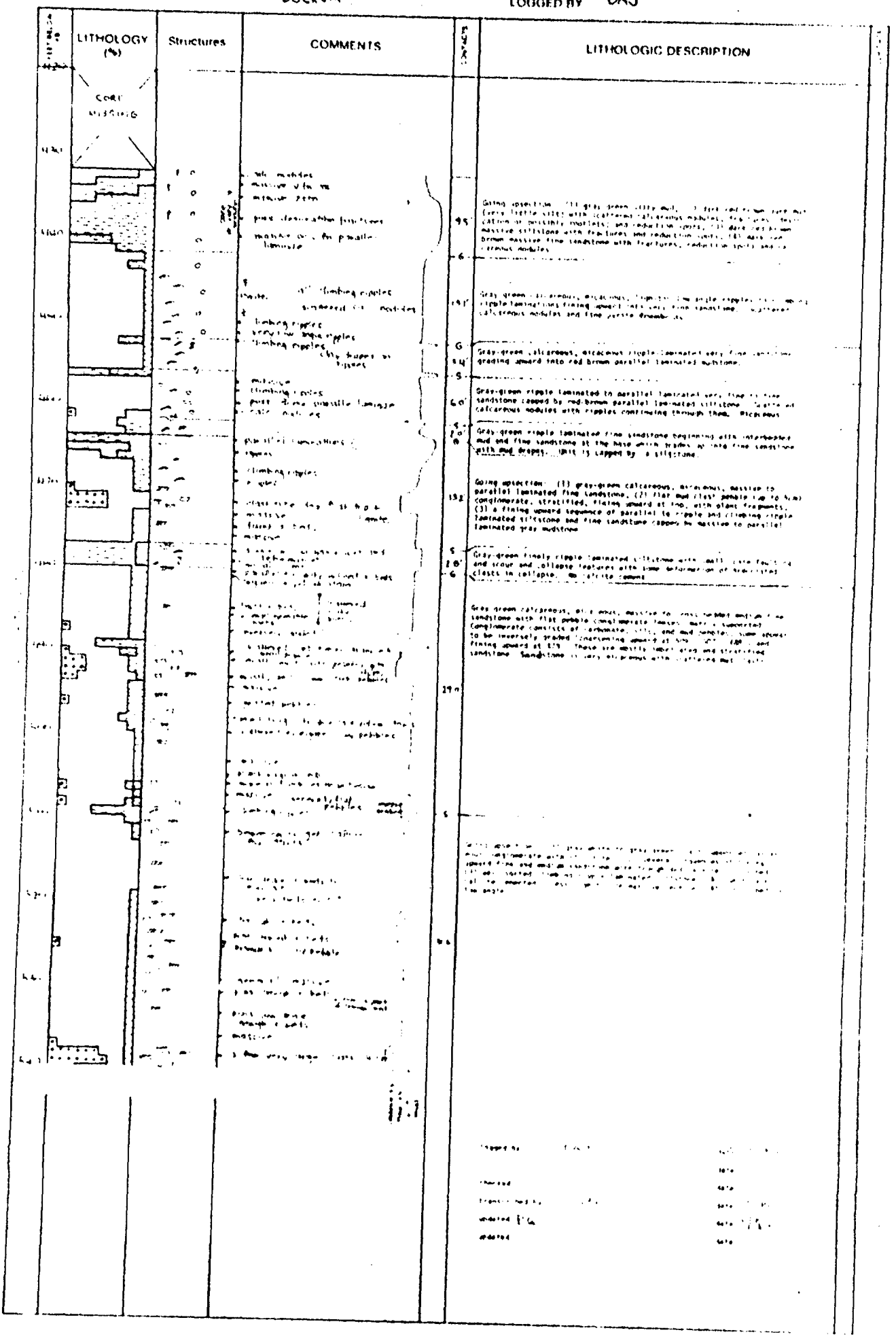
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 300-420' Dockum LOGGED BY DMJ



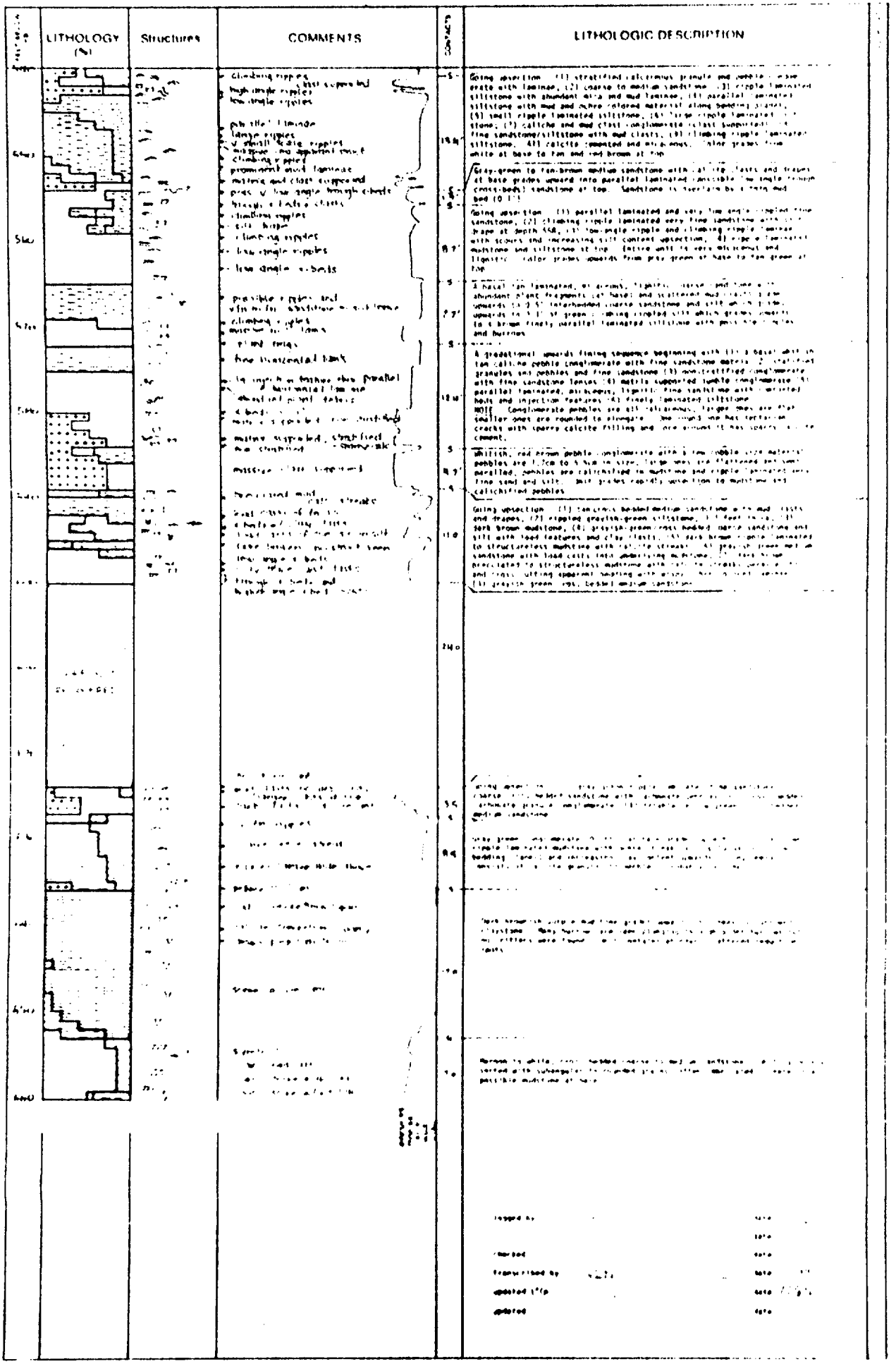
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 420-510' DOCKUM LOGGED BY DAJ



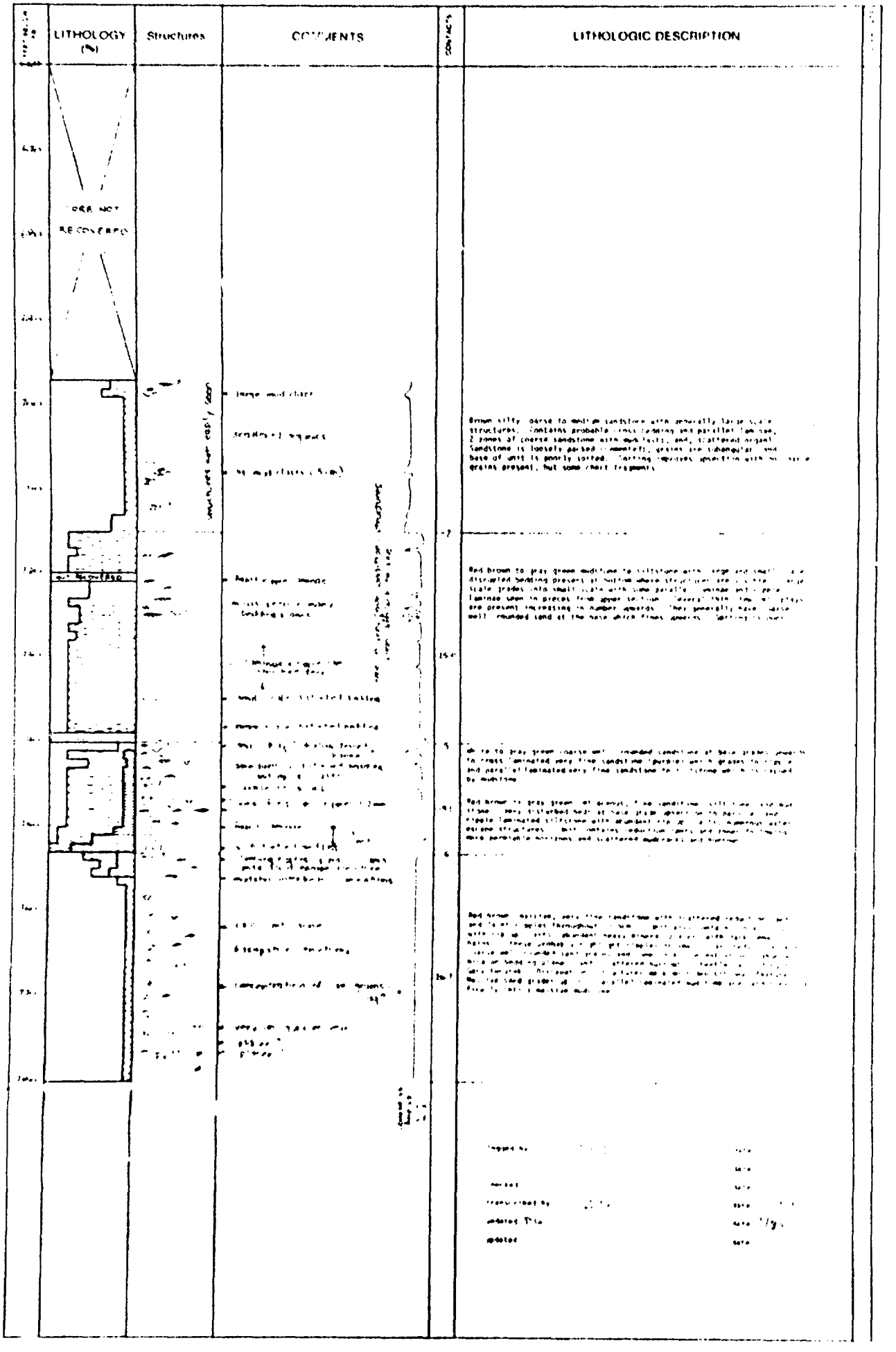
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 540 - 660' LOGGED BY DAJ



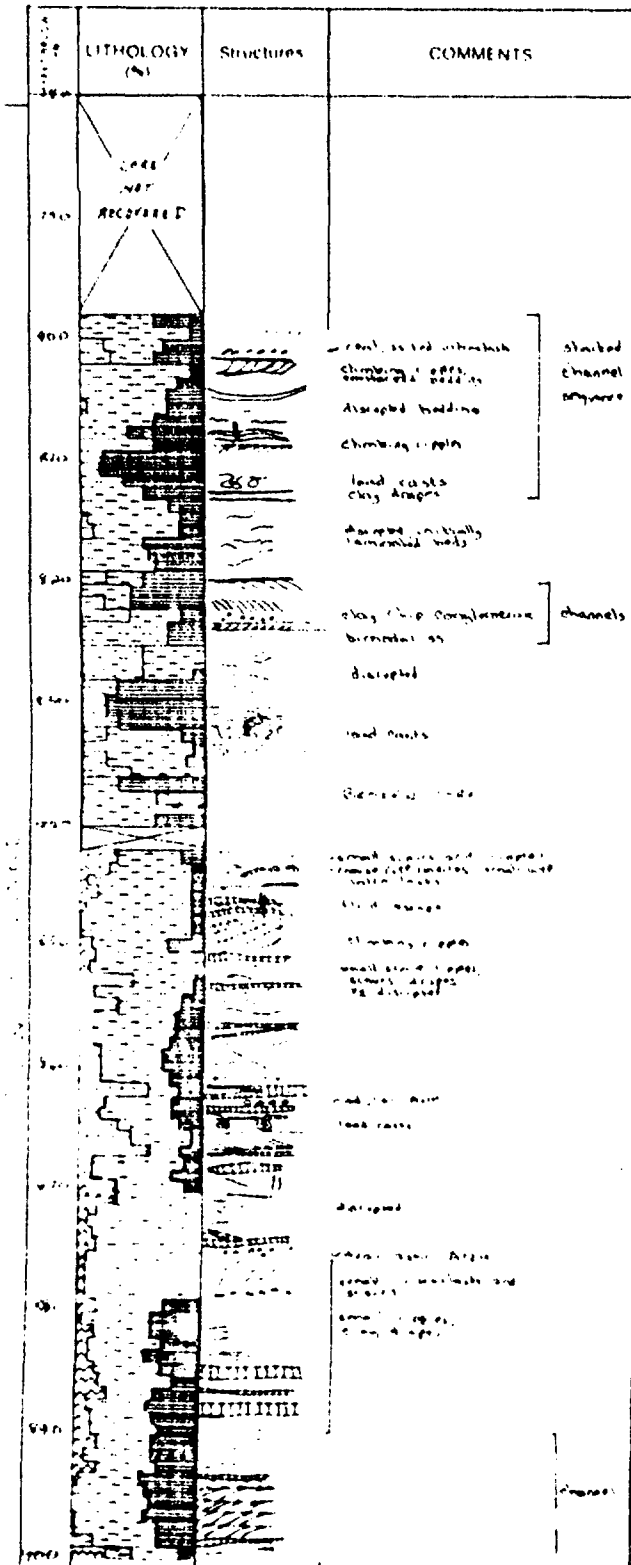
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 660-780' LOGGED BY DAJ



WELL # 1 GRABBE COUNTY SWISHER DATE 3/79

INTERVAL 720 - 900 DEWEY LAKE LOGGED BY WPS, RAM, CS, SH



LITHOLOGIC DESCRIPTION

logged by WPS, RAM, CS, SH date 3/79

date

checked date

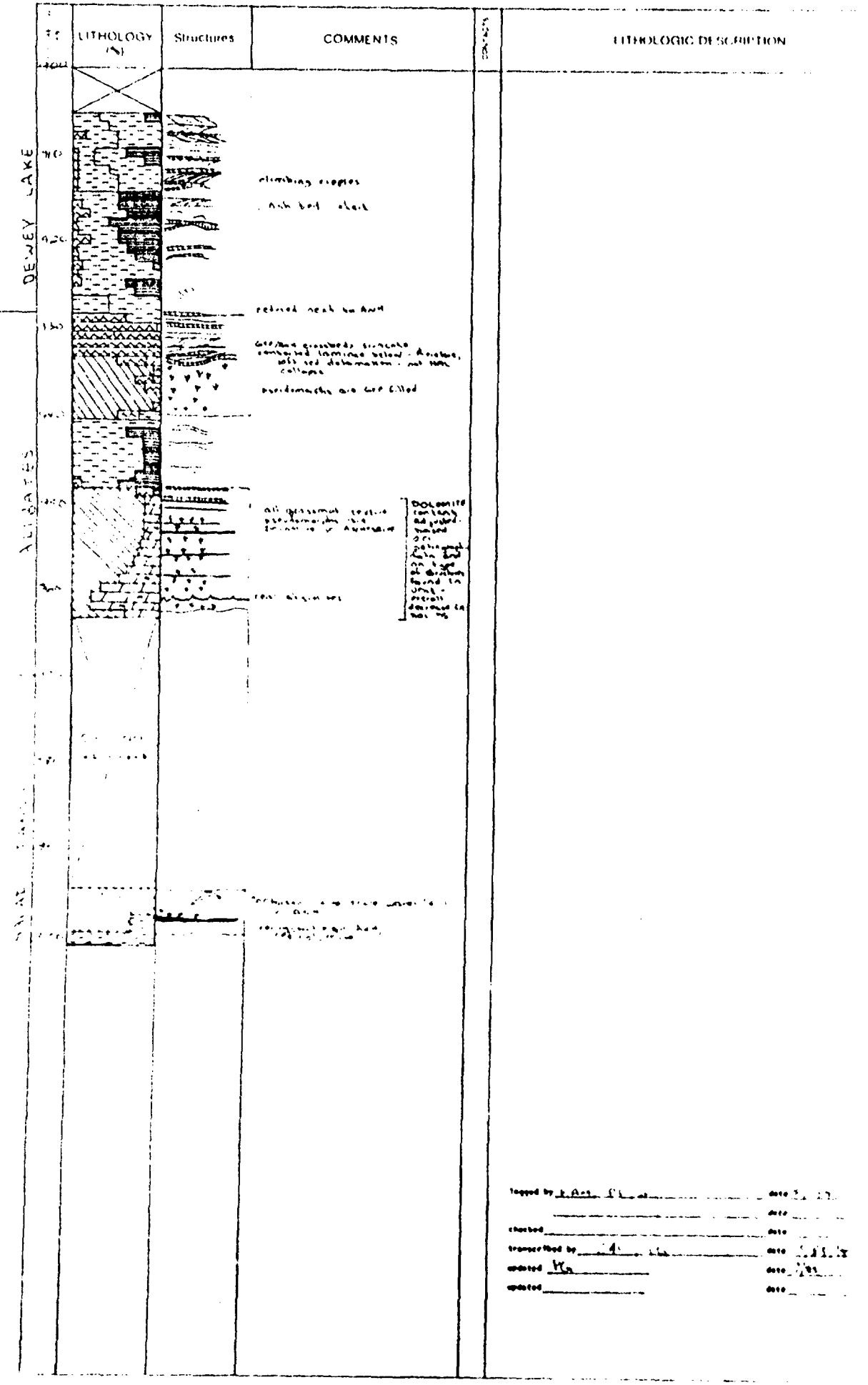
transcribed by CAL date 5/80

updated WPS date 7/81

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 5-24

INTERVAL 900 - 1000 DEWEY LAKE, ALIBATES, SALADO - LOGGED BY KAM, PE, SH



logged by K.A.M. date 5-23

checked date

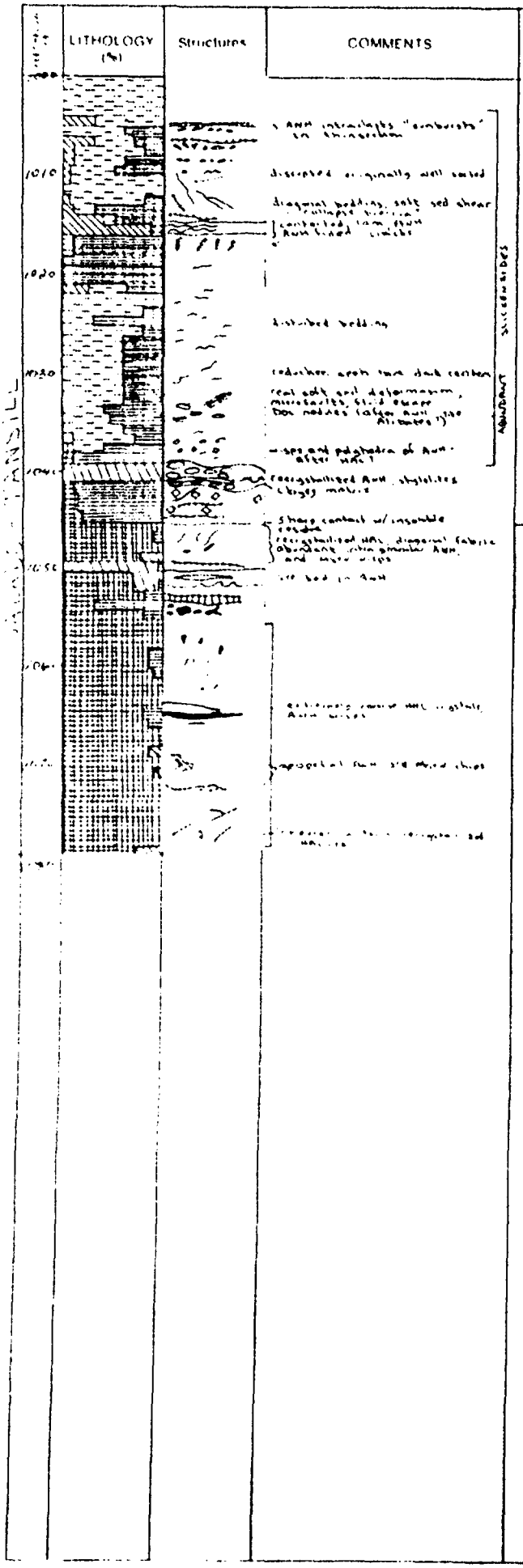
transcribed by date 5-31-84

updated date

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE

INTERVAL 1000'-2079' SALADO-TANSILL LOGGED BY PE, JSM, WES, SW



logged by _____ date _____

_____ date _____

checked _____ date _____

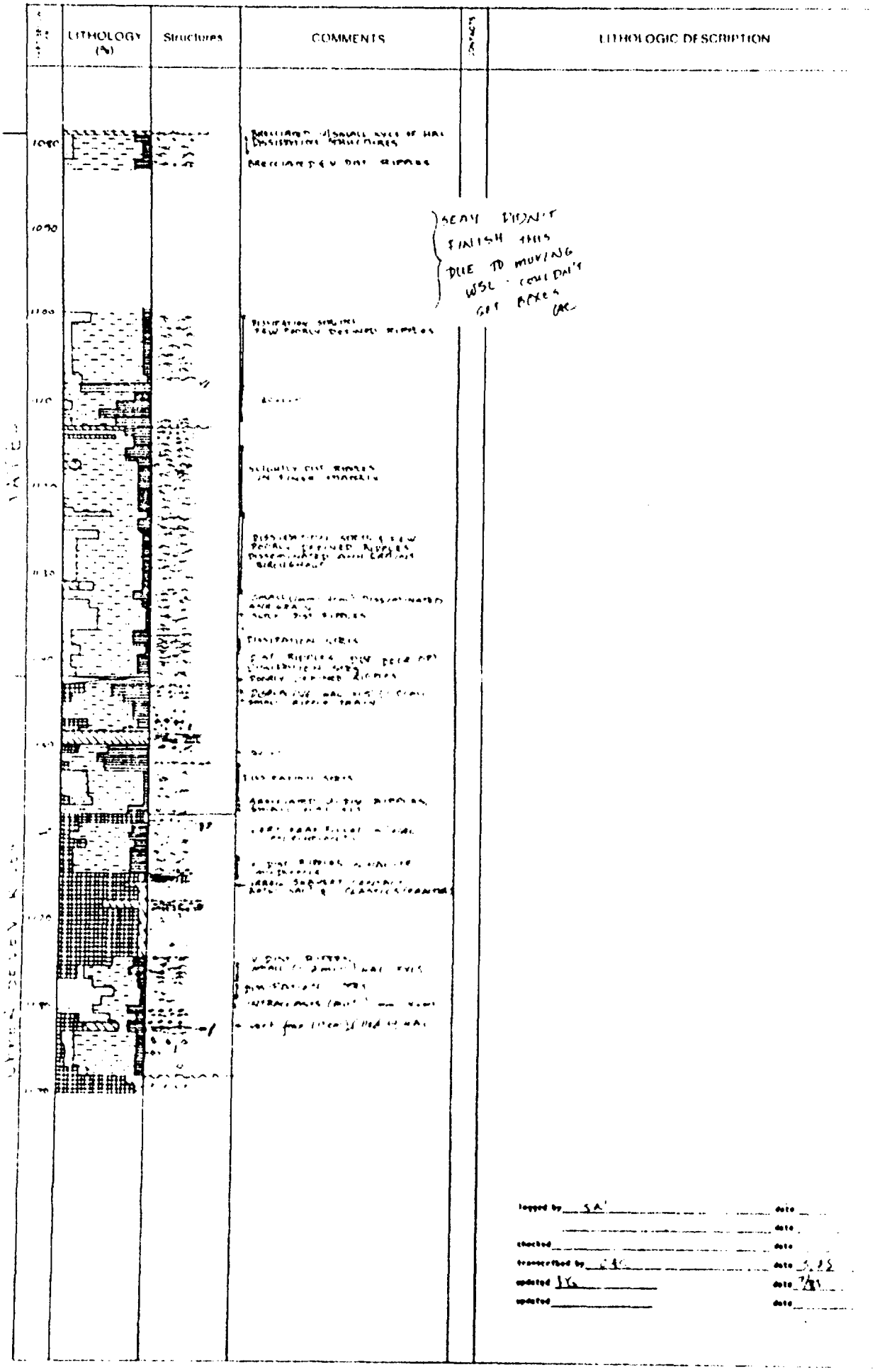
transcribed by _____ date _____

updated _____ date _____

updated _____ date _____

WELL # 1 GRABBE COUNTY SWISHER DATE

INTERVAL 1079 1190 YATES, UPPER SEVEN RIVERS LOGGED BY SA



logged by SA date

date

checked date

transcribed by date 5/15

updated JK date 7/1

updated date

WELL #1 GRABBE COUNTY SWISHER DATE

INTERVAL 1170 - 1260 UPPER SEVEN RIVERS LOGGED BY

DEPTH (FEET)	LITHOLOGY (%)	Structures	COMMENTS	SAMPLES	LITHOLOGIC DESCRIPTION
1170					
1200					
1210					
1220					
1230					
1240					
1250					
1260					

logged by _____ date _____

_____ date _____

checked _____ date _____

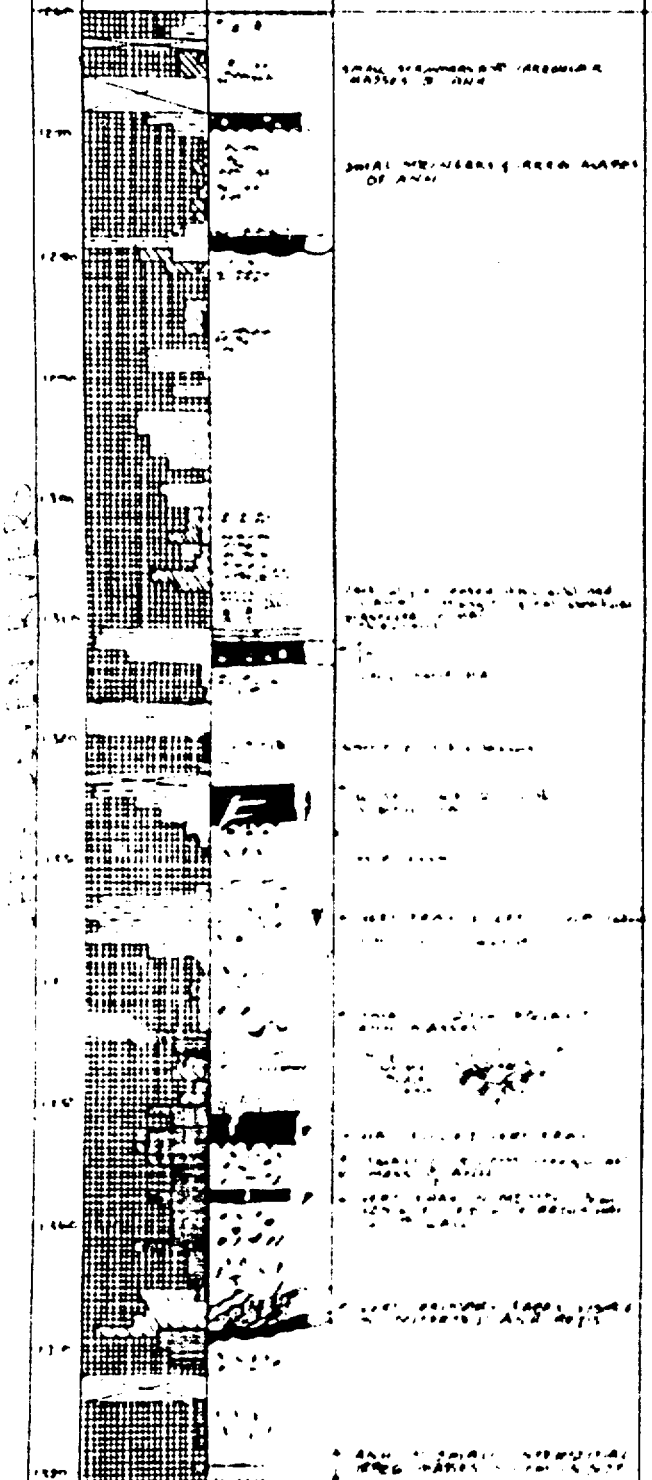
transcribed by 4 Yes date 2.15.2

updated 11 date 12

updated _____ date _____

WELL # 1 GRADBE COUNTY SWISHER DATE 3/83

INTERVAL 1260 - 1381 UPPER SEVEN RIVERS LOGGED BY SW



LITHOLOGIC DESCRIPTION

logged by SW date 3/83

date

checked date

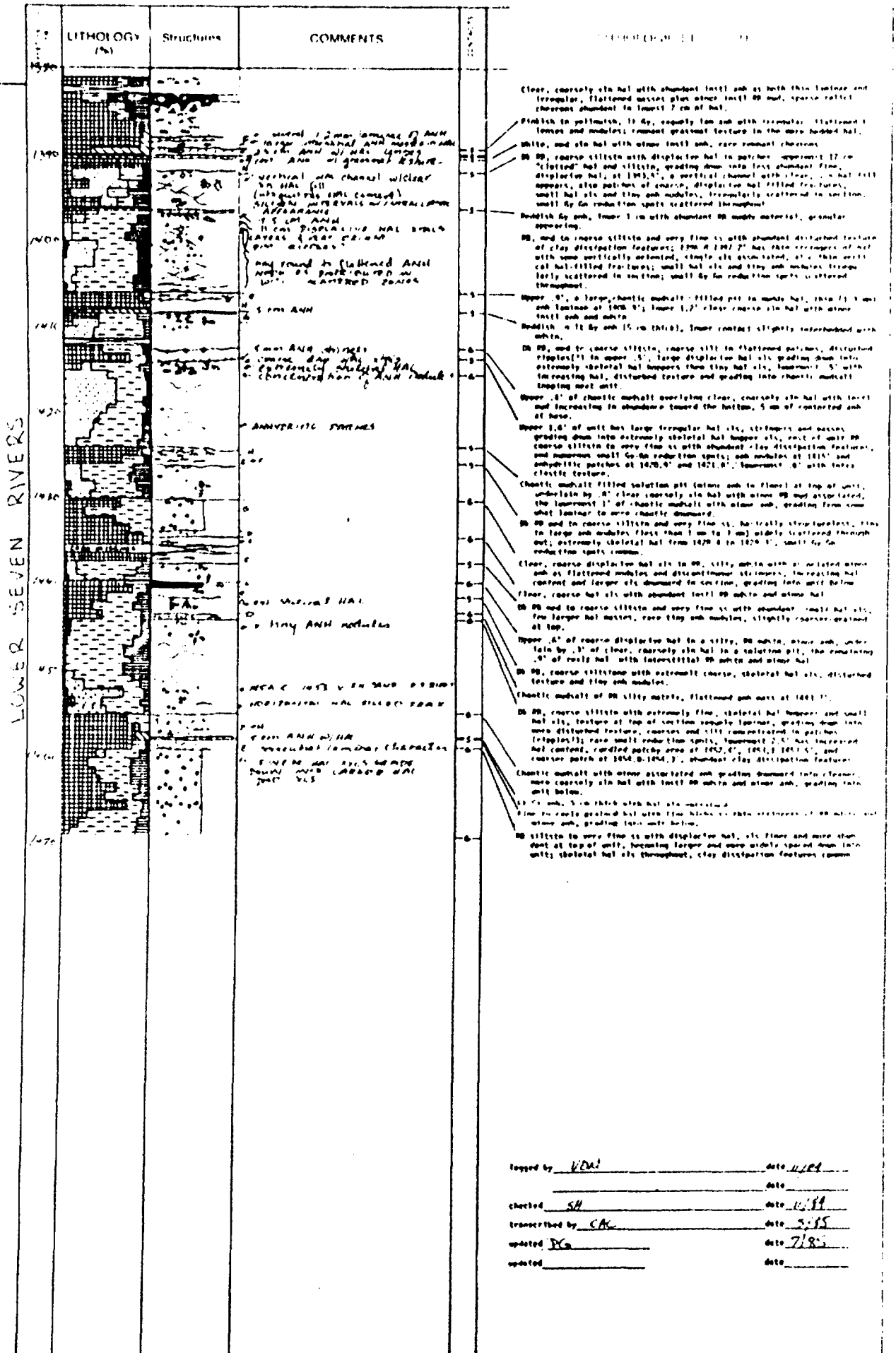
transcribed by SW date 3/83

updated SW date 4/83

updated date

WELL # 1 GRABBE COUNTY SWISHER

INTERVAL 1371 - 1469 LOWER SEVEN RIVERS



logged by VDM date 11/84

date

checked SH date 12/84

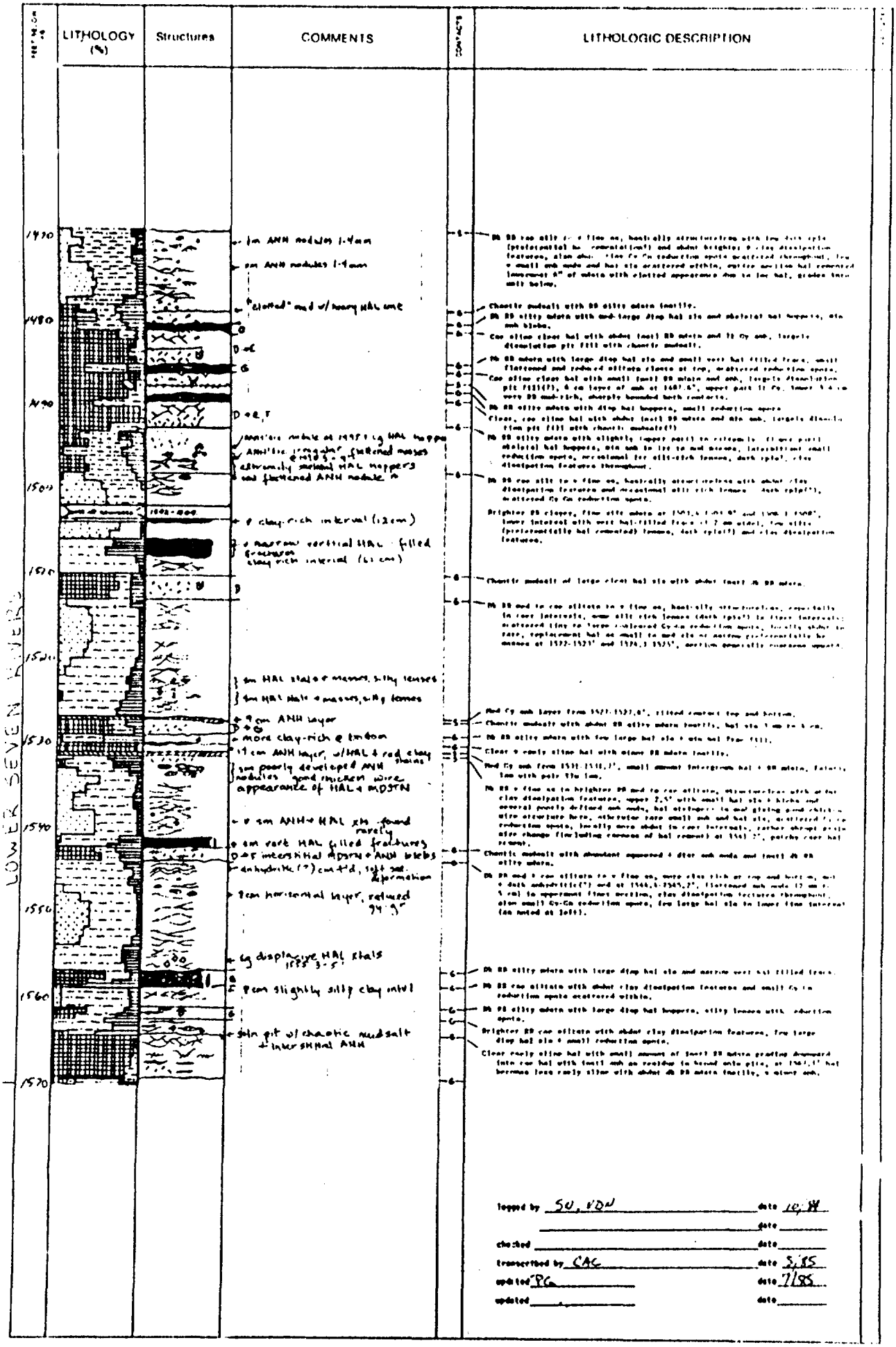
transcribed by CAC date 5/85

updated PG date 7/85

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 10/84

INTERVAL 1469' - 1570' LOWER SEVEN RIVERS LOGGED BY SW, VN



logged by SW, VDW date 10/84

date

checked date

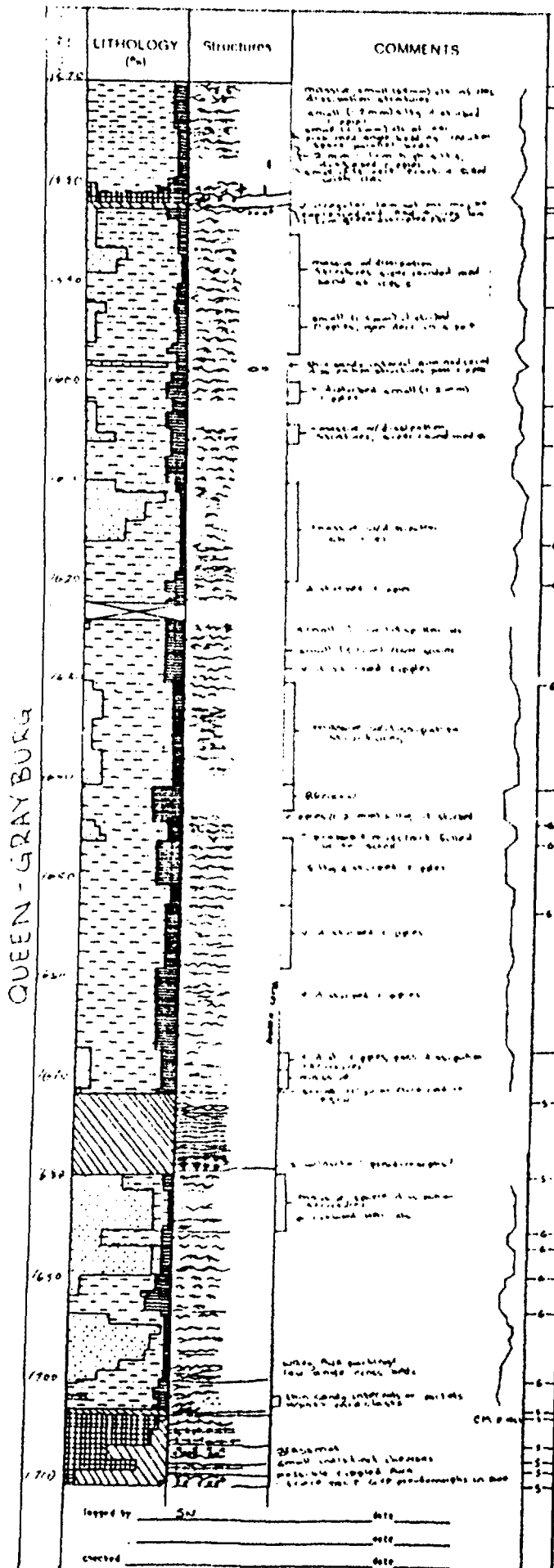
transcribed by CAC date 5/85

updated PG date 7/85

updated date

WELL #1 GRABBE COUNTY SWISHER

INTERVAL 1570 – 1710 QUEEN GRAYBURG LOGGED BY SW



LITHOLOGIC DESCRIPTION

SS massive row siltstn with disrupting structures and scattered small vls of displctive hal.

SS silty clayey row sand siltstn with silty dark pvrtly defined rpls (wl cm 2 mm) to sandy row siltstn with pvrtly defined rpls and low ang cross bedding, small (25 mm) hal vls scattered at about 1575.5', 0.5' vert frac filled with hal at 1578'.

SS chaotic hal admix with coarse chevrons most base, grading into SS siltstn to clayey siltstn with disp hal (indvs less than 2.5 cm)

Dy, SS fr anh lam.

SS sandy row siltstn with pvrtly defined rpls (2.5 cm), silty dark.

SS, generally massive, sandy to v sandy row siltstn, sand fine/fine to v fine sand at about 1588.5', upper rounded frosted and sand grained, disruptive structures may incompletely define some indistinct rpls.

SS sandy row siltstn to clayey row sand siltstn with pvrtly defined rpls, between 1597-1597' rpls (1.5 cm) dec in size upward, rpls 1.00,5' 1602' about 1-2 mm, v dark, generally massive with disruptive structures from 1597-1599' and small (less than 2 cm) anh nods at about 1598 1599'

SS massive sandy row siltstn with disruptive structures, upper rounded sand at about 1605.5'.

SS clayey row-fine siltstn with silty dark rpls (about 1.5 mm), rpls fw to slcs upward.

SS v sandy row siltstn grading upward to slightly silty v fine ss with generally massive appearance and disruptive structures, sand portion fw upward to about 1611' where it grades into overlying siltstn.

SS row siltstn with massive appearance and disruptive structures

SS row-fine clayey siltstn with small v dark rpls in lower 5' and pvrtly defined silty dark rpls in upper 5' (2' core siltstn 1612-1612.5'), small (greater than 1 cm) disp hal vls at about 1620.5' and small (less than 1 cm) anh grains at about 1626.5'.

SS massive sandy row siltstn with disruptive structures, sand to fine/v fine/v fine sand at about 1631-1636' and 1637-1640.5'.

SS siltstn, upper 2.5' crumbled to bag, lower 1' has dark rpls 1-2 cm high.

SS sandy row siltstn with pvrtly defined rpls, probable mud-rock fillers with v fine sand at 1645.5'.

SS v clayey row-sand siltstn with silty dark rpls.

SS clayey silty-fine siltstn with v dark rpls stable in places, rpl wavelength about 1 cm.

SS sandy row siltstn with pvrtly defined rpl to massive appearance, rpls dark with possible disruptive structures.

Wht to Gy to SS anh with irr to lam about 1 cm to 1 cm thick, Wht anh at 1672.5', possible primary structures (anh after gyp nodules/vtl at about 1670').

SS silty clayey fine v fine ss with massive texture and sparse disruptive structures, laminae finer grained immediately beneath overlying anh.

SS clayey sandy siltstn with v dark rpl texture.

SS slightly mottly v fine ss with probable pvrtly defined rpls incompletely mottled by disruptive structures.

SS clayey siltstn with v dark rpl texture, interval coarsens upward, grades into overlying interval.

SS silty sandy siltstn to silty clayey fine to v fine sandstone with disruptive structures at 1695', 1696' and 1698'; interval coarsens upward to 1696.5', then fines upward, lower part is predominant form underlying siltstn interval and upper part is predominant to overlying clayey siltstn, disruptive structures probably incompletely mottled pvrtly defined rpls, rest of interval massive.

SS clayey siltstn with v dark rpl texture.

Pale Gn to Purple very lam anh.

Wht to pale SS recrystd hal with rmnt and disc lyr lam of anh.

Wht to pale Purple anh/hal rock with probable hal pseudomorphs after gyp.

Wht to pale SS hal with possible chevrons and rmnt/alter lam of anh.

Pale Gn to Purple lam anh with hal pseudomorphs after gyp at base and possible rpls at 1709.5'.

logged by SW date

date

checked date

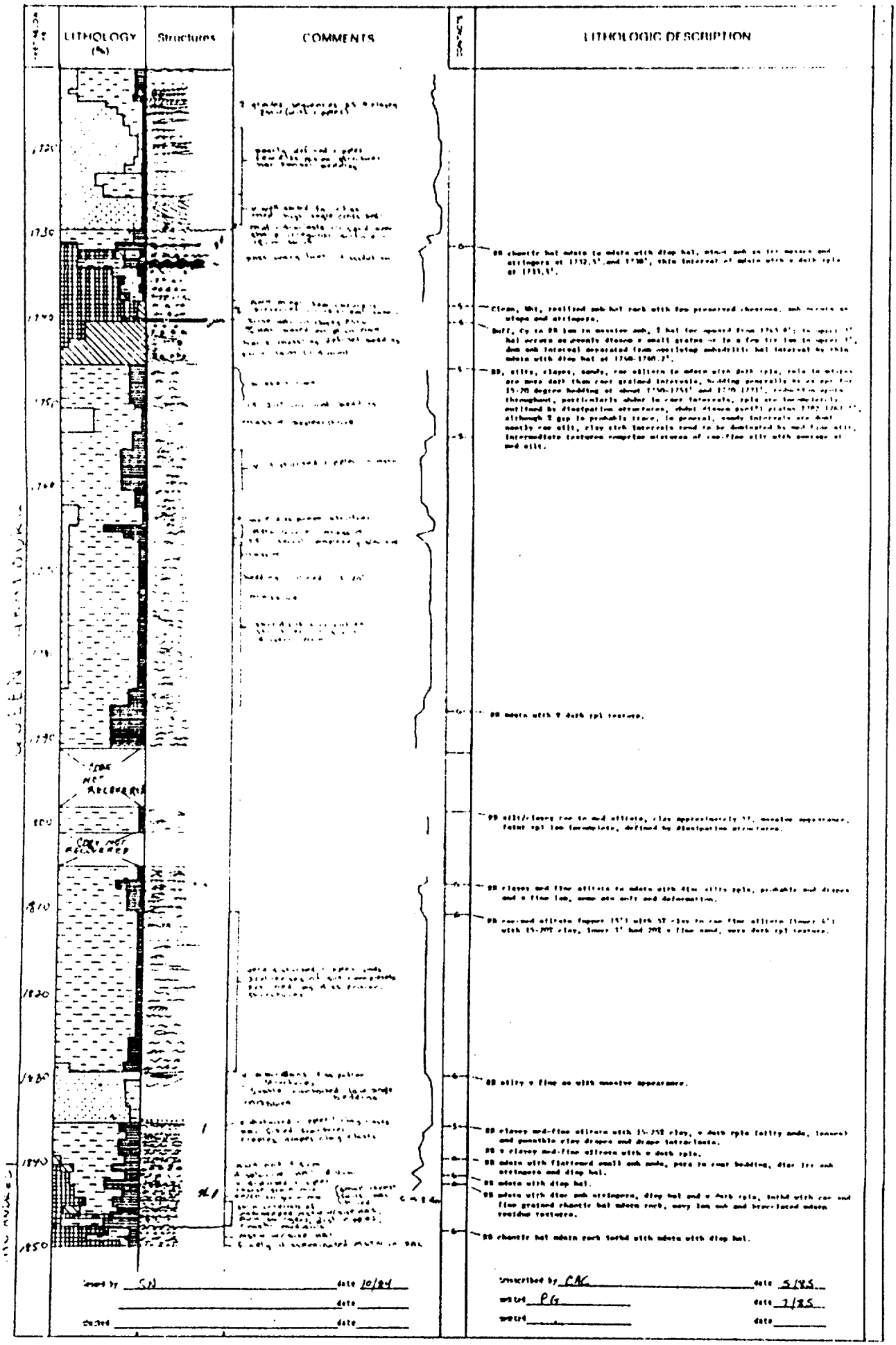
transcribed by KAC date 5/85

updated PG date 7/85

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 6/20/84

INTERVAL 1710 - 1850 QUEEN Grabbe, upper San Andres LOGGED BY SDY



Logged by SDY date 10/84

date

Checked date

Described by CAC date 5/85

Typed PG date 7/85

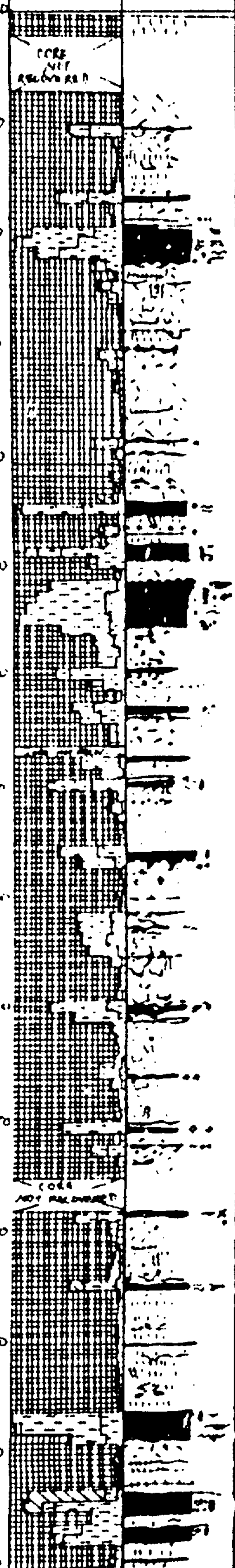
Typed date

WELL #1 GRABBE COUNTY SWISHER DATE 10-24 84

INTERVAL 1850-1990 UPPER SAN ANDRES LOGGED BY JV

UPPER SAN ANDRES

Depth	Lithology (%) / Structures	Comments	Lithologic Description
1850	CORE NOT RECOVERED	MISSING FOOTAGE 1852-1857'	Banded hal with trace [illegible] mud + anh, missing footage from 1852-1857'.
			Anhed hal with trace [illegible] mud.
1860		interbed apparent from back side of core	Anhed hal with [illegible] silt + anh → silty mdstn [illegible] (0.5') with small anh clasts → anhed hal with abdnt patches of siltstn → banded hal with [illegible] mdstn within piece → anhed hal with minor [illegible] mud → anhed hal with patches of silty mdstn → silty mdstn [illegible] (0.4') with [illegible] hal.
1870		curved slickenside surface	Anhed hal with [illegible] mud + silt and with an area of [illegible] large patches of silty mdstn presumably associated with a large pipe → thin clastic interval with patches of anh + mdstn → mdstn + siltstn [illegible] with abdnt disp hal and minor hal [illegible] fill, [illegible] changes from massive silty mdstn at base up into a chaotic siltstn + mdstn fabric with abdnt small anh clasts, then up into a dark [illegible] muddy siltstn.
1880		banded ANH, interbed caps [illegible]	Anhed hal with minor [illegible] mud + silt [illegible] upward → anhed hal with abdnt small patches of muddy siltstn → banded hal with anhed [illegible] and minor [illegible] mud + anh; unit capped by a thin (1 cm) siltstn [illegible], large [illegible] with little mud [illegible] occurs in lower portion of unit.
1890		coarse xyls	Anhed hal with min [illegible] mud + anh → thin clastic mdstn/hal interval → banded hal with occasional chevron structures → anhed hal with patches of anhedritic mdstn along [illegible] and with min [illegible] mud and anh → muddy siltstn [illegible] (0.1') with abdnt disp hal.
			Anhed hal with [illegible] anh + mdstn → silty mdstn [illegible] (1.4') with a [illegible] frac filled with fibrous hal, upper part of [illegible] is a [illegible], overlying this is banded hal with minor [illegible] anh + mud and interrupted by a thin mdstn [illegible] and a chaotic mdstn/hal interval → muddy siltstn [illegible] (1.5') with dark [illegible] and disp hal in upper part.
1900		1.3' long vertical fr. 1.5" 2 cm wide [illegible] interbed filled w fibrous HAL; [illegible] xpedling [illegible] interbed [illegible] rotation within sediment)	Anhed hal with abdnt patches of muddy siltstn and clastics content [illegible] upward → muddy siltstn [illegible] (about 1.8') with [illegible] hal [illegible] and small clasts of anh + mdstn; [illegible] are [illegible] with [illegible] preservation of original [illegible] structures, especially at top of [illegible] where siltstn has well-developed [illegible].
1910		1-2% ANH	Anhed hal with abdnt clasts of [illegible] silty mud + containing a [illegible] thick silty mdstn [illegible] → silty mdstn [illegible] (0.5') with minor disp hal + [illegible] fill → anhed hal with minor [illegible] mud and silt → anhed hal with abdnt silty mdstn patches → silty mdstn [illegible] with disp hal.
		1% ANH; core missing 1916.0-1916.9'	Anhed hal with [illegible] silt + trace mud + anh → anhed hal with abdnt small patches of muddy siltstn + minor anh → muddy siltstn [illegible] with [illegible] frac filled with fibrous hal → another siltstn [illegible] with [illegible] + a small [illegible] anh clast → anhed hal with abdnt patches of muddy siltstn [illegible] upward → siltstn [illegible] interrupted by missing footage.
1920		large vertical fr. w/ HAL cmt cut through interbed	Anhed hal with [illegible] silt and anh with a thin interval containing abdnt well-developed chevron structures → muddy siltstn [illegible] (1.0') with [illegible] anh clasts and a long, [illegible] hal filled frac [illegible] across; this [illegible] [illegible], [illegible] has dark [illegible] structures, dissolution features occur in lower part of section.
1930			Anhed hal with [illegible] silt and trace anh → anhed hal with abdnt patches of dark [illegible] muddy siltstn and anhedritic siltstn, clastics content [illegible] upward throughout unit, several dissolution features, especially pits, occur in lower part of section.
1940		2% ANH	Anhed hal with minor [illegible] silt + trace mud → [illegible] of anhed hal with abdnt patches of [illegible] muddy siltstn → anhed hal with [illegible] silt → anhed hal with abdnt patches of siltstn which quickly grade upward into a [illegible] siltstn [illegible] with abdnt disp hal + [illegible] small clasts of mud + anh, dissolution features are [illegible], especially in lower part, upper contact is gradational with overlying [illegible] hal, beginning of cyclic nature of clastics.
		1% ANH; slickensides in MDSTN	
1950		grains outlined by [illegible]; [illegible] small clasts of [illegible]	Anhed hal with min [illegible] mud, silt and trace anh → anhed hal with abdnt small patches of muddy siltstn + containing a thin (0.2') [illegible] to dark silty mdstn [illegible] → silty mdstn [illegible] (0.1') with disp hal, core missing from 1955-1958'.
	CORE NOT RECOVERED		
1960			Anhed hal with [illegible] mud → anhed hal with abdnt small patches of muddy siltstn → [illegible] muddy siltstn [illegible].
			[illegible] of [illegible] siltstn + anh with minor disp hal → anhed hal with abdnt patches of muddy siltstn + anhedritic mdstn.
		0.5" thick [illegible] ANH; [illegible] interbed w/ [illegible] displacive HAL, ANH at base	Banded hal with minor [illegible] hal + mdstn, unit has several pipes and pits resulting in areas of anhed hal with [illegible] mud ([illegible] hal), hal morphology is usually gradational between [illegible] and anhed.
1970		pink; irregular interbed of MDSTN & ANH clasts	
			Anhed hal with minor [illegible] mud + anh and occasionally patches of siltstn in upper portion → dark [illegible] muddy siltstn [illegible] with disp [illegible] hal hoppers, a frac filled with fibrous hal near the top, and occasional small clasts of mdstn scattered throughout.
1980		8 cm salt xyls; irregular interbed of ANH & md	Banded hal with minor [illegible] anh, large pit cuts across upper part.
		slickensides fr.	Mdstn [illegible] with large hal filled fracs and skeletal hal hoppers, [illegible] grades upward into siltstn → anhed hal with min [illegible] mud → [illegible] colored silty anh [illegible] (2.1') with frac in lower part + disp hal in upper part, anh consists mostly of very small [illegible], upper part is [illegible], sharp dissolution upper contact.
1990		1.5 cm thick [illegible] interbed	Banded hal with minor [illegible] mud, lower part containing a thin siltstn [illegible] and occasional patches of muddy siltstn.



[illegible] by JV date 10/84

date

[illegible] SH date 10/84

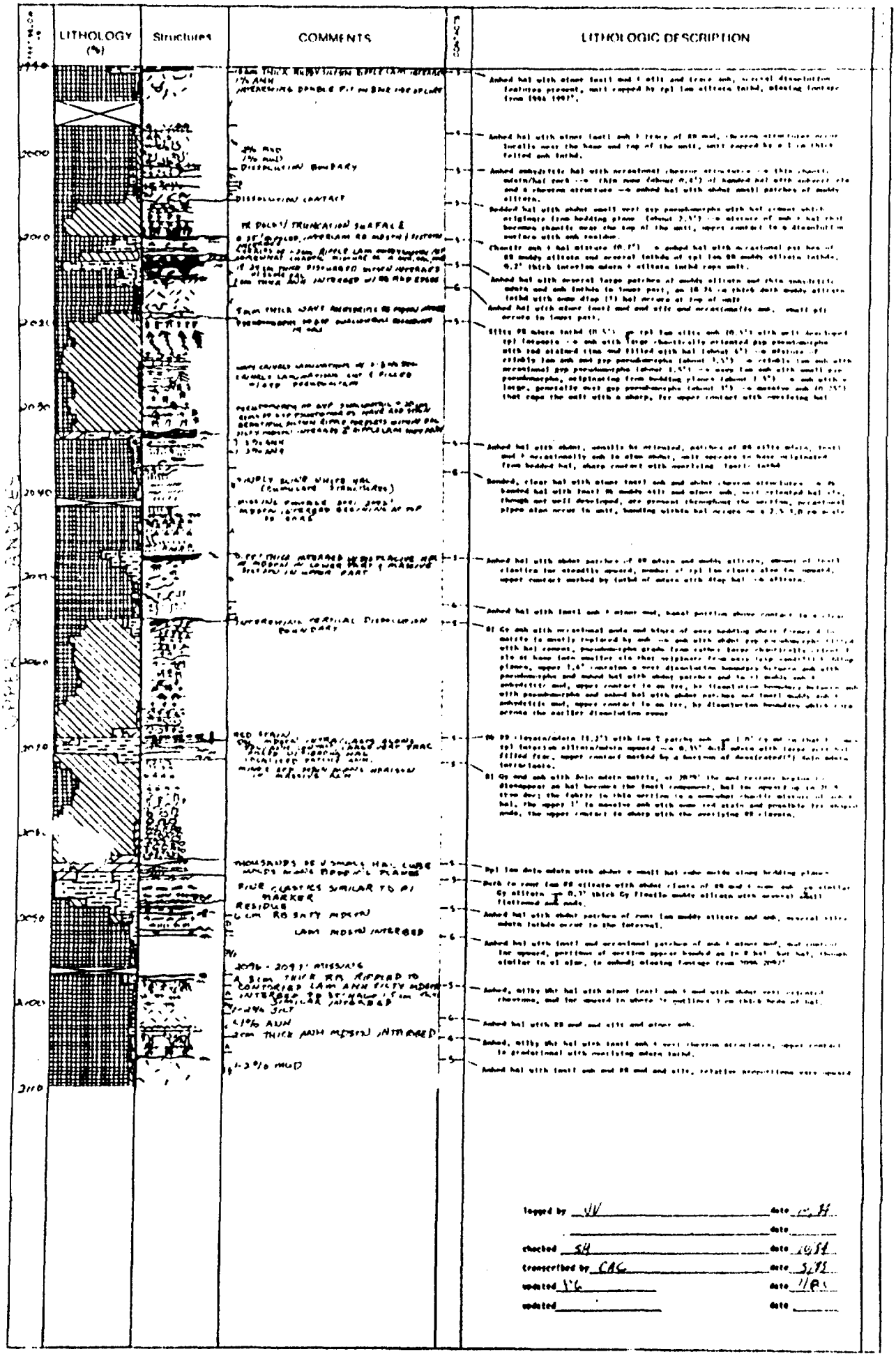
Transcribed by CAC date 5/85

[illegible] PG date 7/85

[illegible] date

WELL #1 GRABBE COUNTY SWISHER DATE 10/84

INTERVAL 1990' - 2110' UPPER SAN ANDRES LOGGED BY JV



logged by JV date 10-84

date

checked SH date 10/84

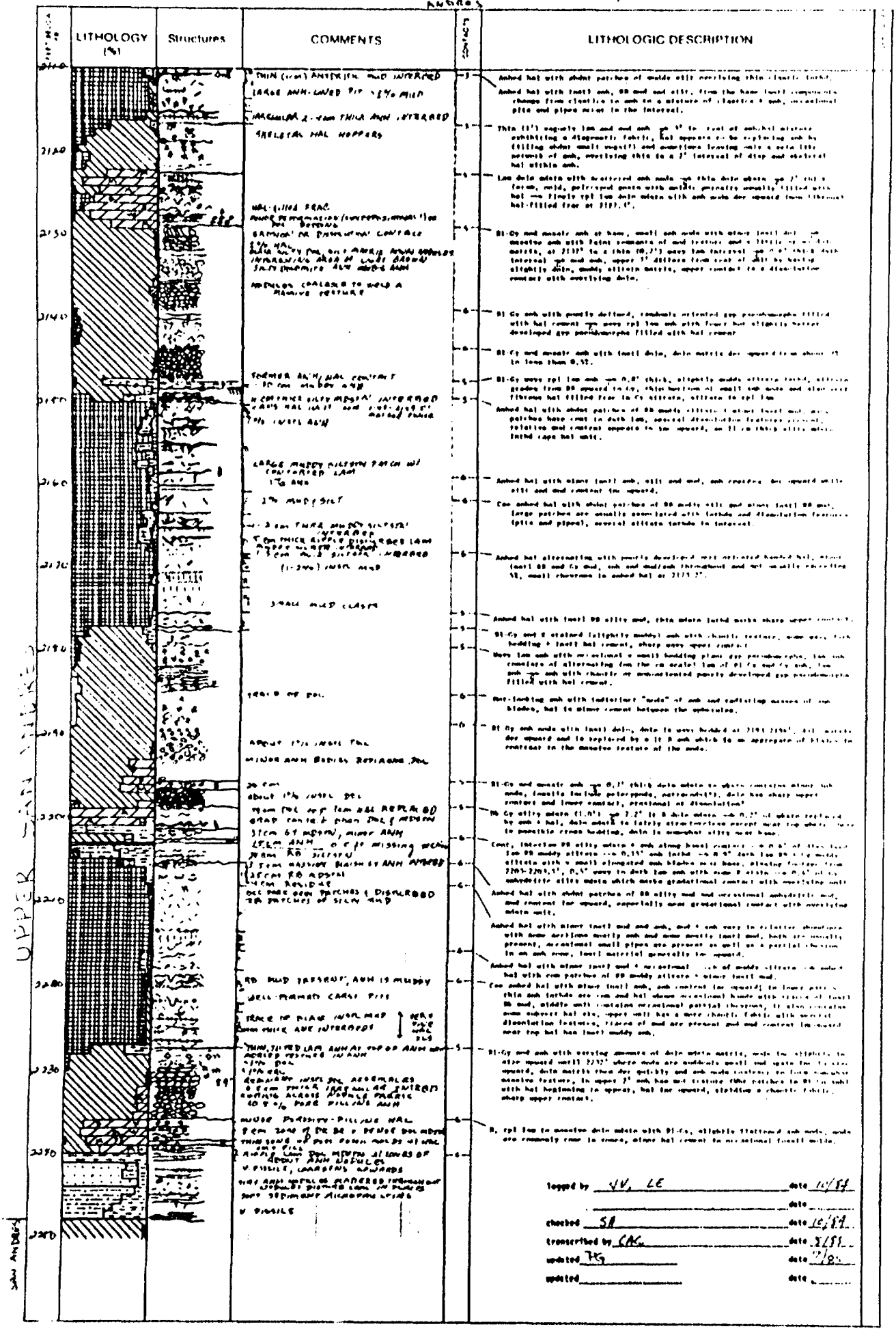
transcribed by CAC date 5/85

updated SG date 11/85

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 4/84

INTERVAL 2110-2250 UPPER SAN ANDRES, MIDDLE SAN ANDRES LOGGED BY JV, LE



logged by JV, LE date 10/84

checked SH date 10/84

transcribed by CAC date 3/85

updated TG date 7/85

updated _____ date _____

WELL #1 Grabbe COUNTY Swisher DATE 9-84

INTERVAL 2250' - 2345' Middle San Andres LOGGED BY PG
Lower San Andres Unit 5

FEET	LITHOLOGY (%)	Structures	COMMENTS	CORES	LITHOLOGIC DESCRIPTION
2350			dolomite interbeds	5	Mb subpeloidal siltstone, dark bedding grades upward into silty dolo grnstn
			lag intraclast grainstone		Dolo is shelly with anh filled moldic porosity and anh replacement of dolo; anh nodes present below algaling zone are large - 8 cm and remove
			dolomitic/vug breccia with anhydrite cement		Above algaling zone bedded and anh with abdnt (rare) dolo and forkd dolo, from 2361-2350' dolo with scattered large anh nodes and persistent silt partings
			silt partings		Dolo mdstn with algpy organic rich lam, rarely with pores with anh filled moldic porosity, massive Gy-B anh with dolo inclsns and algpy lam within anh.
2360			silt partings		
			anhydrite after pustular halite	5	Mb siltstn, algpy of dolo & anh, disrupted texture grading to forkd anh & siltstn, floatin from 2370-2370', becoming more indurated as dolo inc
2370			rippled fabric modified by wispy laminations and microstylolitization micro drapes		dolo is lt B with Mb B lam, spl and burrowed (algae).
			packstone grainstone layer		Anh filled skeletal hat anhdr in upper dolo section.
			fossil claystone		Bl-Gy anh, mod, bedded, grading to massive anh at top.
2380			bedded dolomitic anhydrite	5	Mb Gy anh with algpy of siltstn, grades to Mb siltstn with anh nods and stringers, dolo, irr bedding to 2391'.
			anhydritic/ impured dolograinstone		Anh nods with (rare) dolo and dolo forkds, Mb Gy bedded nods with Mb or lt B (rare) mottled nods grade to massive anh with indistinct bedding.
2390			dolomitic mudstone		Dolo beds have extensive anh replacement of siltstone
			23909 23910 missing		
			gradational anhydritic mudstone transition, compressed nodules	6	Mb, floatin anh matrix grading to dolo in basal 1', dolo matrix has hal & anh-filled moldic porosity similar to below, anh nods with (rare) dolo, Mb Bl-Gy, becomes lighter upward with dkr dolo, and dkr in size and grade to bedded, massive anh.
2400			light brown dolomite	5	Mb, floatin anh matrix with small anh nods at base - becoming dolo toward top, grading to dolo at 2417', spl (no pores), anh-replaced siltstone to dolo, dolo grades into mod bedded anh - Bl-Gy anh with (rare) lt B dolo
			dark gray dolomitic mudstone		2415.5-2411.5' Gy-B-Mbt anh, mot with rather B bedding, grades mott to hat anh forkds, platnptic anh to hat, grades to B Gy bedded hat, becoming more mod with (rare) dolo.
			anhydrite with disrupted texture		Dolo beds have hat & anh filled moldic porosity.
			dolomitic anhydrite		2395-2390', bedded massive anh with dolo forkds
			laminated anhydrite + dolomite separated by anhydrite nodules pseudomorphs		
			dolomite bed		
			basal algal stromatolitic mat		
			dolomite bed - rippled grainstone/packstone		
			subhedral cavities may be pseudomorphs after gypsum		
2410				5	Gradation of dolo into clastics, fav clastics and dkr dolo separation with anh cement & beds, grades to dolo anh, massive bedded with dolo stringers, becomes anh at top with (rare) dolo.
2420			Gas detail below	4	Lt B dolo, algpy to well lam, cross bedding and bioturb at 2372, 71.5', 71.1', anh nods at 2370, top 1' is laterally anh and dolo to lt B in mm lam, hat filled moldic porosity.
				6	Bl Gy bedded mod anh with (rare) lt B dolo, irr and contorts
2430				6	Lt B dolo grnstn, cross bedded & plane lam, hat filled moldic porosity, irr throughout dolo, tan mod anh beds, silty spl dolomicrite at base.
				4	Mot lam to massive siltstn, Mb with algpy Bl (rare), grades to massive bedded anh, top 1' Mb siltstn with anh nods, hat-filled pores
2440				6	Bot, cycle 5.
			Lithology of 23220 - 23232		Fav in clastics mot, anh cement and rare nods or beds, dolo throughout, limited siltstn & claystn.
2233			- wispy clay stringers - enterolithic Anh - fluid escape? - interbedded Anh/Dol		
2229					

logged by PG date 9.84

checked SH date 9.84

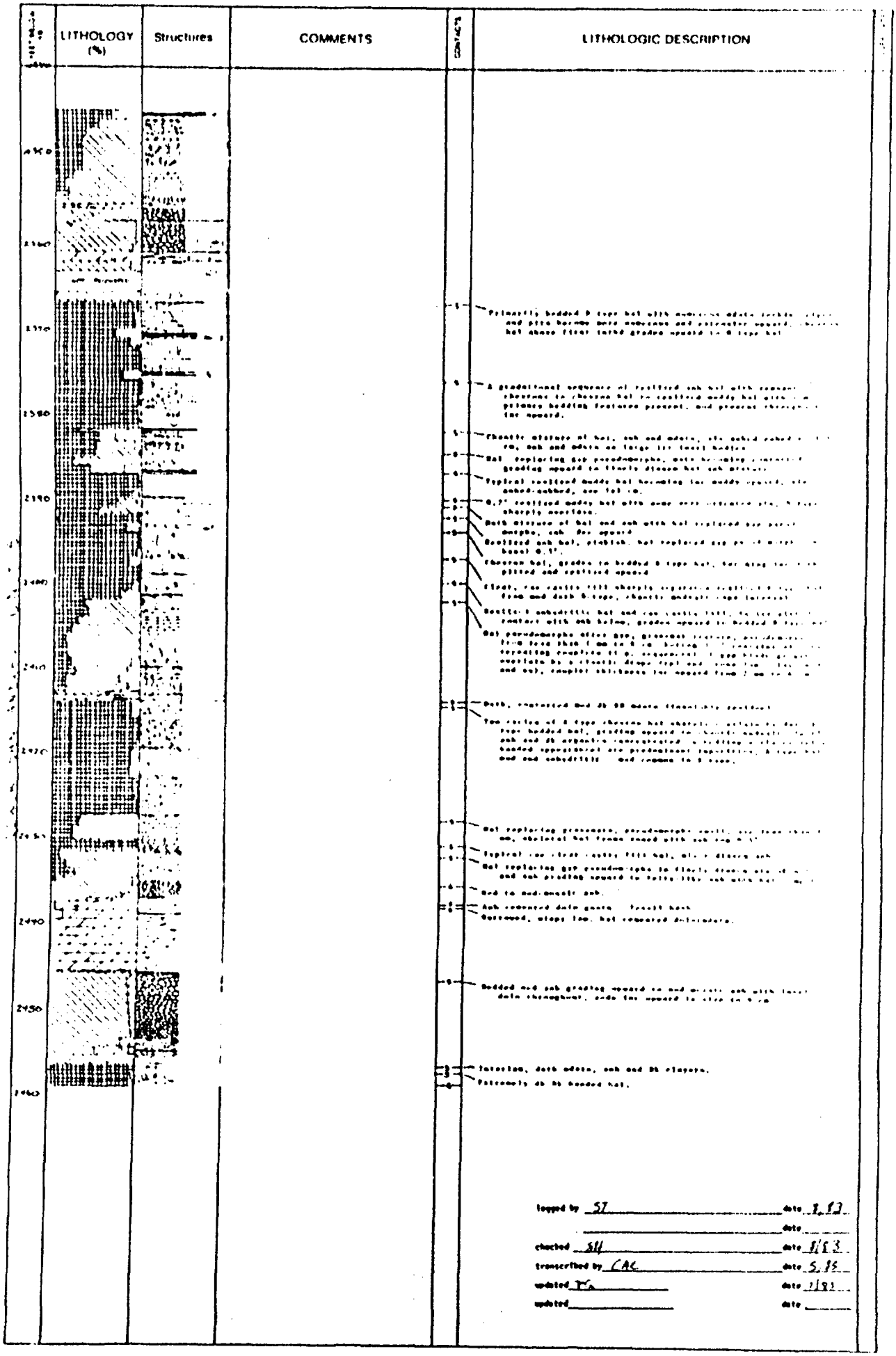
transcribed by CAC date 5.85

updated JPA date 7/87

updated _____ date _____

WELL # 1 GRABBE COUNTY SWISHER DATE 5/83

INTERVAL 2345 -2460 LOWER SAN ANDRES - UNIT 5 LOGGED BY S THOMAS



logged by SI date 3.83

date

checked SH date 5/83

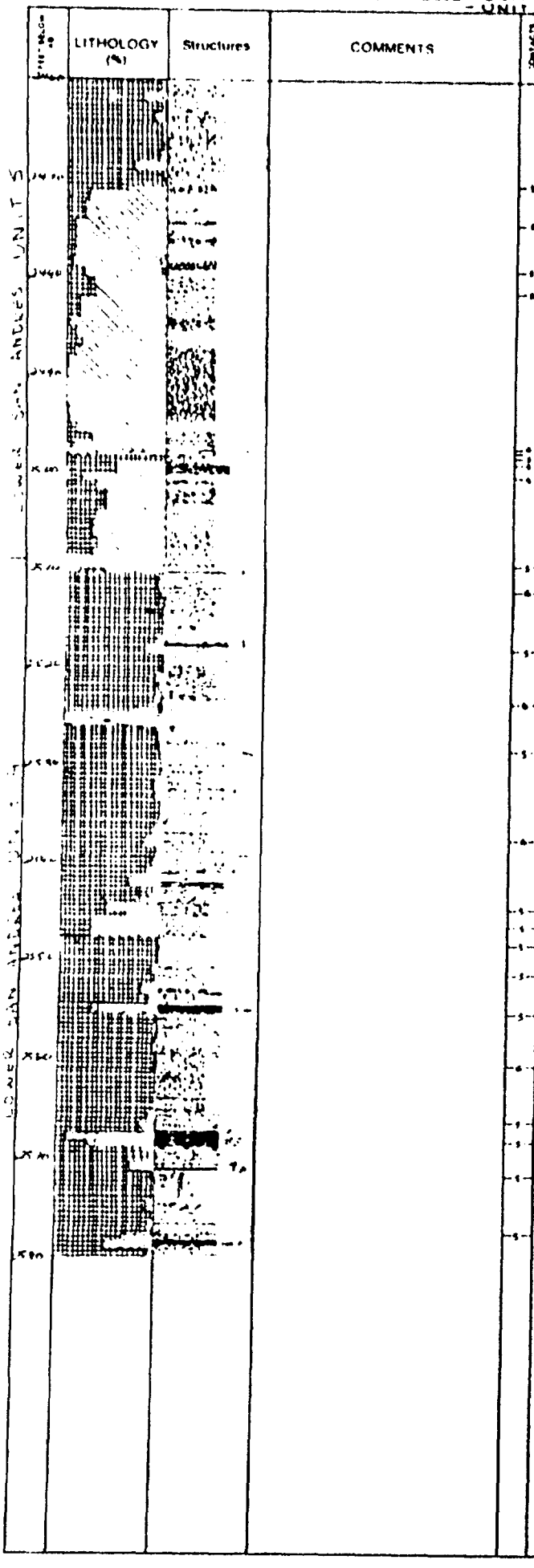
transcribed by CAC date 5.85

updated TA date 7/91

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 8, 8 4

INTERVAL 2460 - 2590 Lower San Andres UNIT 8 - UNIT 5 LOGGED BY J. Thomas



logged by S.F. date 9.84

date

checked SH date 9/85

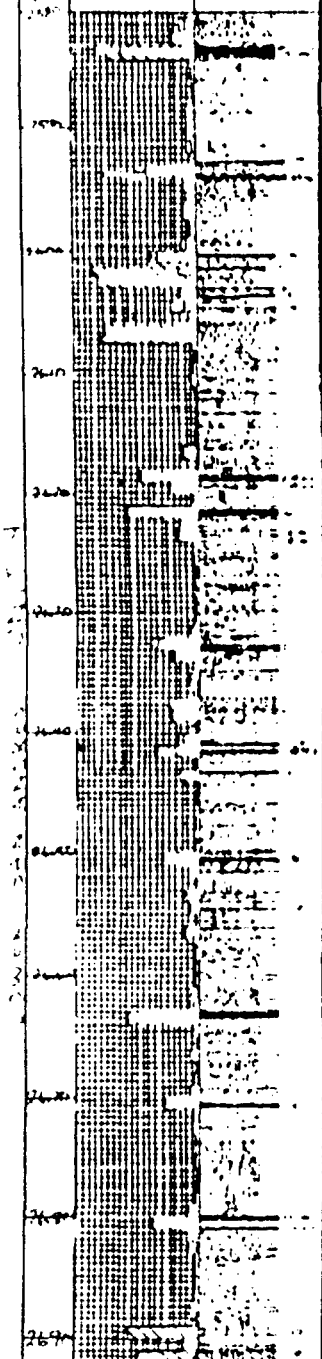
transcribed by LAC date 5.85

updated PK date 7/85

updated date

WELL #1 GRABBC COUNTY SWISHER DATE 5/15

INTERVAL 2590 - 2612 LOWER SAN ANDRES-UNIT 4 LOGGED BY S. THOMAS



Depth (ft)	LITHOLOGY (%)	Structures	COMMENTS	Depth (ft)	LITHOLOGIC DESCRIPTION
					Slightly bedded A type bst, burrowed to pitted and vuggy upward, capped by an interval of typical A type bst associated with the adobe facies, and is overlain by [illegible] facies.
					Two overcompacted bst units grading from [illegible] to partially leached A type bst, the second [illegible] ft thick, each unit capped by dark adobe siltstone facies at [illegible] the upper 5 is reduced
					Cy ank, bottom 8 cm is massive, becomes bladed bst pseudomorphed and later vuggy.
					Facies, recrystal bst capped by A type vuggy mud [illegible] abruptly the upward shales facies
					Cy ank with bedded bst passed [illegible] 17 cm is lotted ank to bst
					Recrystal B and B type bst, grades to bladed bst with vugs, oriented ste and unoriented shelter vugs, bladed bst [illegible] from and is heavily recrystal.
					B type bst to varying degrees of recrystallization, not to adobe facies, for to ank upward.
					A and B type bst with well developed bedding, bioclasts grain from 60/mm to 4/mm/ft, bst burrowed for both upward [illegible] by fine siltstone/adobe facies.
					Bedded bst burrowing for both upward, grading to B type bst
					Chaotic bst not to mud filled pipes, for nodes and both upward.
					Typical B type bst, burrowing from at mud and not to see [illegible] facies, [illegible]
					Poorest facies dropo like ank facies to silica ox bst
					Recrystal B type bst grades to B type with to to mud upward into nodes, greater than 1 ml
					Prog B bedded bst with vugs oriented [illegible] upward to [illegible] adobe facies
					Recrystal facies/silicement, about 1 cm to other bst pre upward to chaotic bst, abruptly capped by a adobe facies
					Well bedded A and B type bst, ank facies from [illegible] to organic debris overlying for bst
					Alternating units of B and B type bst, to adobe [illegible] with adobe facies, and [illegible] for upward
					Dark B type bst, common pits and local ank stringers
					Minor to mod pitted B and A type bst, [illegible] units of B, B, and B type bst associated with adobe facies
					Generally a blocky dark B type bst capped by a 5 cm adobe drape, bst retained bst bedding texture at base [illegible] B type bst associated with adobe facies.
					Chaotic mudpeb bst to thick adobe facies, adobe [illegible] small dep to 2x1 cm) bst bst numerous
					Bedded bst with ank facies burrowing for both upward
					B type bst showing varying degrees of recrystal.

logged by [illegible] date 5.15

date

checked [illegible] date 5.15

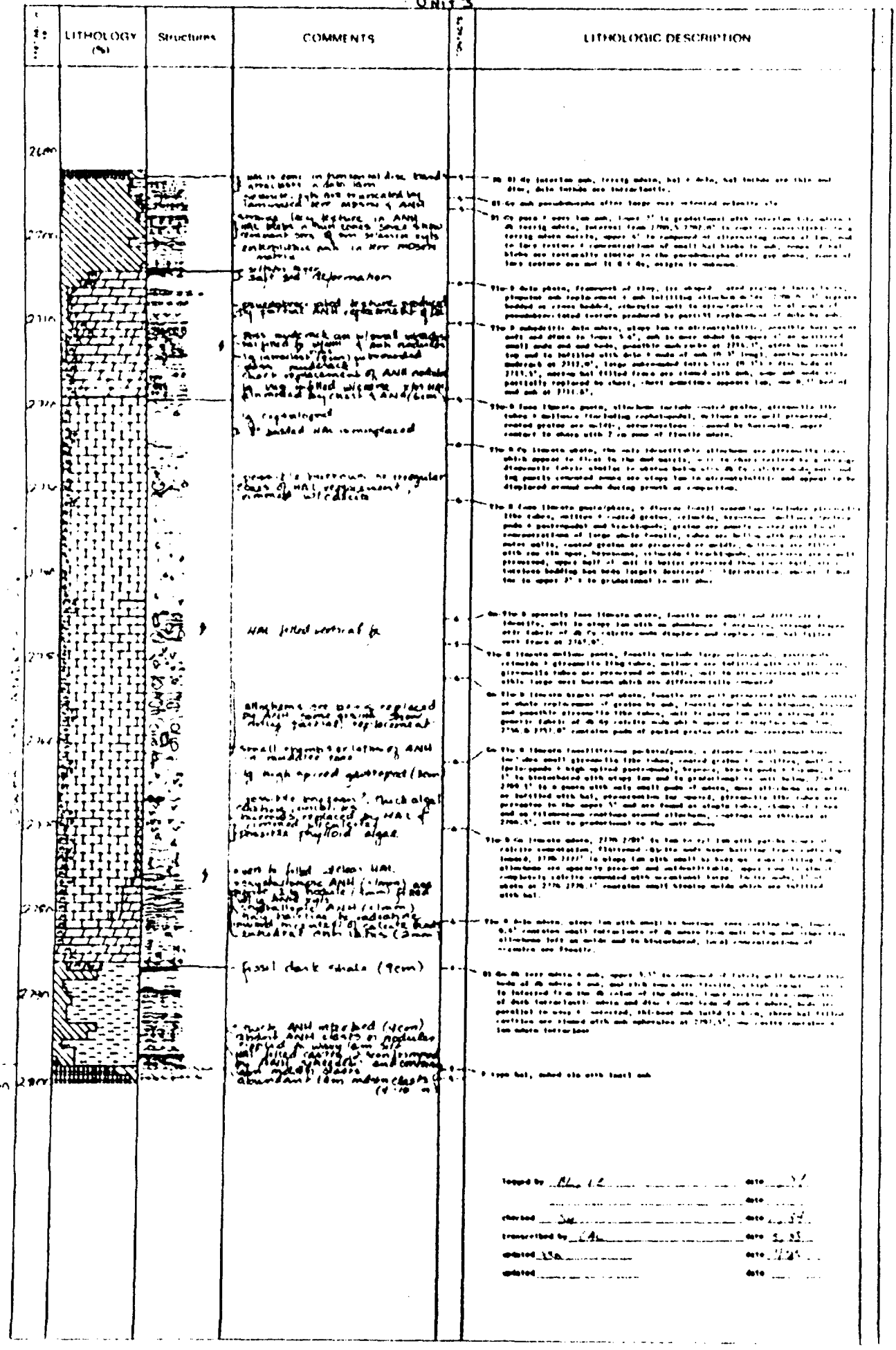
transcribed by [illegible] date 5.15

updated [illegible] date 7.25

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE VOL, '87

INTERVAL 2692' - 2900 LOWER SAN ANDRES UNIT 4 UNIT 3 LOGGED BY Lanham, Elliott



logged by RL, LE date 1/87

date

checked JW date 2-87

transcribed by CM date 5-87

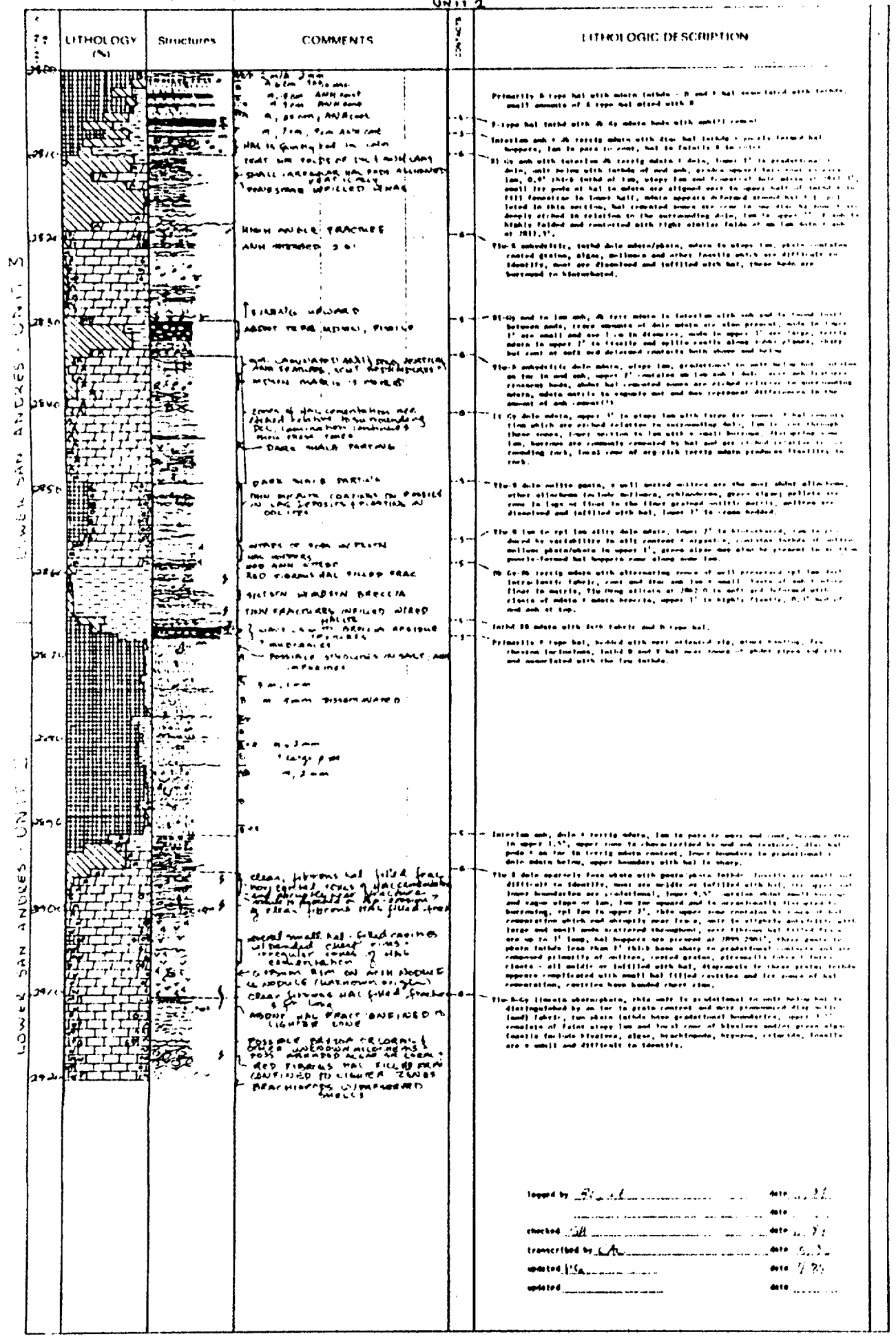
updated LEA date 7/87

updated date

WELL # 1 CRABBE COUNTY OWISHER. DATE Nov 1981

INTERVAL 2800 - 2920 LOWER SAN ANDRES UNIT 3 LOGGED BY Lucas, Elliott

UNIT 2



logged by [illegible] date [illegible]

[illegible] date [illegible]

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated [illegible] date [illegible]

WELL * 1 GRABBE COUNTY SWISHER DATE 7/84

INTERVAL 2120 3040 LOWER SAN ANDRES - UNIT 2, LOGGED BY C. GLORIETA

FEET	LITHOLOGY (%)	Structures	COMMENTS	CORES	LITHOLOGIC DESCRIPTION
2900					
2930			Diagonal open fracture large gray calcite cemented nodule Red Clay-rich, lined fracture Red Clay-rich, lined fracture		
2940			Red Clay-rich, lined fracture		
2950			Red Clay-rich, lined fracture Dissolution seams		
2960					
2970					
2980					
2990					
3000					
3010					
3020					
3030					
3040					

logged by LE date 7-84

checked GH date 9-84

transcribed by EM date 1-85

updated JSA date 11-85

updated _____ date _____

WELL # 1 Graves COUNTY Swisher DATE

INTERVAL 3040 3160 GLORIETA LOGGED BY

	LITHOLOGY (%)	Structures	COMMENTS	SAMPLES	LITHOLOGIC DESCRIPTION
3050					
3060					
3070					
3080					
3090					
3100					
3110					
3120					
3130					
3140					
3150					
3160					

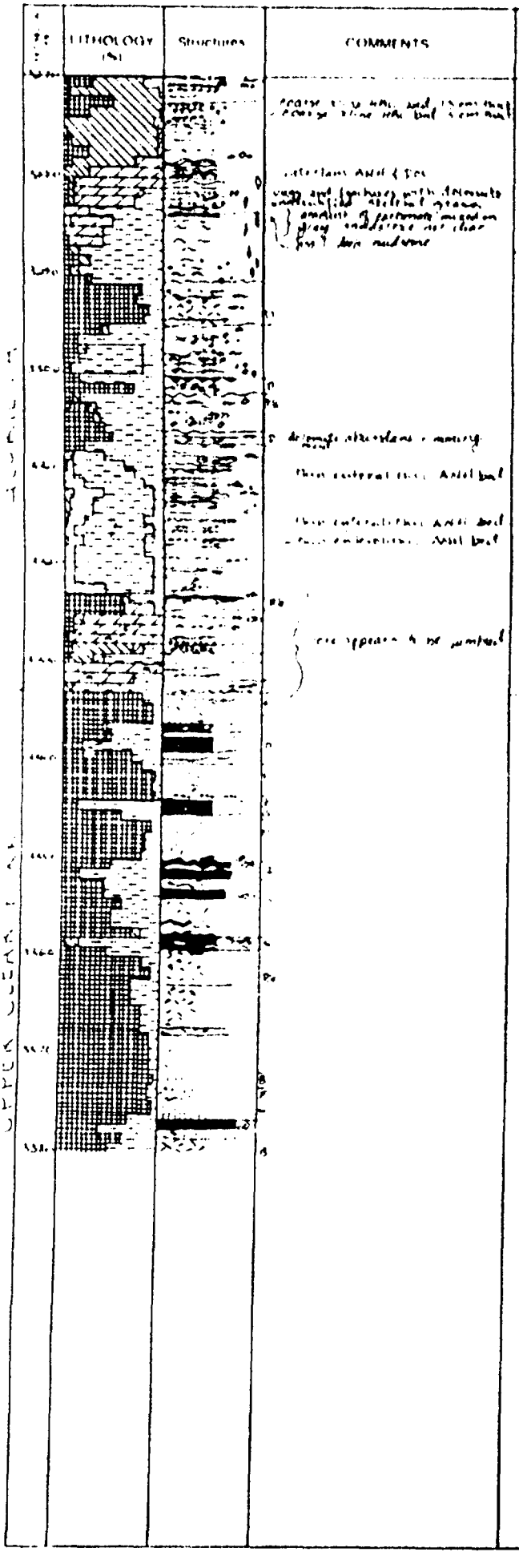
WELL #1 GRABBE COUNTY SWISHER DATE

INTERVAL 3160 - 3270 GLORIETA LOGGED BY

Depth (ft)	LITHOLOGY (%)	Structures	COMMENTS	SAMPLES	LITHOLOGIC DESCRIPTION
3160					
3170					
3180					
3190					
3200					
3210					
3220					
3230					
3240					
3250					
3260					
3270					

WELL GRABBE COUNTY [illegible] PA DATE [illegible]

INTERVAL [illegible] - 5550 GLORIETA, UPPER CLEAR FORK LOGGED BY PG



LITHOLOGIC DESCRIPTION

logged by PG date 2/85

checked SH date 3/85

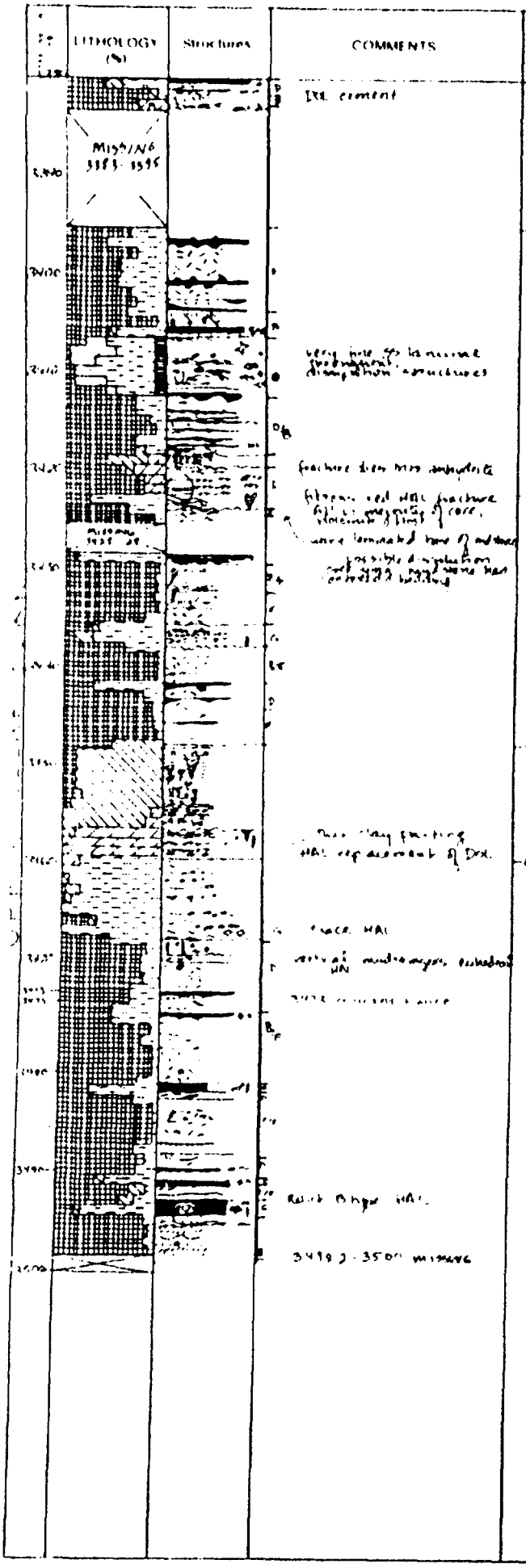
transcribed by CAS date 5/85

updated DS date 7/85

updated _____ date _____

WELL # 1 GRABER COUNTY SWISHER DATE 2/85

INTERVAL 3380 - 3500 UPPER CLEAR FORK LOGGED BY PG



LITHOLOGIC DESCRIPTION

Interclam dolo wkstn w hal with drop hal to dol, overlain by bedded hal and chaotic mudst.

9 large 8 fibrous hal filled fract. running length of dolo and into unit at 3498.5', dolo to 8 Gr with rpl lam and hal replacement of dolo.

Interclam unit, dolo w hal moldic lam, mound shaped unit with poorly preserved pyp pseudomorphs.

Chaotic mudstone with rolled bedded textures, underlies 9' siltstone with fine sand lam and clipsore breccia, lam to dolo with crumbs, fluid escape and overdrop microfaulting.

Siltstone to sharply overlain.

5 Chaotic mudstone with rare remnants of bedded hal, 80 mdstn laminae with 8 hal, and nodules, beds, 90 at top of unit, becomes dolo and has large frac filled with 8 fibrous hal

Lt 8 rpl dolo mdstn, hal replacing dolo along bedding planes, lam pinch and every few cms.

Dolo and silty dolo lamst w 10% clasts, lacking dolo upward, and to more lam with dark laminae, hal replacement

Hal defines large multimoldic pyp pseudomorphs

Top of unit is lam to crudest with overlying hal

6 Predominantly chaotic mudstone with scattered hal, 80 mdstn, wkstn with dark bedding, dolo mud, drop hal, some units of 8 type hal - dark bands are mud-rich - rest altered dolomud silt.

Occasional pits and pipes.

80 mdstn at top with rolled hal to crumbled, elongate dolomite, dolo nodules, dark and brecciated bedding, fissile - mottling clays.

Grade from 80 to 40 Do lam, fissile at top.

logged by PG date 2/85

date

checked PG date 2/85

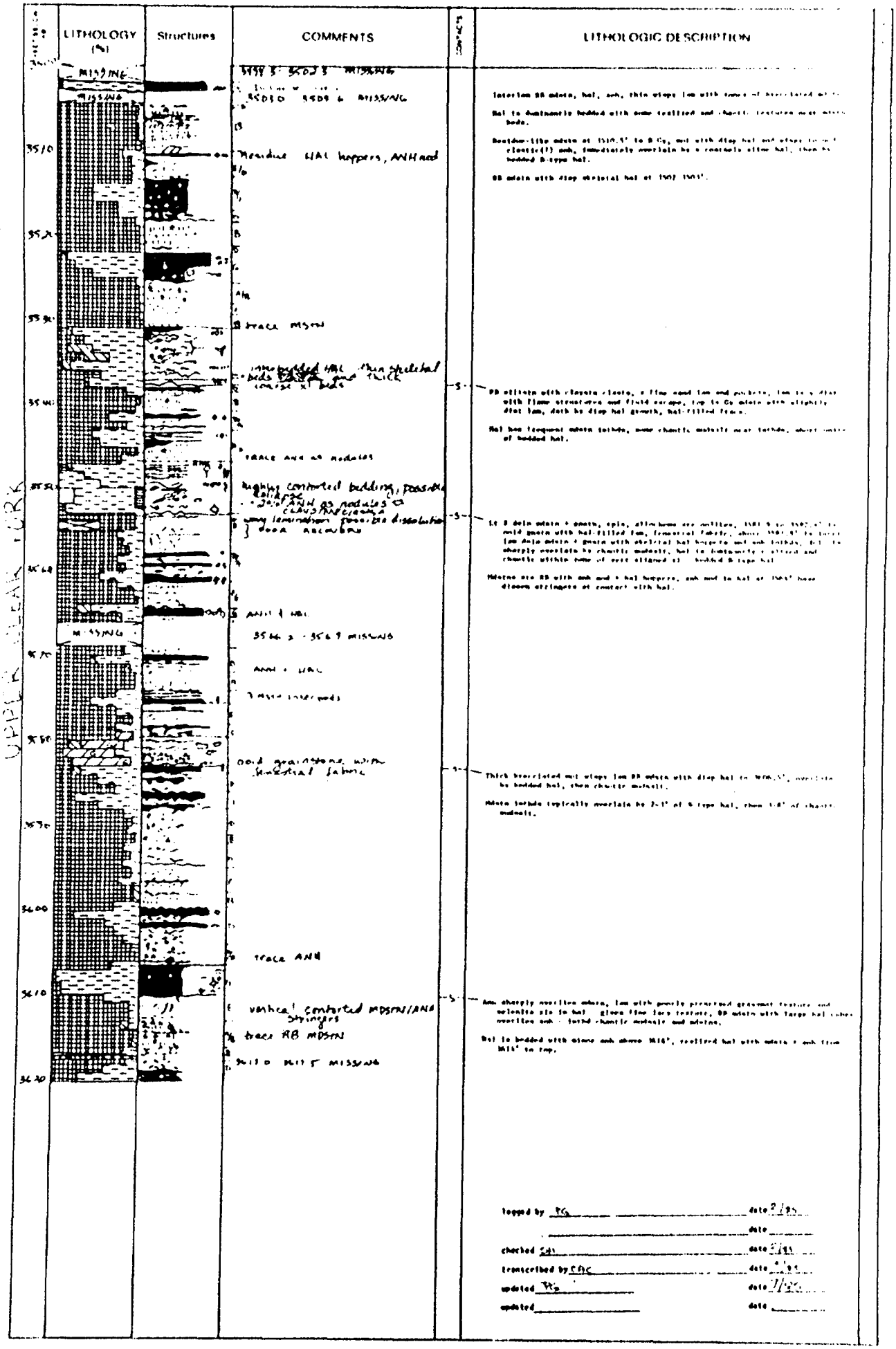
transcribed by CAS date 3/85

updated PG date 3/85

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 2/85

INTERVAL 3500 - 3620 UPPER CLEAR FORK LOGGED BY PG



logged by PG date 2/85

checked [illegible] date 2/85

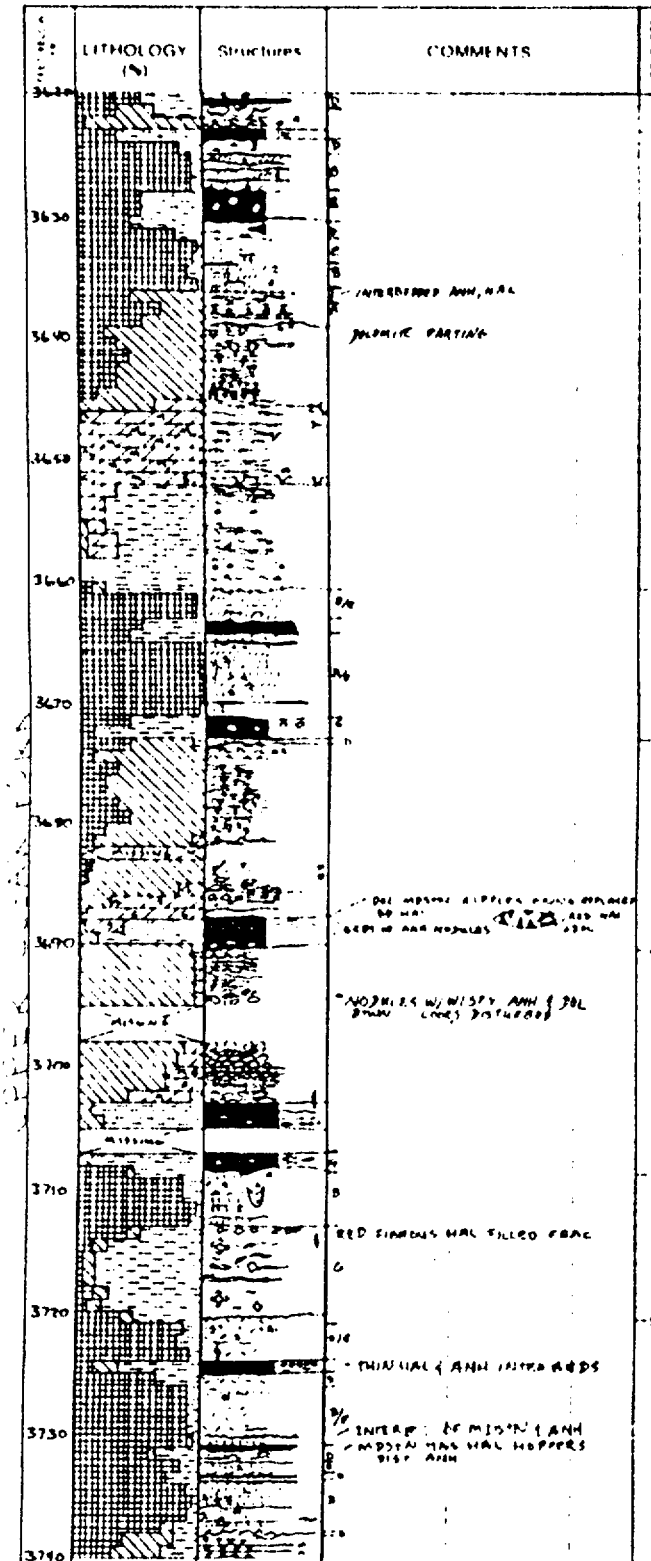
transcribed by CDC date 4/85

updated PG date 11/85

updated _____ date _____

WELL #1 GRABBE COUNTY SWISHER DATE 1/85

INTERVAL 3620-3740 UPPER CLEAR FORK LOGGED BY PG



CORES

LITHOLOGIC DESCRIPTION

Perceptionally long, well developed cycle for Mid, from highstand to sabkha with steep dist bedding, fx mdstn contacts abruptly with SB mdstn, massive to brecciated, depth lam, A to above 3638', textured and nodular to chicken-wire Cy above 3638' with Cy and SB mst, grade to clayey dolo

Dolo to rpl lam with burrows, dark bedding, lt B mdstn and mdstn with hal fills & molds after gradon, Cy mst to B dolo, skeletal hal to fx, fract & vug, sharp contact with anh.

Anh in lam at base with well developed gyp pseudomorphs preserved in hal, mostly single sls as large as 4x7 cm, lam runs through some sls, top 2' is dolo with mst anh, hal interbeds.

Anh interbeds with hal at 3637' & 3636'.

Hal is SB bonded with thn vert elongated sls, black and crumbly fx & vugs, some chevrons.

Mdstn bed at 3631', has large hal hoppers, steep hal capped by bonded hal at portion of thin mdstn beds.

SB mdstn bed at 3626.5' sharply overlies hal.

SB mdstn with steep hal, massive, sharply overlain by bonded hal with mudst interbeds at 3668' and 3665'.

SB mdstn lacks at 3660.4' grades to B Cy dist mdstn interval, minor steep hal

Bonded hal, vert oriented sls, thin mdstn [illegible] anh partings, grades to anh at top.

Cy mdstn with anh mud, friable, grades to SB mdstn then to B to Bx Cy dist anh mud, sharply overlain by rpl dolo grain with isolated hal mdstn ret, latbds with mud anh.

Mud anh becomes poorly bedded with dark lam hal after gyp pseudomorphs poorly preserved - little or no primary texture preserved

Above 3682' - well-preserved lam anh with preserved gyp texture, grades to lam anh with large gyp pseudomorphs cutting across lam, pseudomorphs preserved in hal.

Top 1' is lam anh with small gyp pseudomorphs.

Muddy and hal rich at top.

Lt SB mdstn with wispy anh, breccia, lam clasts, laterlam and, fx Cy at top of mdstn.

Dolo overlies mdstn, gradational contact(?), dolo grades to mud anh with fewer dolo and dolo latbds, mdstn poorly defined above 3698.5'

Both anh dolo between 3694-3693', lam anh with dolo defining lam in top of mdst.

SB mdstn with Cy reduced stream, wispy, mst bedding, rip up clasts, brecciated small anh mud, large skeletal hal hoppers, fx fill lam mdstn at top with lam filled with hal, overlain by chaotic mudcalt, long sections of B type bedding hal with zones of mdstn nods, anastic hal, thin mdstn latbds.

Lt SB mdstn with wispy lam breccia, skeletal hal overlying anh has well preserved gyp pseudomorphs and grainmat texture.

Anh grades to hal with thin mdstn bed at 3730', hal is dominantly B type bedded with mud over aligned sls with mdstn lam and laminated, mst with B type zones within B.

B-type hal with letter B below mdstn at 3725', mdstn overlain by muddy bedded hal and chaotic mudcalt.

logged by PG date 1/85

date

checked PG date 1/85

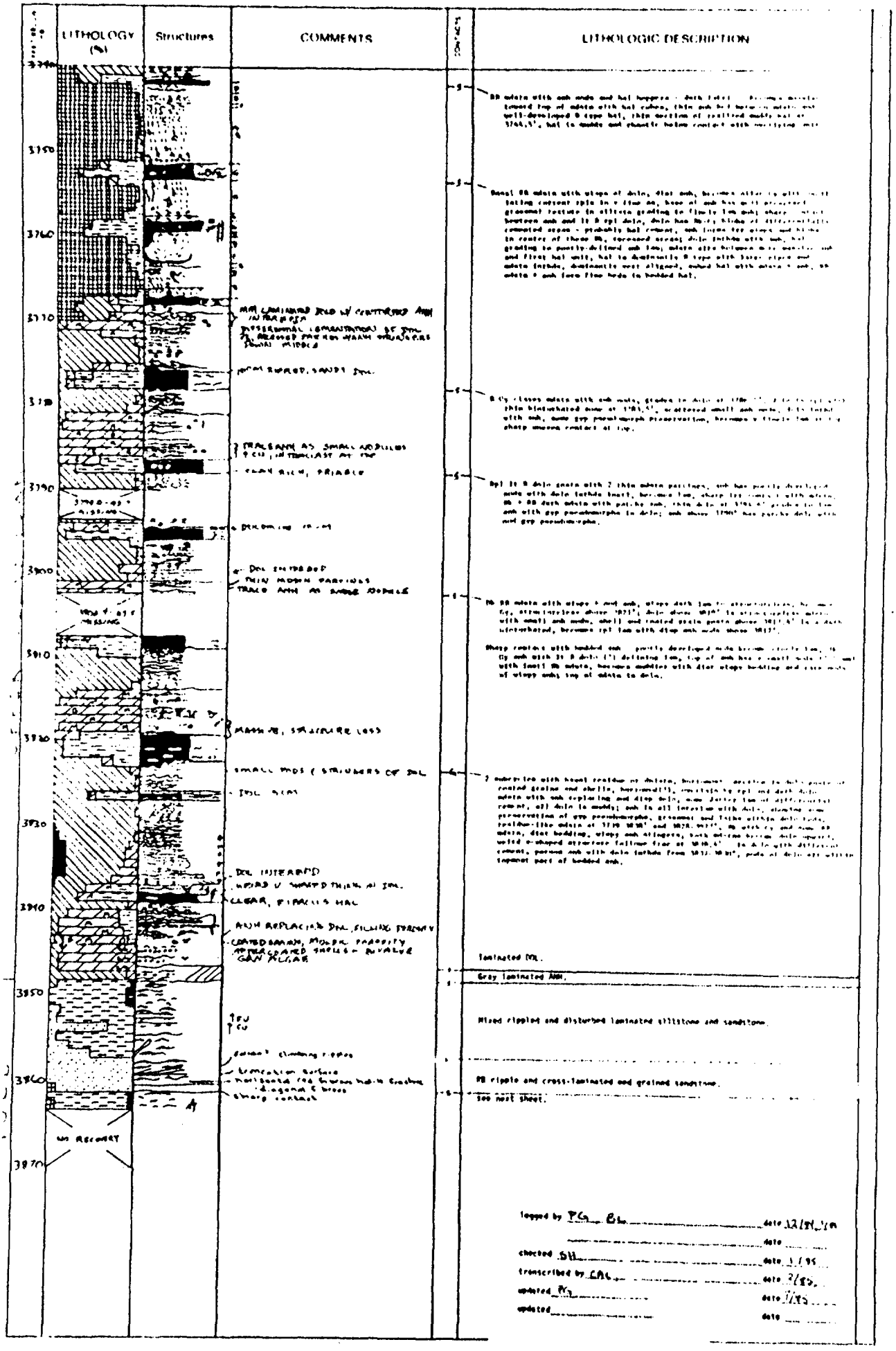
transcribed by CPK date 2/85

updated PG date 1/85

updated date

WELL #1 GRAGG COUNTY SWISHER DATE 1/95

INTERVAL 3740' - 3870 UPPER CLEAR FORK, TUBB LOGGED BY PG



logged by PG, BL date 12/14/94

date

checked SH date 1/95

transcribed by CAL date 2/95

updated PG date 7/95

updated date

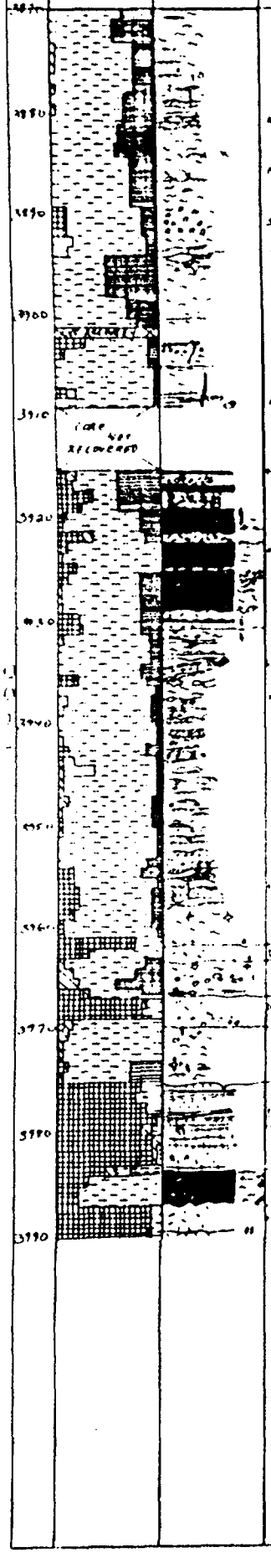
WELL # GRABBE

COUNTY SWISHER

DATE 12/84

INTERVAL 3910 - 3990 TUBB

LOGGED BY B. LUNEAU



LITHOLOGIC DESCRIPTION

Mixed dark and rpt tan DD siltsto.

Zones of transitional D to G type but tanned with dark tan and intraclastic siltsto.

Rpt tan DD siltsto mixed with dark and lt-m-dk gy lt-m-dk mottled, contains pockets of hal and a zone of brecciation

Dark and lt-m-dk gy siltsto tanned with D type hal

Hal, primarily bedded D type with some F or Bank, cemented with mats of lt-m-dk, tanned with tan siltsto and anh.

logged by BL date 12/84

date

checked SH date 12/84

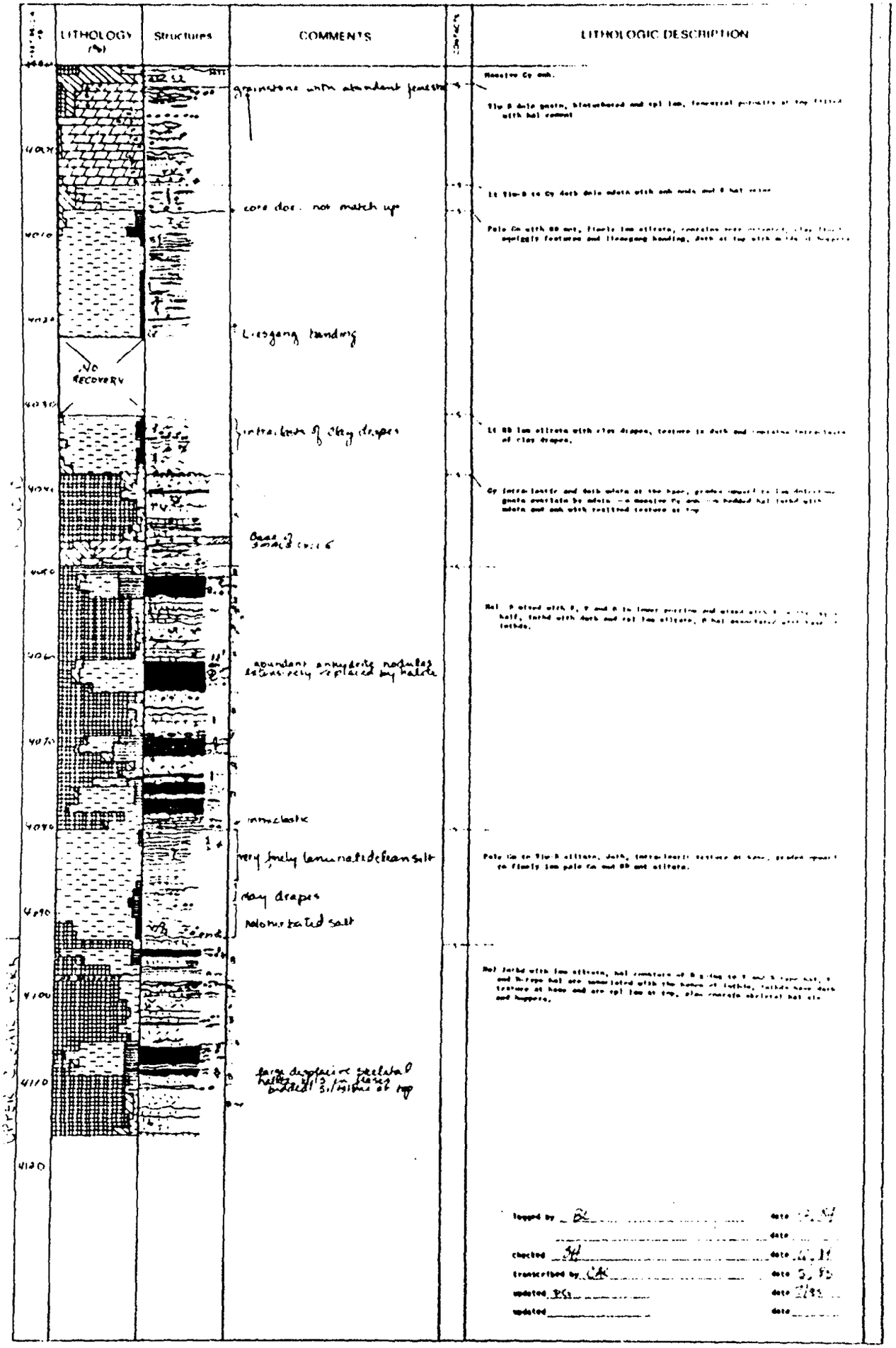
transcribed by CAC date 2/85

updated DV date

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE Dec 1984

INTERVAL 3990 - 4116 TUBB, LOWER CLEAR FORK LOGGED BY B Lunsford



logged by BL date 12-84

date

checked SH date 6-11

transcribed by CAC date 5-85

updated BG date 2/93

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 2/85

INTERVAL 4176 4210 LOWER CLEAR FORK LOGGED BY PG

FEET	LITHOLOGY (%)	Structures	COMMENTS	FEET	LITHOLOGIC DESCRIPTION
4150					
4175			red and green mudstone with interclasts of mudstone, stabilized		
4200			CALCITE CEMENT		
4225					
4250					
4275					
4300					
4325					
4350					
4375					
4400			AMH filled pipe.		
4425			trace FE sandstone		
	TD				

logged by PG date 2/85

date

cored SH date 2/85

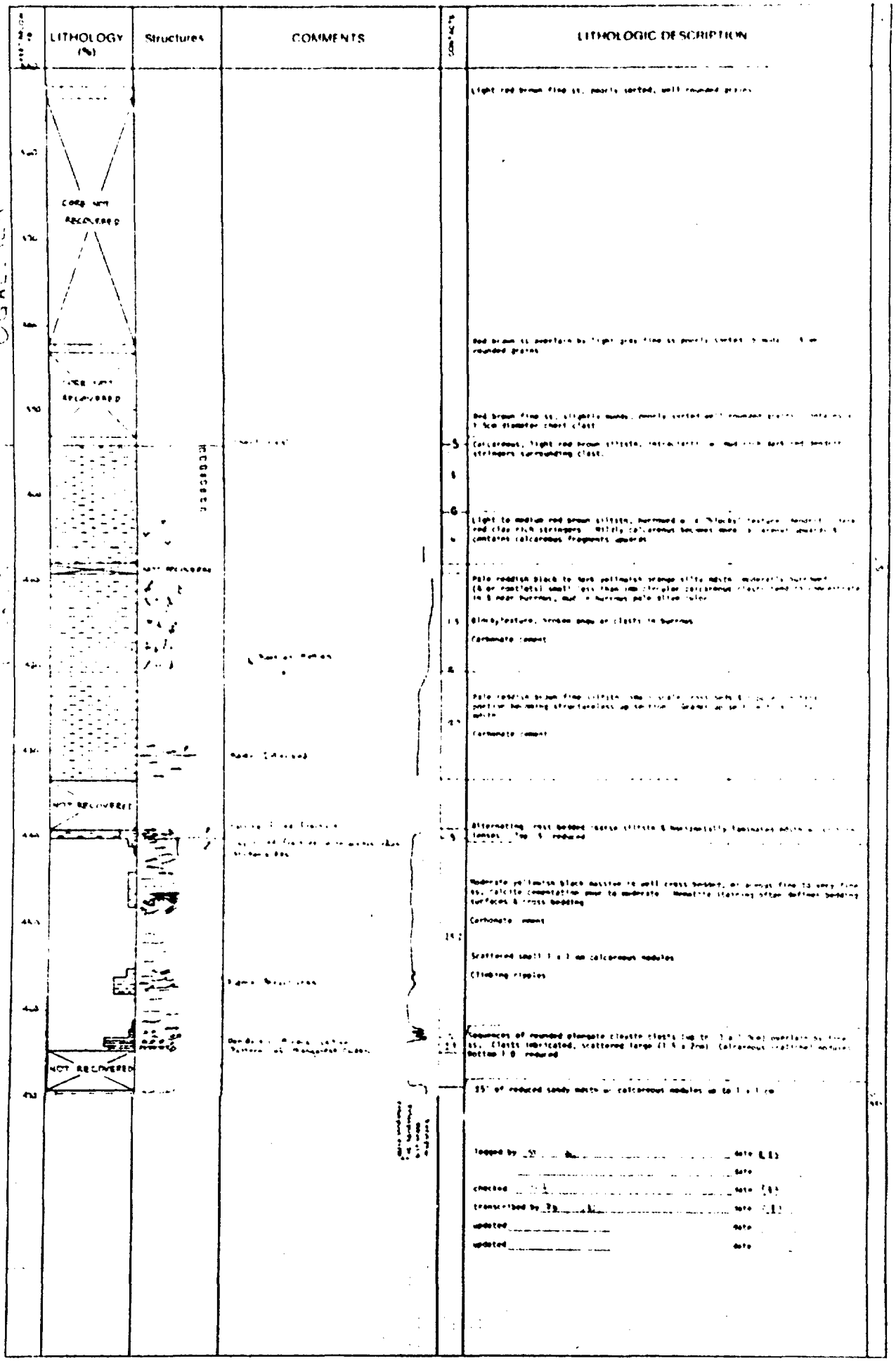
transcribed by CA date 5/85

updated PG date

updated date

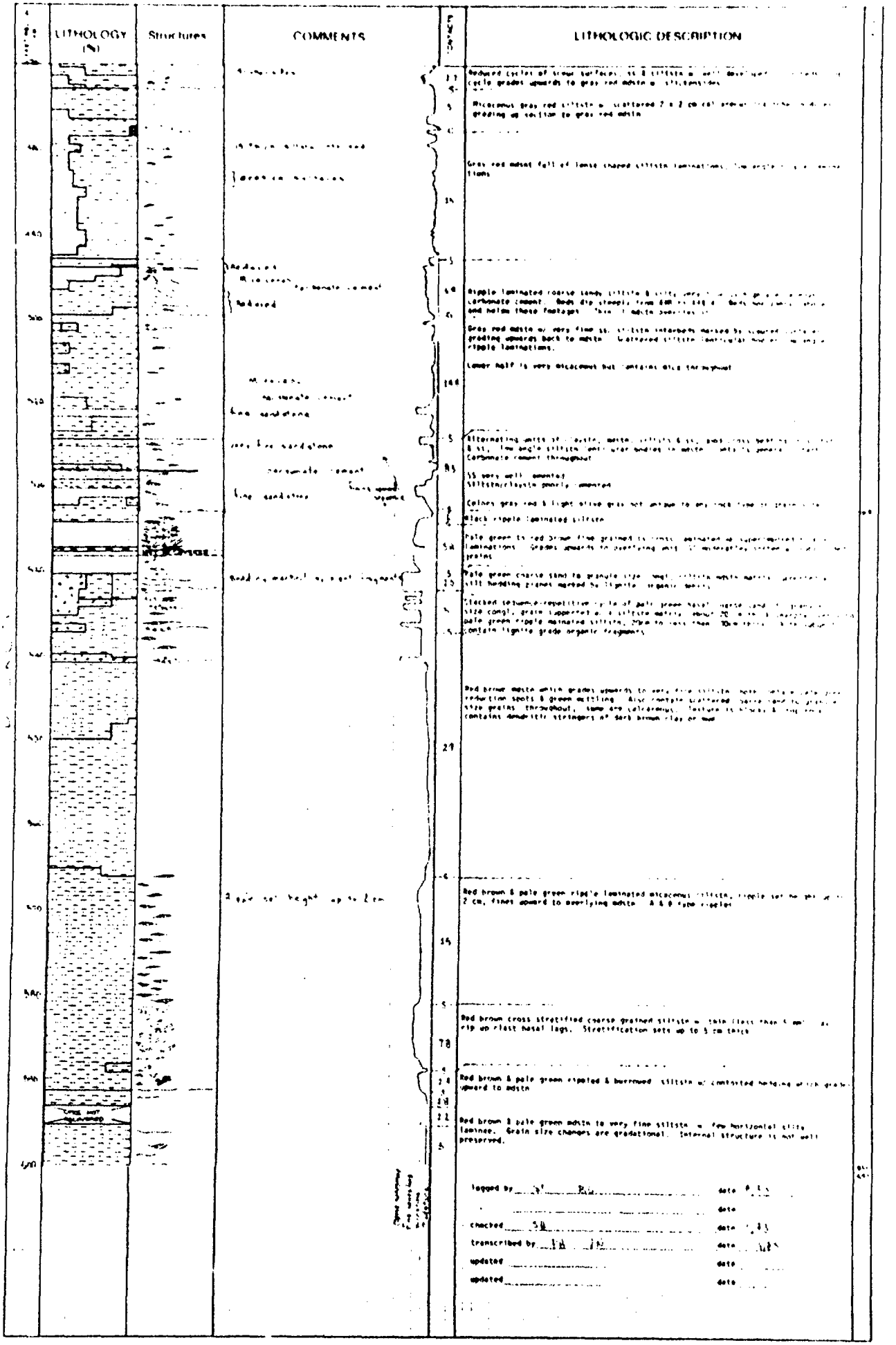
WELL J Sammel COUNTY [illegible] DATE [illegible]

INTERVAL [illegible] OGALLALA, DOCRUM LOGGED BY [illegible]



WELL [illegible] COUNTY [illegible] DATE [illegible]

INTERVAL [illegible] DOCUM LOGGED BY [illegible]



logged by [illegible] date [illegible]

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checked [illegible] date [illegible]

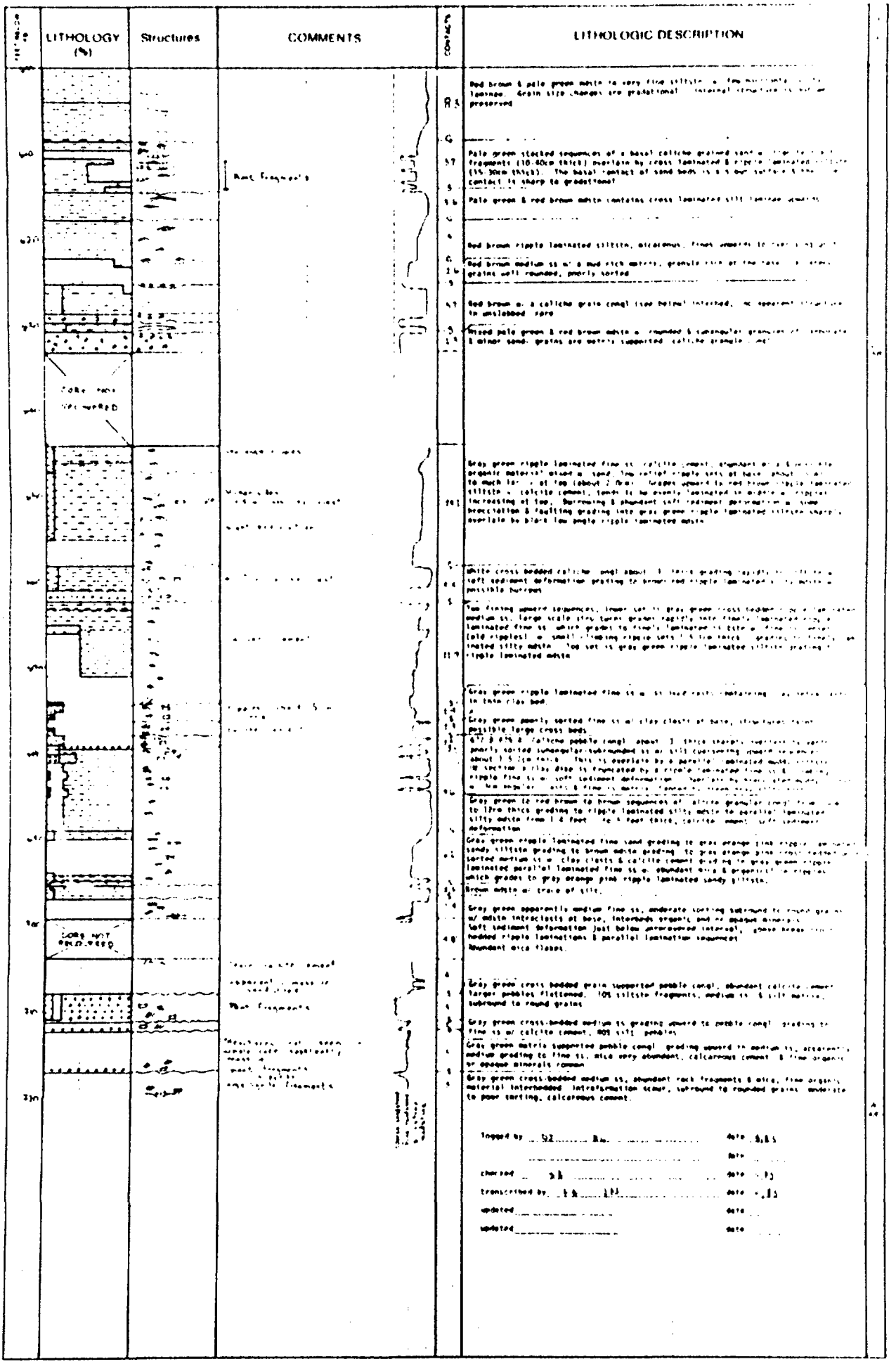
transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated [illegible] date [illegible]

WELL J. Kimmel COUNTY Deaf Smith DATE August 1983

INTERVAL 220 - 320 DOCKUM LOGGED BY S. Holt, S. Wilson, J. Hall



Red brown & pale green white to very fine siltsto. w. few micaceous ss. lenses. Grain size changes are predational. Internal structure is not well preserved

Pale green stacked sequences of a basal calliche grained sandstone (10 to 15 fragments (10-40cm thick) overlain by cross laminated & ripple laminated (15-30cm thick). The basal contact of sand beds is a S over surface & the contact is sharp to predational

Pale green & red brown white contains cross laminated silt laminae sandst

Red brown ripple laminated siltsto, calcareous, fine sandst to

Red brown medium ss w/ a mud rich matrix, granule size of the fine grains well rounded, poorly sorted

Red brown w. a calliche grain congl (see below) interbed, no apparent structure in unslabbed core

Mixed pale green & red brown white w. rounded & subangular grains of siltsto & other sand. grains are matrix supported calliche granule cong

Gray green ripple laminated fine ss, calcite cement, abundant w. & irregular organic material mixed w. sand. Low relief ripple sets at base, about 1 to much larger at top (about 2 feet), changes upward to red brown ripple laminated siltsto w. calcite cement, lower 1½ to evenly laminated in middle w. irregular increasing at top. Burrowing & abundant soft sediment deformation w. some brecciation & faulting grading into gray green ripple laminated siltsto sharply overlain by black low angle ripple laminated mdsto

White cross bedded calliche congl about 1 thick grading rapidly to siltsto w. soft sediment deformation grading to brown red ripple laminated w. mdsto w. possible burrows

Two fining upward sequences, lower set is gray green cross bedded fine to low angle medium ss, large scale clay lined grades rapidly into ripple laminated ripple laminated fine ss which grades to ripple laminated silty & fine ss. Upper set (old ripples) a small climbing ripple sets 1-5 cm thick, grading to rippled silty mdsto. Top set is gray green ripple laminated siltsto grading to ripple laminated mdsto

Gray green ripple laminated fine ss w. ss lens rarely containing to into clay bed.

Gray green poorly sorted fine ss w/ clay clasts at base, structures ruined possible large cross beds.

6" to 2 ft thick calliche pebble congl about 1 thick sharply overlain by poorly sorted subangular-subrounded ss w. silt containing interbedded about 1 ½ to rarely thick ss overlain by a parallel laminated mdsto, siltsto to thin w. a clay drape is truncated by a ripple laminated fine ss & ripple fine ss w. soft sediment deformation w. [illegible]

Gray green to red brown to brown sequences of silicic granular congl fine to 12cm thick grading to ripple laminated silty mdsto to parallel laminated silty mdsto from 1 to 4 feet thick, calcite cement w/ soft sediment deformation

Gray green ripple laminated fine sand grading to gray orange pink ripple sandy siltsto grading to brown mdsto grading to gray orange pink rarely sorted medium ss w. clay clasts & calcite cement grading to gray green laminated parallel laminated fine ss w. abundant mica & organics to ripple which grades to gray orange pink ripple laminated sandy siltsto.

Brown white w. trace of silt.

Gray green apparently medium fine ss, moderate sorting subround to round grains w/ mdsto intraclasts at base, interbeds organic and or opaque minerals. Soft sediment deformation just below unconformable interval, gravel bedded ripple laminations & parallel lamination sequences

Abundant mica flakes.

Gray green cross bedded grain supported pebble congl, abundant calcite cement larger pebbles flattened. 10% siltsto fragments, medium ss & silt matrix, subround to round grains

Gray green cross-bedded medium ss grading upward to pebble congl grading to fine ss w/ calcite cement, 80% silt pebbles

Gray green matrix supported pebble congl grading upward to medium ss, predominantly medium grading to fine ss, mica very abundant, calcareous cement & fine organic or opaque minerals common

Gray green cross-bedded medium ss, abundant rock fragments & mica, fine organic material interbedded intraformation scour, subround to rounded grains moderate to poor sorting, calcareous cement.

Logged by S2 Date 8.85

Date

Checked S.H. Date 1.85

Transcribed by S.H. LH Date 1.85

Updated Date

Updated Date

WELL

COUNTY

DATE

INTERVAL

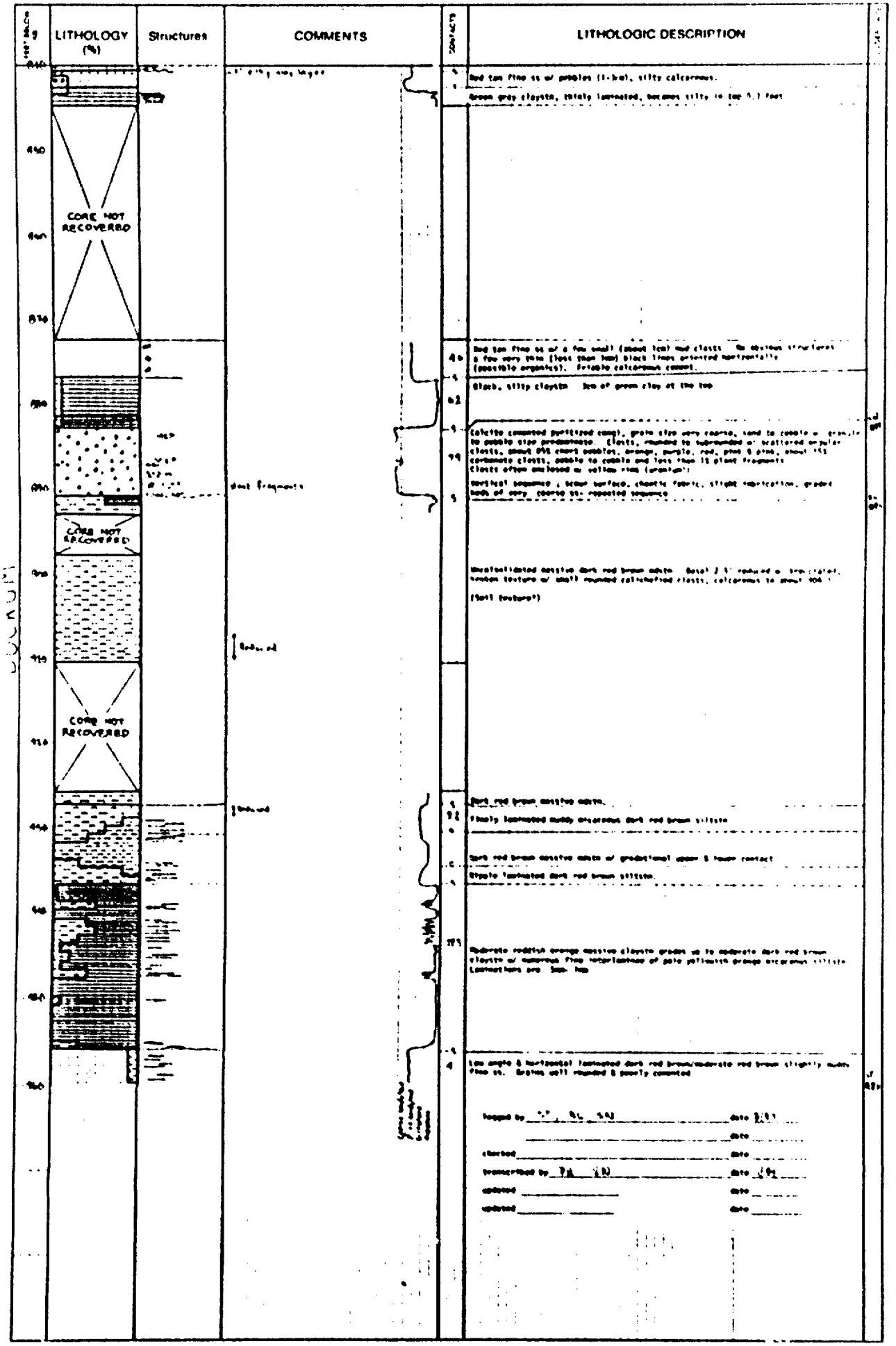
DIAGRAM

LOGGED BY

	LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION

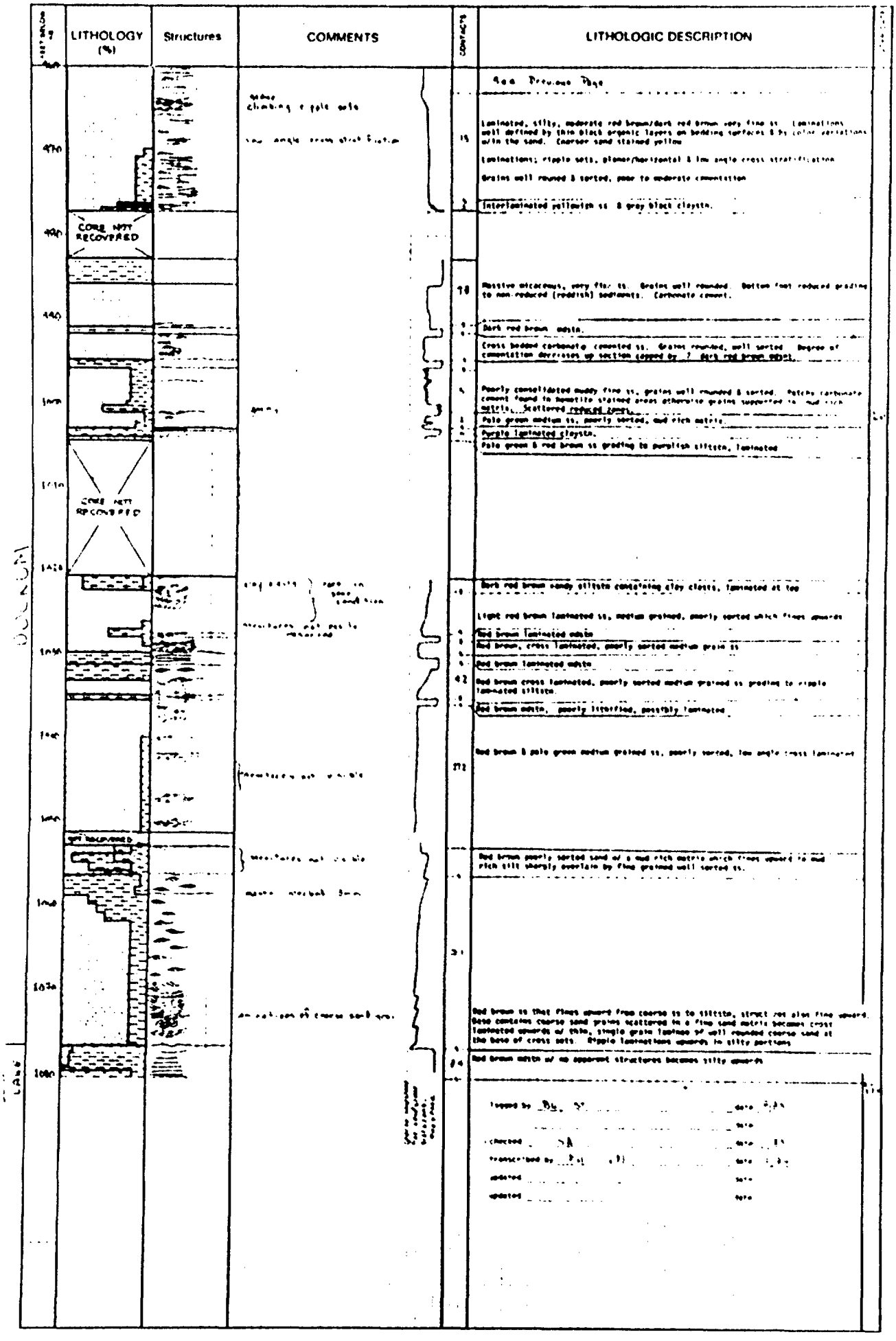
WELL J. Fremel COUNTY Deaf Smith DATE August 1985

INTERVAL 840-960 DOCKUM LOGGED BY SJ, DJ, BG, SM, CW, MC, PM



WELL J Friemel COUNTY Deaf Smith DATE August 1983

INTERVAL 960 - 1080 DOCKUM, Dewey Lake LOGGED BY BL, ST, SN, DJ, Rd, JS, DM



Logged by BL, ST, SN, DJ, Rd, JS, DM

Typed by DM date 8/84

checked date

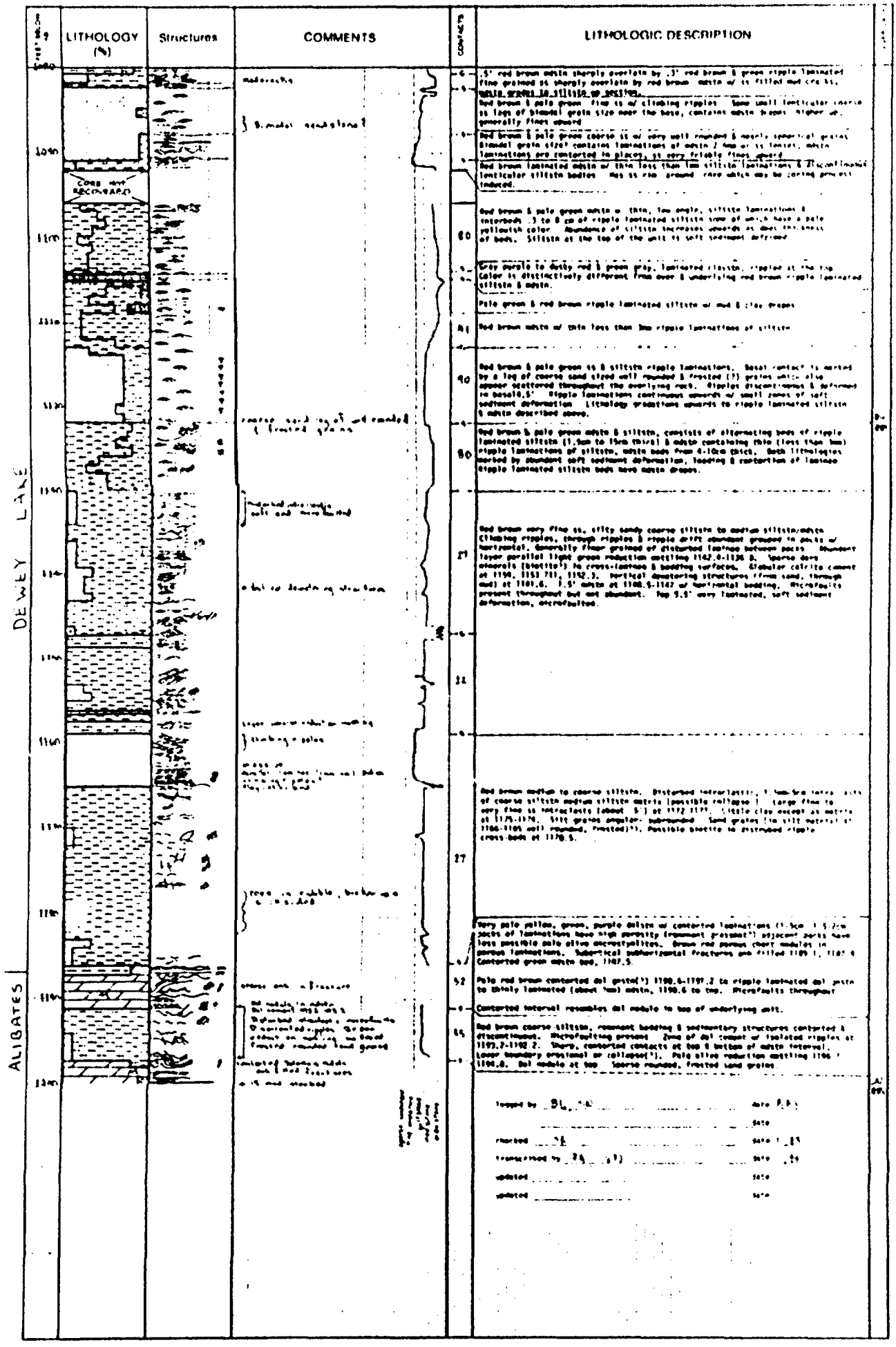
transcribed by date

entered date

updated date

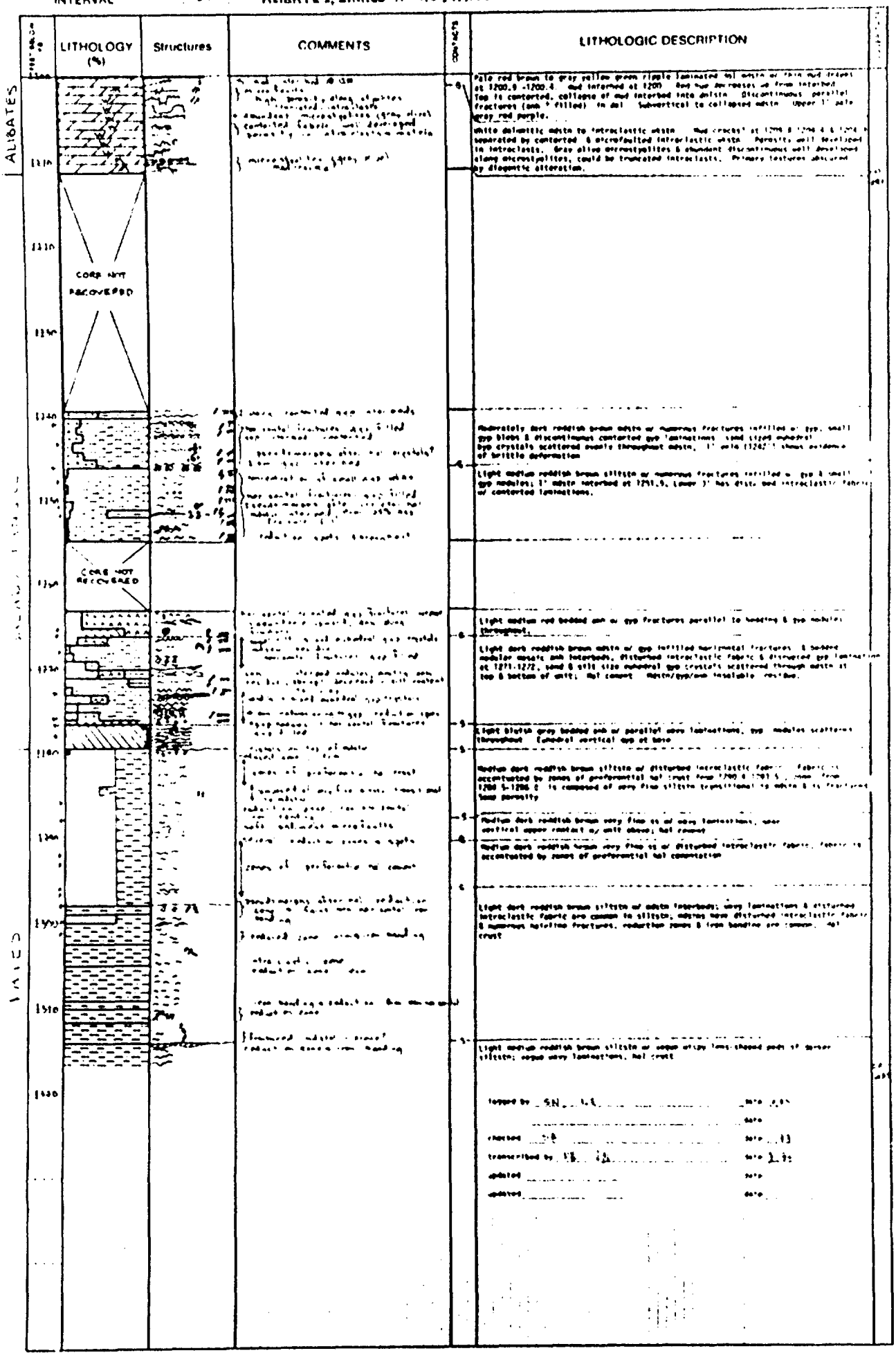
WELL J Friemel COUNTY [illegible] DATE [illegible]

INTERVAL 1080 - 1200 DEWEY LAKE, ALIBATES LOGGED BY SI, BT, BG, SH, CW, DE, PA



WELL ... Fresnal COUNTY Deaf Smith DATE ...

INTERVAL 1200' 1317' ALIBATES, SAN ROO TRANSIT, YATES LOGGED BY SN, DJ, BG, SN, KW, ...



WELL 3 Fasken

COUNTY Lea County

DATE August 1985

INTERVAL 1314' - 1450'

YATES, UPPER SEVEN RIVERS LOGGED BY CSU, WA, MG, SM, CB, EH

YATES

UPPER SEVEN RIVERS

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
CORE NOT RECOVERED		reduction zone		
	massive	microfaulting along nodular bed; small gypsum nodules (average 4 grains 2-5mm)		Light dark reddish brown wavy laminated very fine ss/mdst, irregular low-relief pods of mdst & microfaulting along mdst laminations in mid portion of unit; isolated lens-shaped pods of ss in upper portion; transitional to disturbed intraclastic fabric, possible ripple laminations in mid portion of unit; hal cmt
		Dark reddish brown mdst w/ disturbed intraclastic fabric, gradual increasing ss content to top of unit, core is highly fractured, bottom 6" crumbly & disorganized; fractures filled w/ gyp, hal crust		Dark reddish brown mdst w/ disturbed intraclastic fabric, gradual increasing ss content to top of unit, core is highly fractured, bottom 6" crumbly & disorganized; fractures filled w/ gyp, hal crust
		Light dark reddish brown siltsts w/ wavy to contorted laminations, thin wispy lens shaped pods of dark reddish brown mdst & disturbed intra-clast fabric at base; infilling small fractures, one anh interbed, hal crusts, grades into mdst		Light dark reddish brown siltsts w/ wavy to contorted laminations, thin wispy lens shaped pods of dark reddish brown mdst & disturbed intra-clast fabric at base; infilling small fractures, one anh interbed, hal crusts, grades into mdst
		Light dark mottled reddish brown mdst w/ disturbed intraclastic fabric, gyp infilling fractures, poorly cemented & crumbly, nodular & nonlaminated		Light dark mottled reddish brown mdst w/ disturbed intraclastic fabric, gyp infilling fractures, poorly cemented & crumbly, nodular & nonlaminated
				Light medium bluish gray bedded anh w/ 2-20% claystn present as wavy to contorted laminae; collapsed & disturbed intraclastic fabrics at 1342.6'
				Reddish brown claystn, highly fractured & crumbly, gyp infilling fractures; hal cement
				Disturbed intraclastic fabric at base
				Medium light bluish gray massive anh w/ wavy claystn laminations & interstitial filling
				Medium reddish brown claystn, highly fractured & crumbly w/ discontinuous gyp infilling fractures; hal cement
				Light dark bluish gray bedded anh; lower 5cm is composed of hal pseudomorphs after prismatic gyp & relict gyp crystals which are now anh, bedding is wavy to crinkled & disrupted in central portion
				Reddish brown chaotic claystn-hal rock (type D hal) average 30% hal, claystn content greatest at top & bottom of bed, claystn intraclasts (2-4mm) in sandy matrix at base of unit; 10cm of recrystallized hal at 1361
				Red brown claystn/hal, minor anh in angular brecciated & ripple laminated fabric; present in some claystn clasts
				Colorless, cloudy, recrystallized anh/hal rock (1 lower 4.5' is 5 anh interbeds grading to pinkish recrystallized anh/hal rock(upper 1.5'); irregular interbedded anh tends to occur as thin subhorizontal, radially undulating surfaces & as white bodies of fine hal, giving cloudy appearance & becoming pink-ish in upper 1'; Chevron & hal pseudo/gyp abundant in lower 1.5' small (1-2 mm) hal crystals have jig saw like appearance becoming clear & larger (greater than 5mm) in upper 1.5'
				Red brown chaotic mdstn -hal rock (D), 30-50% interstitial clay, Percent clay increases upward
				Very light red brown coarsely crystalline hal rock (1-2% interstitial clay at 1386', 5% interstitial anh at 1390'; lesser amount of interstitial anh & clay throughout. Probable vug cavity fill (no well defined walls or floors); vug size increases upward (2-4mm)
				Red brown chaotic mdstn-hal rock(D, 40% hal) small claystn nodules preferentially brecciated,
				Red brown recrystallized anh hal rock (1 lower 2.5' is chaotic mdstn hal rock (1 upper 10.5'). 15-40% interstitial clay. Generally hal crystal size, claystn interstitial bodies, size & clay abundance increase upwards. Type F has irregular anh bodies w/ offshoot stringers defining grain boundaries with a surrounding hal matrix
CORE NOT RECOVERED				
		~45% vugs uniformly & elongated vugular nodules		Red brown muddy hal (about 40% hal, D type), interstitial clay (mud) preferentially distributed in small bodies (1mm-1cm)
		vugular nodules filled w/ hal		Red brown recrystallized hal (E/F type) w/ interstitial anh/gyp (about 10%) & red brown clay (less than 3%), hal is equant
				Yellow red orange, gray anh, thinly laminated to nodular, 10% hal in top 1' lower part has thin pink dol partings & zones of hal pseudomorphs after gyp (less than .1-1cm).
				Reddish brown hal cemented fine & very fine ss, disturbed intraclastic & massive, angular bodies of clear hal (.1-1cm) & tiny anh nodules sharply overly thin silt & clay layer coarsening up section at base.
		Tiny vug nodules (< 5mm) in this zone		
		hal filled (D type) pink anh		Reddish brown chaotic mdstn hal grading up section to recrystallized anh hal (impurity returns to clay in top .3' of the unit
				Reddish orange & pale olive laminated anh grading up section to white laminated anh w/ zones of tiny hal pseudomorphs after gyp (less than 1-3mm)

see next page

logged by CSU, WA date 5-85

checked SH date 1-86

transcribed by SH, SM date 2-86

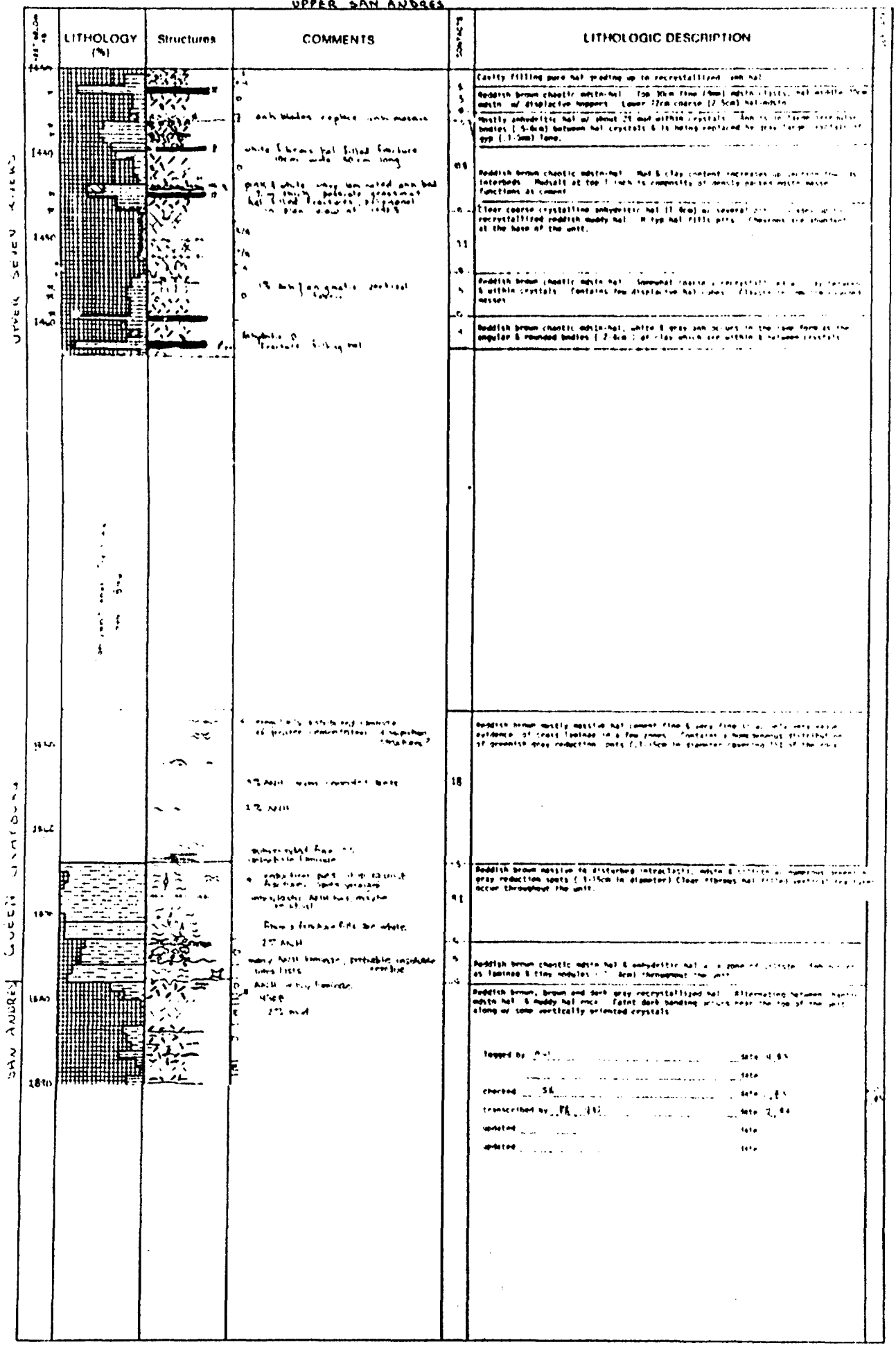
updated date

updated date

WELL J. Fremel COUNTY Lea & Eddy DATE Nov 84

INTERVAL 1450 - 1850 UPPER SEVEN RIVERS, QUEEN, GRAYBURG LOGGED BY SL, DT, AL, [illegible] DE, TA

UPPER SAN ANDRES



Logged by [illegible] date 4-85

[illegible] date

checked SL date 4-85

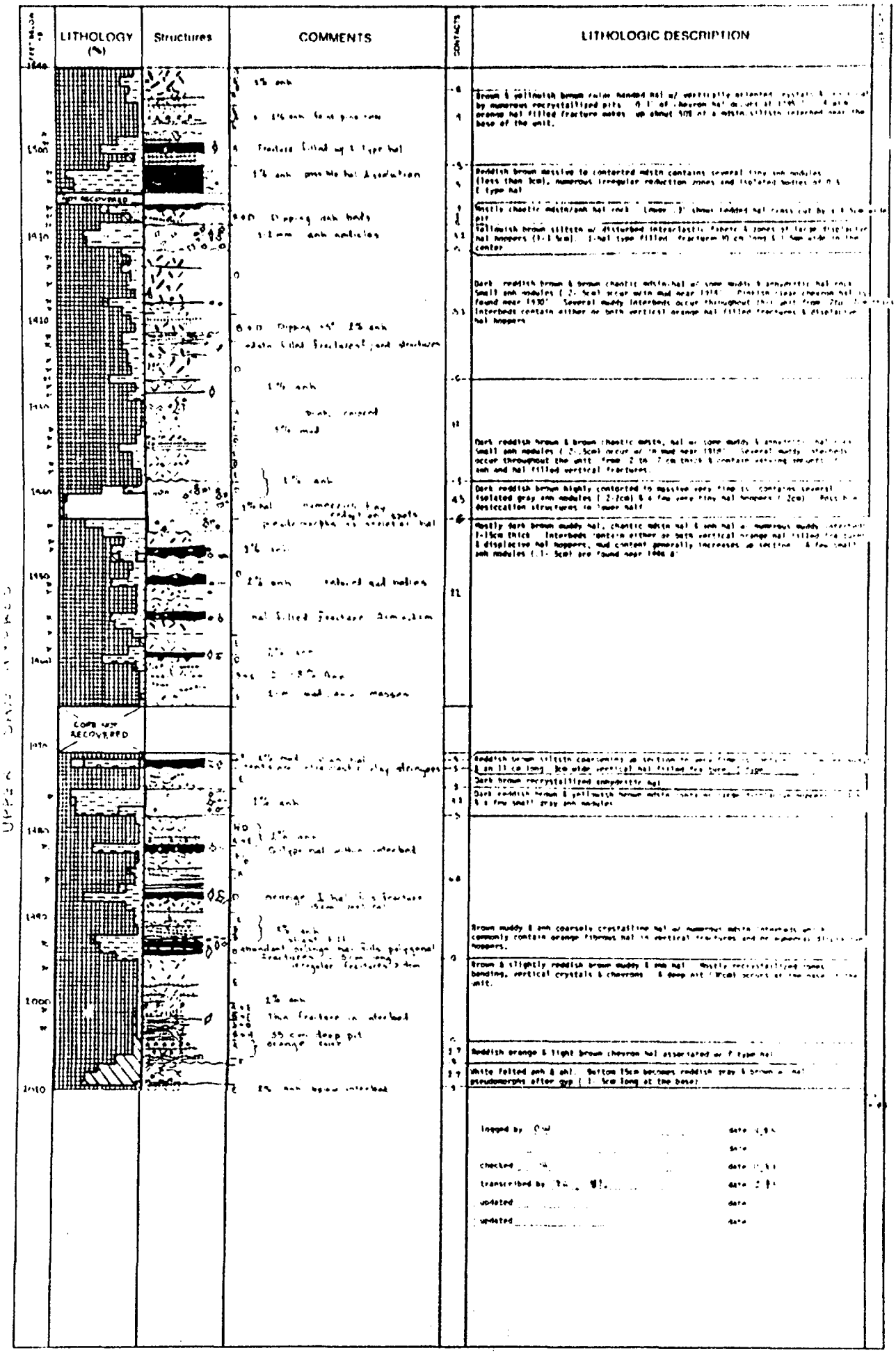
transcribed by PK, DT date 2-86

updated [illegible] date

updated [illegible] date

WELL 3 Fenimal COUNTY Deaf Smith DATE October 1984

INTERVAL 1840' 2010 UPPER SAN ANDRES LOGGED BY [illegible]



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transcribed by [illegible] date [illegible]

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updated date

WELL J Freeman COUNTY Lea/Smith DATE

INTERVAL 1810 2130 UPPER SAN ANDRES LOGGED BY

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
				Brown to reddish brown hal w/ numerous interbeds of both mud & anh vertically oriented crystals & dark banded hal grading up to recrystallized muddy & anh hal w/ zones of chaotic mdstn hal. Much of the mud grades into the anh and crystal sizes tend to coarsen upwards.
				Light gray white & red laminated anh packed w/ hal pseudomorphs after gyp [.1-1 5mm] w/ a 3 cm E type hal at the top. Top includes displacive hal cubes (2cm) at top
				Interbedded dark brown rippled very fine ss & red & white laminated anh w/ hal pseudomorphs after gyp [.1-1 5mm] w/ a 3 cm E type hal at the top. Horizontal cracks & irregular voids in ss are hal filled.
				Dark brown chaotic mdstn hal w/ some euhedral displacive hal cubes (1cm) in mud
				Brown banded hal w/ vertically oriented crystals up to 4 cm long. Banding is cut by a pit 10 cm deep at 2034.6'.
				Pink chevron hal rock w/ vertical crystals grades up to light brown in color
				Color-banded vertically-oriented bedded (B-Type) hal transitional to anhedral muddy (E-type) hal. Mdstn percentage varies from 2-30% , chaotic mudfill is present in zones w/ high mdstn percentages; abundant mdstn interbeds, reddish brown to dark gray in color; 8cm of chevron hal at top.
				Chaotic mud salt (D-type) transitional to anhedral muddy (E type) hal, bottom portion is characterized by large solution pits containing thick reddish brown to dark gray mdstn, large displacive hal hoppers, & anh clasts. mdstn content & hal crystal size increases upward, small fractures filled w/ red fibrous hal at top.
				Light medium bluish gray anh (60-80%) composed of alternating contorted beds of anh & hal pseudomorphs after twinned gyp, pseudomorphs increase in size & become better formed upward; largest pseudomorph is 1 cm in length.
				Medium dark gray nodular aphanic anh; interstices between nodules filled w/ dk gray mud; small (1-2mm) salt crystals at top of unit
				Light olive gray dolostone, 20 cm containing red anh nodules, burrows & wispy laminations
				Reddish brown to olive gray very fine ss/siltsto, abrupt color change at 2115.4 Contains displacive hal hoppers, disturbed intraclastic fabric & contorted laminae, vertical fractures filled w/ fibrous hal; red anh nodules in upper portion
				Chaotic mudstone (D-type hal) transitional to anhedral muddy (E type hal). Mdstn is reddish brown in color w/ some light olive gray reduction zones. Mdstn percentages vary from 15-75%, present as interstitial material between grain boundaries & as interbeds, interbed at 2090' is 30cm thick & contains displacive hal hoppers & vertical fracture filled w/ deep orange fibrous hal; some of vertically oriented hal crystals, chevrons & cubic corrugation zones at 2085.4'
				Color banded, vertically oriented bedded (B-Type) hal w/ 5% reddish brown mdstn in the form of thin interbeds & interstitial between grain boundaries, less than 1% anh as thin interbeds & drapes & finely disseminated between grain boundaries, thin zone of chevron hal at 2106'
				Vertically oriented bedded (B type) hal transitional to anhedral muddy (E type), contains 5-10% mdstn in the form of interbeds lining solution pit floors & interstitial between grain boundaries, banded (B-type) hal is best preserved in basal & mid portions of unit & becomes less well preserved upward
				Anhedral anh/hal w/ continuous & discontinuous anh interbeds & interstitial anh outlining grain boundaries, transitional to anhedral muddy hal (E-type) contains 15cm of vertically oriented (B-type) hal at 2121', small solution pipes & voids filled w/ anh.
				Light medium bluish gray anh (about 75%) w/ small (1mm) hal filled cavities & hal pseudomorphs after zoned gyp crystals (up to 2 cm in long direction), discontinuous anh laminations at base.

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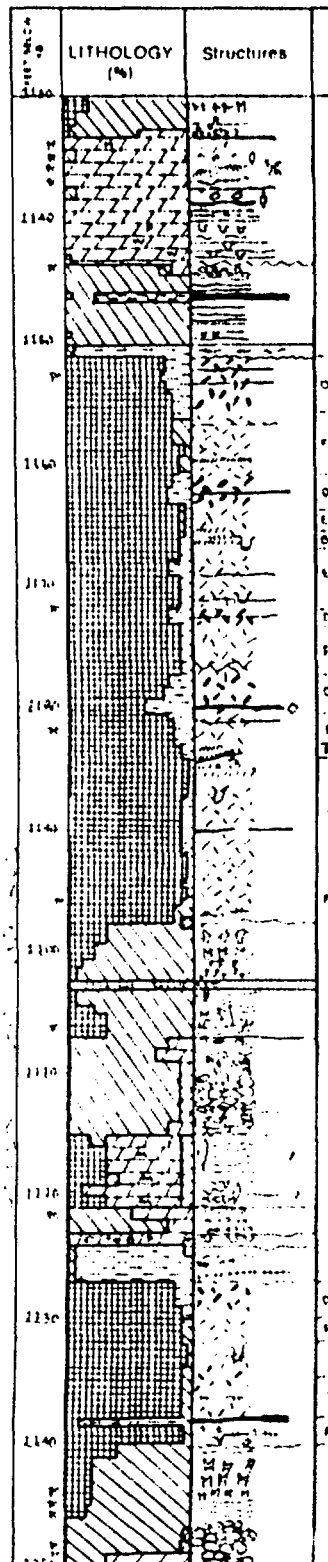
WELL J Trammel COUNTY Lea DATE [illegible]

INTERVAL 2130 2250 UPPER SAN ANDRES LOGGED BY [illegible]



FEET	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
2130					
					Gray thinly bedded anh w/ tiny hal pseudomorphs after gyp. Bottom 4 highly contorted dol & anh nodules (.1-1cm) & laminations.
				10S	Blue light olive gray & greyish yellow white horizontally laminated hal cemented dolosts. Containing isolated zones of fracture filling cal & anh & anh nodules (.2-2 3cm). Some black algal laminations, bioturbations & ripples. Top 1.5' becomes highly fractured. Fractures randomly vertical orientation 5-3cm long.
2140					
					Gray bedded anh contains numerous reddish brown laminae. Top 1' becomes nodular in a dol matrix.
2150					Black dark gray & reddish brown mdstn w/ moderately contorted anh stringers.
					Chaotic mdstn hal, reddish brown mud bodies .2-2 3cm
			Pink color		Mostly dark gray to brown recrystallized anh hal but there color change to moderate orange pink from 2157.6-2159.5
2160					Chaotic mdstn hal, angular mud bodies (.5-2cm) vary in color from reddish brown at base to brown at the top
					Recrystallized muddy hal mostly reddish brown & gray. Mud mdstn between crystals. Thin zone of cavity filling hal at 2171. Bedding (dark bands) in cross section. 1 1/2cm deep pit at 2165'
2170					Very muddy recrystallized hal. Mud grades up section reddish brown to dark gray.
					Recrystallized hal w/ dark gray mud between crystals & reddish mud between crystals.
					Recrystallized hal w/ large pieces of reddish mud (1-3cm) between & in crystals. Mud becomes grayer at the top.
2180					Recrystallized muddy hal, mud is both red & gray.
					Bedded muddy hal
					Recrystallized muddy hal. Top 1 foot contains some evidence of bedding. Minor traces of anh are found near the bottom & the middle of the unit.
2190					
					Recrystallized hal grading up section from dark brown to light yellow. Top 1' contains traces of hematitic mud.
					Folded anh in hal matrix; trace mdstn at top.
2200					Numerous large (3-6cm) anh & hal pseudomorphs after gyp resting bedded anh.
					Bedded anh w/ very small gyp pseudomorphs between bedding.
					Thinly laminated anh w/ long (1-10cm) hal pseudomorphs after gyp.
					Nodular & bedded anh & dol w/ traces of hal filled porosity. Some dol intervals contain crystalloblastic anh.
2210					Nodular anh (.1-4cm) w/ mostly dol matrix. Nodules at base have yellow green or reddish centers.
					Yellowish blue to gray laminated dol mdstn w/ long vertical fractures filled w/ orange fibrous hal. Tiny anh nodules (less than 1cm) throughout but more in top portion. Bottom half is well bioturbated, top silty.
2220					Gray anh nodules become supported in dol matrix. 10cm
					Dol mdstn (tan) & mdstn (gray) burrowed.
					Dark gray anhydritic mdstn, disrupted intraclastic texture.
					Dark muddy recrystallized hal w/ angular mud bodies (2-4cm).
2230					Mostly recrystallized hal w/ some relict bedding of mud & anh.
					Dark banded hal w/ numerous fractions by pits & pipes of recrystallized hal w/ anh layers at the bases.
					Minor discontinuous anh interbeds in hal. 2 5cm of anh just above mdstn interval.
			Reddish brown nodular dol & anh nodules in tan hal, moderate bioturbation, pseudo morph, precipitation zone upper 10 cm		Hal sparse chevrons, discontinuous anh partings, anh cavity fillers?
2240					Incremental laminated anh grainstone up to interlaminated hal & anh (contorted) grading up to large scale herringbone hal & anh after gyp pseudomorphs.
					Med gray nodular to nodular massive anh w/ intermodular dol matrix. Dol proportion decreases up section.
2250					Yellow brown ripple laminated mdstn/wkstn, abundant anh nodules.

logged by CW date 9-84

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checked [illegible] date 4-85

transcribed by TA date 4/85

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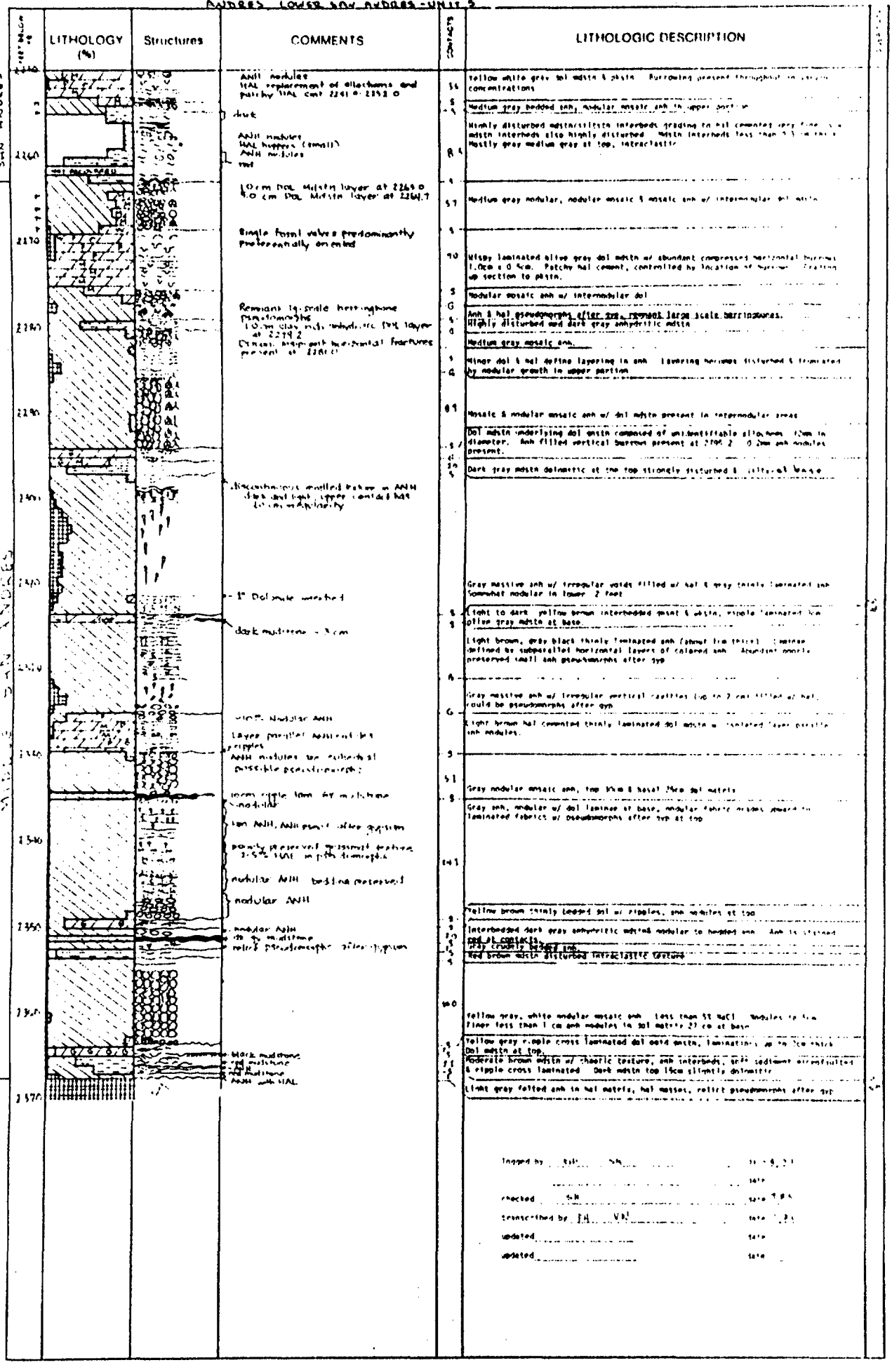
WELL J Fremel COUNTY Deaf Smith DATE August 1984

INTERVAL 2250 2390 UPPER SAN ANDRES, MIDDLE SAN ANDRES, LOWER SAN ANDRES-UNIT 5 LOGGED BY SH BL DJ LL KH PH



Logged by SH date 8-21

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checked SH date 9-84

transcribed by PH VH date 1-85

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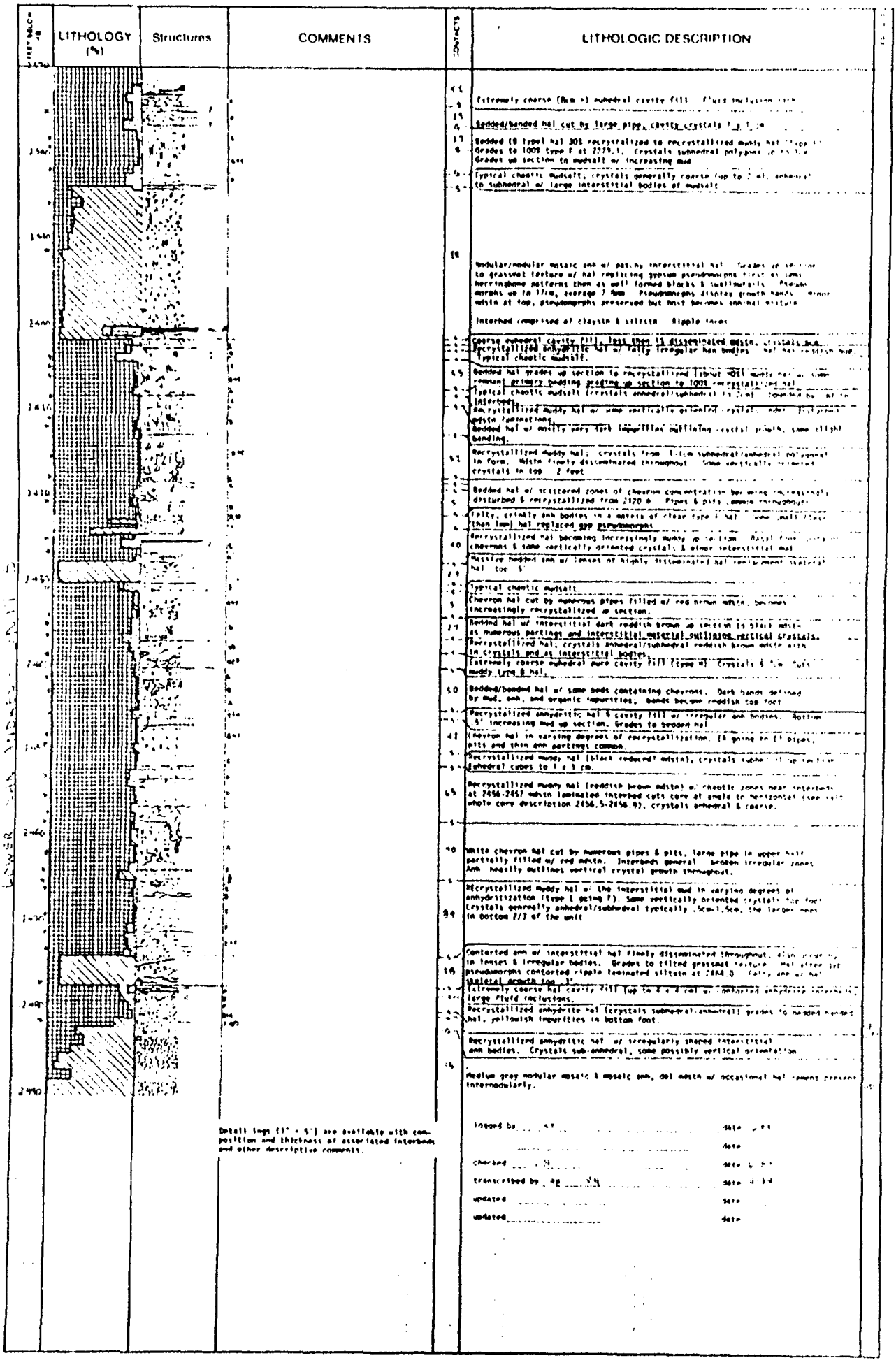
WELL J. Fromel COUNTY Deaf Smith DATE

INTERVAL 2310 2490 LOWER SAN ANDRES - UNIT 5 LOGGED BY



Detail logs (1" = 5') are available with composition and thickness of associated interbeds and other descriptive comments.

Logged by date

date

Checked date

Transcribed by date

Updated date

Updated date

WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

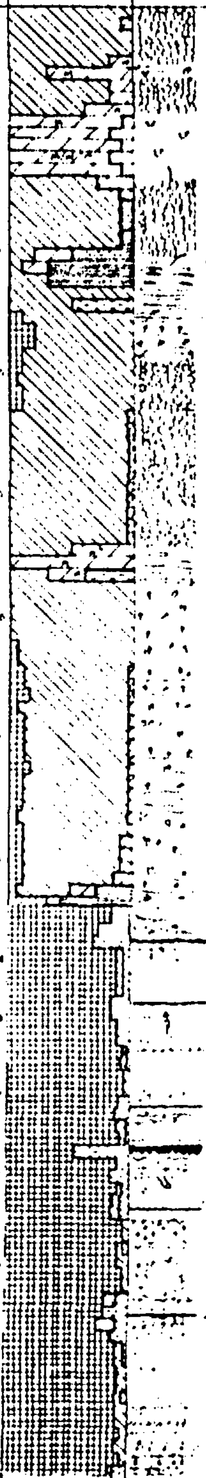
INTERVAL 2490 2610 LOWER SAN ANDRES - UNIT 5 / UNIT 4 LOGGED BY [illegible]

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION

2490, 2500, 2510, 2520, 2530, 2540, 2550, 2560, 2570, 2580, 2590, 2600, 2610

LOWER SAN ANDRES - UNIT 5

LOWER SAN ANDRES - UNIT 4



Lithologic description:

See Previous page

Light olive gray to yellow white gray burrowed (?) mdstn/wkstn

Medium gray nodular mosaic anh w/ dol as internodular material

Yellow/white gray limey dol w/ patchy hal cement, [illegible] fragments hal replaced

Light gray to medium light gray nodular mosaic anh w/ dolomitic terrigenous [illegible] present as internodular material

Olive gray dolomitic terrigenous claystn, laminated. Very fine [illegible] disturbed intraclastic at base

Bedded, massive anh w/ minor terrigenous clay defining bedding

Grassmat hal after gyp pseudomorphs w/ pseudomorphs up to [illegible]

Medium gray mosaic anh w/ dol present on some sides of the nodules

Grayish olive to yellow white gray dol mdstn overlain by [illegible] underlain by dark gray anhydritic mdstn

Medium gray to medium dark gray anh w/ yellow gray ripple laminations [illegible] of dol

Gray black anhydritic claystn. Contorted intraclastic texture

Banded B type hal w/ well developed interstitial disseminated bands of mdstn & minor anh; vertically oriented crystals are 1 to 1.5cm high. Bedding is transected by pipes & pits. The unit contains an interbed unit (less than 1') of D type hal.

Anhedral hal w/ interstitial bodies of mdstn w/ contorted silt laminations & anh nodules. D-type hal; The D-type hal contains an interbedded zone of H type Crystal mosaic of crystals up to 3cm & a zone of F type hal, anhedral crystals w/ discontinuous irregular anh laminae mixed w/ D-type hal.

Banded B type hal w/ vertically oriented crystals about 1cm high, transected by a large pipe filled w/ hal & irregular bodies of red brown mdstn

Mixed E & F type hal w/ pipes at the base protruding into underlying A type A hal w/ chevron fluid inclusions & vertically oriented crystals 2 cm high.

Predominately F type hal of anhedral crystals w/ discontinuous, irregular anh laminations mixed w/ vertically oriented crystals w/ chevrons at the base & also mixed w/ E type hal throughout.

Clear coarse crystal mosaic of H type hal w/ minor interstitial anh & a concentration of anh at the base

Type D hal, chaotic mudsalt w/ interstitial bodies of contorted & disrupted laminated siltstn & mdstn. The unit contains isolated patches of banded B type hal

Bedded & banded B type hal w/ vertically oriented crystals & bedding marked by disseminated bnad of anh & mdstn. At 2600.5 there is a planar crack about [illegible] deep filled w/ gray mdstn. The B type hal contains a zone in which the banded hal is becoming partly recrystallized anhedral hal w/ interstitial bodies of anh F type hal.

Bedded A type hal w/ chevron fluid inclusions & anh drapes & pipes

See Next page

Detail logs (1" - 5') are available with composition and thickness of associated interbeds and other descriptive comments.

logged by [illegible] date [illegible]

date

checked SH date [illegible]

transcribed by [illegible] date [illegible]

updated date

updated date

WELL [illegible] COUNTY [illegible] DATE [illegible]

INTERVAL [illegible] LOWER SAN ANDRES UNIT 4 LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
			4	Complex interval of primarily F type hal of anhedral crystals w/ interstitial anh; this is mixed w/ a 75' interbed of banded B type hal at 2612' that has horizontal bedding. At 2609' it contains an interbed of D type hal & at the base it is mixed w/ zone crystals containing chevrons
			6	Red brown & pale green siltsh w/ mdstn drapes; simple laminated to distorted & disturbed
			14	Poorly developed B type hal w/ chevron fluid inclusions; bedding not well marked, contains zones of recrystallization. F type hal contains pits filled w chaotic mudsalt zone pink color
			4	D type hal, chaotic mudsalt, anhedral hal w/ interstitial bodies of red mdstn containing anh nodules.
			6	Banded B type hal going to F type, crystals anhedral, bands composed of vertically oriented crystals, contains interbeds
			5	red brown mdstn disrupted & contorted textures w/ orange fibrous hal filled fractures.
			88	Anhedral hal w/ interstitial mdstn bodies; D type, chaotic mudsalt & small patches of banded B type hal at the base & an elongate patch of banded B type hal w/ chevron fluid inclusions at the top. Some mdstn & anh beds have horizontal orientations.
			5	
			110	Predominately banded B type hal w/ vertically oriented crystals & disseminated mdstn & anh drapes & partings, bedding is transected by pipes & pits of recrystallized hal. Also contains localized zones of B type hal w/ chevron fluid inclusions & zones of E & F hal also of anhedral hal w/ interstitial laminations of mdstn & anh, laminations are discontinuous & fluid inclusions are few, these zones occur predominately bordering interbeds. Many mdstn beds are cracked
			5	
			9	Anhedral hal w/ interstitial laminations of anh, little internal structure
			4	
			19	Banded B type hal w/ p ts & pipes filling w/ clear hal, banded hal has vertically oriented crystals & disseminated interstitial material
			4	Chaotic mudsalt, D type hal, anhedral crystals w/ interstitial bodies of mdstn.
			5	
			27	Banded, B type hal w/ vertically oriented crystals & dark disseminated mdstn throughout
			6	
			60	Banded B type hal going to F type, anhedral crystals w/ interstitial laminae of mdstn & minor anh, these lithologies are mixed w/ D type chaotic mudsalt
			6	
			40	Bedded & banded B type hal, at the base 1' it is mixed w/ A type hal w/ chevron fluid inclusions, both types are transected by pits w/ insoluable residue & zones of coarser crystalline hal. Bedding is marked by disseminated bands of mdstn & anh w/ some interbeds of mdstn & anh drapes
			4.0	Orange/yellow hal; interbedded B & F hal types, & D thin, & anh partings & drapes. Stringers of anh completely surround vertically oriented crystals, chevron fluid inclusions are poorly preserved
			6	
			60	Bedded B type hal w/ vertically oriented crystals, disseminated anh bands & wisps transecting bedding. Contains a one foot interbed of A type hal w/ chevron fluid inclusions & small zones of recrystallized hal
			6	
			40	Bedded hal w/ well developed chevrons fluid inclusions pipes cutting bedding & anh drapes & partings.
			5	
			55	Predominately bedded B type hal w/ local zones of recrystallized anhed. hal w/ interstitial anh & mdstn
			6	
			27	Anhedral hal w/ interstitial bodies of red brown mdstn containing disturbed silt laminae-D type hal, base of unit is a large pit w/ insoluable residue at base.
			5	
			63	Bedded B type hal w/ vertically oriented crystals & predominantly anh drapes & partings w/ one zone of A type hal w/ chevron fluid inclusions (see left), contains pipes transecting bedding.
			5	
			49	Milky white bedded A type hal w/ abundant & well developed chevron fluid inclusions Crystals are vertically oriented, bedding 1-2cm thick marked by anh drapes Bedding transected by few pipes.
			5	
			40	Anhedral hal w/ angular & irregular shaped interstitial bodies of red brown mdstn D type hal, contains irregular & undulate mdstn interbeds cut across by orange fibrous hal filled fractures
			5	
			90	Bedded & banded B type hal w/ vertically oriented crystals, some bevonned A type hal near top; chevrons poorly developed Bands, transected by pipes of recrystallized hal, contains drapes & partings of anhydritic mdstn
			6	
			10	D type Hal anhedral w/ interstitial bodies of dark red brown mdstn w/ disturbed silt laminae-chaotic or disorganized texture
			5	
			154	Predominantly bedded to banded B type hal, cut through by pits & pipes, also containing localized zones of anhedral, recrystallized E & F type hal. B type hal has vertically oriented crystals, anh drapes, & disseminated mdstn & anh bands Chunks of mdstn in zones of D type hal (see left) are dark gray, breccia-bearing or intraclastic.
			5	
			25	Banded B type hal w/ patches of vertically oriented crystals & disseminated bands of anh going to disturbed F type hal of anhedral hal w/ interstitial anh, contains disturbed irregular anh beds near contact w/ underlying anh

Detail logs (1" = 5') are available with composition and thickness of associated interbeds and other descriptive comments

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WELL J Fremont COUNTY Lea New Mexico DATE [illegible]

INTERVAL 2750' 2850' Lower San Andres - Unit 4 LOGGED BY [illegible]

UNIT 3

FEET	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
				46	Medium gray nodular mosaic anh & interlaminated anh & dol
				5	Oolite-fossil fragment grnst w/ nolites well sorted, ranging locally from micro size of 0.06mm to 0.5mm. Abundant anh & hal replacement of allochems. Mollusk fragments are up to 1 Ocm in length
2750				44	
				5	Mollusk fragments wkstn/mdstn, light olive gray in color
				49	Oncolites at 2754.2- 5 Intraclasts ? 2760-51
				5	
				40	Medium dark gray nodular mosaic & mosaic anh w/ dol mdstn present as intermodular material.
				5	
				30	Yellow gray oolite grstn w/ anh nodules & brachiopod fossil fragments. Oolites are 0.2mm.
				5	
				44	Yellowish gray to grayish olive mdstn grading up section to wkstn. Fair mixing of color variation suggests patchy hal cement.
				5	
				32	Light olive gray to grayish olive burrowed wkstn. Burrows contain lower concentration of fossils, (B-brchs/bivalves).
2800				5	
				60	Yellow gray to light olive gray wispy laminated mdstn w/ compressed horizontal burrows. Hal/calcite cementation variations defined by patchy color differences
				5	
				61	Brach-mollusk phylloid algae (?) wkstn-grstn grading up section to a forams-mollusk grstn w/ mdstn interbeds. Possible encrusting algae or bryozoans variably present.
				6	
				50	Light olive gray mdstn w/ irrational organic wisps, compressed horizontal burrows. Patchy color variations define hal and calcite cement variations. Brachiopod fossils abundant
				6	
				41	Light olive gray bryozoan mollusk fossil fragment packs, hal cement defines lighter patches. Grading to wkstn then mdstn
				5	
				81	Light olive gray bryozoan-mollusk pkstn grading upward to finely dol mdstn wisps present. Burrows slightly compressed. Wisps laminae grayish orange concentrations, up to highly concentrated. Brachiopod valves abundant
2850				6	
				40	Light olive gray to yellow white gray dol mdstn grading to pkstn w/ 1-3 mm burrows. Allochems are mollusk fragments and unidentifiable [illegible]
				5	
				110	
					Medium gray anh w/ intermodular yellow gray dol mdstn
				0	
				70	Yellowish gray sparsely wispy laminated bedded mdstn. Bedded nodular anh present, small nodules.
				5	
				47	Poorly indurated grayish black clayst w/ disturbed siltstn layers & possible starved ripples, anh present as cement, discontinuous & continuous layers, nodules & bedded nodules.
				5	
				50	Recrystallized anhydritic hal (F type) intra & intercrystalline anh present anh more concentrated in crude discontinuous 1cm layers. Hal crystals average less than 1 Ocm, 1 Omm fluid inclusions abundant
				5	
				55	Bedded & hal w/ mdstn laminations & vertically oriented [illegible]
2950				35	Brown to light red brown ripple laminated mdstn w/ interbedded anh [illegible] lenticular bodies of hal & hal hoppers, laminations are contorted at the top

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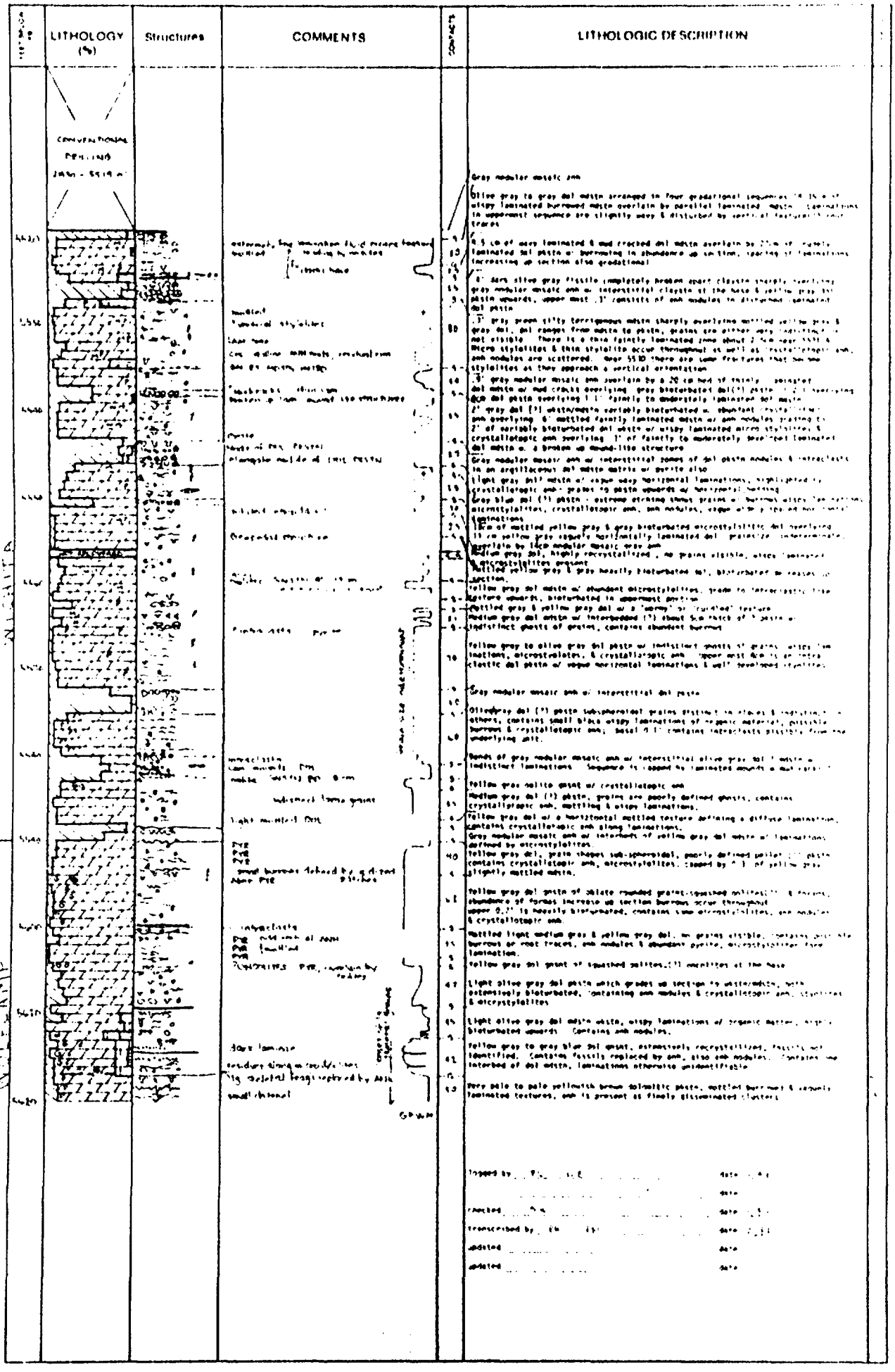
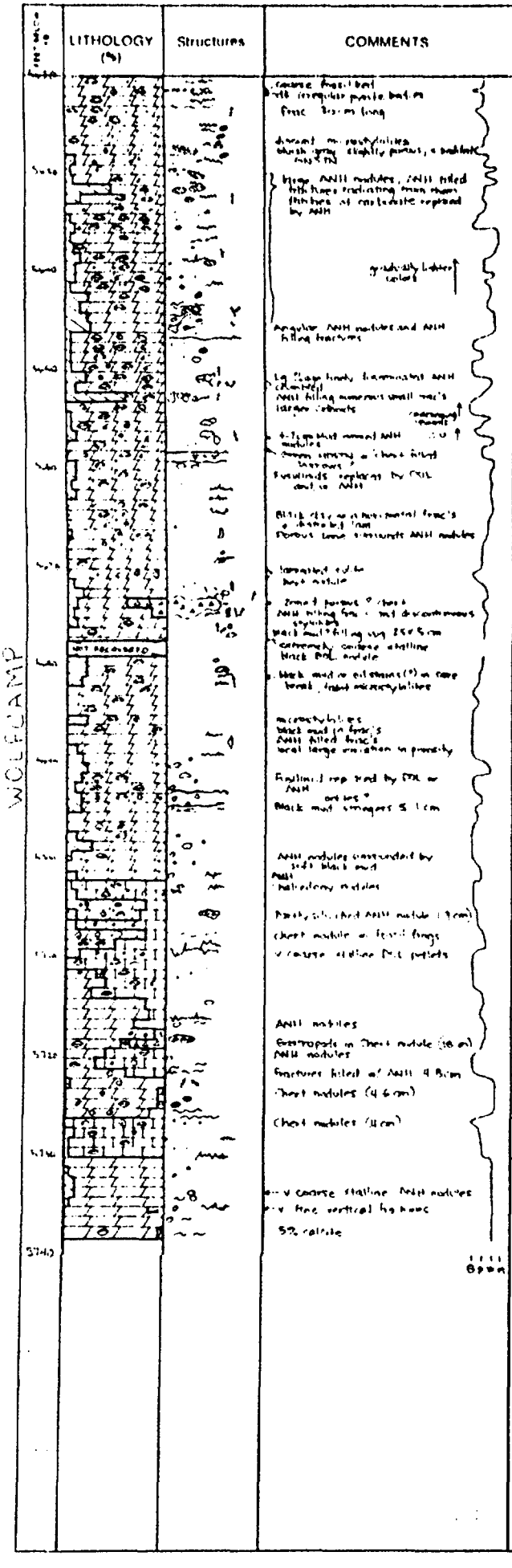
WELL [illegible] COUNTY [illegible] DATE [illegible]

INTERVAL [illegible] WICHITA, WOLFCAMP LOGGED BY [illegible]



WELL [illegible] COUNTY [illegible] DATE [illegible]

INTERVAL 5610 5740 WOLFCAMP LOGGED BY [illegible]



Footage	Samples	LITHOLOGIC DESCRIPTION
5610		
	73	Yellowish gray dol contains abundant stylolites & a few very large anh nodules (4-10cm). Long vertical fractures occur throughout & are often seen radiating from anh nodules, remnant allochems have been completely pseudomorphed. Lower part is massive, cut by stylolites & microstylolites.
	6	
5650	41	Dark gray massive dol w/ dark blue angular anh nodules (2-5cm) & anh filling numerous fractures. Fusulinid molds filled w/ anh are dispersed throughout. Massive, no bedding defined.
	6	
5690	110	Gray massive dol w/ numerous thin fractures & abundant fossils pseudomorphed. Anh "allochems" are all replaced by anh or recrystallized to dol. Lower 2' are very burrowed. Anh also occurs as blue large nodular mosaic areas.
	5	
5730	60	Yellowish gray dol wkstn/pkstn w/ abundant anh pseudomorphed throughout.
	5	
	86	Gray & yellowish gray very porous, massive dolostone. All allochems are recrystallized remnants or filled w/ anh. Some anh nodules are partly silicified & solid chert occurs at 5671.2'. Much of the unit contains fine vertical fractures 1-10cm long. The top 1.5' appears less porous.
	5	
	49	Dark gray, porous coarse crystalline dolomitized wkstn/pkstn. Allochems have been leached away leaving large secondary porosity. Anh nodules generally increase up section in size & abundance & often are partially silicified w/ soft black mud rims.
	5	
	44	Massive partially dolomitized pkst/grnst w/ fusulinids, crinoids, coarse recrystallized dol crystals & isolated anh, chert or chalcedony nodules (1-5cm). Uppermost dolomitized zone shows contorted laminations at 5727.2'. Top contact is an erosional surface.
	6	
	75	Dark gray & yellowish gray, contorted & wispy laminated, mostly dolomitized pkstn/grnst. Contains isolated coarse crystalline anh nodules (1-5cm) & a very large chert nodule at base which contains mollusk fragments. Rare coarse crystalline dol occurs near the chert.
	6	
5730	18	Yellowish gray, coarse partially dolomitized pkstn. Contains fusulinids, crinoids, dol pellets & silicified grains. One anh nodule (2cm) at 5729.
	6	
	42	Dark gray dolomitized Pkstn. Remnant allochems are fusulinids, crinoid columnals & bryozoans. Includes isolated silicified nodules & anh filling 6-8 cm fractures at 5722'.
	5	
	41	Coarse fusulinid pkstn/grnst w/ some dolomitized zones, chert nodules, & a few silicified grains. Fabric shows wispy laminations & is mostly stylolitized in bottom 15cm.
	6	
5740	69	Dark gray wispy & contorted laminated dolostone w/ isolated anh nodules which have micrite rims & some are partly silicified. Calcite component increases above base & fusulinids occur in the lower half. Fine vertical fractures are found at 5734.5'.

No intervals were point counted

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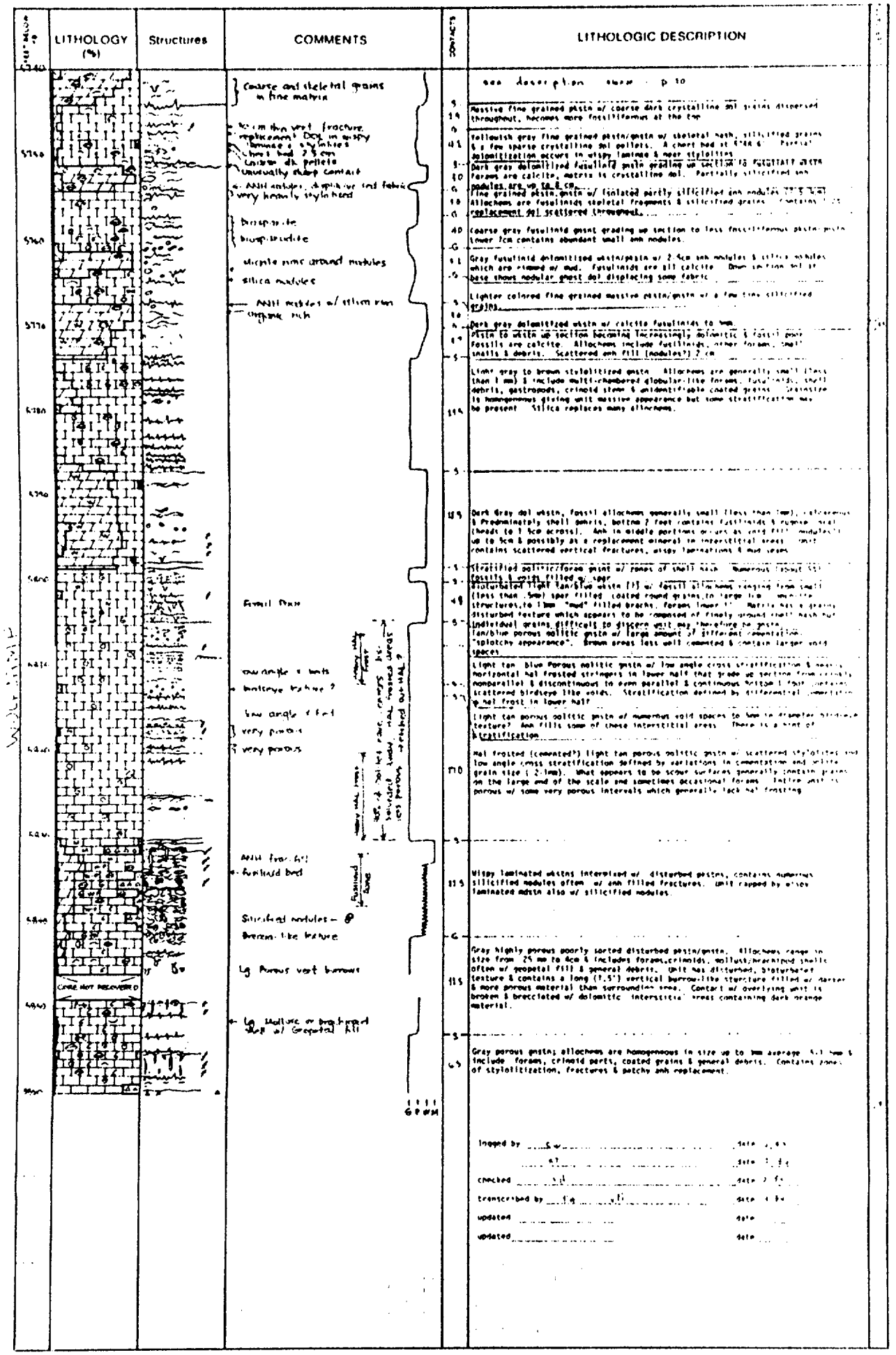
WELL J Fremel COUNTY Deaf Smith DATE

INTERVAL 5740 5960 WOLFCAMP LOGGED BY SF NE BL SD LF FW TH JH



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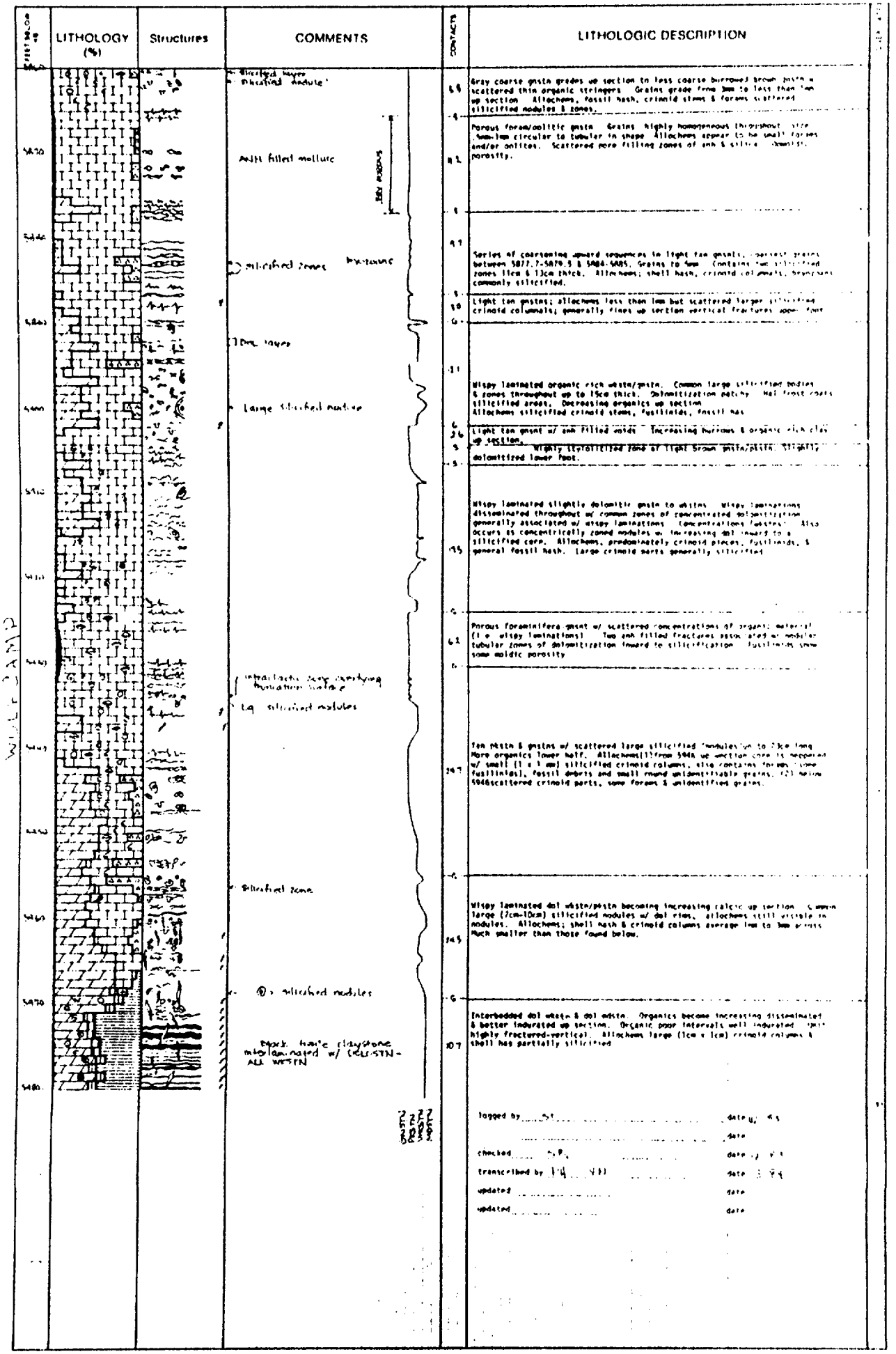
INTERVAL ... 5460 - 5980 ... WOLFCAMP ... LOGGED BY ...



WELL [illegible] COUNTY Deaf Smith DATE [illegible]

INTERVAL [illegible] WOLFCAMP LOGGED BY [illegible]

Feet MD	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
5880					
5940				4.9	Dolomitic, fairly well indurated, black mdstn/claystn to argillaceous dolomite w/ 10-20% fossil allochems primarily crinoid columns & brachiopods often w/ geopetal fill. Fossils are generally partially silicified. Contains scattered zones & pockets of dolastn some w/ silicified algae. The mdstn/ claystn appears bedded which may or may not be original. Has undergone deformation. Fossils don't appear deformed. Unit fractured throughout but fractures less numerous than underlying core.
				6	
6000			Tilting debris flows Slumpfolds Lamp joint - pods Common siliceous layers	10.9	Mud-rich nodular-like carbonate argillaceous mdstn/wkstn interbedded w. fossiliferous (wkstn) clay-mud stones unit has undergone alot of diagenesis giving it a highly disturbed look. The carbonate 'nodules' are well cemented & contain an enclosing siliceous ring, are generally zoned inward: silica, dolomite, limestone mud w/ silica replaced fossil allochems. The lithology outside these 'nodules' is a melange of well indurated, bioturbated muddy dolomite & black shales w/ calcic allochems only partially silicified if at all, most common & the largest present, in the shaley zones. Allochems include, crinoid columns (up to 1cm x 1cm in shale), brachiopods commonly productids w/ geopetal fill, mollusks, forams, possible algae bodies & scattered rugose coral Unit full of calcite filled vertical fractures & contains scattered partially to totally filled calcite voids Plate at 6010-6012.8 high diversity, small fossils average 1mm & never 1 foot contains tilting, graded crinoid debris flows in lime mud matrix
6060					
6120			shaley breaks		
6180					Note: estimating lithologies in shale core proved extremely difficult, especially delineating mud:clay & dol fractions, actual % of dol might prove to be less after petrographic analysis.
6240					
6300				35	Black dolomitic claystone becoming somewhat better indurated from 6427.5 up section. Contains disseminated small white calcic flecks less than 1mm (shell hash) & scattered small brachiopods up to 1.5cm (average .5-1cm) throughout. Shell hash less than 3% below 6437.0 increasing up section. Horizontal burrow traces throughout on bedding surfaces. Fractures from 6427 up section possibly due to coring. Note: petrographic analysis may give different dol %.
6360			1.5cm brachiopod		
6420					
6480					

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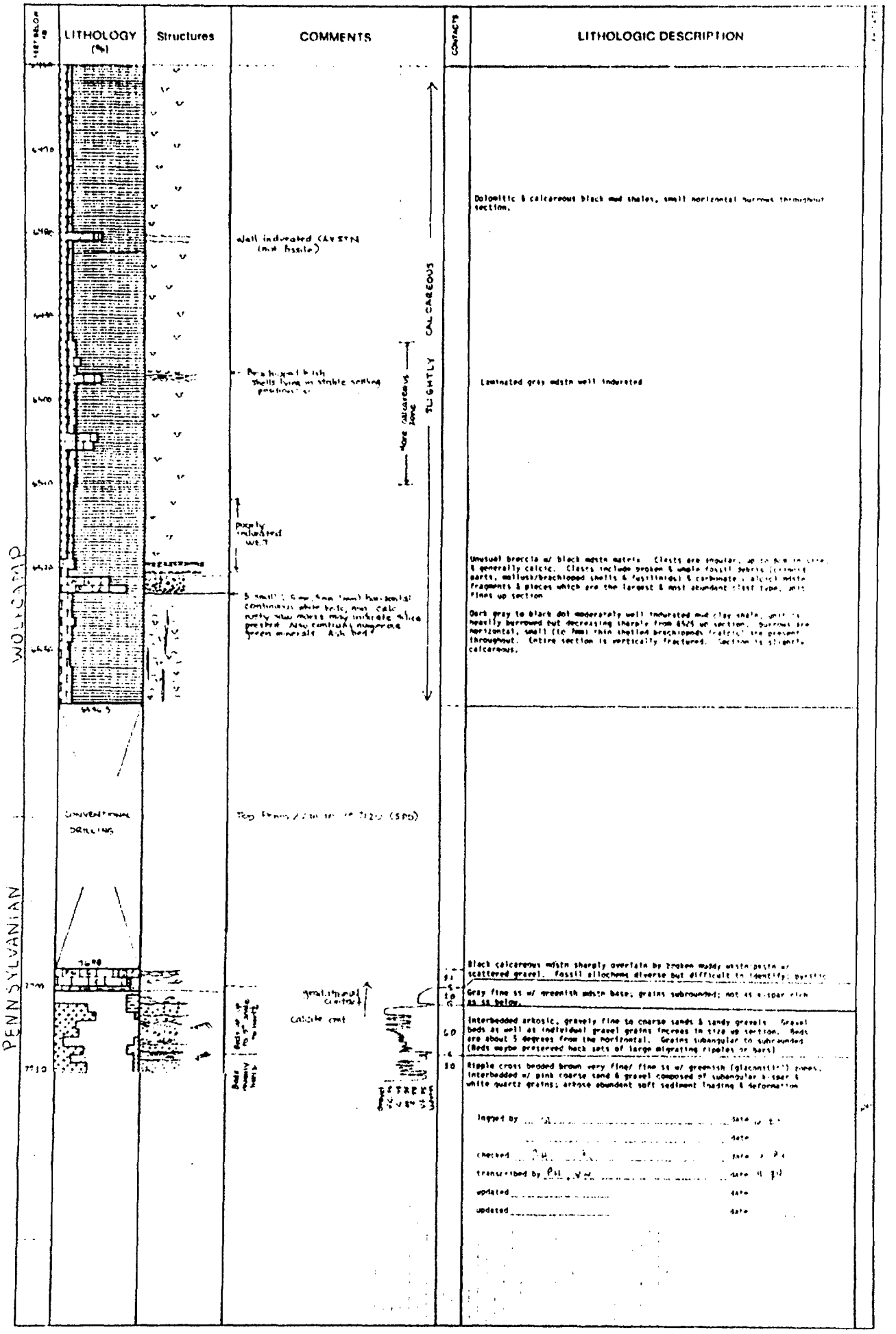
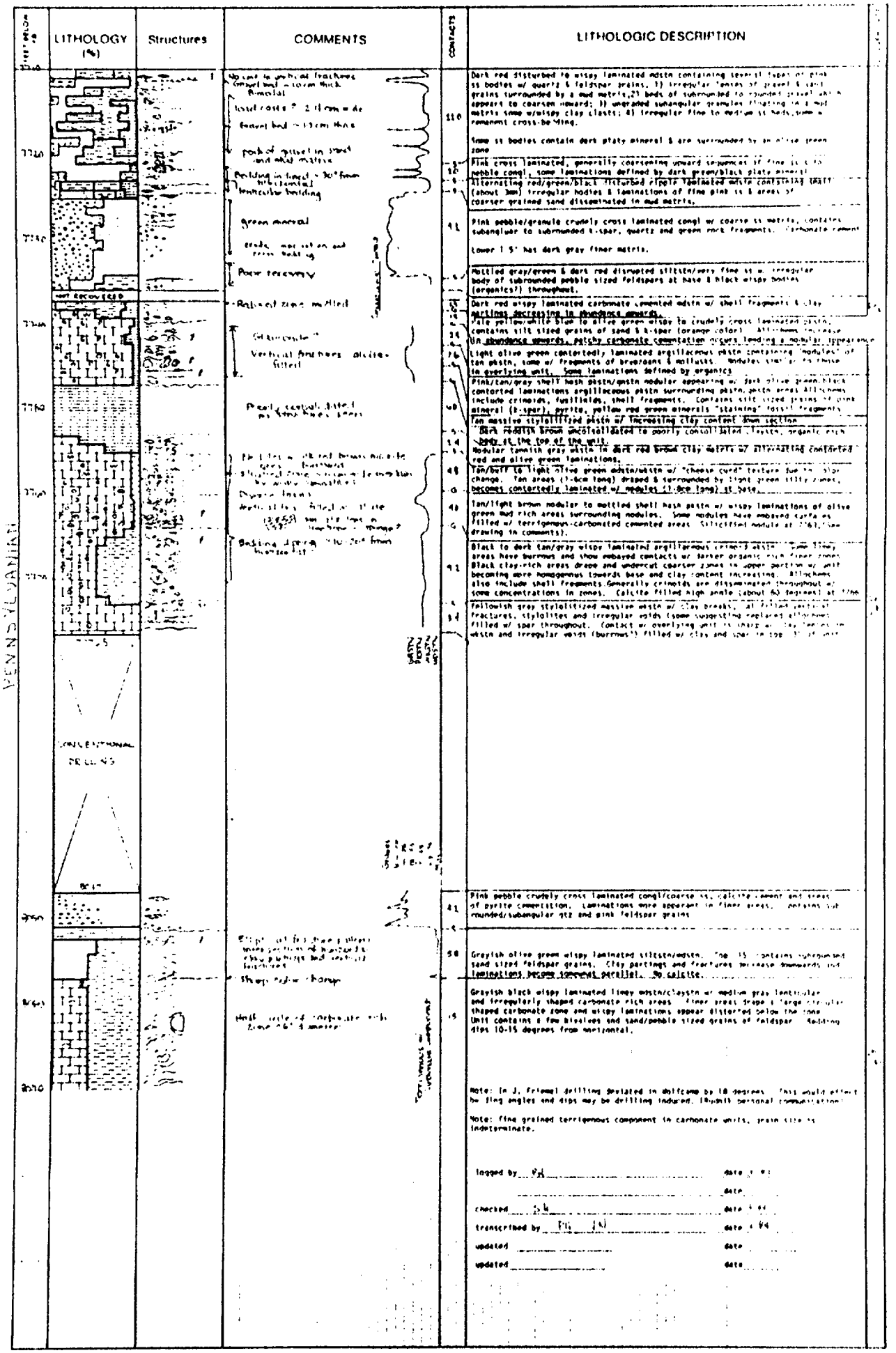
WELL J Fremal COUNTY Deaf Smith DATE

INTERVAL 6440 7210 WOLFCAMP, PENNSYLVANIAN LOGGED BY



WELL 3 Friemel COUNTY Deaf Smith DATE Jan Feb 1984

INTERVAL 7710 8070 PENNSYLVANIAN LOGGED BY ST BL DJ SN LE RW PH



Dark red disturbed to wispy laminated mdstn containing several types of pink ss bodies w/ quartz & feldspar grains. 1) irregular lenses of gravel & sand grains surrounded by a mud matrix,2) beds of surrounded to rounded gravel which appear to coarsen upward; 3) ungraded subangular granules floating in a mud matrix some w/wispy clay clasts; 4) irregular fine to medium ss beds,some w remanent cross-bedding.

Some ss bodies contain dark platy mineral & are surrounded by an olive green zone

Pink cross laminated, generally coarsening upward sequences of fine ss to pebble congl, some laminations defined by dark green/black platy mineral

Alternating red/green/black disturbed ripple laminated mdstn CONTAINING (RARE (about 3mm) irregular bodies & laminations of fine pink ss & areas of coarser grained sand disseminated in mud matrix.

Pink pebble/granule crudely cross laminated congl w/ coarse ss matrix, contains subangular to subrounded k-spar, quartz and green rock fragments. Carbonate cement

Lower 1.5' has dark gray finer matrix.

Mottled gray/green & dark red disrupted siltstn/very fine ss w. irregular body of subrounded pebble sized feldspars at base & black wispy bodies (organics?) throughout.

Dark red wispy laminated carbonate cemented mdstn w/ shell fragments & clay partings decreasing in abundance upwards.

Pale yellow/white blue to olive green wispy to crudely cross laminated siltstn, contains silt sized grains of sand & k-spar (orange color). Silt content increase

In abundance upwards, patchy carbonate cementation occurs, lending a nodular appearance

Light olive green contorted, laminated argillaceous paste containing "nodules" of tan paste, some w/ fragments of bryozoans & mollusks. Nodules similar to those in overlying unit. Some laminations defined by organics

Pink/tan/gray shell hash paste/mdstn nodular appearing w/ dark olive green/black contorted laminations argillaceous paste surrounding paste,paste areas ALLochems include crinoids, fusilinids, shell fragments. Contains silt sized grains of pink mineral (k-spar), pyrite, yellow red green minerals "staining" fossil fragments

Tan massive stylolitized paste w/ increasing clay content down section

Dark reddish brown uncalcitalized to poorly consolidated clayston, organic rich zone at the top of the unit.

Nodular tan/ish gray mdstn in dark red brown clay matrix w/ interwoven contorted red and olive green laminations.

Tan/buff to light olive green mdstn/wkstn w/ "cheese curd" texture due to slight change. Tan areas (1-6cm long) draped & surrounded by light green silty zones, becomes contortedly laminated w/ nodules (1-8cm long) at base.

Tan/light brown nodular to mottled shell hash paste w/ wispy laminations of olive green mud rich areas surrounding nodules. Some nodules have embayed surfaces filled w/ terrigenous-carbonated cemented areas. Silicified nodule at 7761.5(see drawing in comments).

Black to dark tan/gray wispy laminated argillaceous cemented mdstn. Some silty areas have burrows and show embayed contacts w/ darker organic rich finer zones. Black clay-rich areas droop and undercut coarser zones in upper portion of unit becoming more homogenous towards base and clay content increasing. Allochems also include shell fragments.Generally crinoids are disseminated throughout w/ some concentrations in zones. Calcite filled high angle (about 60 degrees) at 7766

Yellowish gray stylolitized massive mdstn w/ clay breaks, all filled portions of fractures, stylolites and irregular voids (some suggesting replaced allochems) filled w/ spar throughout. Contact w/ overlying unit is sharp w/ clay lenses in mdstn and irregular voids (burrows) filled w/ clay and spar in top 3" of unit

Pink pebble crudely cross laminated congl/coarse ss, calcite cement and areas of pyrite cementation. Laminations more apparent in finer areas. Contains sub rounded/subangular qtz and pink feldspar grains

Greyish olive green wispy laminated siltstn/mdstn. Top 15" contains suborunded sand sized feldspar grains. Clay partings and fractures increase downwards and laminations become somewhat parallel. No calcite.

Greyish black wispy laminated limey mdstn/claystn w/ medium gray lenticular and irregularly shaped carbonate rich areas. Finer areas drape & large irregular shaped carbonate zone and wispy laminations appear distorted below the zone. Unit contains a few bivalves and sand/pebble sized grains of feldspar. Bedding dips 10-15 degrees from horizontal.

Note: In J. Friemel drilling deviated in dir/comp by 10 degrees. This would affect bedding angles and dips may be drilling induced. (Dunn personal communication)

Note: fine grained terrigenous component in carbonate units, grain size is indeterminate.

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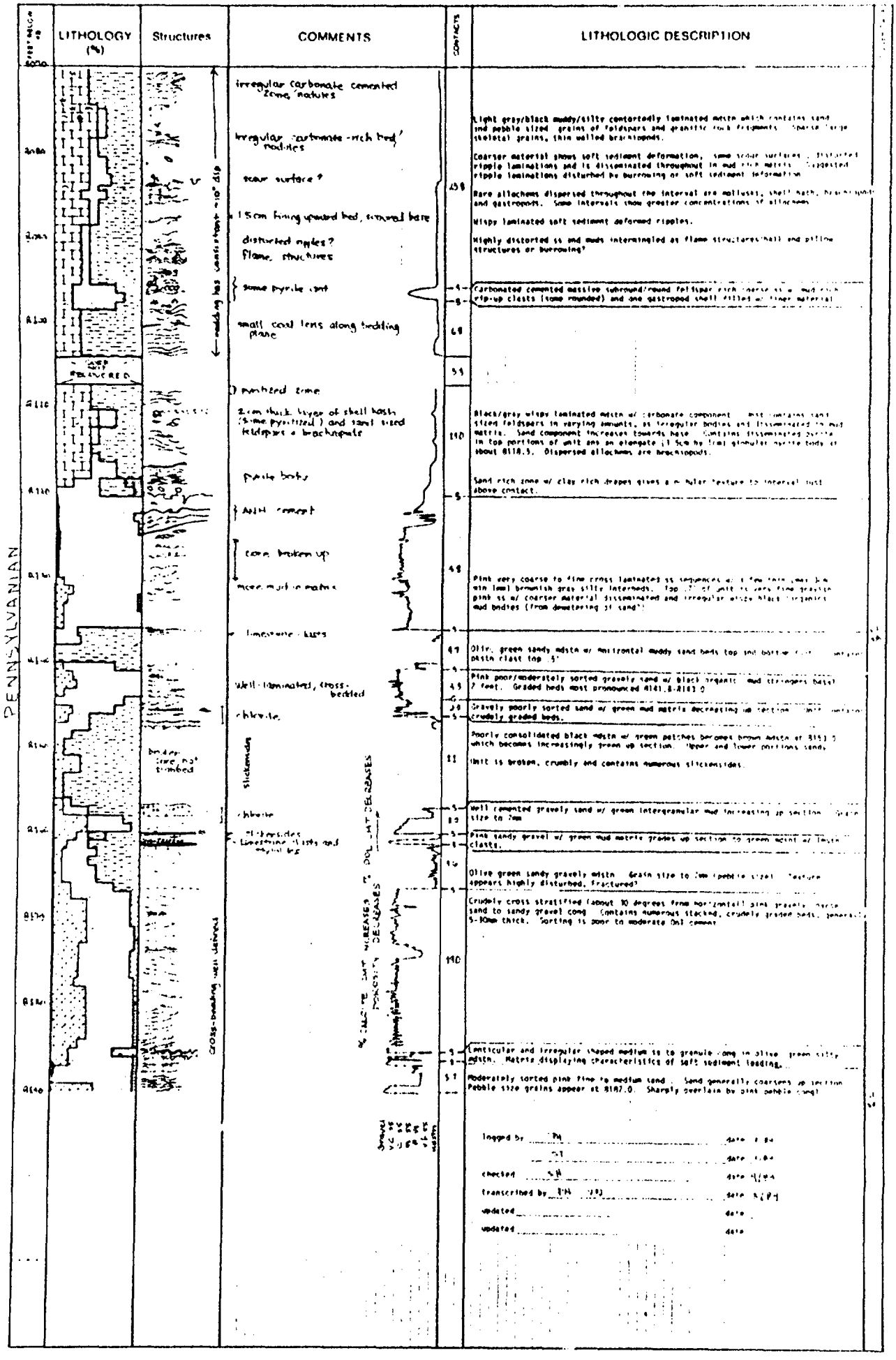
WELL [illegible] Fremont COUNTY Dent Smith DATE March 84

INTERVAL 8010 8190 PENNSYLVANIAN LOGGED BY [illegible]



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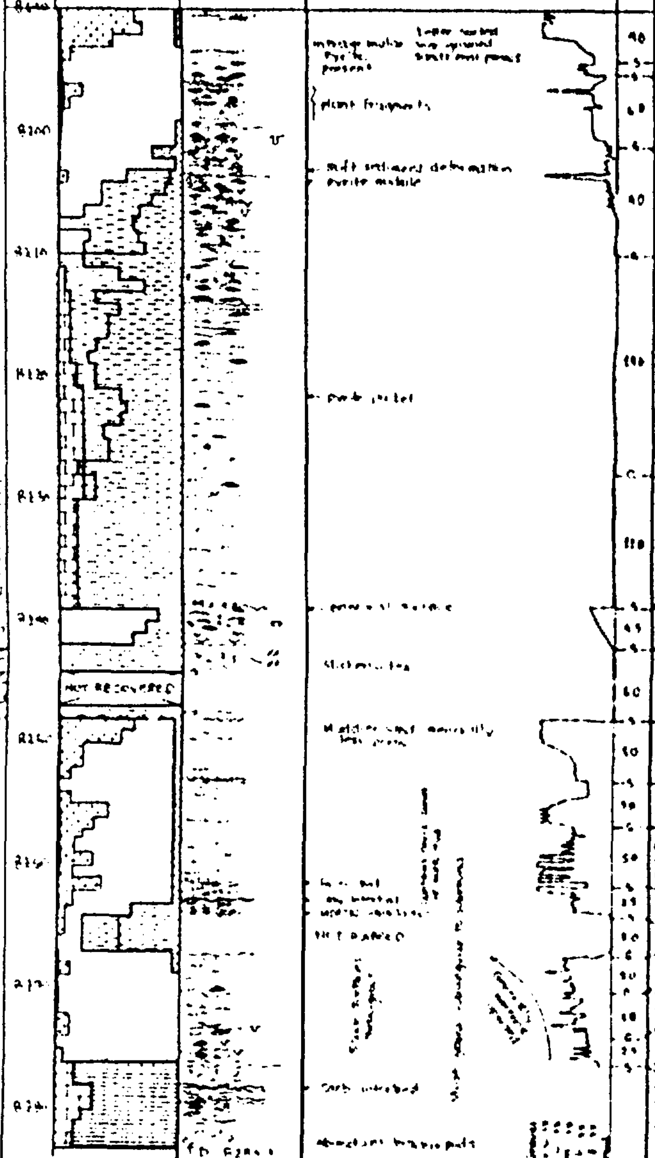
WELL J. Friemel COUNTY Deaf Smith DATE February March, 81

INTERVAL 8090 8183.5 PENNSYLVANIAN LOGGED BY [illegible]

Depth	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Well sorted fine sand grades up section to pinkish sandy gravel gravelly sand w/ poor to moderate sorting. Contains crude cross stratification and graded beds in upper 2 feet. Dol cement.

Horizontally stratified graded beds, of very coarse sand to fine sand. Dol cement

Very porous gray to pinkish very fine to fine ss containing repeating sedimentary structure sequences, of trough cross bedding, climbing ripples and fine parallel to undulatory ripple laminations. Black organics generally increase in each sequence up section and most abundant in rippling parallel laminations. Contains sharply bounded gravel bed at 8196.6. Dol cement?

Finely interlaminated ss/siltstn and black mdstn. Sedimentary structures [illegible] fine parallel and ripple laminations and climbing ripples. [illegible] small discontinuous lenses, 1cm long by 1mm high. [illegible] outwards and slightly curved concave up. Burrows & soft sediment deformation features common.

Interbedded slightly calcic black, pyritic, mdstn-mud shale and lighter [illegible] ripple laminated siltstn. Common horizontal partings occur along bedding planes. Siltstn grades from discontinuous lenses to continuous horizontal beds. [illegible] bed thickness and percentage silt increasing up section. [illegible] section.

Black carbonaceous mud shale becoming better indurated and increasingly calcareous up section. Contains faint whitish silty laminae which increase in number [illegible] 2 feet. Small (less than 1mm) brachiopods scattered throughout, increase up section.

Greyish olive green muddy very fine-fine ss, w/ disturbed intraclastic texture, some ripple laminations in middle portion.

Broken crumbly, fractured (calcite filled) mud mdstn, mottled greyish red and greyish green in color. Slickensides throughout.

Poorly sorted gravely medium-coarse ss grades to sandy gravel (to pebble size). Gravel size increases up section. Contact w/ overlying mdstn marked by about 5-6cm immature gravel which contains green mud. Carbonate cement.

Poorly sorted sandy gravel (to pebble size) grades to [illegible] fine ss. Carbonate cement.

Repeating sequences of sandy gravel grading to coarse to medium ss [illegible] very coarse sands grading to medium sands up section. [illegible] generally [illegible] thinner and less defined up section. Dol cement.

Repeating sequences of sandy gravels grading to fine ss, interval thickness increases up section.

Green to reddish brown unconsolidated mud.

Mature to submature medium to coarse qtz arkose ss. Dol cement

Poorly sorted, submature fine to gravely coarse qtz-arkose ss. [illegible] larger grains more angular. Dol cement

Burrowed greenish very fine to fine ss with thin medium ss interbeds, sorting decreases and medium sand component increase up section. Mature to submature up section. Qtz, arkose ss. Some calcite cement in lower half. Dol cement

Carbonaceous black shale w/ scattered carbonate interbeds [illegible] carbonate starved ripples. Carbonate (small) [illegible] inclinations at about 20 degrees from horizontal. Large brachiopod valves [illegible] present upper and lower portions.

Note: In J. Friemel drilling deviated [illegible] degrees. This would affect bedding angles and dips may be drilling induced.

Note: Fine grained units, grain size indeterminate without grain size analysis.

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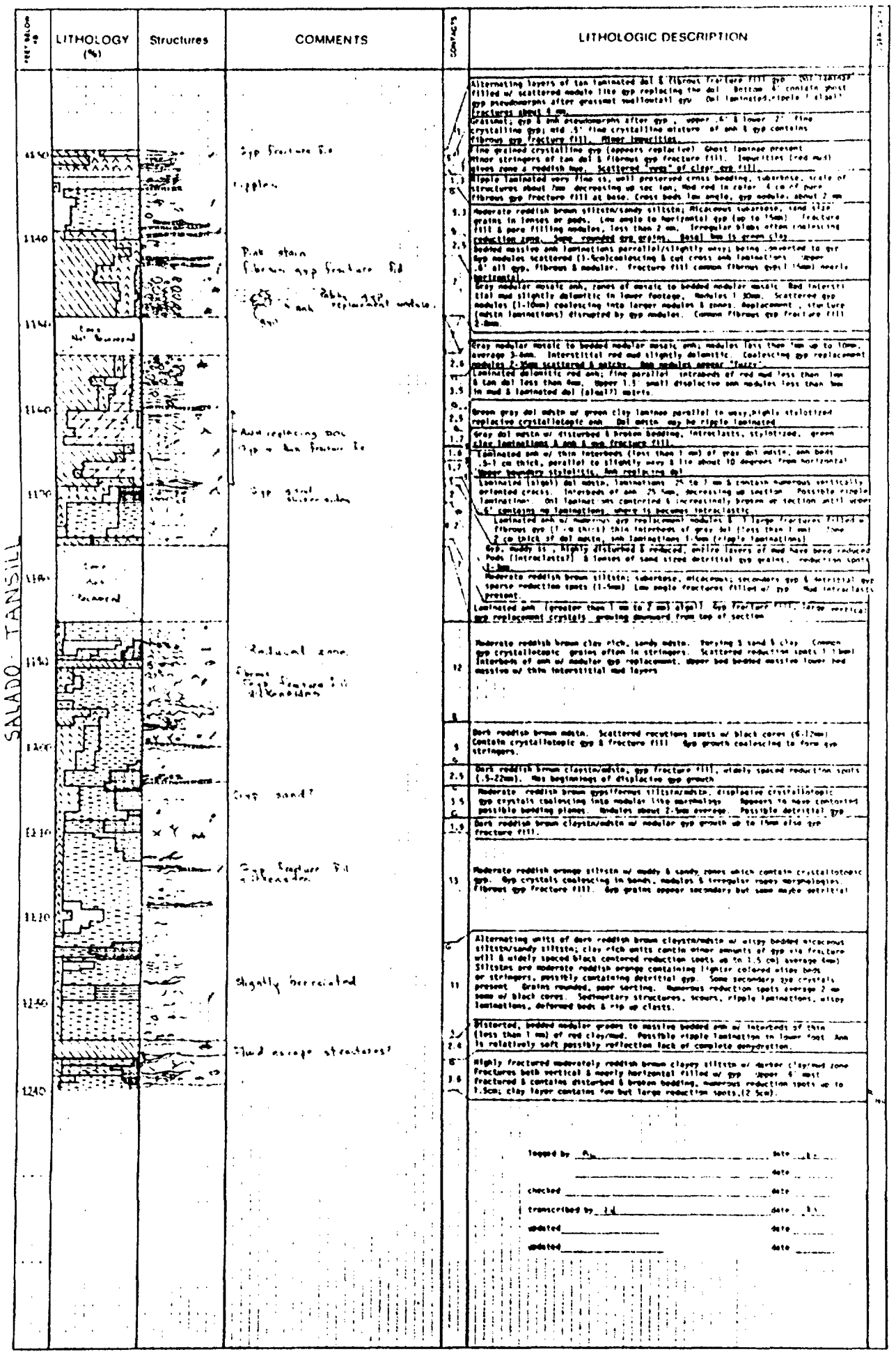
WELL Dalton COUNTY Deaf Smith DATE

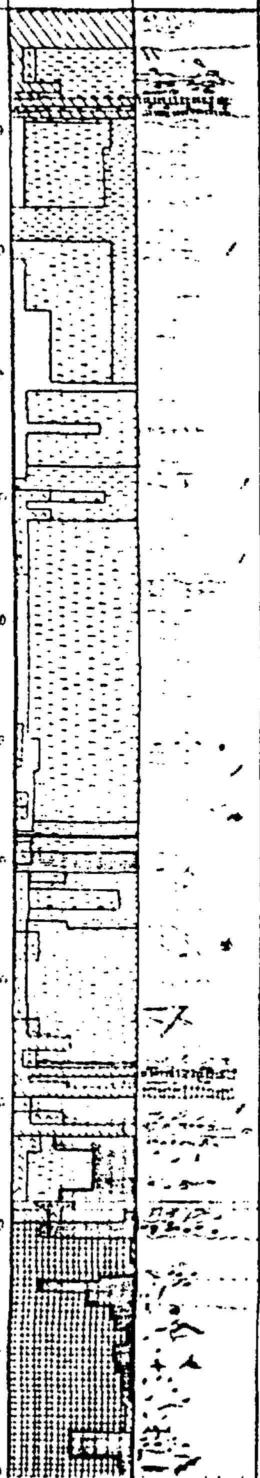
INTERVAL 1129-1240 SALADO - TANSILL LOGGED BY SI, DH, BL, MW, DP



WELL Dalton COUNTY Deaf Smith DATE

INTERVAL 1240-1560 SALADO-TANSILL, YATES, UPPER SEVEN RIVERS LOGGED BY BL, DN, MW, DP

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



TANSILL / YATES / UPPER SEVEN RIVERS

1240, 1250, 1260, 1270, 1280, 1290, 1300, 1310, 1320, 1330, 1340, 1350, 1360

Comments:

- Reduction spots
- Contorted? ripples
- Reduction spots
- disturbed crossbeds 2 mm high
- bimodal ss, disrupted pieces
- shore [illegible] break allowed [illegible]
- Reduction spots
- Reduced zone
- Reduction spots
- Reduced zone
- [illegible] rounded mud clasts define disturbed bedding
- [illegible]
- Polyhalite, magnesite

Lithologic description:

.3 — Disturbed bedded mosaic to massive anh; disturbed bedded mosaic contains large amount of anhydritized red mud which gives it a reddish color. Mud decreases down section.

2.2 — Insoluble residue: about 2mm anh nodules; 1-7mm anh fracture fill present, all in mdstn. 5mm average undisturbed reduction spots present 1248.3-1243.0. Some w/ black centers.

1.8 — Brecciated mdstn present 1246.0-1245.4. Bedded nodular anh present 1246.2

White gray anh w/ pink laminations at 1245.6.

White gray laminated anh.

Insoluble residue; mud clasts, disturbed, about 5mm anh nodules. 7mm euhedral gyp crystals present.

White gray laminated anh

Description 1249'-1339'

Red, muddy, sandy siltstn w/ maximum grain size very fine sand. Mdstn & claystn present in distinct intervals & in varying concentrations as disturbed, discontinuous laminae within the siltstn. Silt size & greater clastic grains are predominately gyp. Some (very sparse) metallic oxide minerals present. Reduction spots present in variable concentrations & variable size (.25 mm up to a few cm thick layers) throughout the clastic interval. Mdstn/claystn intervals generally fissile. Minor carbonate cement present throughout.

Very porous in this interval. Variations in hematite stain define faint discontinuous laminations. Quartz makes up larger proportion of clastic grains. Clay percentage is much less in this interval.

Fine to medium very well rounded quartz grains in muddy coarse silt very fine sand matrix at 1278.75.

Less than 5% .5mm gyp crystals aggregates present in this interval. Interstitial gyp forms layer at 1280.8, 1279.3.

74 — Cementation (hardness) increases up section from 1295.3 to 1290

Very thin clay laminae in mdstn at 1307.7.

Mdstn in disturbed laminations/pockets very well defined 1310.3-1311.0

5mm wide, 45° anh veins present at 1317.3 & 1316.3

1.1 — 5mm claystn clasts present. Randomly oriented gyp & anh veins present

1.5 — Distorted bedded nodular anhydrite.

Mdsnt w/ silt size particles predominately gyp. Anh & gyp nodules present

2cm claystn clasts in claystn matrix. 1mm gyp crystals present in the matrix

Wispy laminated anh, nodular at contact.

Disrupted claystn, anh present as fracture fill

Wispy laminated white/pink anh, "broken up" upper contact.

Red claystn w/ gyp present as green spherical nodules, 1-2 mm crystalline aggregates & crystalline interclay clast fill, all in varying concentrations. 1.5mm distorted gyp anh layer (very finely crystalline) present at 1331.

5 — .3' red disturbed laminated anh, .3' white disturbed laminated anh, .15' crystalline blue anh. Grassmat texture present. Distorted mud lamination at upper contact.

1.5' thick concentration of gyp at 1333.3 clastic grains predominately gyp. Upward increase in clay %. Gyp present as aggregates (.5-3mm) & rare nodules. Red siltstn ss w/ thin less than .5mm mud drapes exhibiting parallel laminae, small scale ripple structures & containing intraclasts, less than 1% of small (less than 1mm) anh nodules & scattered small scale hal replacement or fill is present. Numerous green reduction spots.

Disruptive nodular (20mm) silty anh & gyp. Gyp also present as less than 1mm euhedral crystals in veins. Non transported claystn clasts define disrupted beds within very fine ss. Numerous .5mm reduction spots present. Rock texture disrupted insoluble residue.

Chaotic mud salt. High proportion of anh/gyp at distorted basal contact.

Recrystallized hal, anhedral to subhedral crystals up to 3 cm in diameter. Crystal size increases up section. Very finely crystalline anh nodules (5mm in diameter) nonexistent at base increase up section. Very minor wisps of hematitic mud present at 1342.1-1340.3.

7.2 — Chaotic mud salt, mdstn exhibits remnant bedding. Boundary w/ overlying salt is contorted but sharp. .35 cm nodular mass exhibits abundent cleavage traces & possibly contains a significant amount of anhydrite(?).

Red brown mdsnt w/ hal filled cracks at base, filled w/ crystallotopic anh at top

Clear hal crystals 1-2 cm w/ small bodies of interstitial claystn & anh, interstitial material increases up section.

Clear cubic to anhedral hal crystals 1-2 cm w/ interstitial anh becomes muddy up section

Clear anhedral hal w/ interstitial bodies of claystn which become disseminated up section, contains some anh laminations.

Clear anhedral hal w/ small interstitial bodies of claystn & anh.

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INTERVAL 1360-1920 UPPER SEVEN RIVERS, UPPER SAN ANDRES LOGGED BY DP

FEET BELOW KB	LITHOLOGY (%)	Structures	COMMENTS	FEET	LITHOLOGIC DESCRIPTION
				6.	Clear anhedral hal w/ small interstitial bodies of claystn & anh
1370				5	Chaotic mud salt, moderate red brown claystn, clear 2cm x 2cm salt crystals, 1 percent 2 x 2 cm anh nodules at 1369.8. 5mm distorted claystn layer defines upper contact.
				5.6	Milky pink/orange/white anh w/ varying proportions of hal crystals aggregates of inconsistent size & shape. These aggregates are groumed into somewhat horizontal layers with anh crystals penetrating these aggregates. 1mm thick laminations of gyp (& carbonate?) more concentrated lower 3". Hematite stained clay define wispy laminations.
1380			Poorly developed nodular bedding	5.2	Moderate red brown siltstn grading to fine ss. Very faint intraclastic appearance, gyp predominate clastic grains. Sparse anh crystals aggregates. Hal & minor carbonate cement.
				3.0	Chaotic mud salt, anh layers present at 1387.8, 1387.1, 1386.5". Large euhedral hal crystals up to 3 cm x 3 cm. Anh also present as 1 cm & less nodules & stringers
				1"	Slightly disturbed .5cm milky orange/white anh laminations & about 75% hal in hor izontal layers & salt aggregates penetrated by anh crystal growth
1390			Diagonal chevrons	1.5	Sparse horizontal anh layers present. Salt crystals average 75 c 1cm
				- - -	Disrupted laminae.
				2.4	Recrystallized salt, occasional 1 cm x .5 cm anh nodules & anh stringers present Hal crystals up to 3 x 1 cm.
				2	Hal w/ minor 2 cm x .5 cm anh nodules, very sparse 1 cm gyp nodules present in claystn
				3	Chaotic mixture of gyp, anh & claystn present 1392.7, (insoluble residue?) 2 cm recrystallized salt crystals grading upward to chaotic mud salt w/ moderate red brown claystn.
1400				16.5	Chaotic mud salt grading from minor interstitial claystn to predominately angular claystn clasts in hal. Minor interstitial anh is present throughout interval. Hal crystals up to 3 cm diameter. Two gyp nodules present in varying sparse concentrations Subhorizontal salt fracture fill occurs at 1399.8. Upper 1" has claystn w/ about 2cm hal crystals overlain by claystn w/ 4mm euhedral/subhedral salt crystals
1410				6	Chaotic mud salt. large clear to cloudy displacive hal crystals (up to 3 cm Moderate red brown claystn in angular clasts. Distorted gyp nodule present 2cm at about 1418.9. Undeformed mud drape present at 1415.3; high mud content below, less mud above.
1420					
1430					
1440				2	Chaotic mud salt. Clear, subhedral hal crystals up to 2cm x 2 cm. Very disrupted laminations & intraclasts in claystn/mdstn defined by variations in hematite stain Dispersed small (less than 1 mm) anh nodules
			nodules of disturbed and undisturbed Clayers very large hal cubes	11.2	Chaotic mud salt.
1450			Color mottled, no recognizable primary features may be reduced, but no collapse		
			interganular porosity		
1460			primary fabric	9.8	Recrystallized salt w/ bedding preserved Hal crystals size variable, up to 2 x 2 cm Vertically oriented salt crystals present upper .5'. Moderate red brown clay & anh define disrupted laminae & are present interstitially in the salt. 1 to 2 cm claystn layers present at 1900.7, 1898.8. Zones are alternating between rust color & white
1470				7.6	Dark red brown claystn. Excellent ripple w/ cross bedding preserved at 1917.5, about 1 cm high. Laminations defined by variations in hematite stain Carbonate cemented white disrupted & discontinuous "layer" at 1918.4. Several gyp nodules (up to 1 cm) present, with vugs, at 1911.2. Anh present as .5mm to 6 cm nodules from 1910.8-1896.1. Gyp w/thin gray claystn at 1908.1.
				3.2	Chaotic mud salt. Claystn defines disrupted laminations & intraclastic texture in moderate red brown spots. Silt sized grains predominately gyp. Very sparse 1mm anh nodules present. Hal crystals, subhedral are 1 cm x 1 cm. Hal cement. One 2 x .5 cm anh nodule present at 1910.1.
1480			Claystn mostly preserved	1.5	Disturbed .1' claystn layer defined lower contact Hal crystals up to 4cm x 4 cm lower .5'. Very minor anh nodules present.

UPPER SEVEN RIVERS

UPPER SAN ANDRES

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