Department of Energy
Chicago Operations Office
Salt Repository Project Office
505 King Avenue
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LINEHAN
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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

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PDR WASTE
WM-16 PDR

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 8/9/85
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-SRPO	
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 (SWEC)
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. Core storage/handling/cur	~~TBD (SWEC)~~ Dan Davidson (TBEG)
4:00 p.m.	Palo Duro Basin stratigraphic section, locations of DOE test holes, regional correlations of major units, major hydrostratigraphic divisions.	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. Sensenny
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, Hanley, 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

8056B

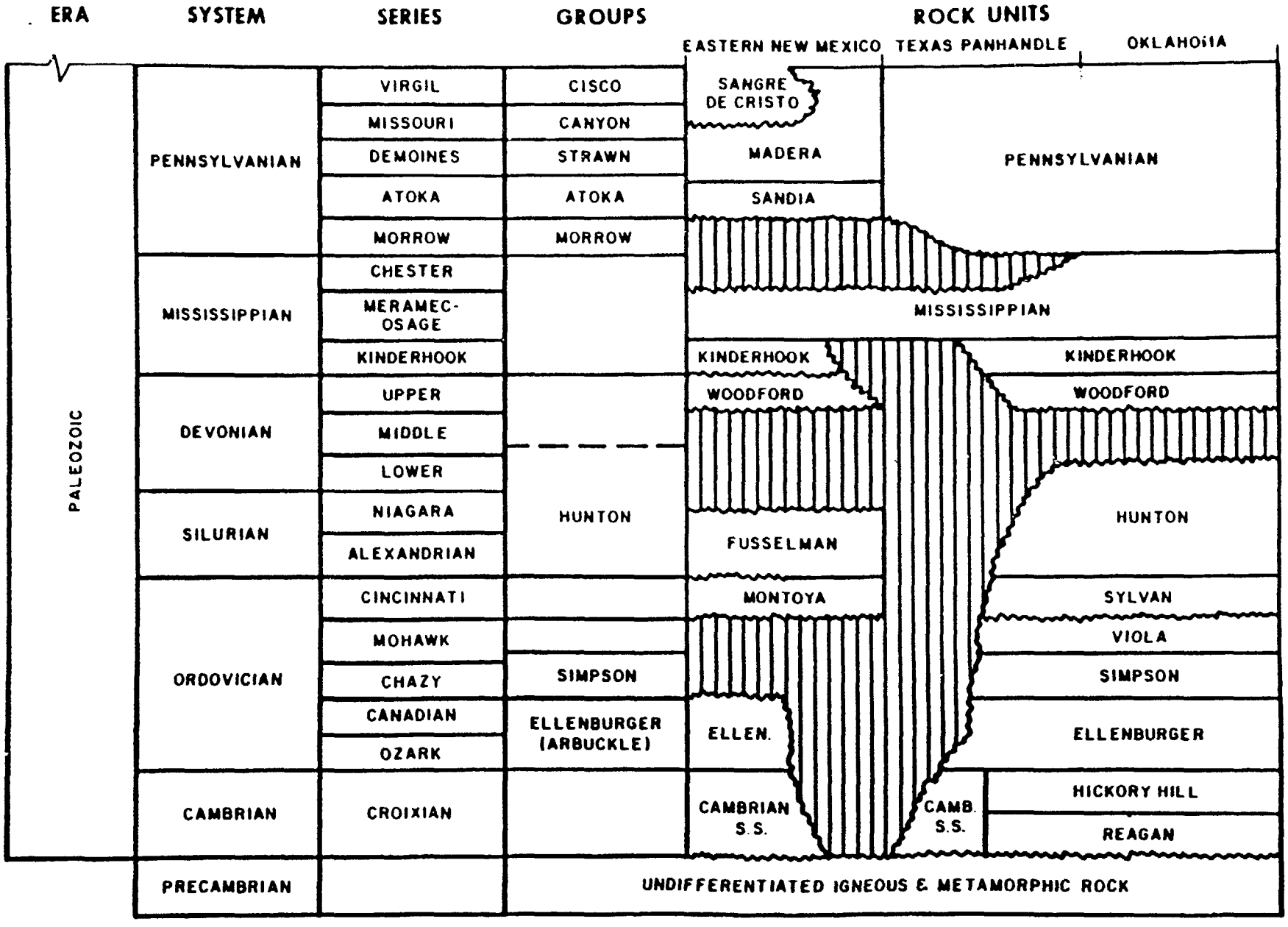
Enclosure 3

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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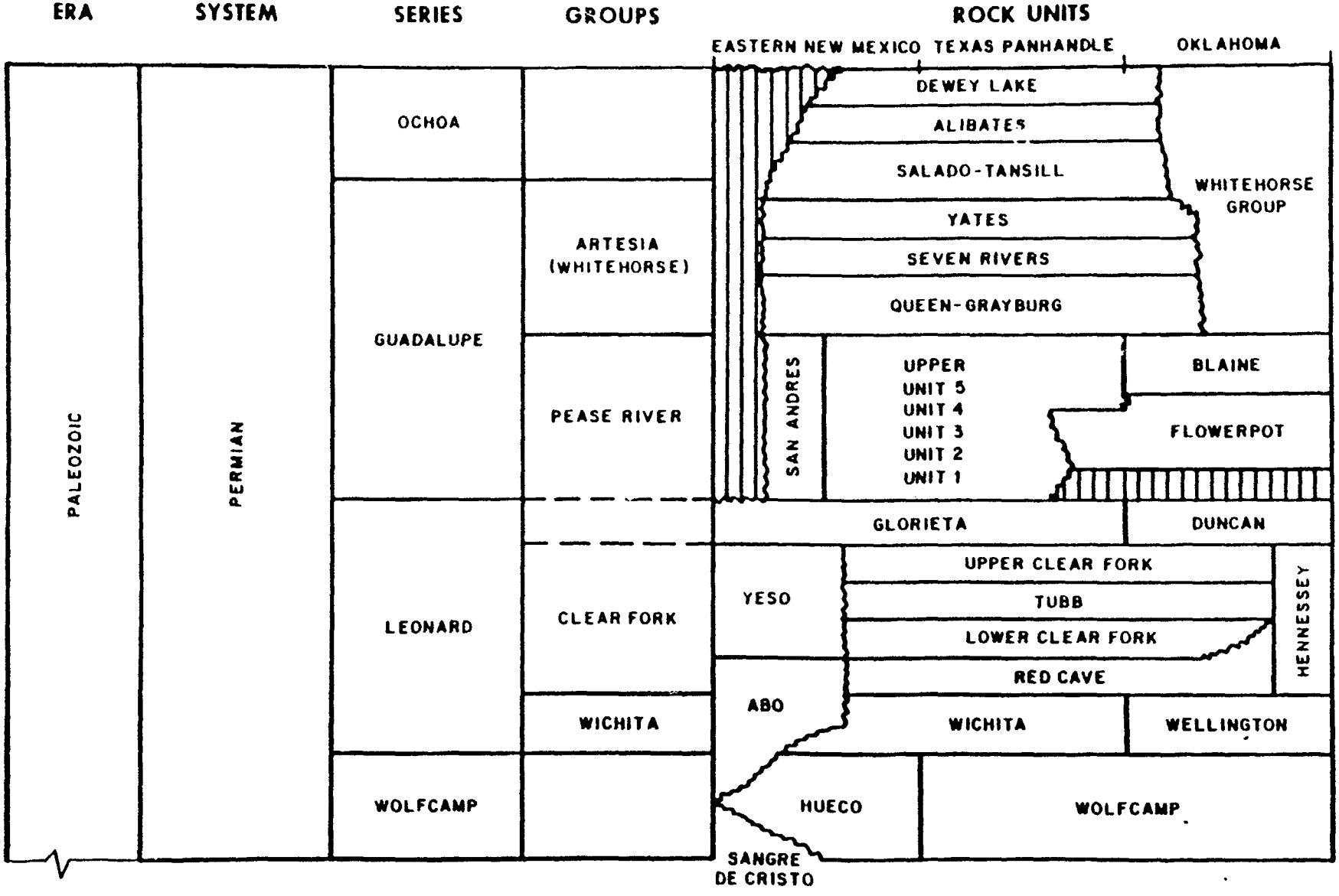
STRATIGRAPHIC SECTION CONT.

PERMIAN SYSTEM



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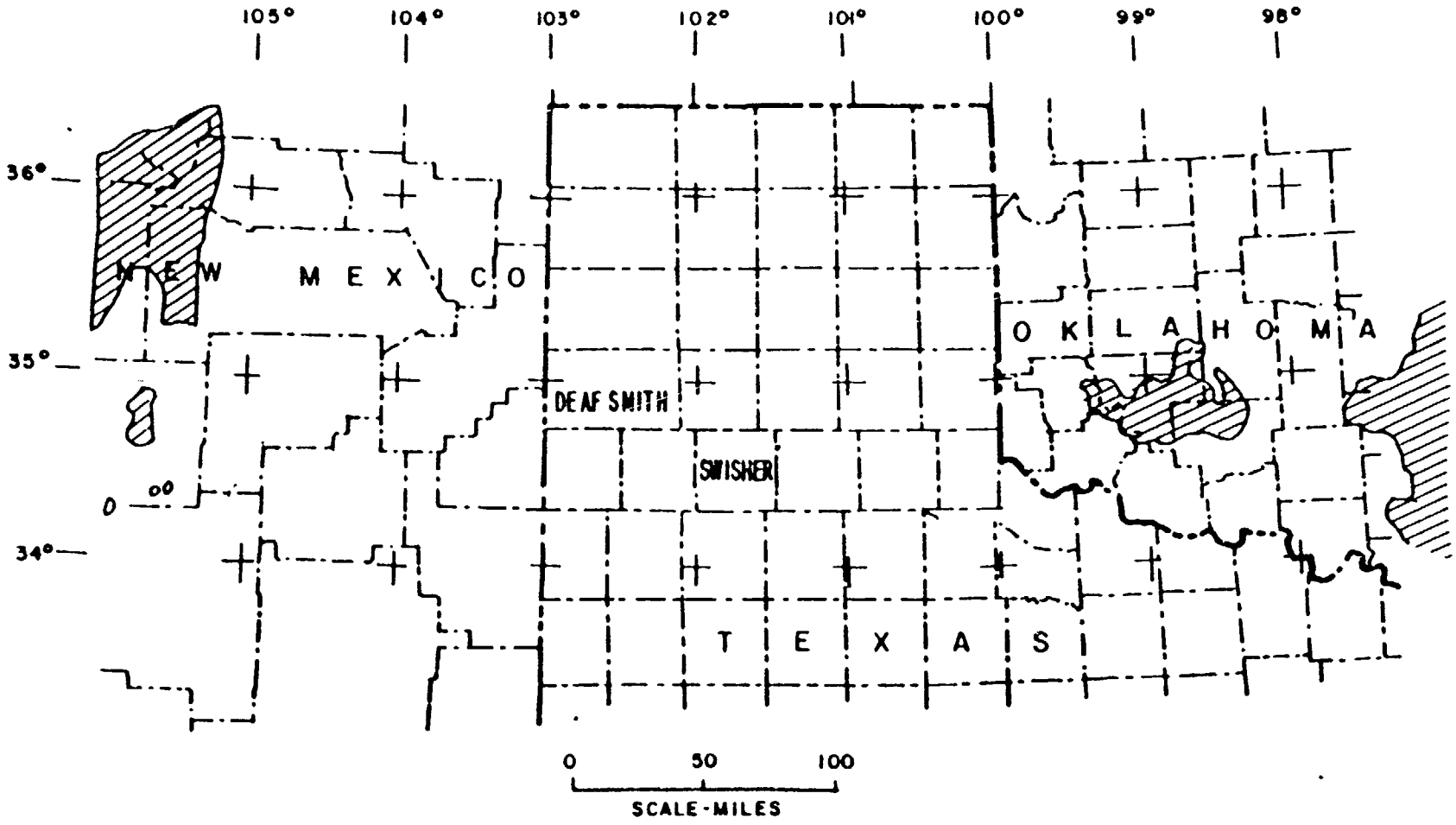
STRATIGRAPHIC SECTION
TRIASSIC TO RECENT

ERA	SYSTEM	SERIES	GROUPS	ROCK UNITS: EASTERN NEW MEXICO	ROCK UNITS: TEXAS PANHANDLE	ROCK UNITS: OKLAHOMA
CENOZOIC	QUATERNARY	RECENT		UNCONSOLIDATED SANDS & GRAVELS		
		PLEISTOCENE				
	TERTIARY	PLIOCENE-EOCENE		OGALLALA		
MESOZOIC	CRETACEOUS			NIOBRARA		
				CARLILE		
				GREENHORN		
				GRANEROS		
				DAKOTA		DAKOTA
			FREDRICKSBURG TRINITY	PURGATOIRE	FREDRICKSBURG TRINITY	
	JURASSIC			MORRISON		
				BELL RANCH-WANAKAH		
				TODILTO		
				EXETER (ENTRADA)		
	TRIASSIC		DOCKUM	CHINLE	DOCKUM	
				SANTA ROSA		

LOCATION OF PRECAMBRIAN-PENNSYLVANIAN OUTCROPS



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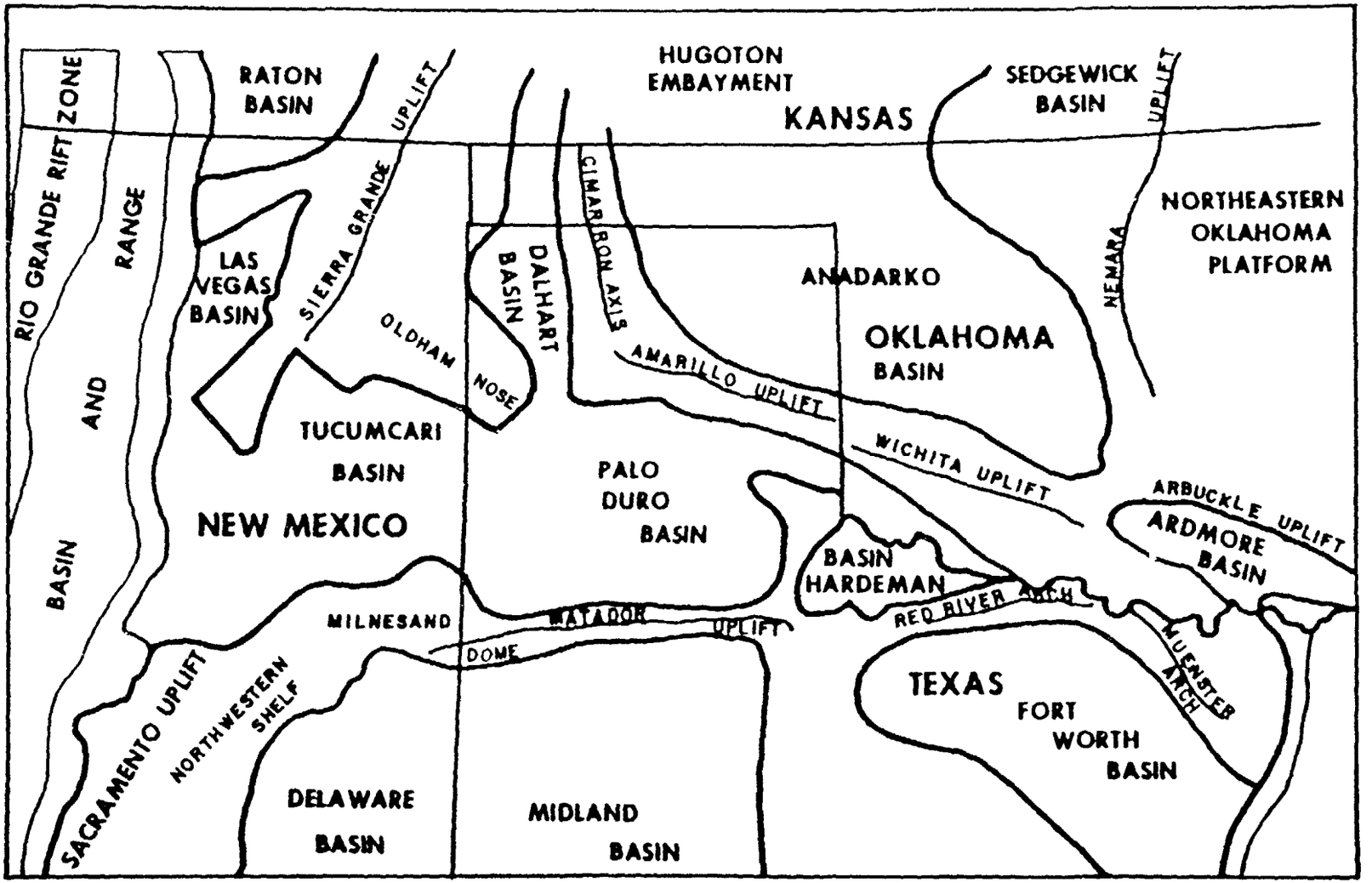
REGIONAL TECTONIC FEATURES



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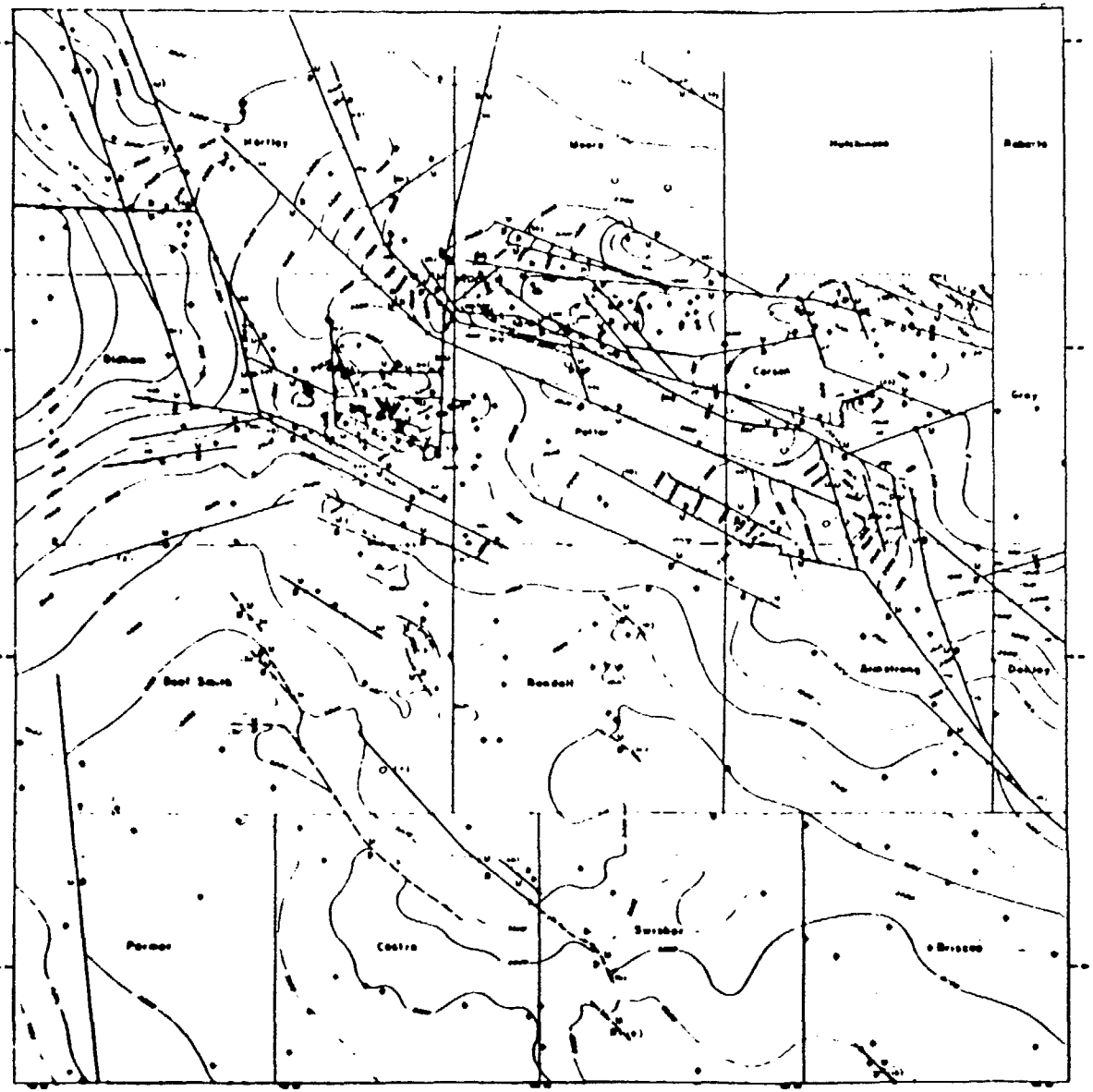


LEGEND

Structure Contour Interval 100 Feet

Well Control

Well Used to Compute Minimum Elevation of Precambrian Surface

Fault Identification Number

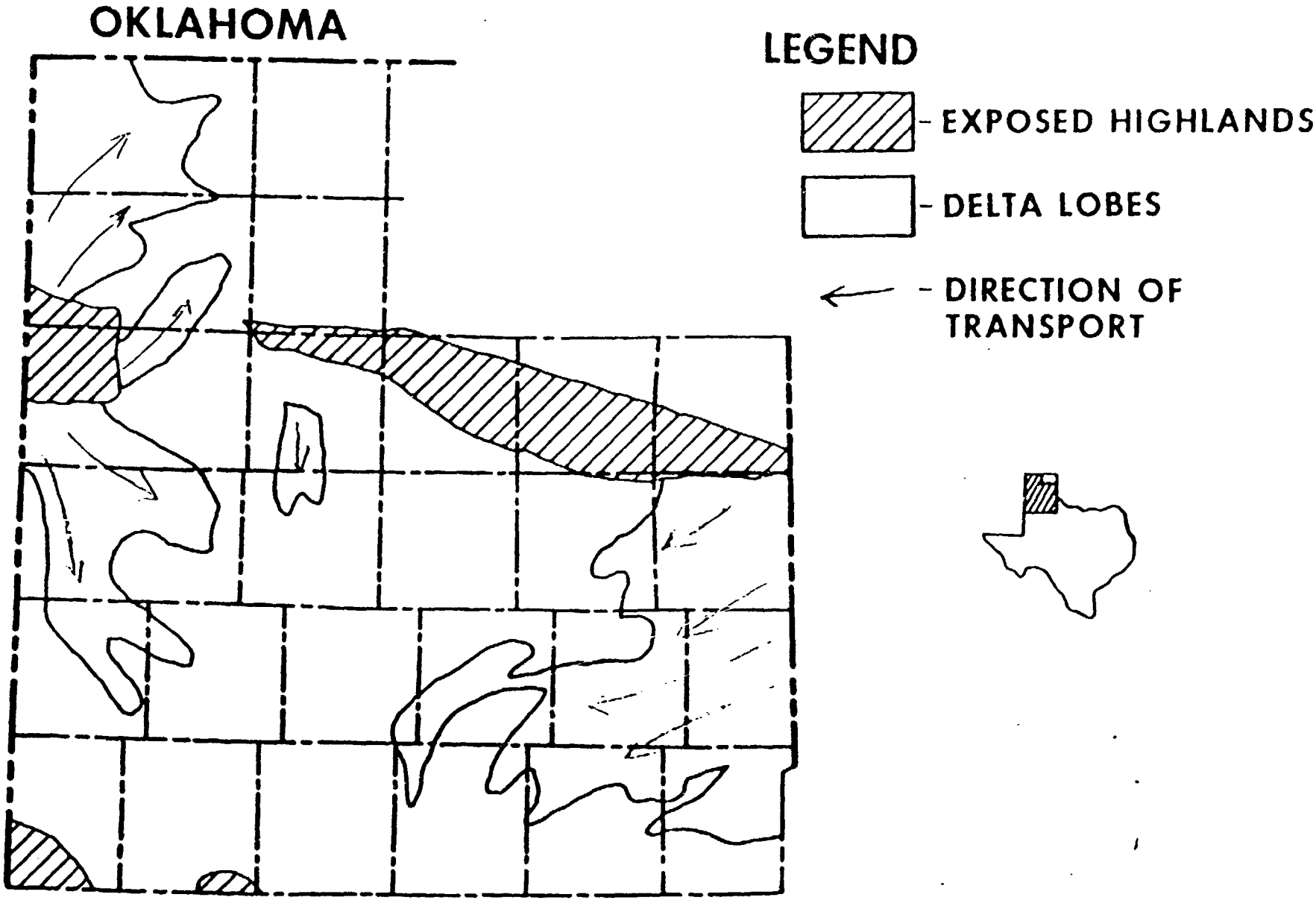
NOTES

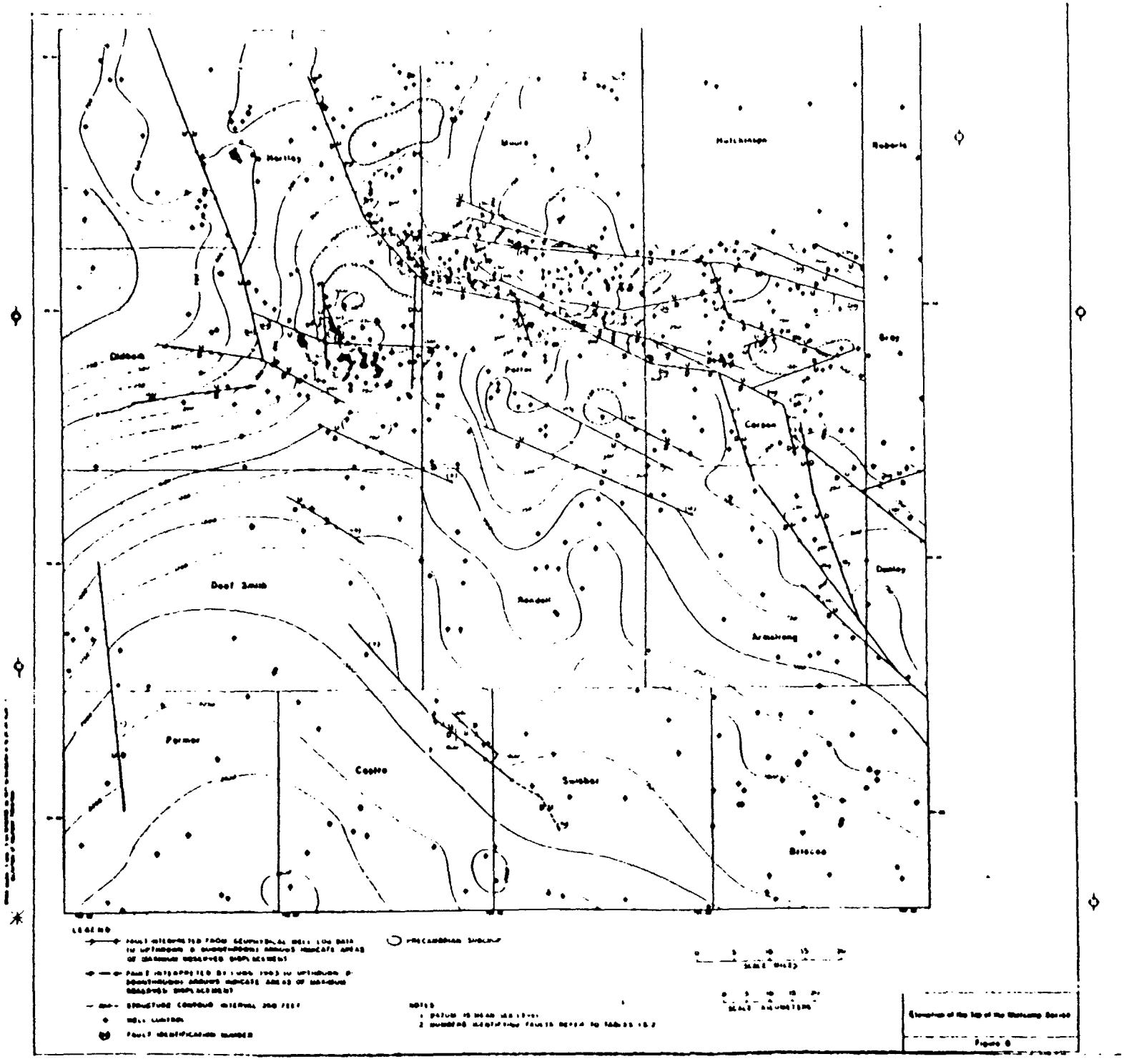
1. Datum is Mean Sea Level.
2. Numbered Identified Faults Refer to Table 1-1.
3. Seismic Data From Long (1983).

Structure of Precambrian

Figure 4

PENNSYLVANIAN DELTAS

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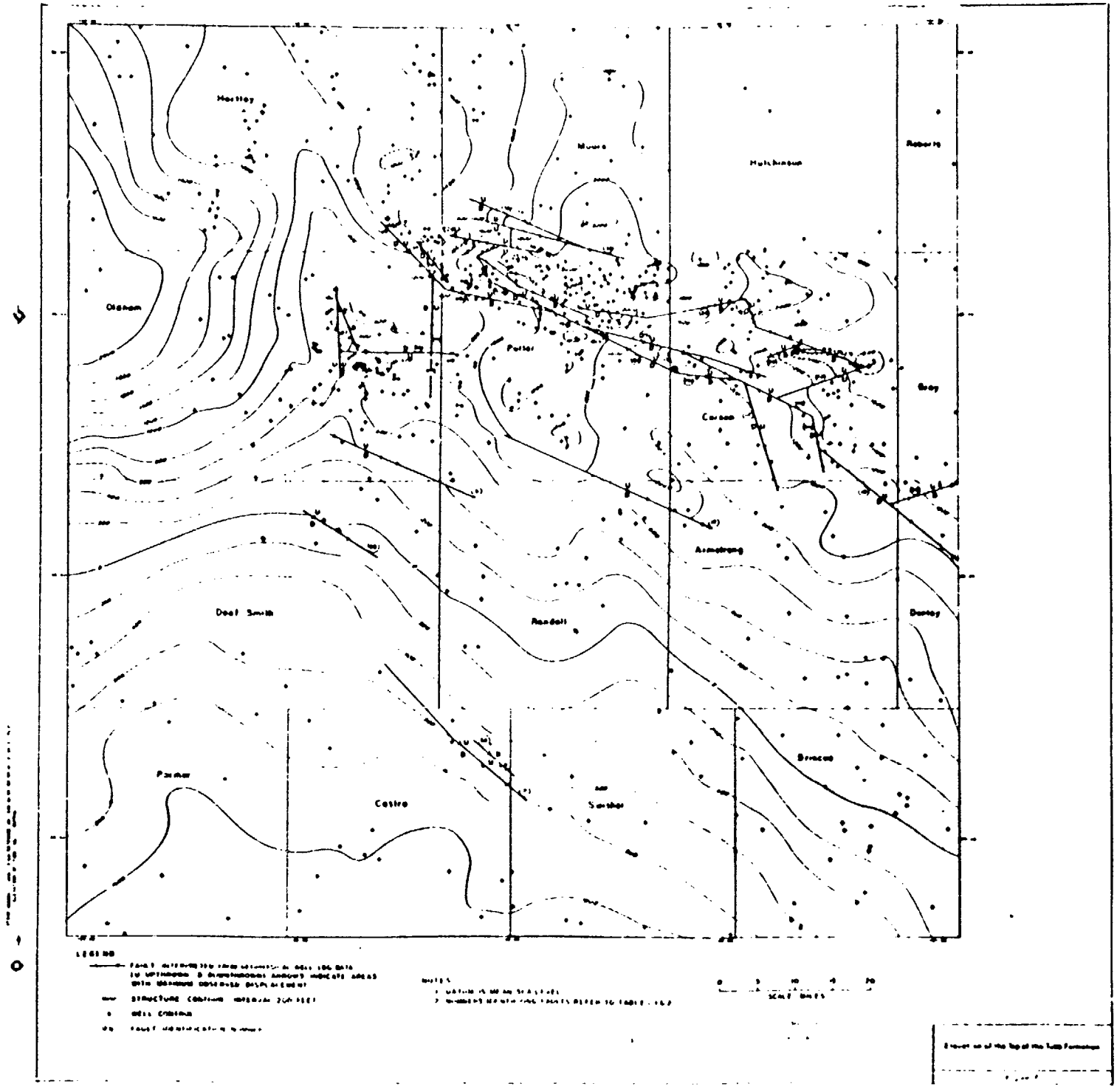
Gray
Carson
Deaf Smith
Randall
Armstrong
Donley
Parmer
Castro
Swisher
Briscoe
LEGEND
PRECAMBRIAN SHELF
STRUCTURE CONTOUR INTERVAL 200 FEET
WELL LOCATION
FAULT IDENTIFICATION NUMBER
NOTES
BASE MAP
Elevation of the top of the Wolfcamp Series
Figure 6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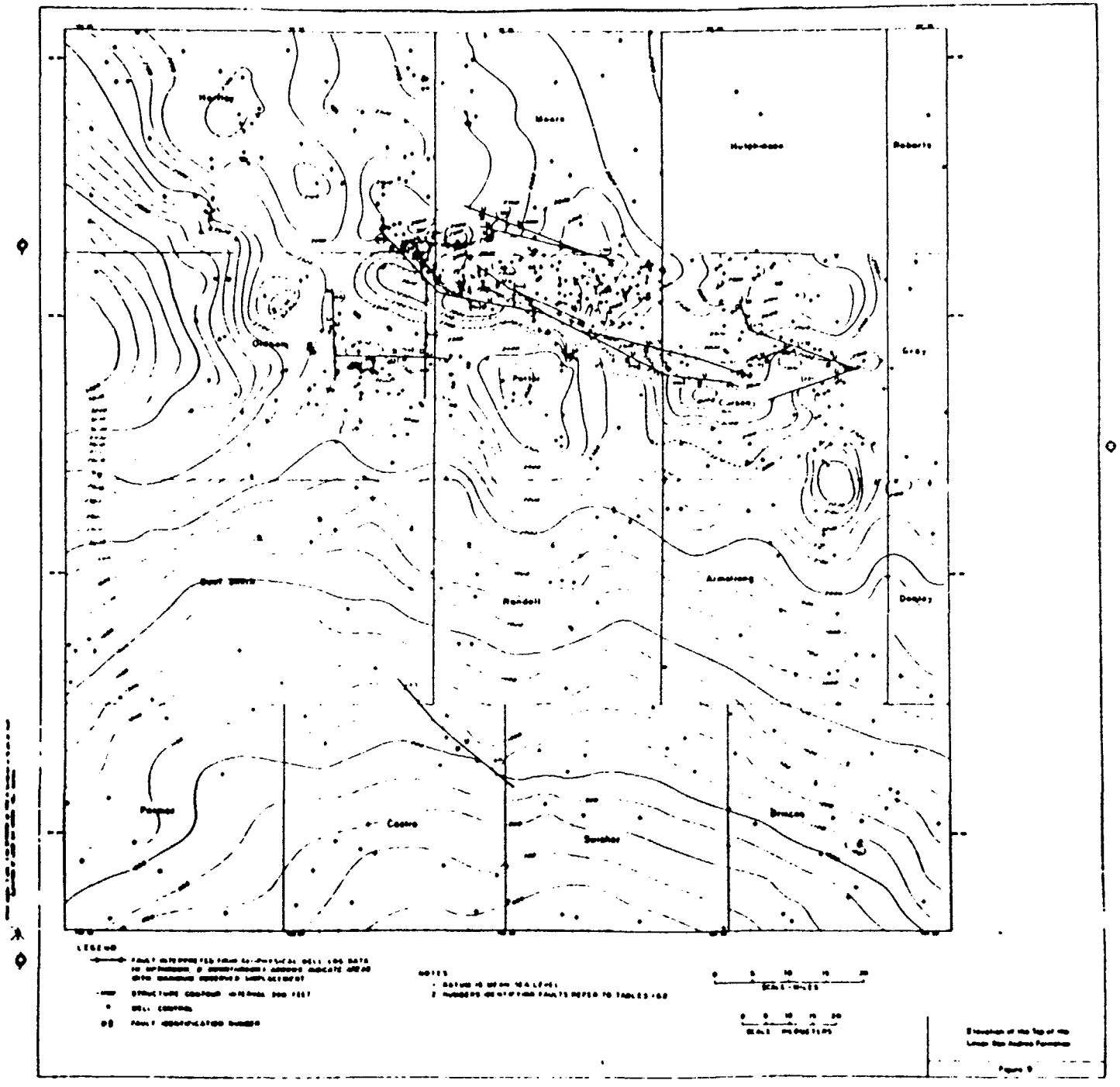
NOTES
SCALE MILES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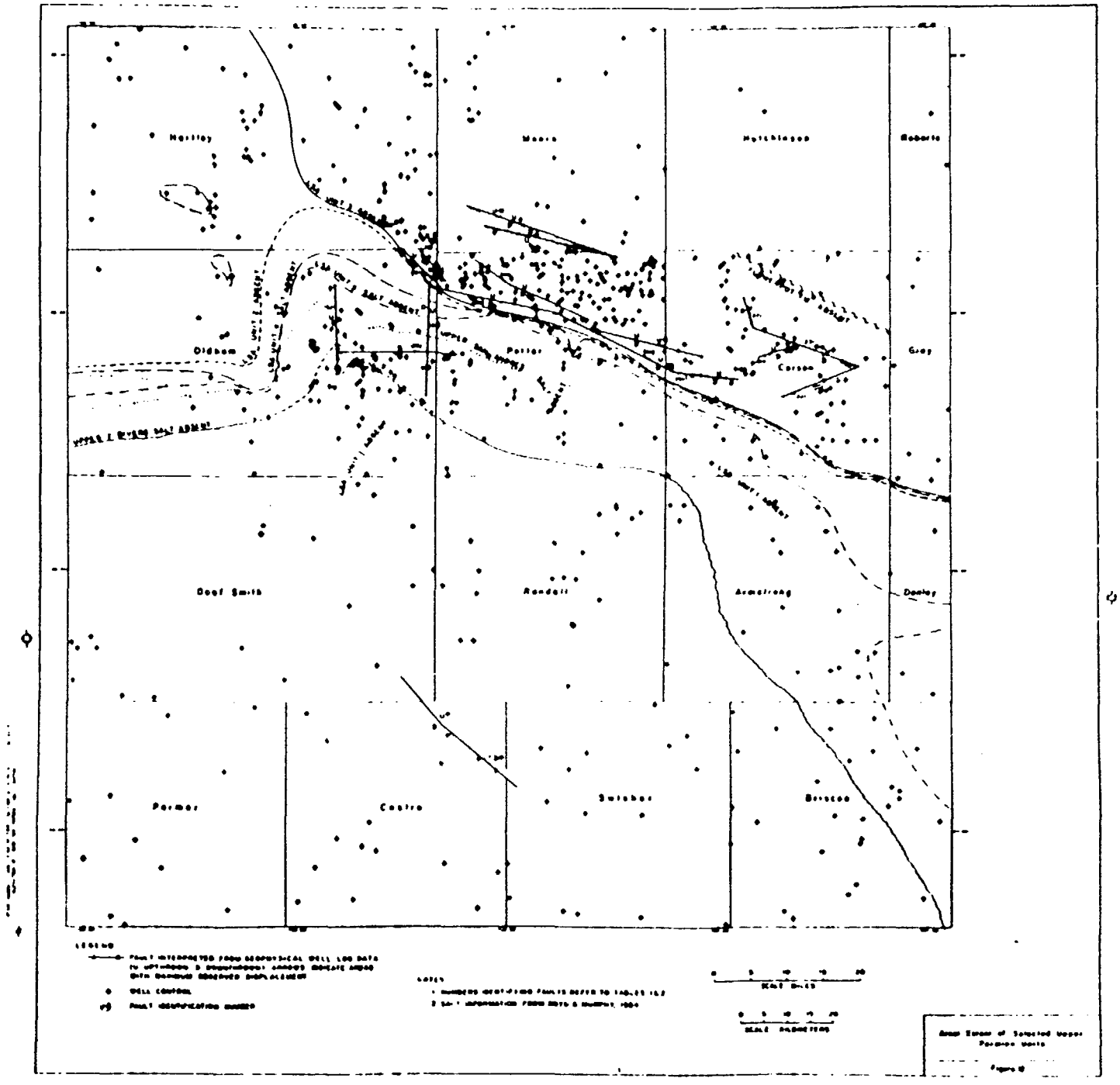
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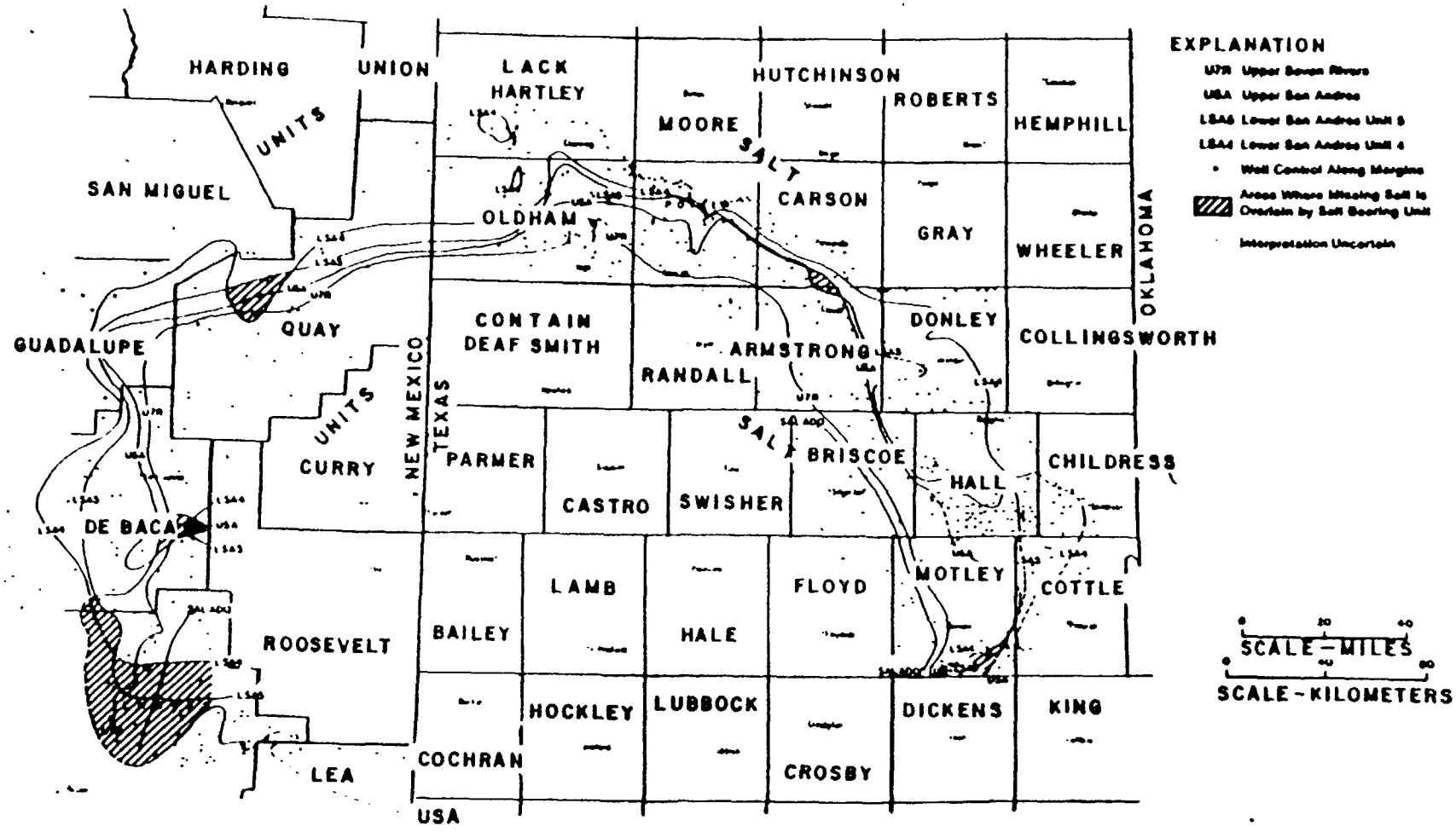
SCALE KILOMETERS

SALT MARGINS



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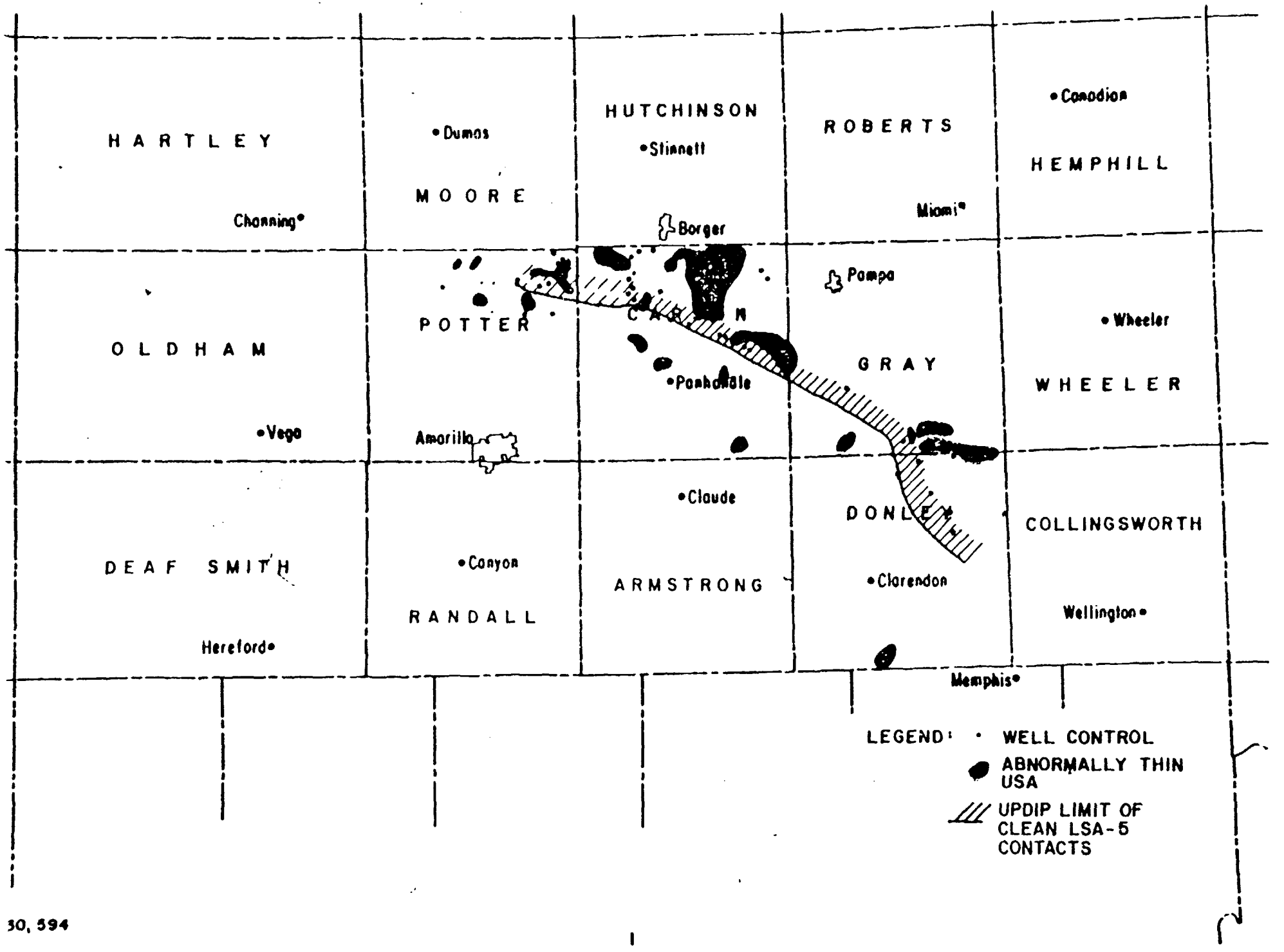
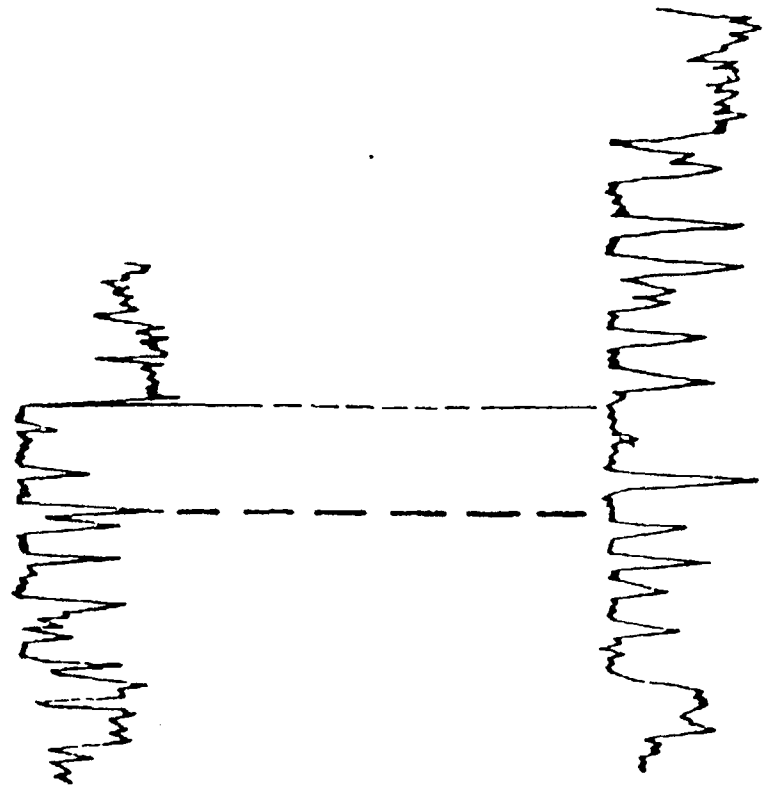

HARTLEY
Channing
MOORE
Dumas
HUTCHINSON
Stinnett
Borger
ROBERTS
Miami
Canadian
HEMPHILL
OLDHAM
Vega
POTTER
Amarillo
Panhandle
Pampa
GRAY
Wheeler
WHEELER
DEAF SMITH
Hereford
RANDALL
Canyon
ARMSTRONG
Claude
DONLEY
Clarendon
COLLINGSWORTH
Wellington
Memphis
LEGEND:
WELL CONTROL
ABNORMALLY THIN USA
UPDIP LIMIT OF CLEAN LSA-5 CONTACTS

30, 594

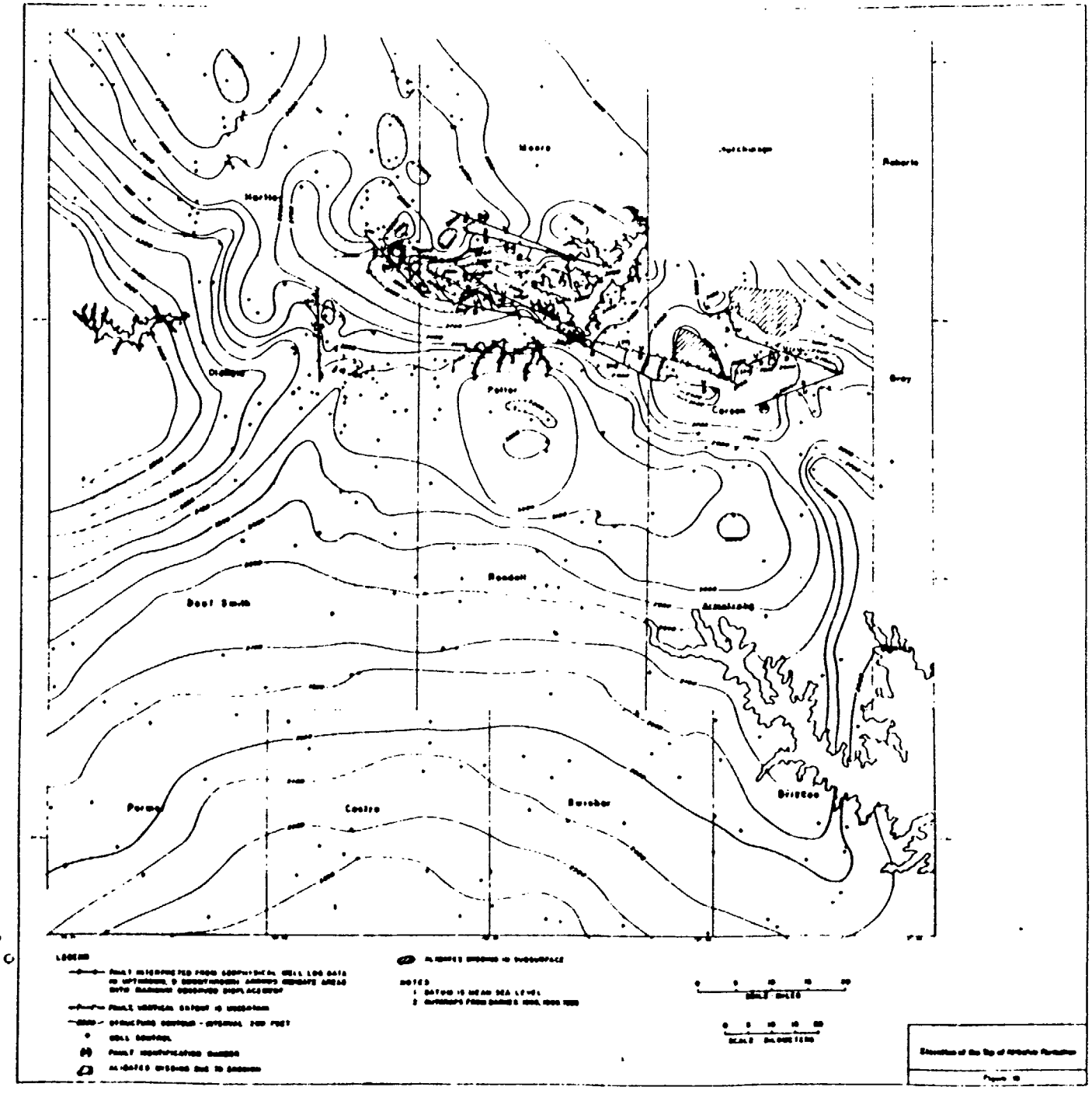
SHORT VS. AVERAGE
USA NON SALT SECTION

CITIES SERVICE
ROYER # 1

TEXAS GULF
BOBBITT # 1



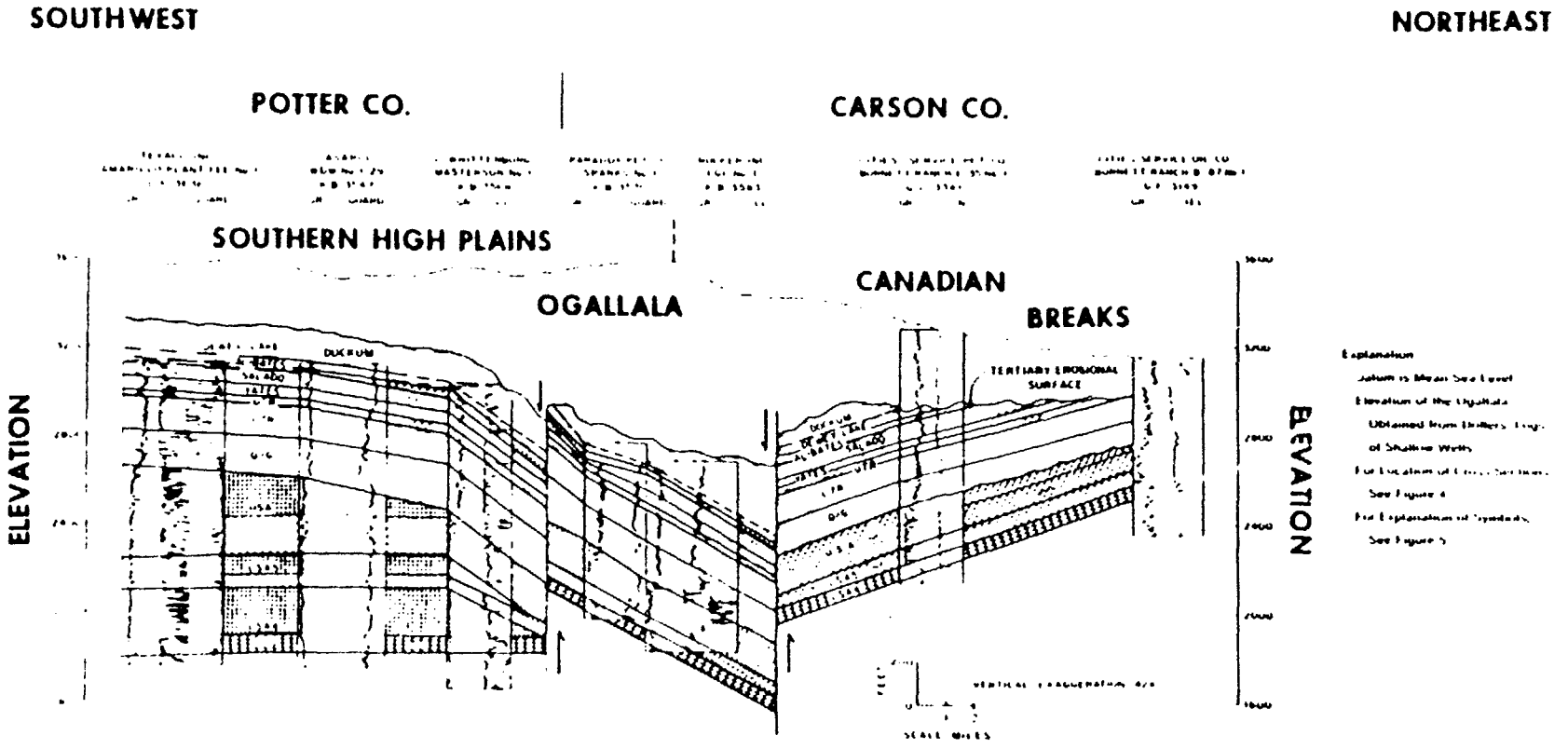
BOTH WELLS IN CARSON CO.

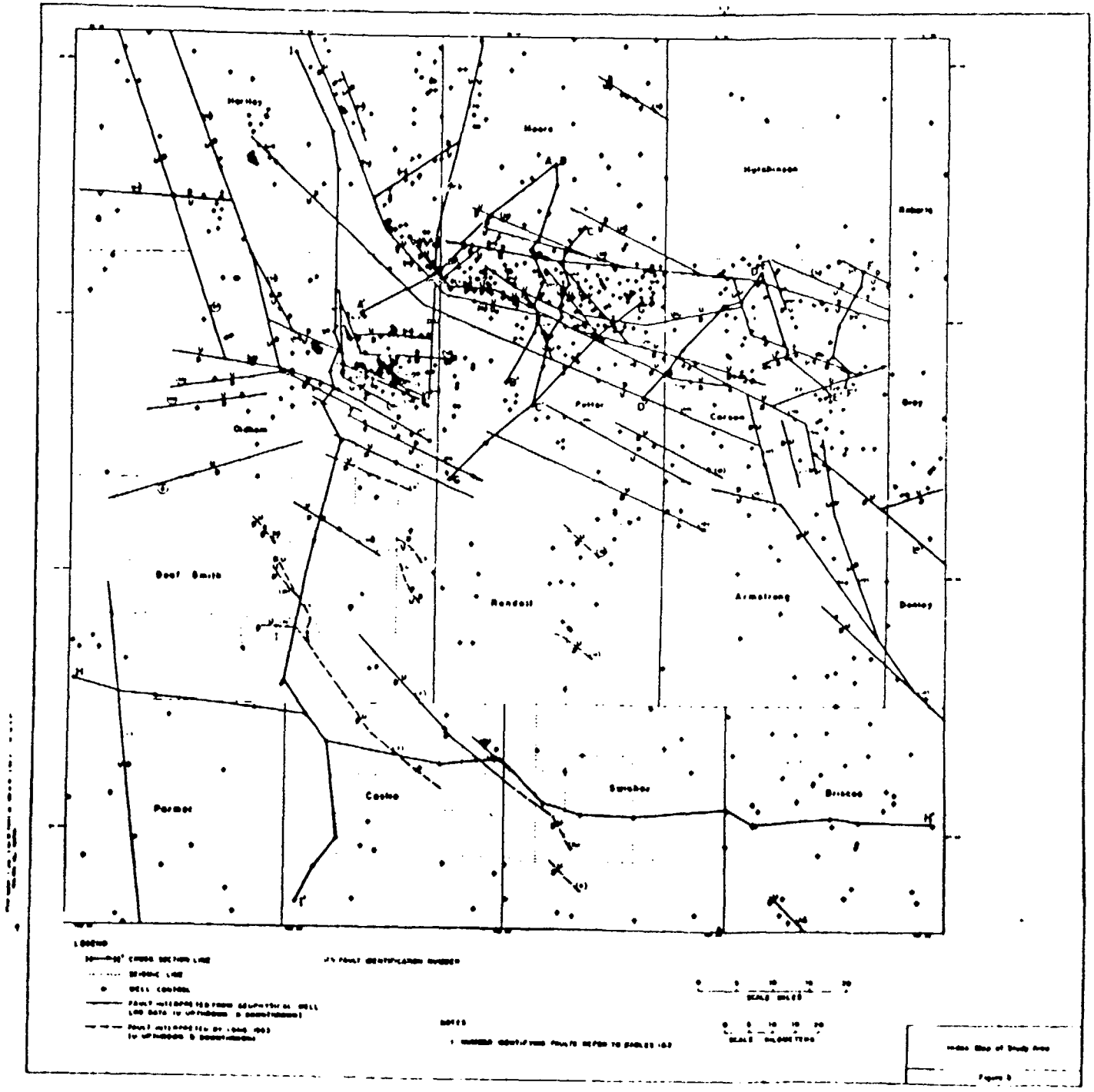


Elevation of the top of Anhydrite Formation

Figure 10

CROSS SECTION H

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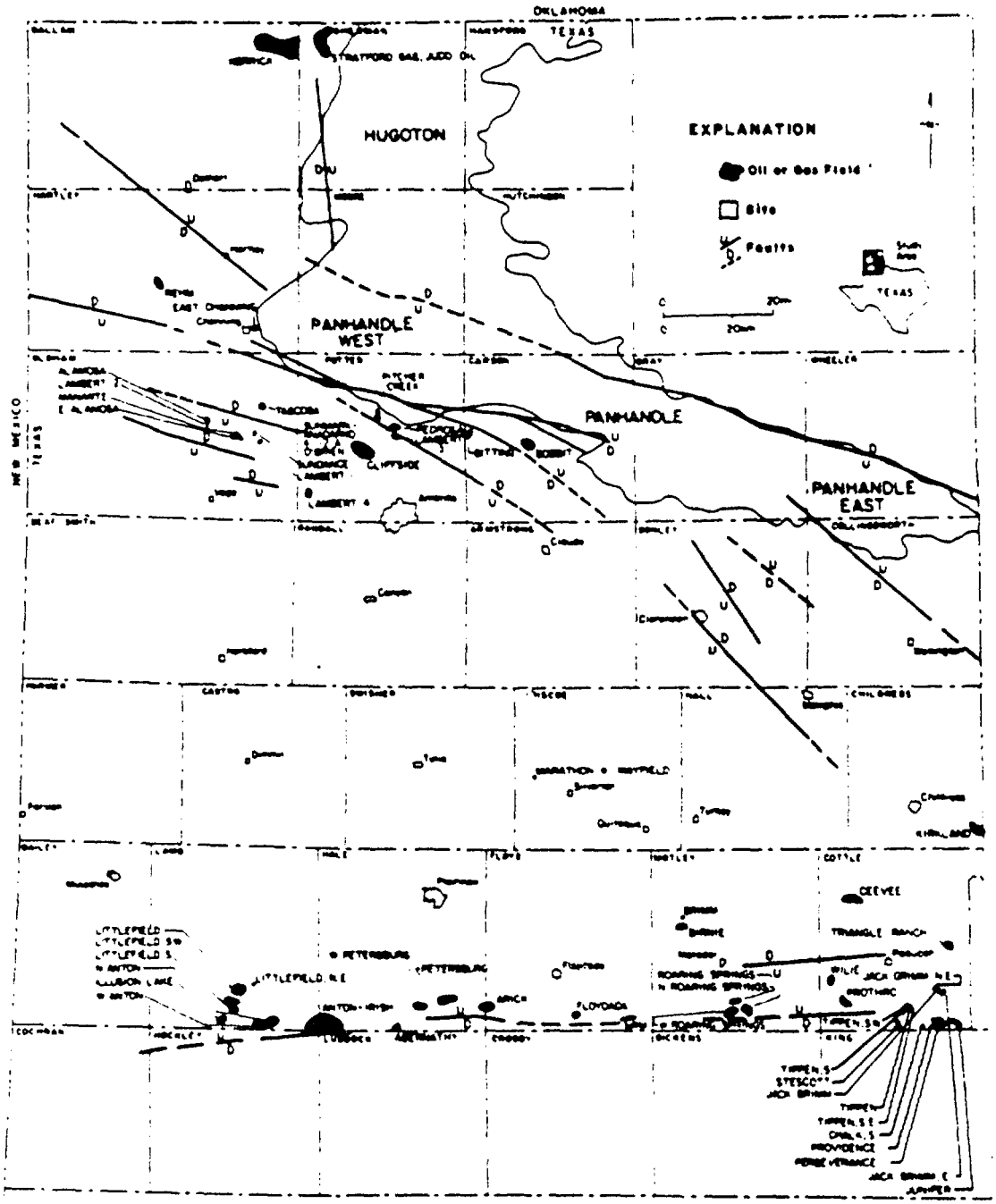
LEGEND
NOTES
SCALE MILES
SCALE KILOMETERS

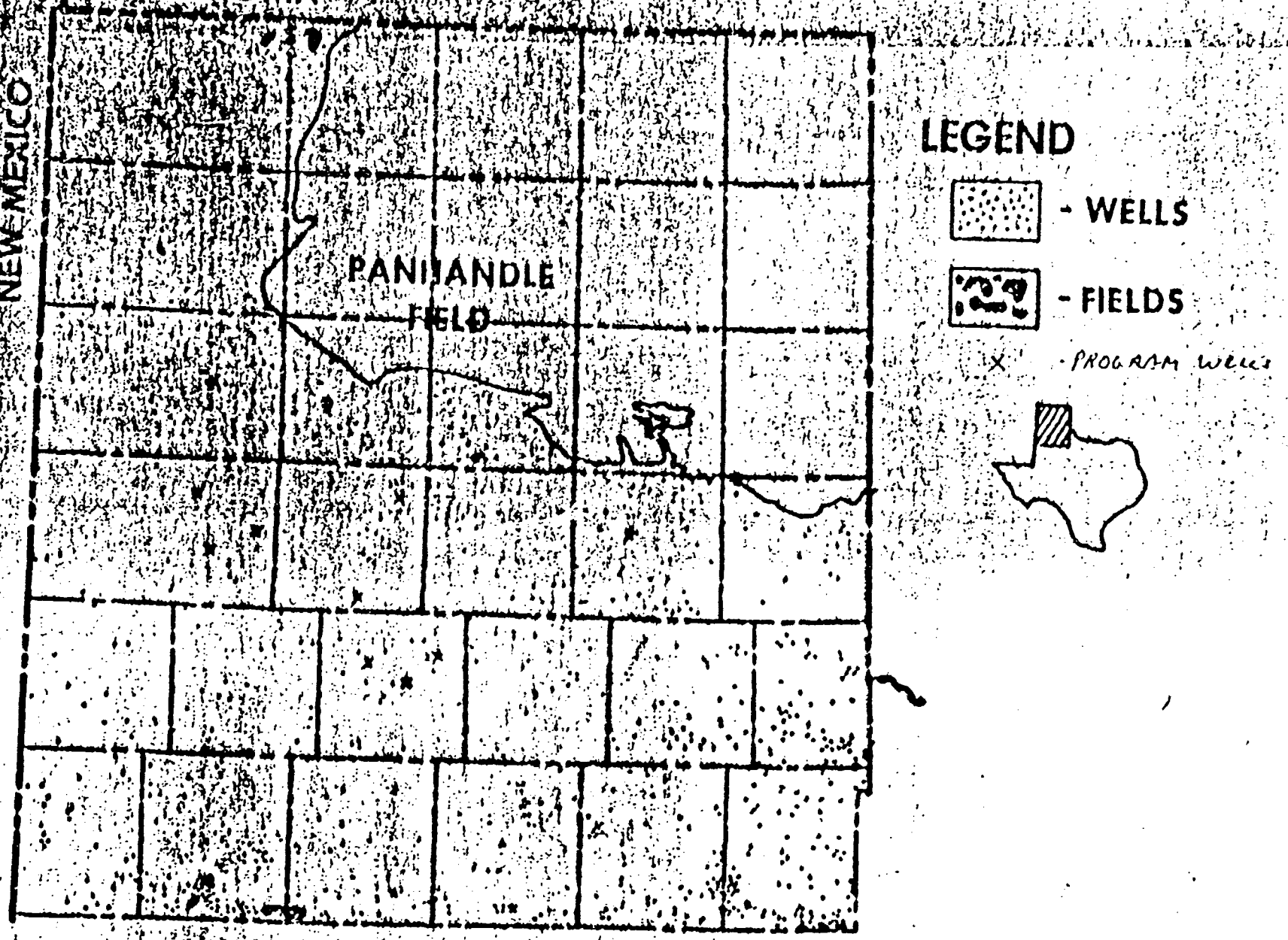


Location of Oil and Gas Fields in the Palo Duro Basin and Surrounding Areas.

Source: Dutton, Goldstein and Ruppel, 1982

Figure 3-3

WELLS IN THE PALO DURO AND DALHART BASINS



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

- 1129.2 ft to 1423.0 ft - Salado, Yates, Upper Seven Rivers
- 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

- o 1191.5 ft to 1312.0 ft - Yates, Upper Seven Rivers
- o 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 2466 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.

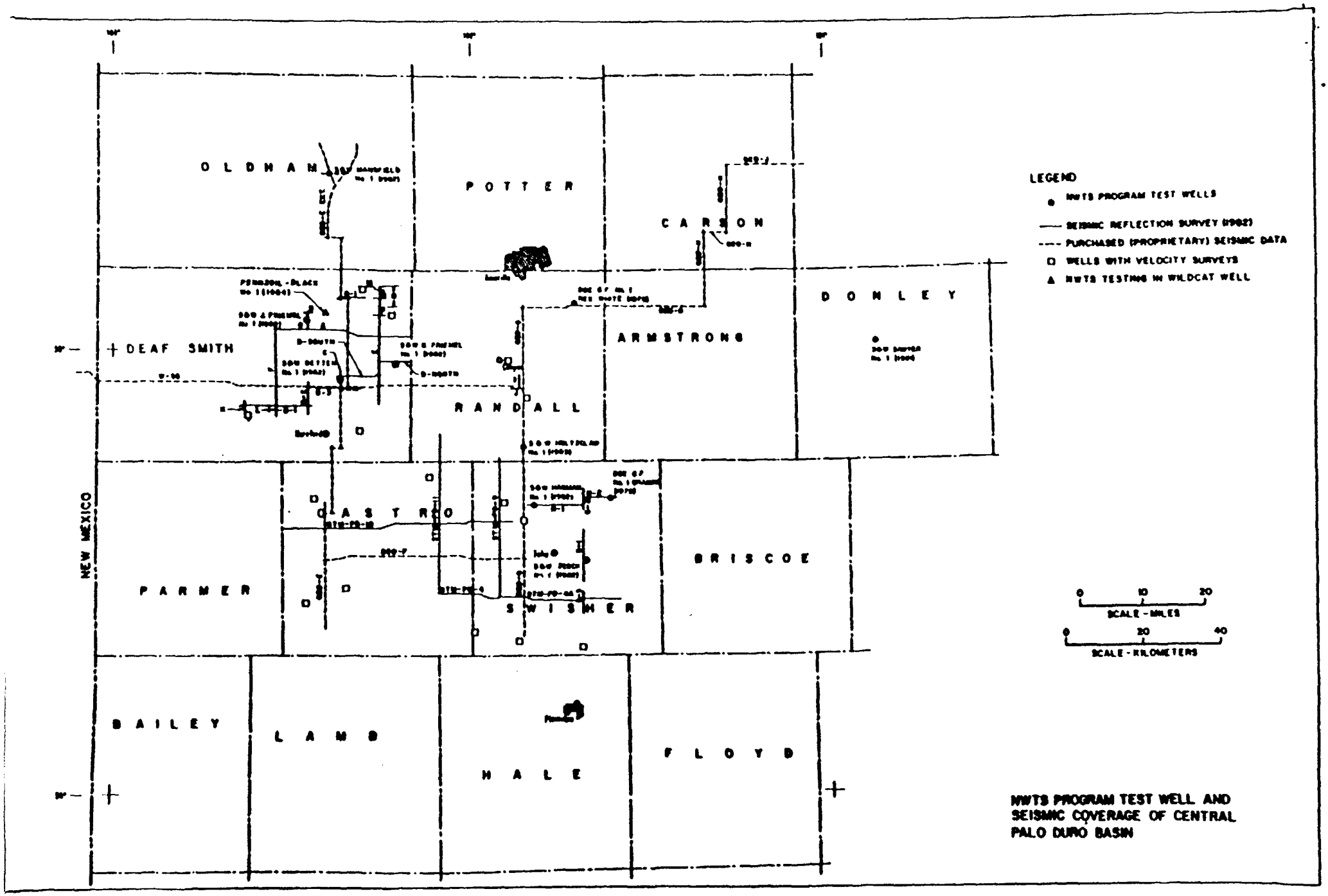
d. Geophysical Logging - Complete suites to T.D. planned.

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

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 / "Playa" Blanco	"cover sands" "Playa"	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	Sabkha salt, anhydrite, red beds, and peritidal dolomite
			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				Shelf and shelf-margin carbonate, basinal shale, and deltaic sandstone
?			?	?	
PENNSYLVANIAN	VIRGIL	CISCO			
	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

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

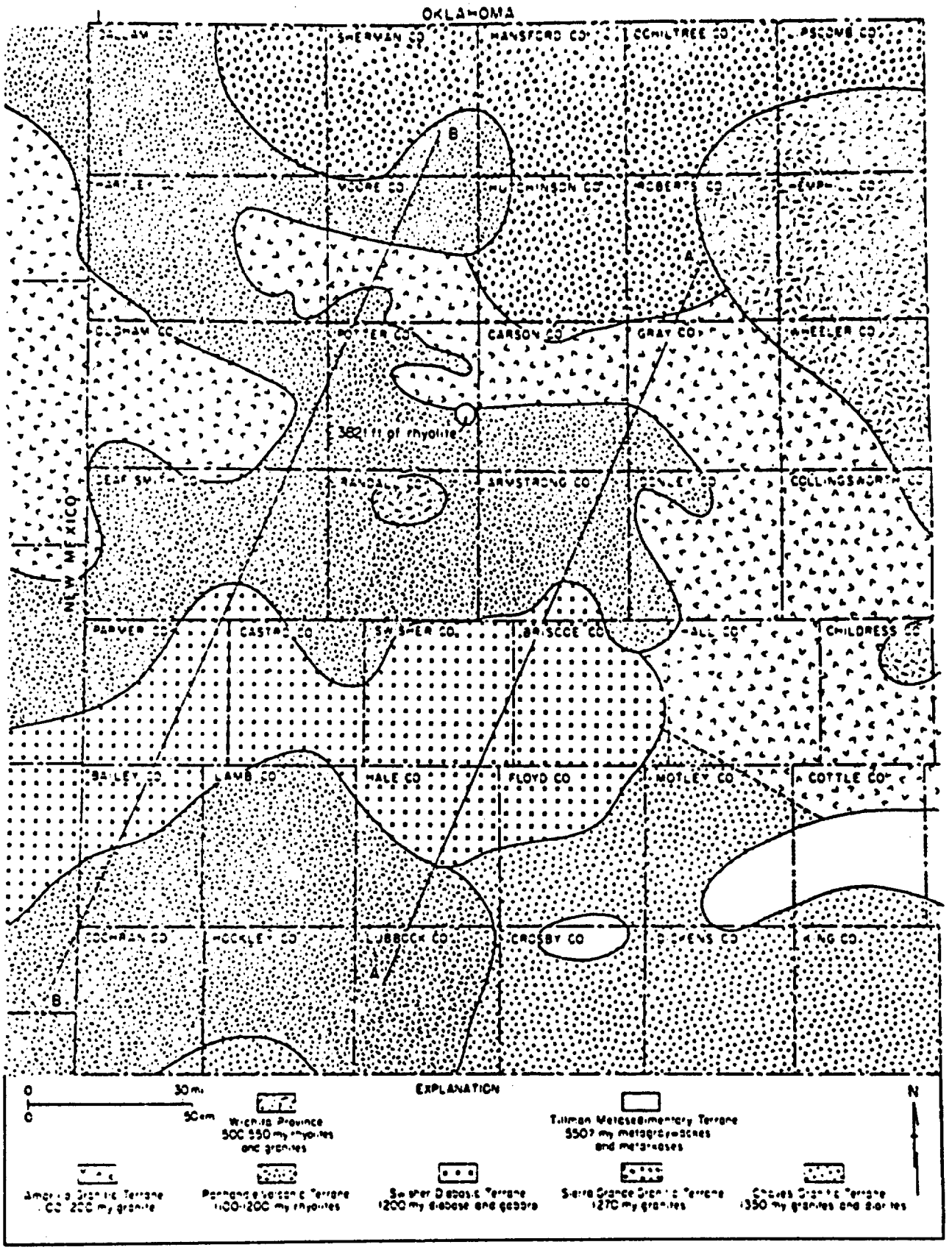
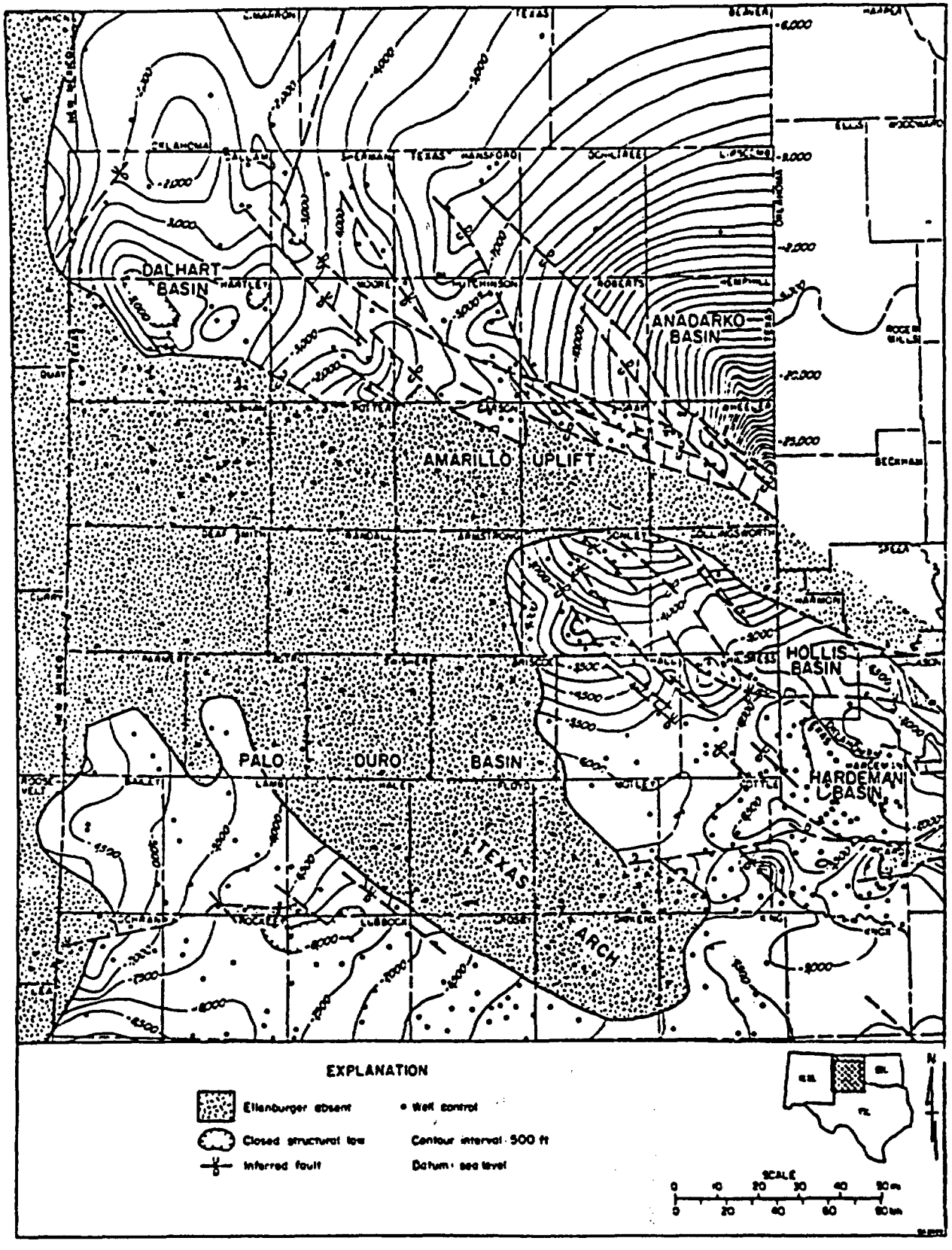
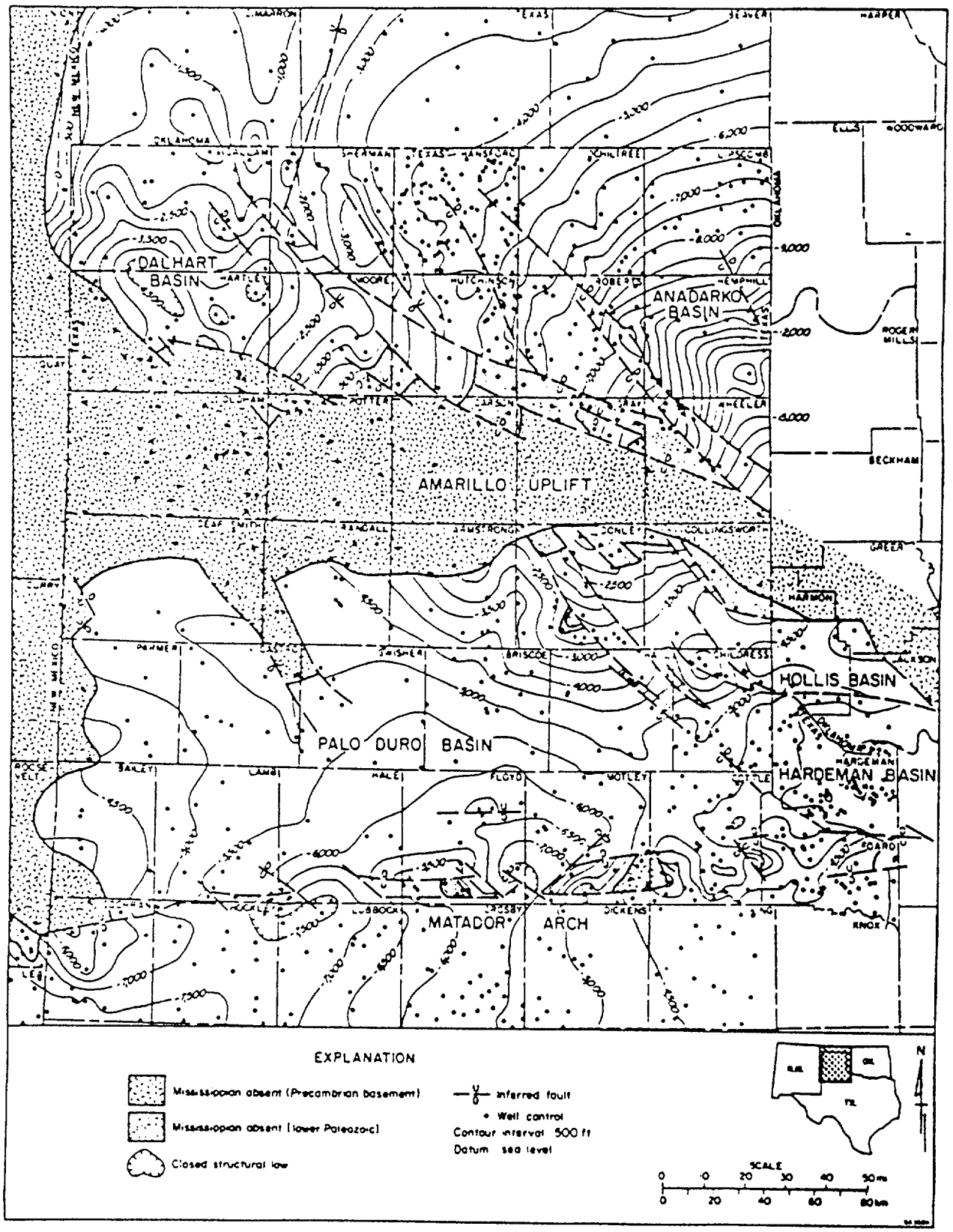


Figure 42. Basement lithologic provinces in the Texas Panhandle (from Muehlberger and others, 1967). A-A' and B-B' are locations of gravity models discussed in this report (see figs. 43 and 44).

ORDOVICIAN ELLENBURGER GROUP: STRUCTURE MAP



MISSISSIPPIAN SYSTEM: STRUCTURE MAP



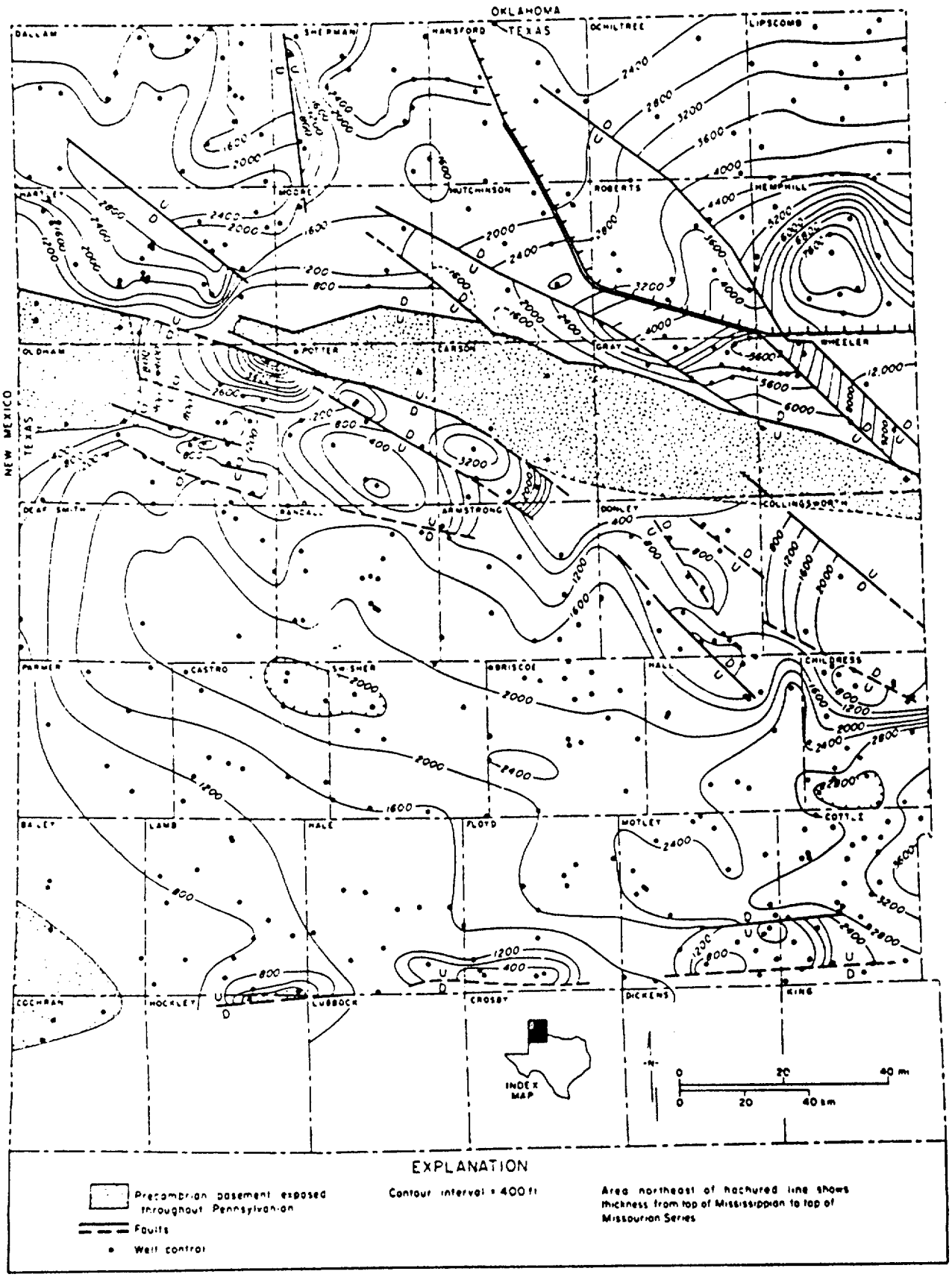


Figure 14. Isopach map of Pennsylvanian System, Texas Panhandle. Sediments thin onto uplifts that were exposed during Pennsylvanian Period.

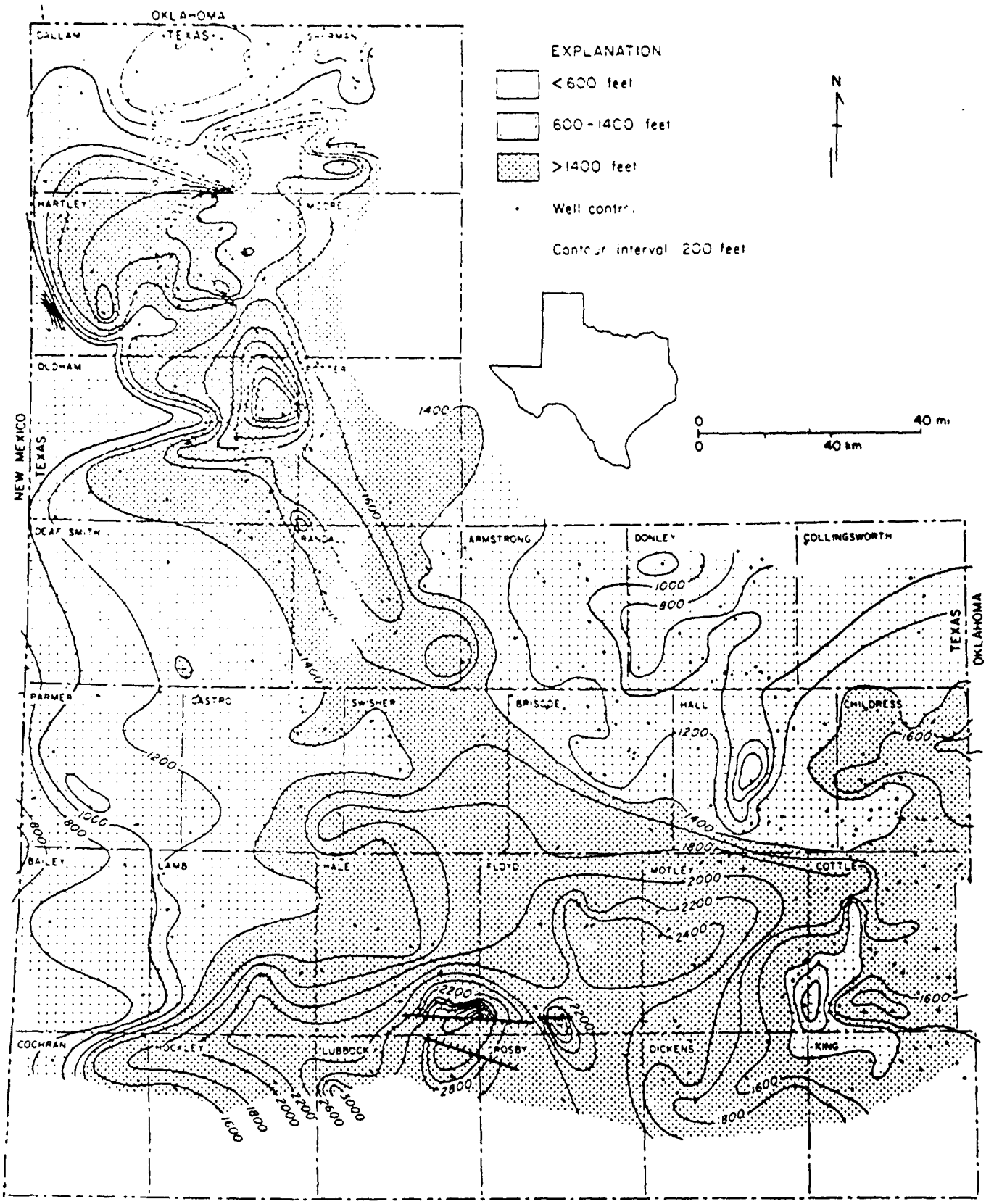


Figure 16. Isopach map of Wolfcampian Series, Palo Duro Basin (Handford, unpublished data).

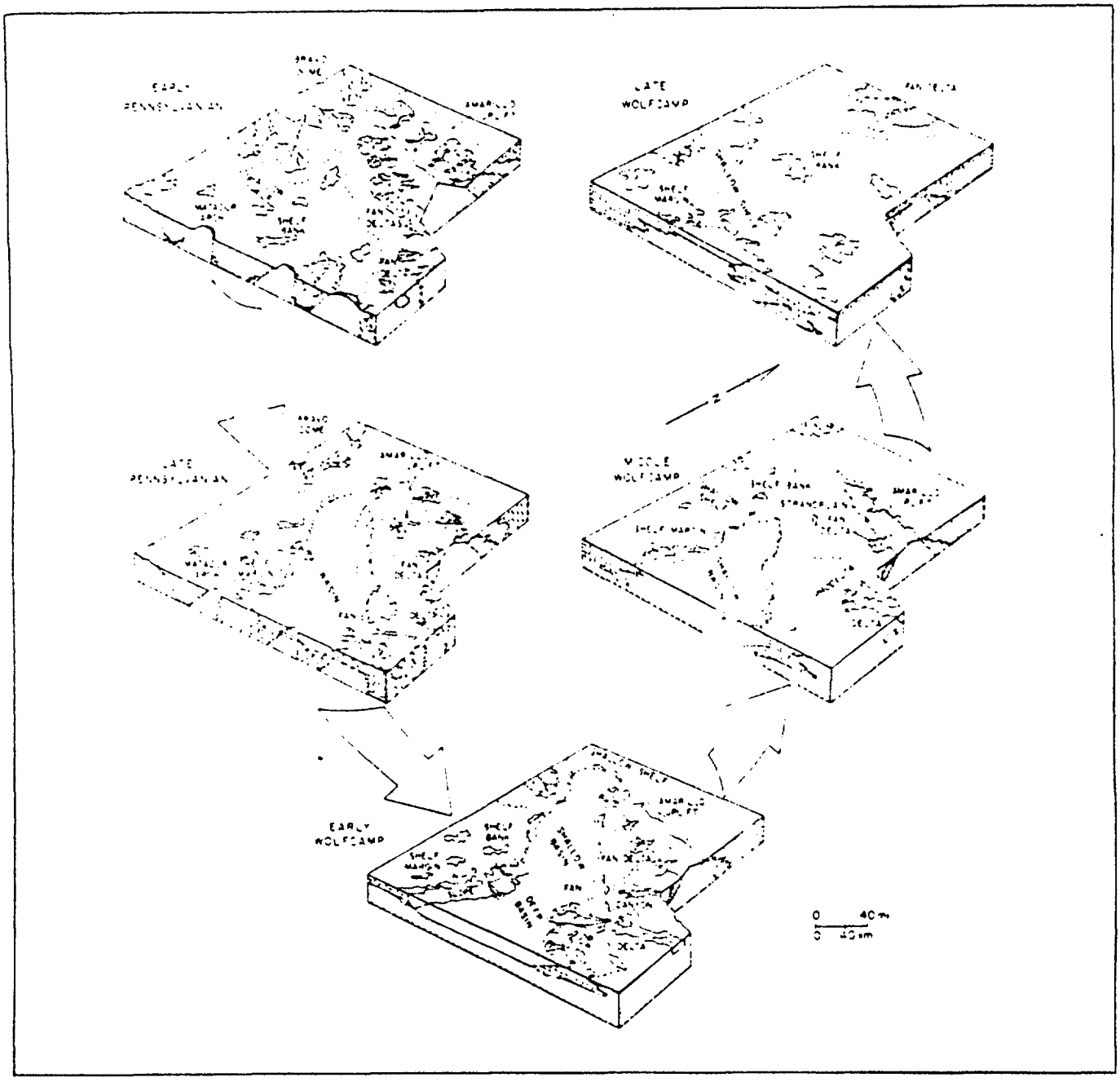


Figure 23. Block diagrams of paleogeographic evolution of Palo Duro Basin during Pennsylvanian and Wolfcampian time (from Handford and Dutton, 1980).

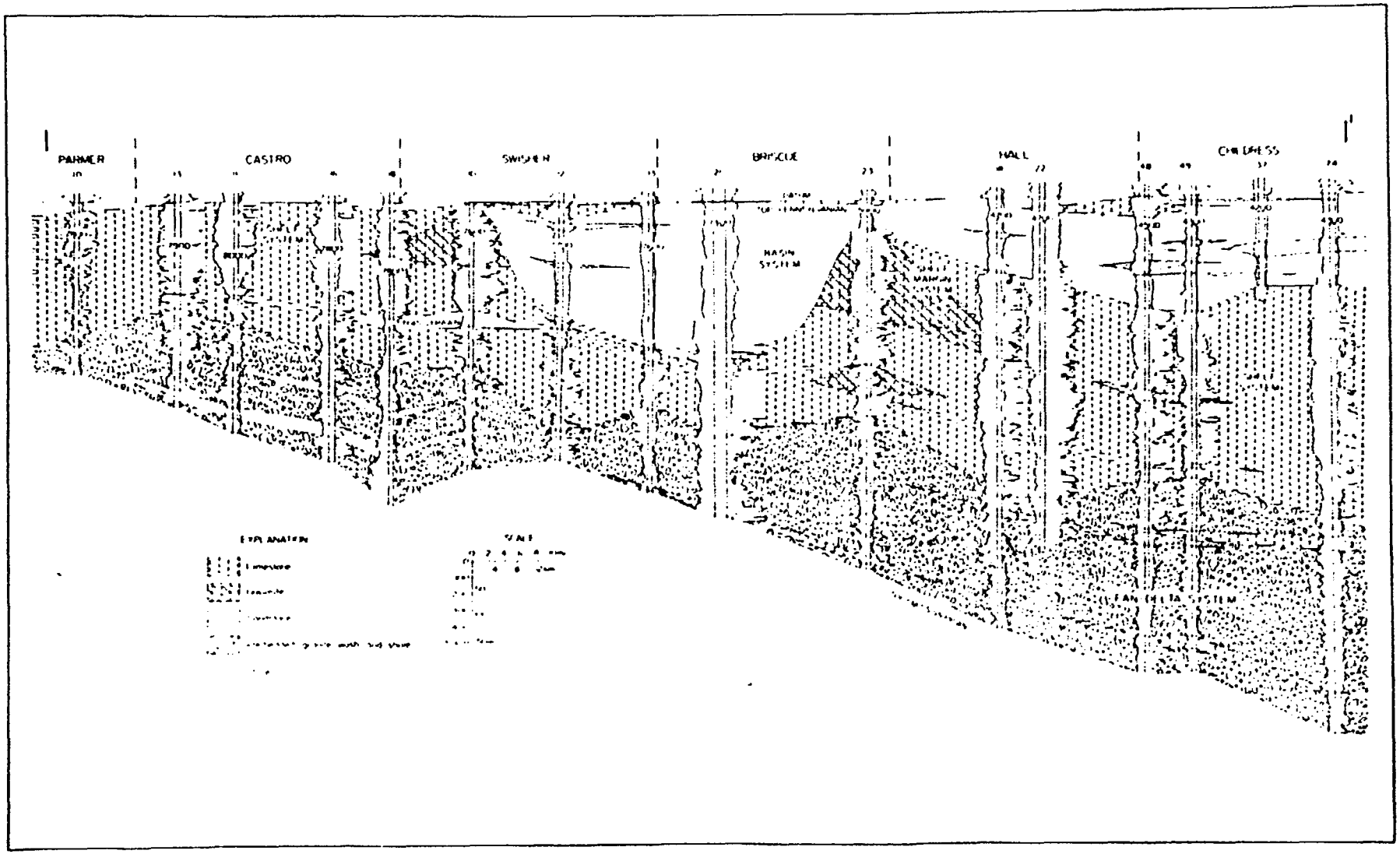


Figure 25. East-west cross section I-I' of Pennsylvanian strata, Parmer to Childress Counties (see fig. 3 for location).

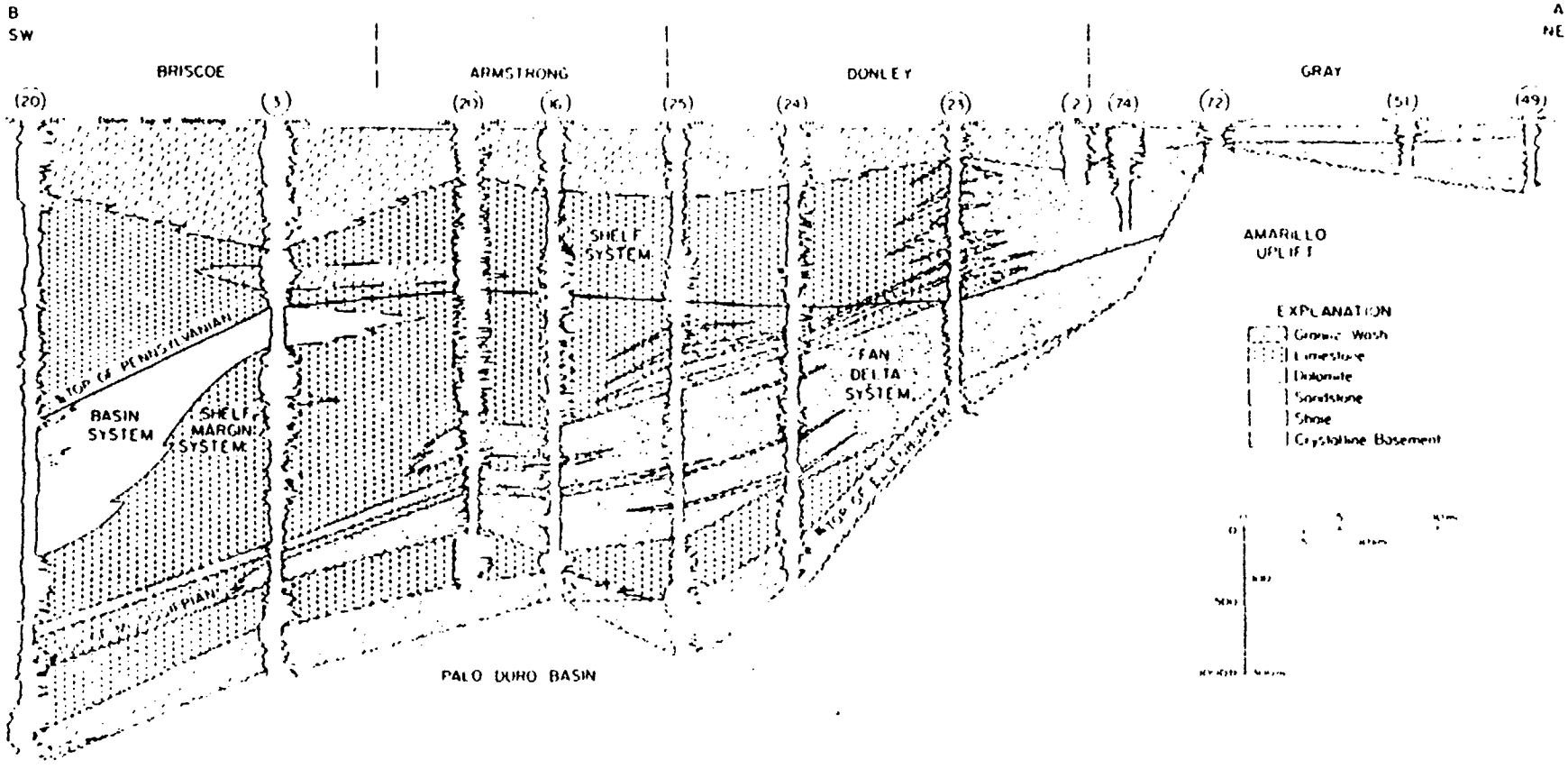


Figure 59. North-south regional cross section A-B from the central Palo Duro Basin to the Amarillo Uplift. Line of section shown in figure 57.

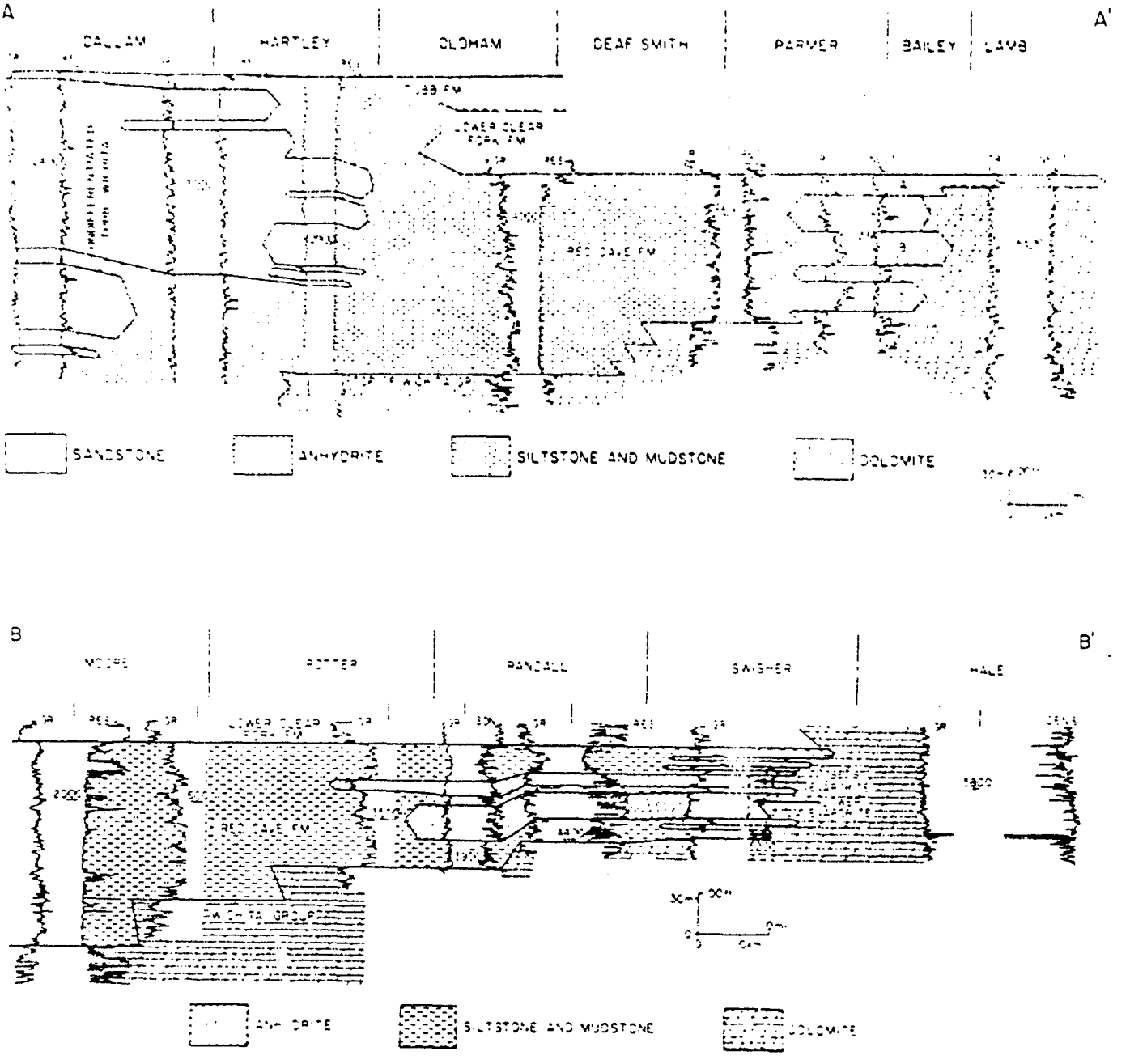


Figure 3. North-south cross sections A-A' and B-B' through the Red Cave Formation.

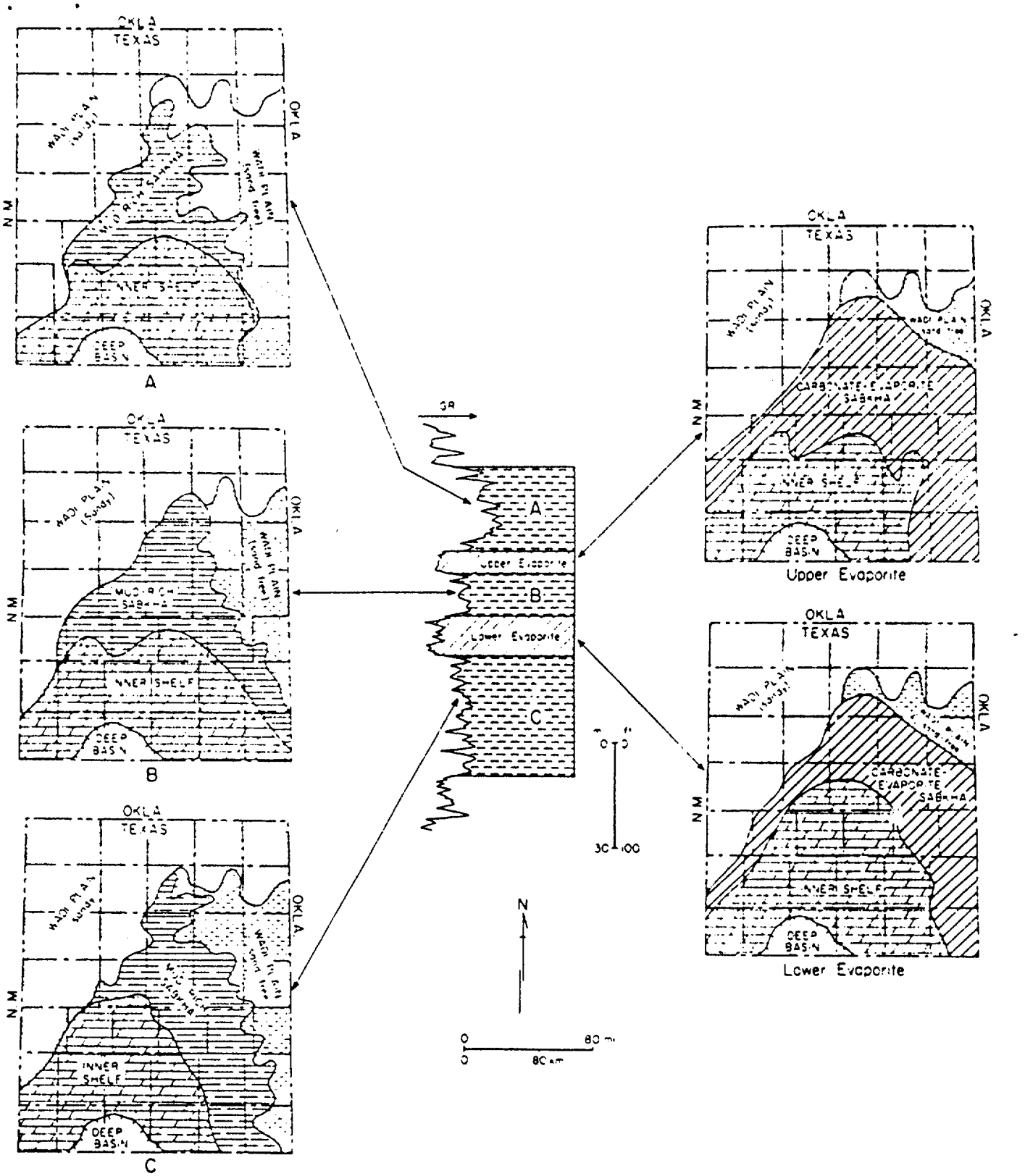


Figure 19. Paleogeography of the Red Cave Formation. Cyclic clastic and carbonate-evaporite facies reflect alternating styles of sabkha deposition that were brought on by the periodic availability and supply of clastics to sabkha environments.

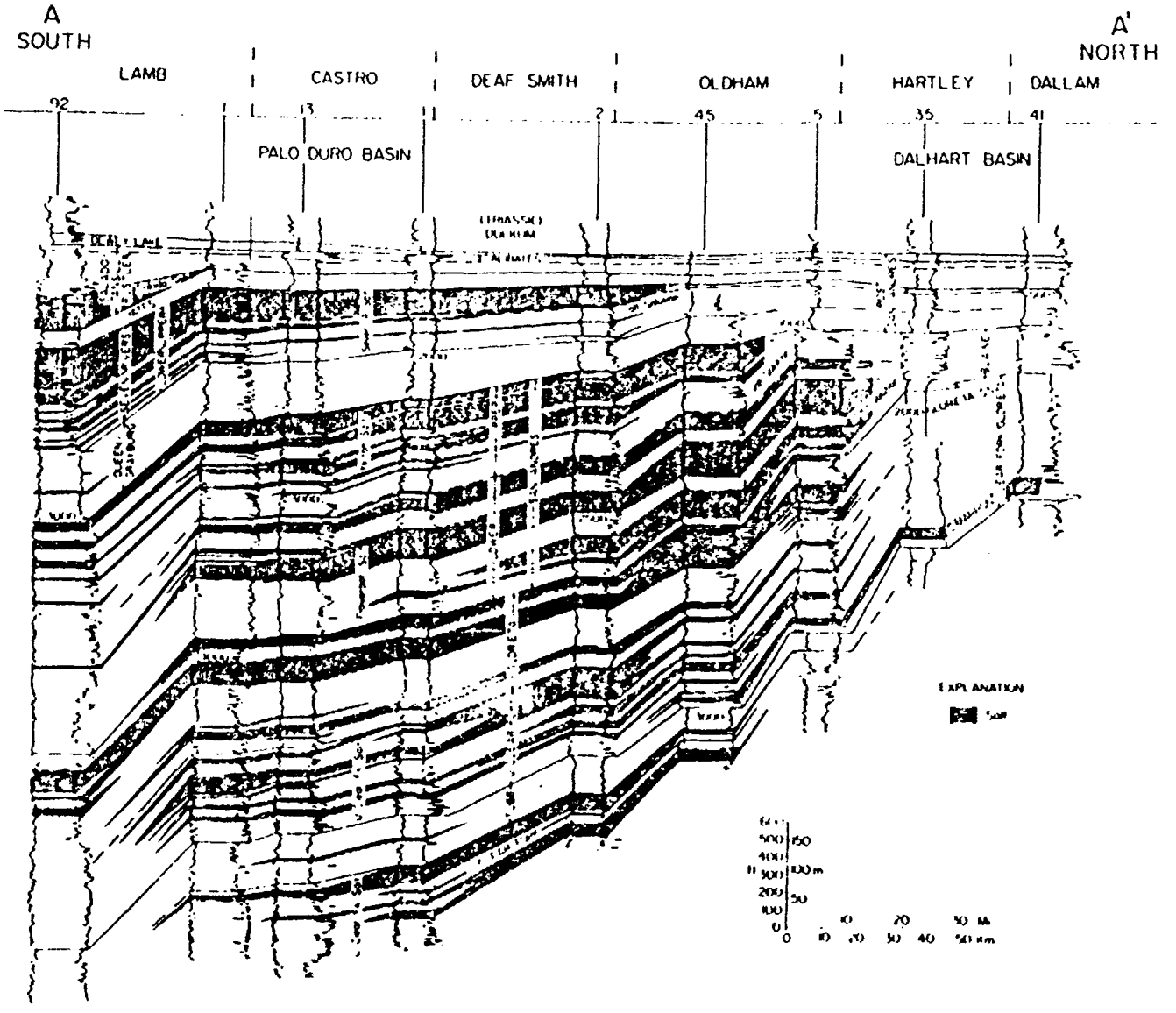


Figure 5. North-south cross section, Upper Permian salt-bearing strata, Texas Panhandle. Generalized salt units are correlated. Location of section in figure 4.

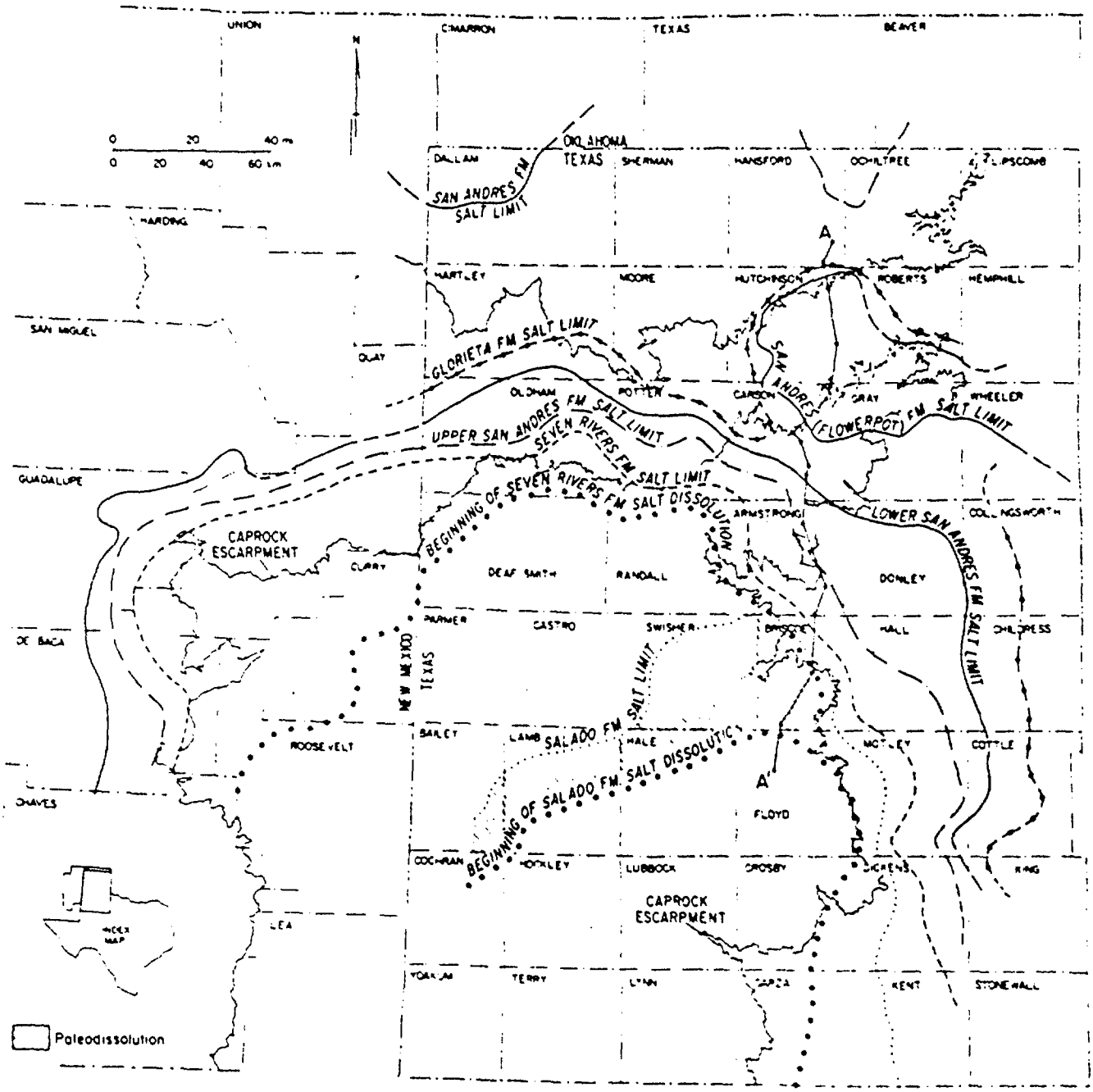


Figure 72. Salt dissolution zones, Texas Panhandle and eastern New Mexico. Except for the Seven Rivers and Salado Formations, where both the beginning of salt dissolution and the limit of salt are shown, the limit of salt for the younger formation marks the approximate beginning of salt dissolution for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

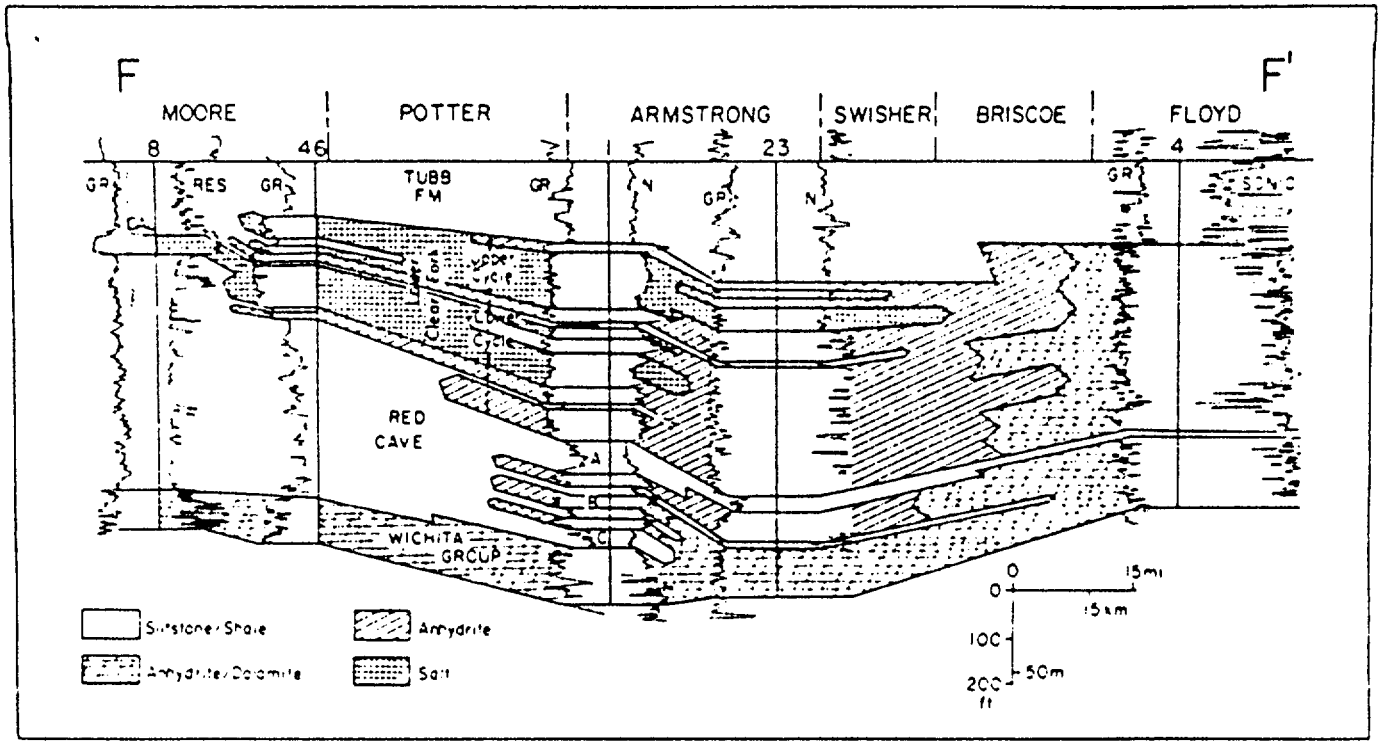


Figure 34. North-south cross section F-F' of lower Clear Fork Formation. See figure 3 for location (from Handford, 1981).

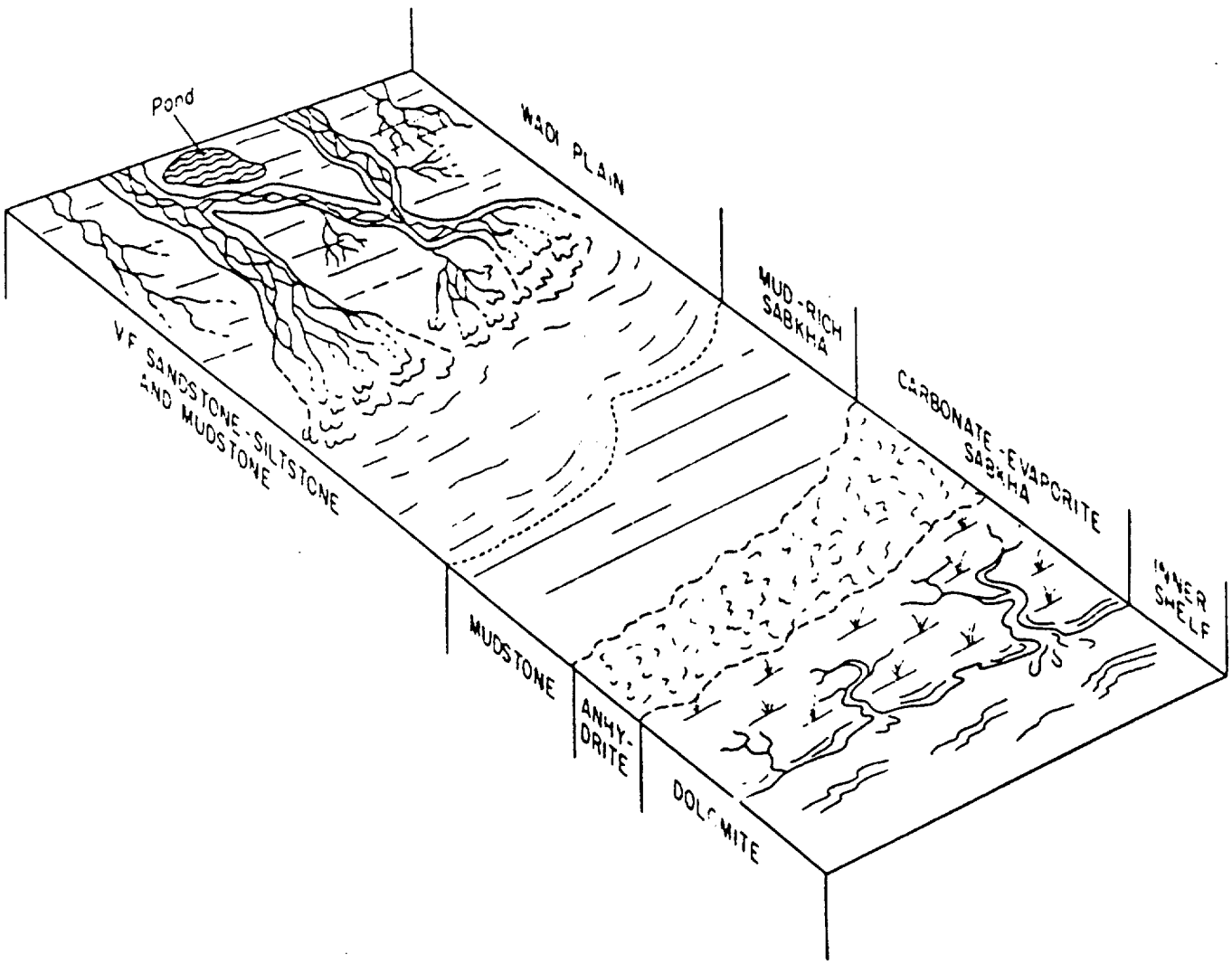


Figure 17. Composite depositional model for Red Cave carbonate, evaporite, and clastic facies.

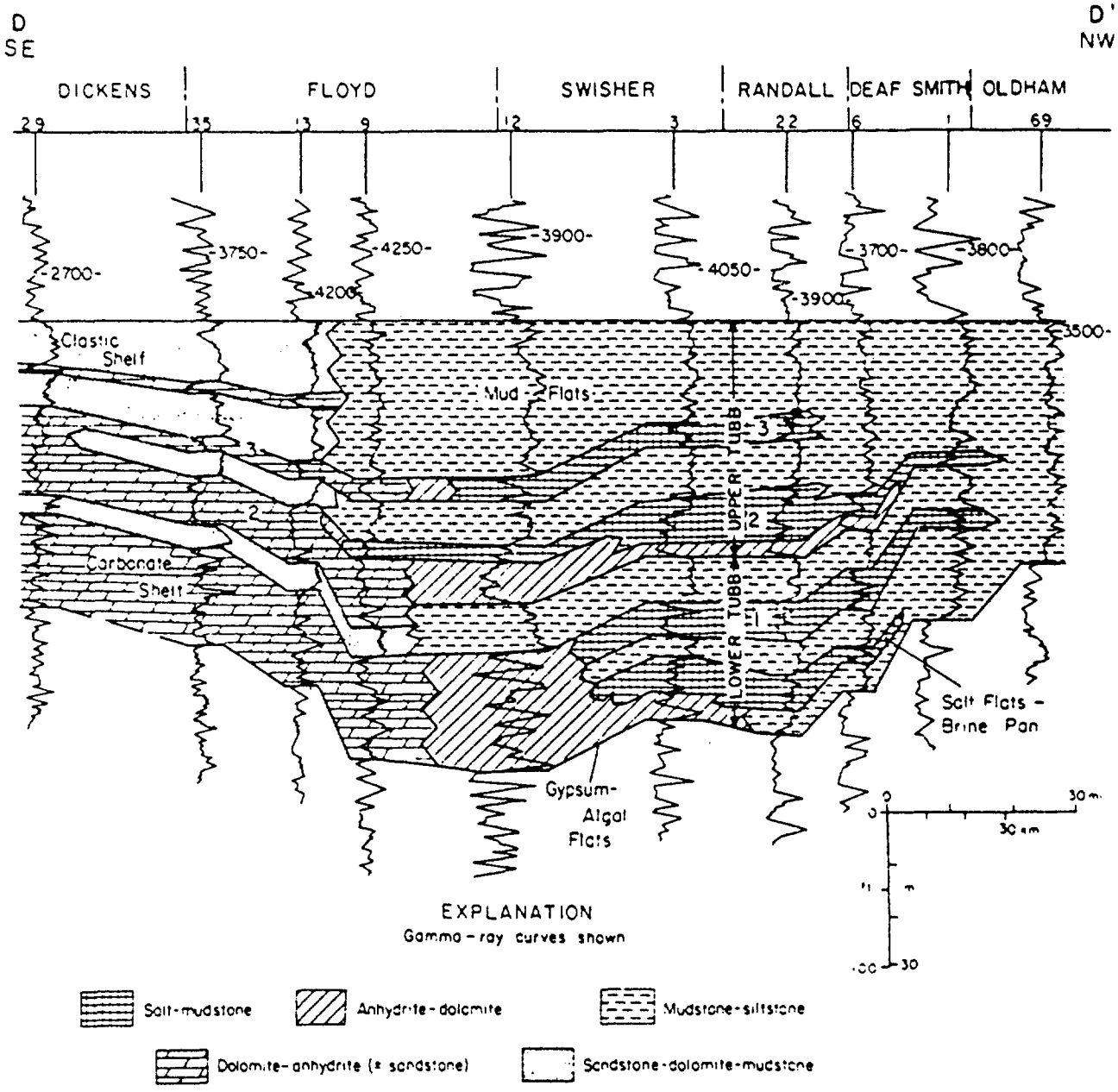


Figure 41. Northwest-southeast cross section, Tubb Formation, Palo Duro Basin. Line of cross section is indicated in figure 87. From Presley (1980b).

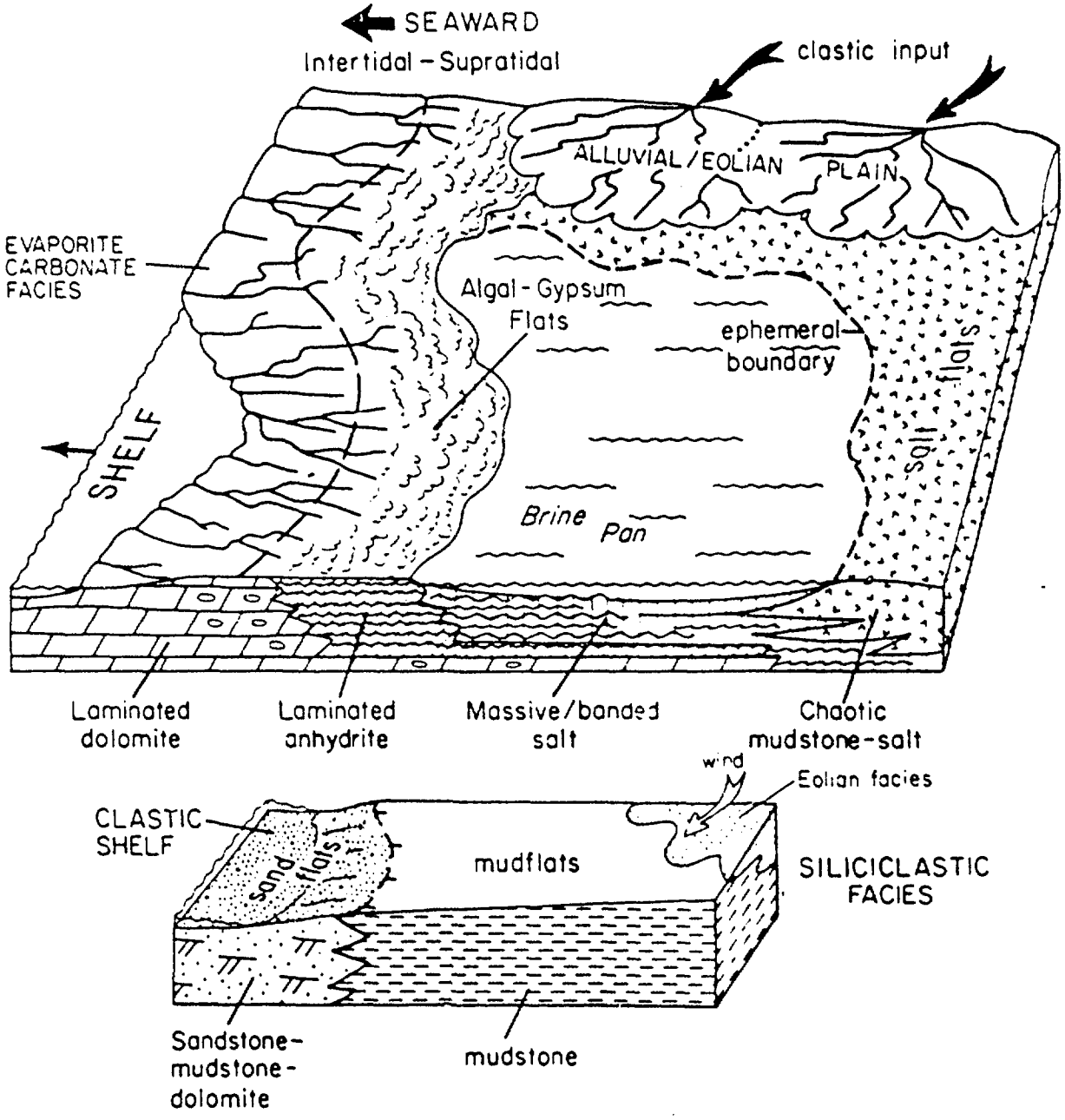


Figure 40. Facies and environments recorded in Tubb strata of the Palo Duro and Dalhart Basins. Evaporite-carbonate facies record a gradual basinward shift in environments. Siliciclastic (red-bed) facies dominate the Tubb sequence, and were deposited in tidal mud flats, which graded basinward into tidal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

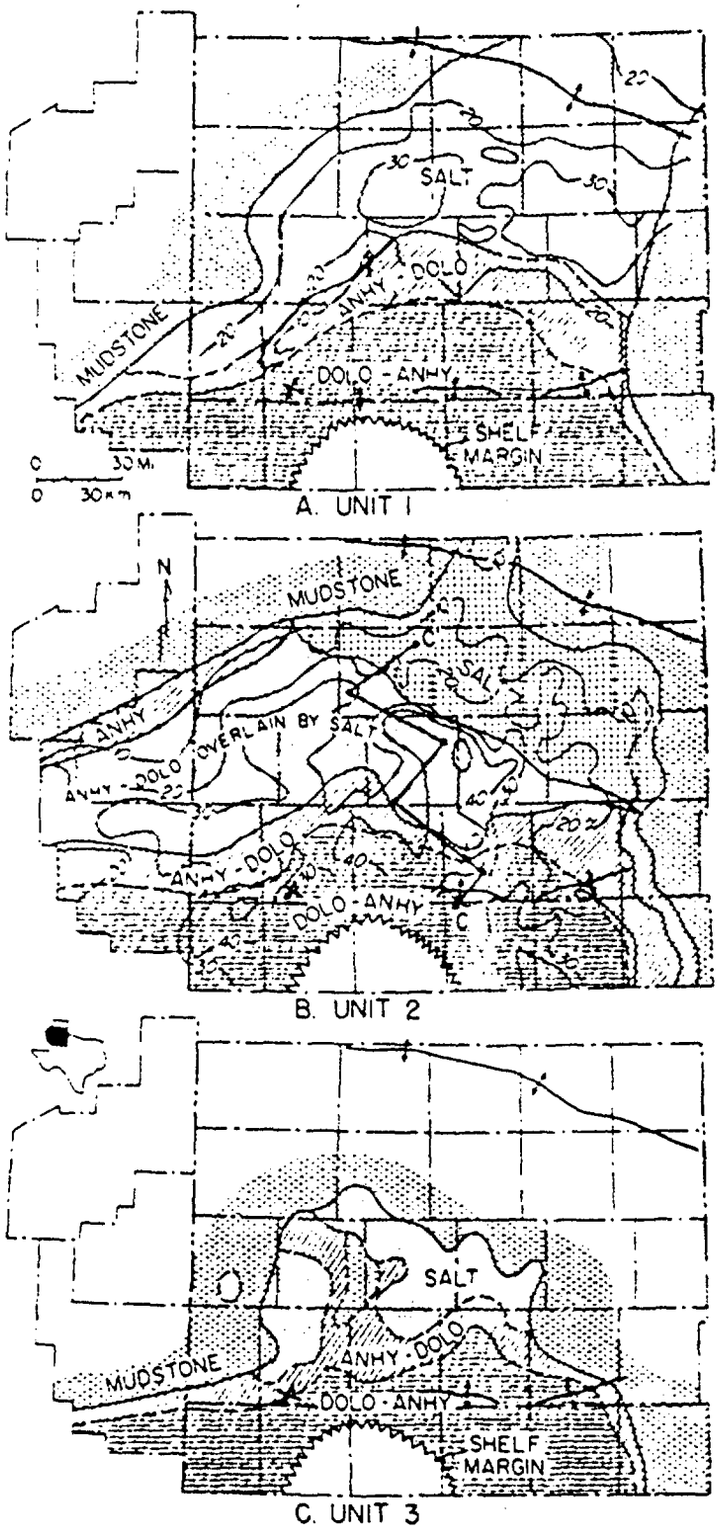


Figure 42. Facies maps of evaporite-carbonate units 1, 2, and 3 (oldest to youngest) of the Tubb Formation. Salt is dominant in updip regions to the north; carbonate is dominant to the south. These units show progressive southerly migration of evaporite-carbonate facies. From Presley (1980b).

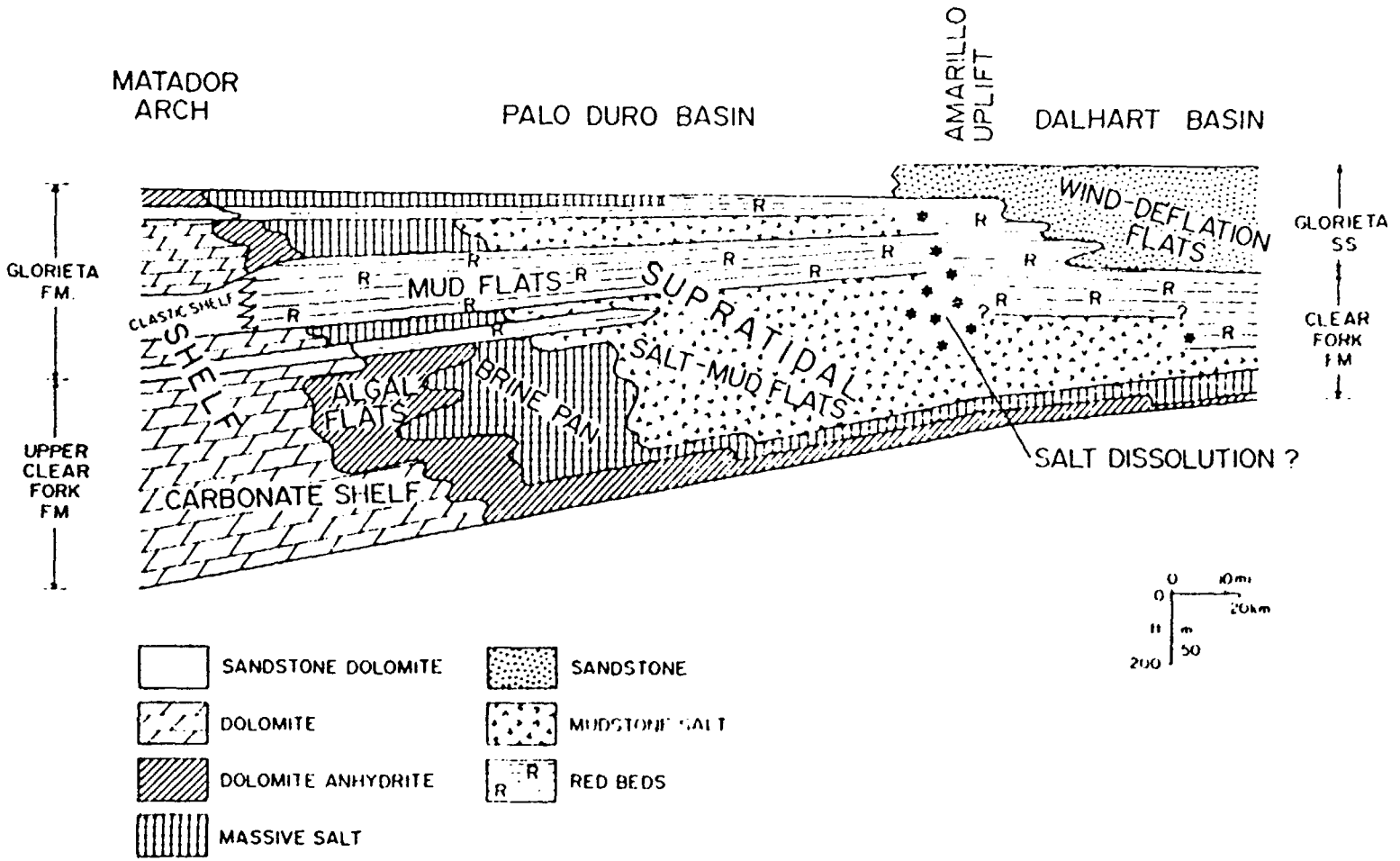


Figure 43. North-south facies cross section through Palo Duro and Dalhart Basins showing relation of environments for the upper Clear Fork and Glorieta Formations. From Presley (unpublished data).

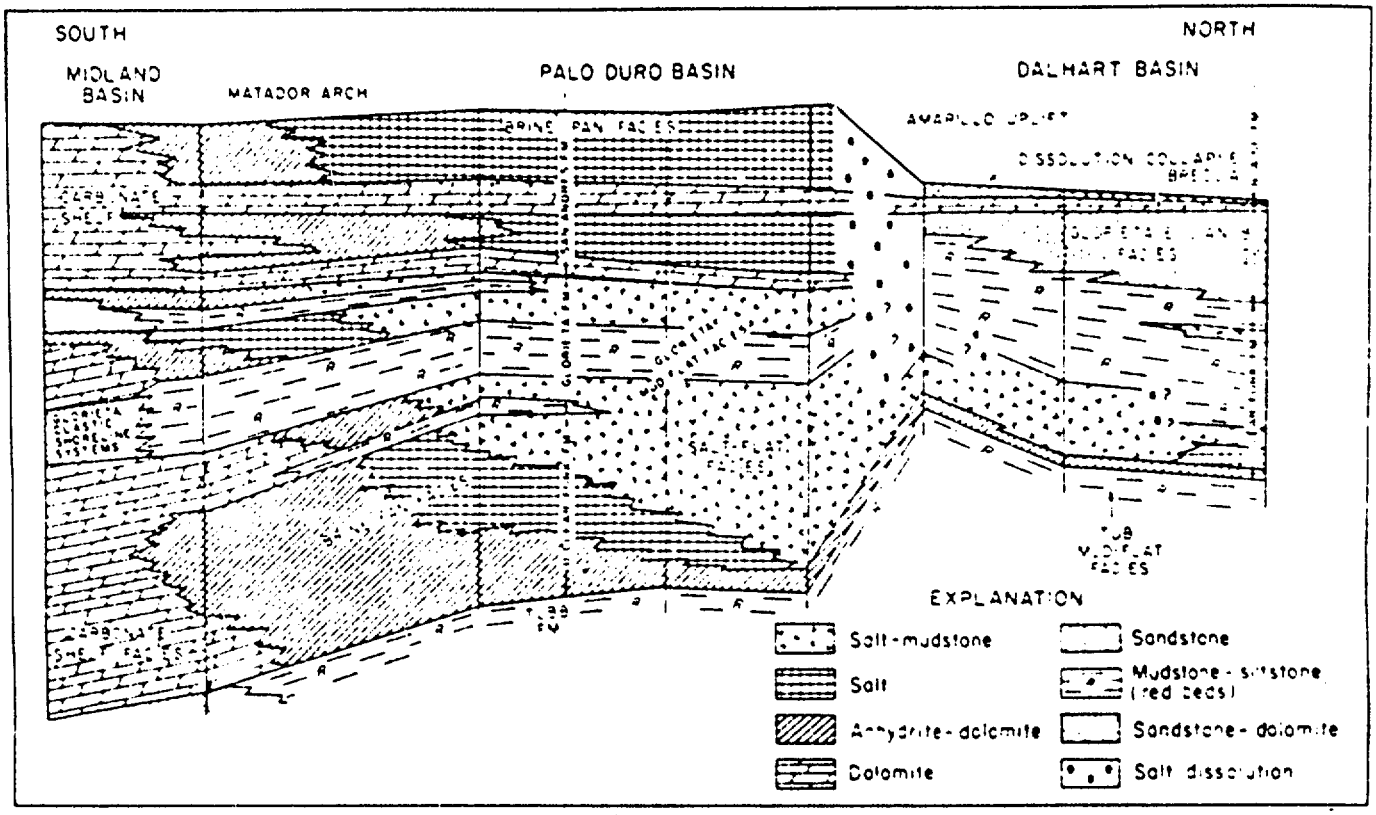


Figure 2. Diagrammatic north-south cross section of upper Clear Fork and Glorieta Formations and underlying and overlying units in Texas Panhandle. Generalized facies interpretations are shown. Location generally follows line of section A-A' in figure 1.

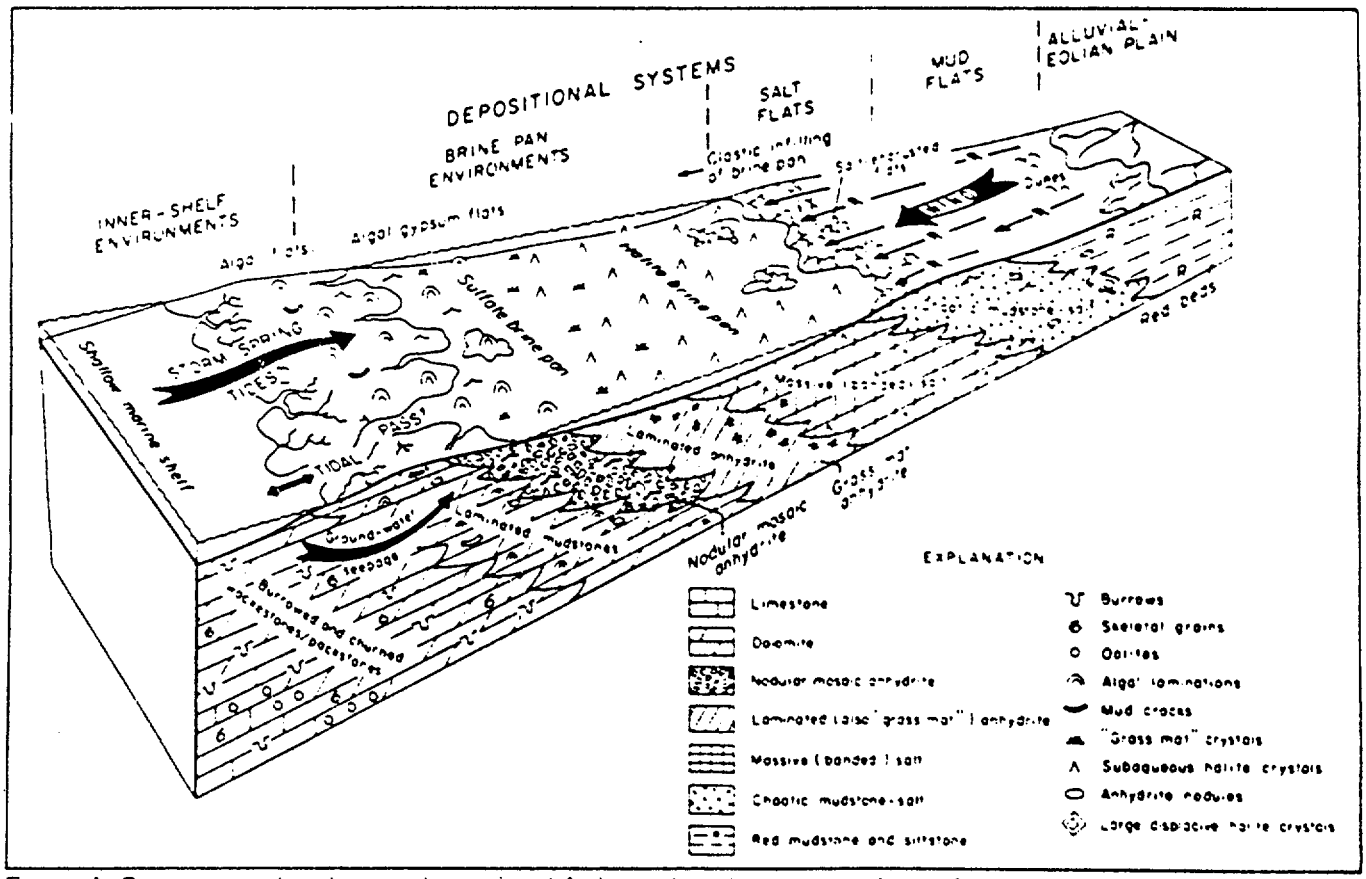


Figure 3. Evaporite and carbonate depositional facies and environments inferred for upper Clear Fork and Glorieta rocks.

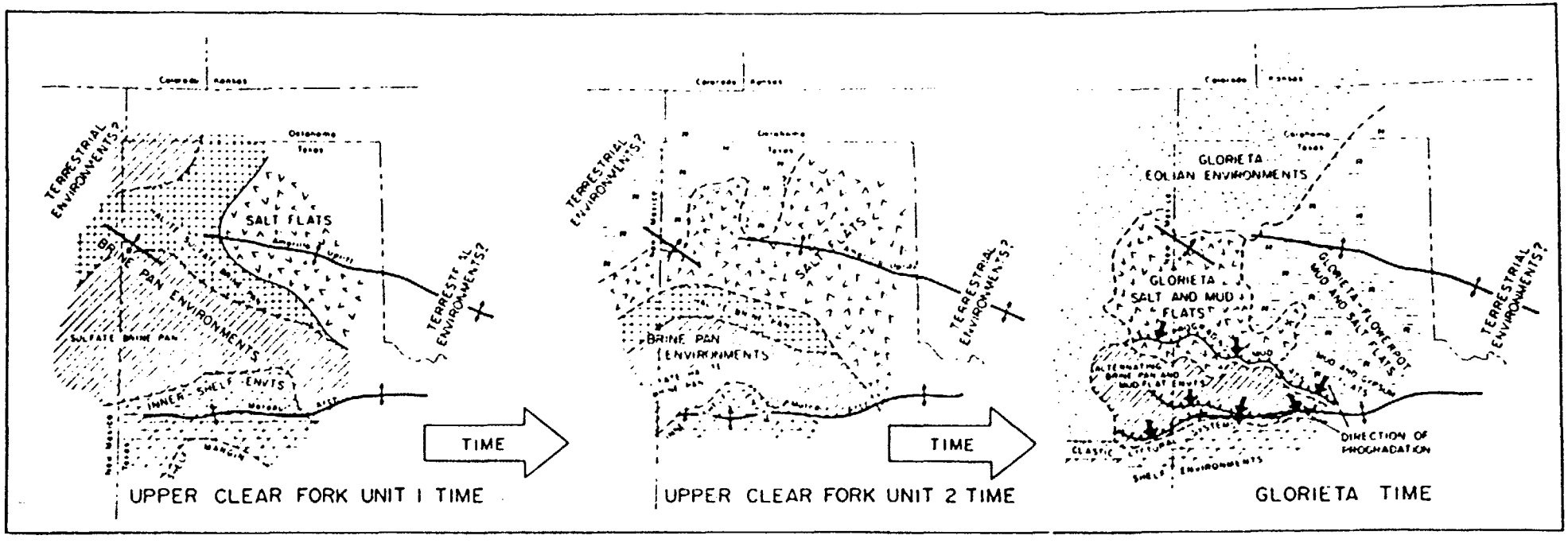


Figure 5. Paleogeography at the time of deposition of the upper Clear Fork and Glorieta Formations.

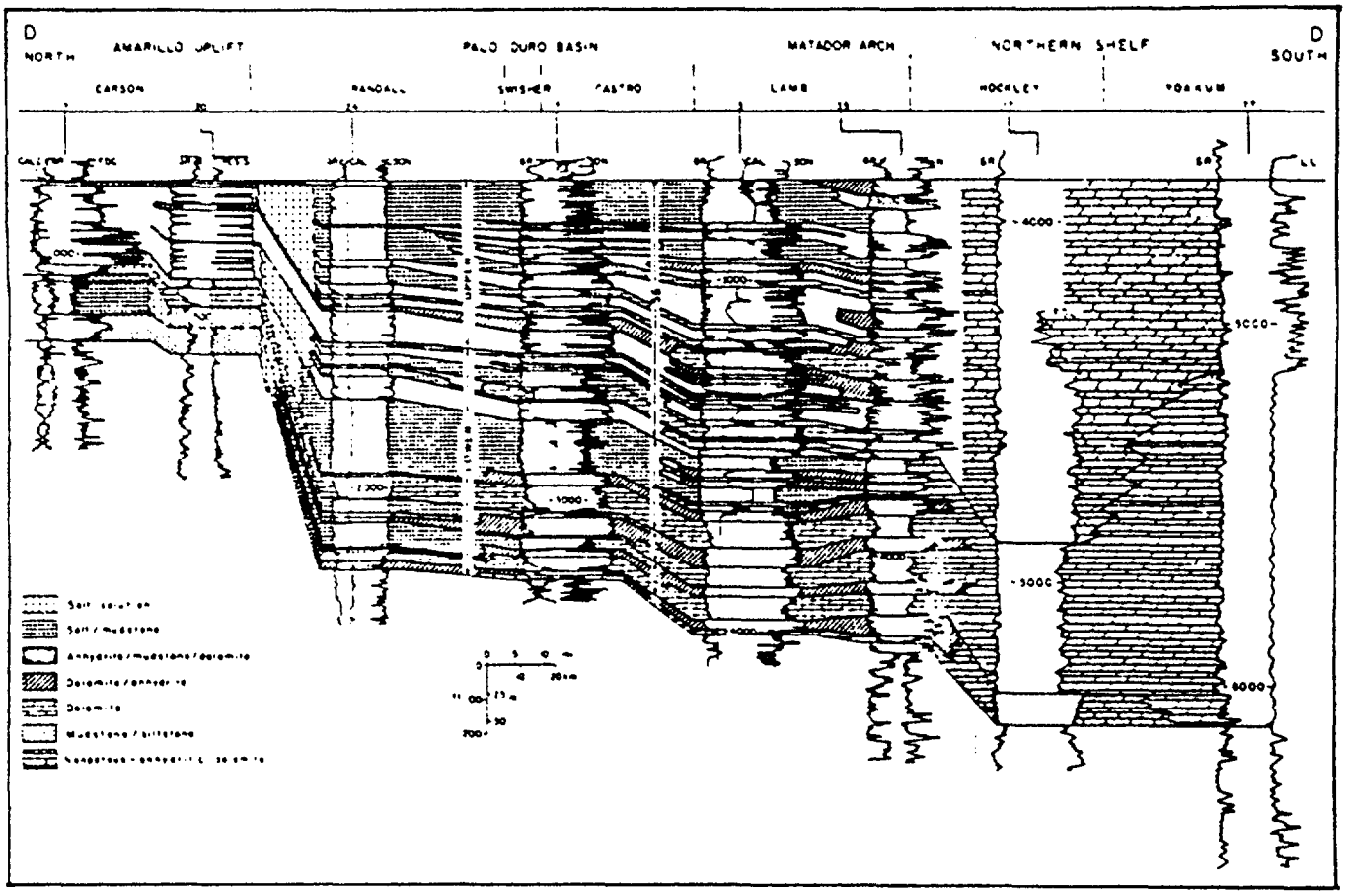
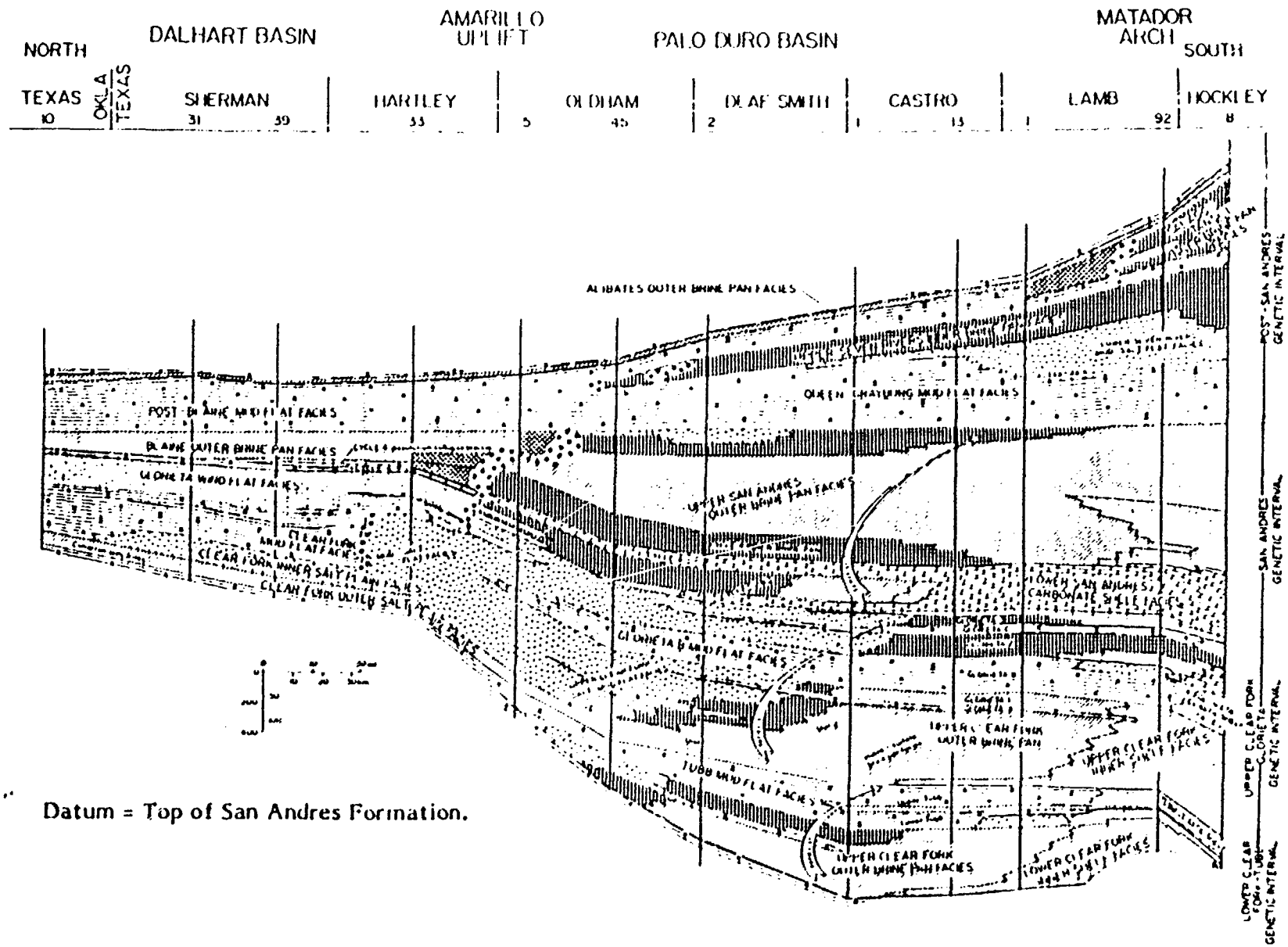


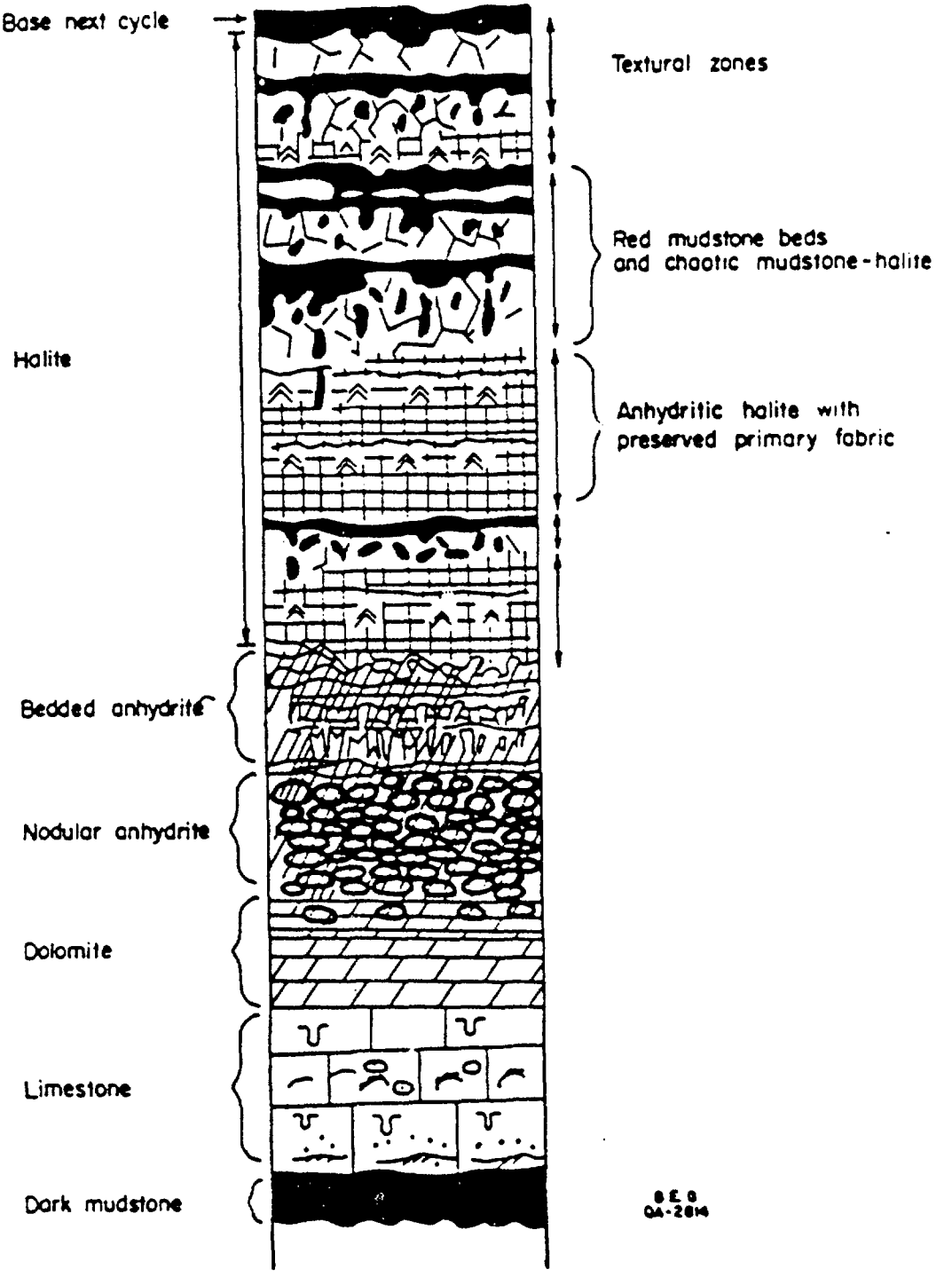
Figure 2. North-south cross section through the study area (after Presley, 1979, and P. Ramondetta, personal communication, 1981). Pinch-out of salt and anhydrite preclude detailed log correlation to the south. Datum: Top San Andres. See figure 1 for line of section.

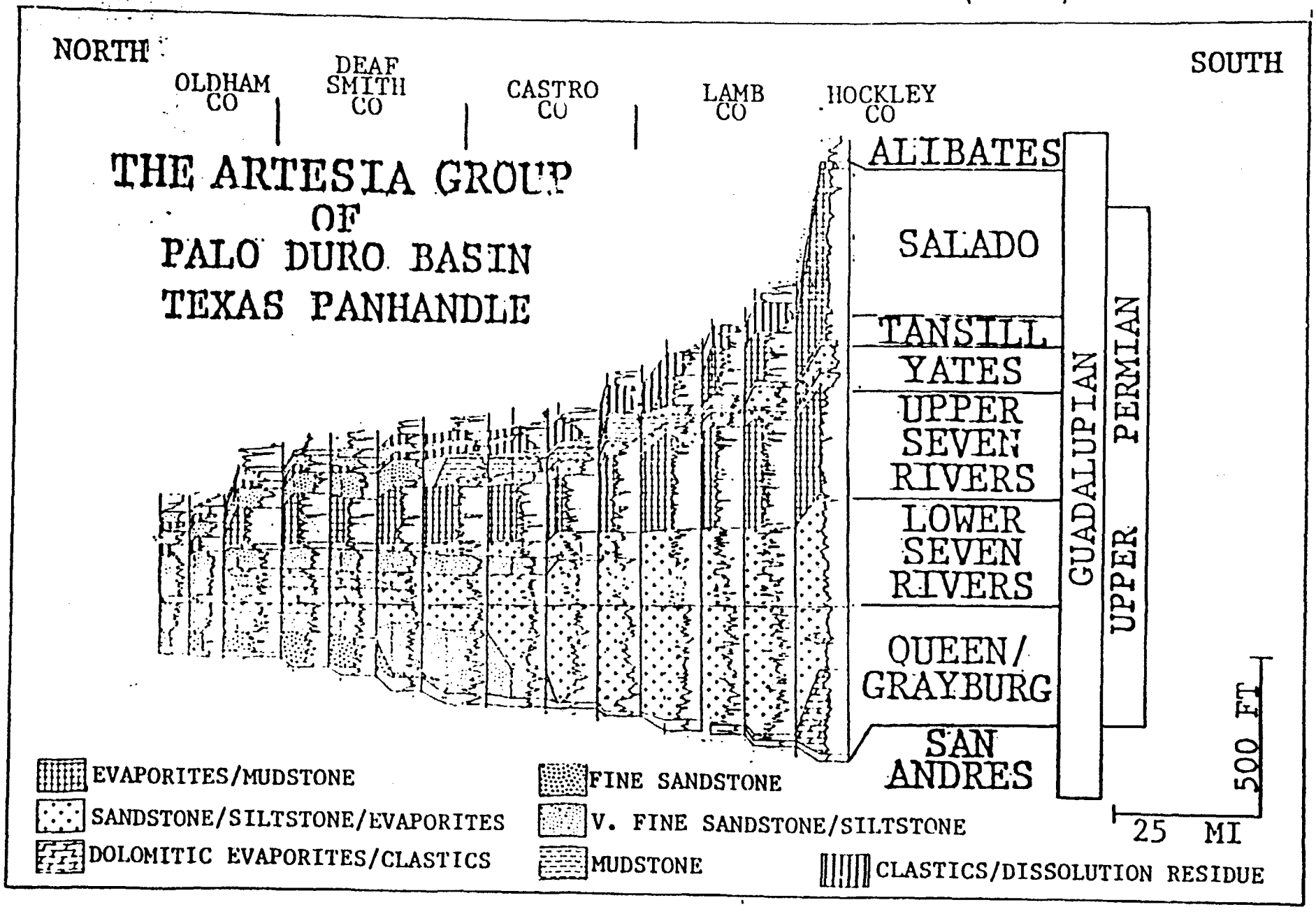
Figure 2



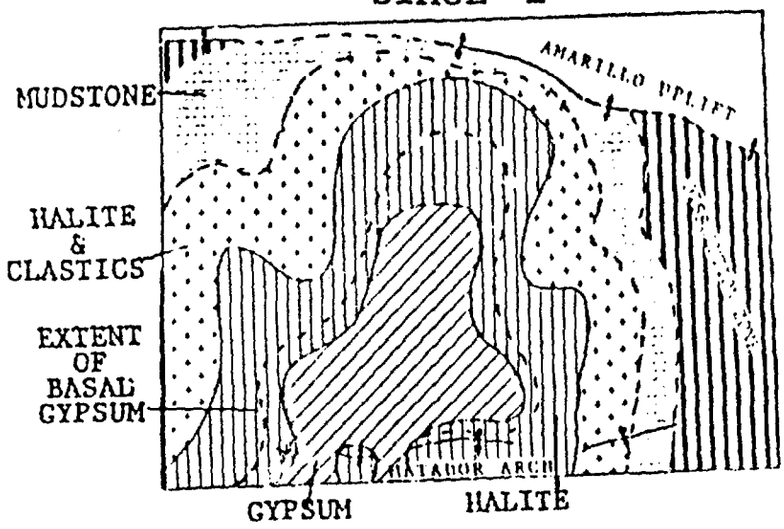
Datum = Top of San Andres Formation.

TYPICAL SAN ANDRES CYCLE

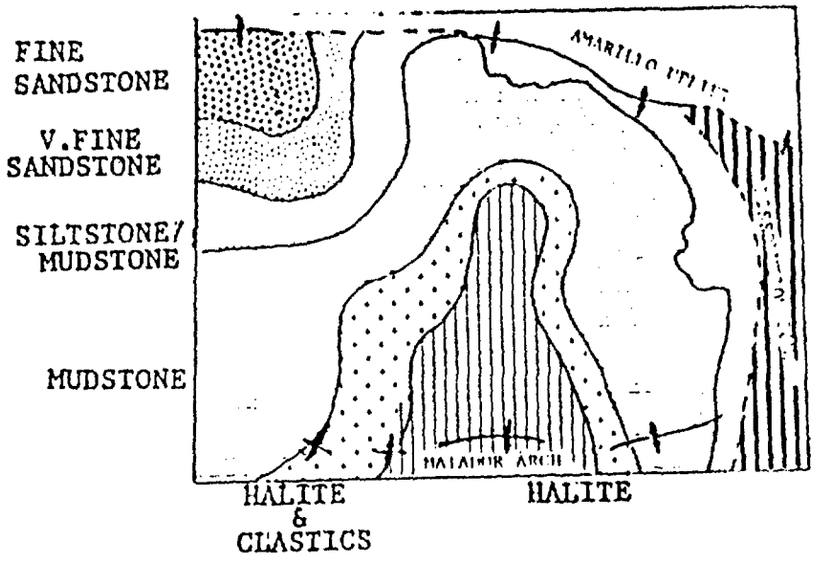



NORTH
SOUTH
OLDHAM CO
DEAF SMITH CO
CASTRO CO
LAMB CO
HOCKLEY CO
THE ARTESIA GROUP
OF
PALO DURO BASIN
TEXAS PANHANDLE
ALIBATES
SALADO
TANSILL
YATES
UPPER SEVEN RIVERS
LOWER SEVEN RIVERS
QUEEN/ GRAYBURG
SAN ANDRES
GUADALUPIAN
UPPER PERMIAN
500 FT
25 MI
EVAPORITES/MUDSTONE
SANDSTONE/SILTSTONE/EVAPORITES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

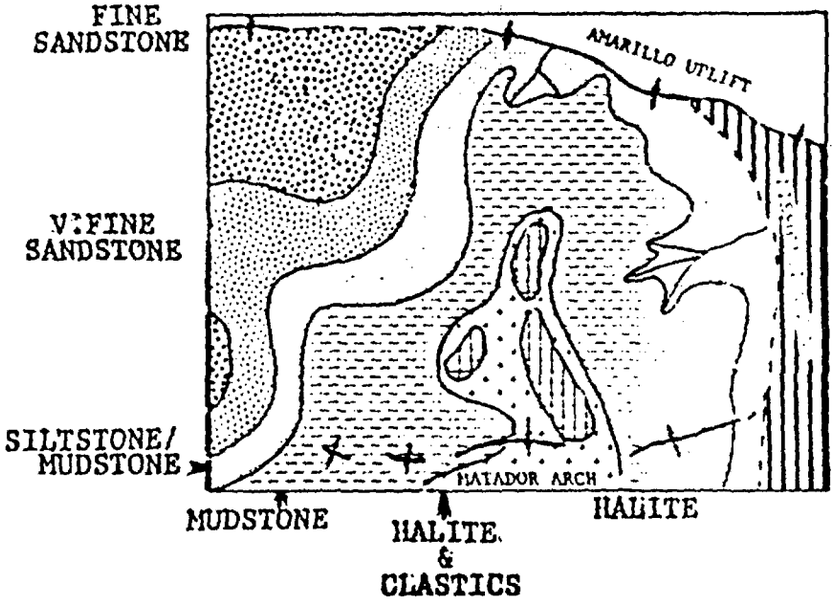
STAGE I



STAGE II



STAGE III



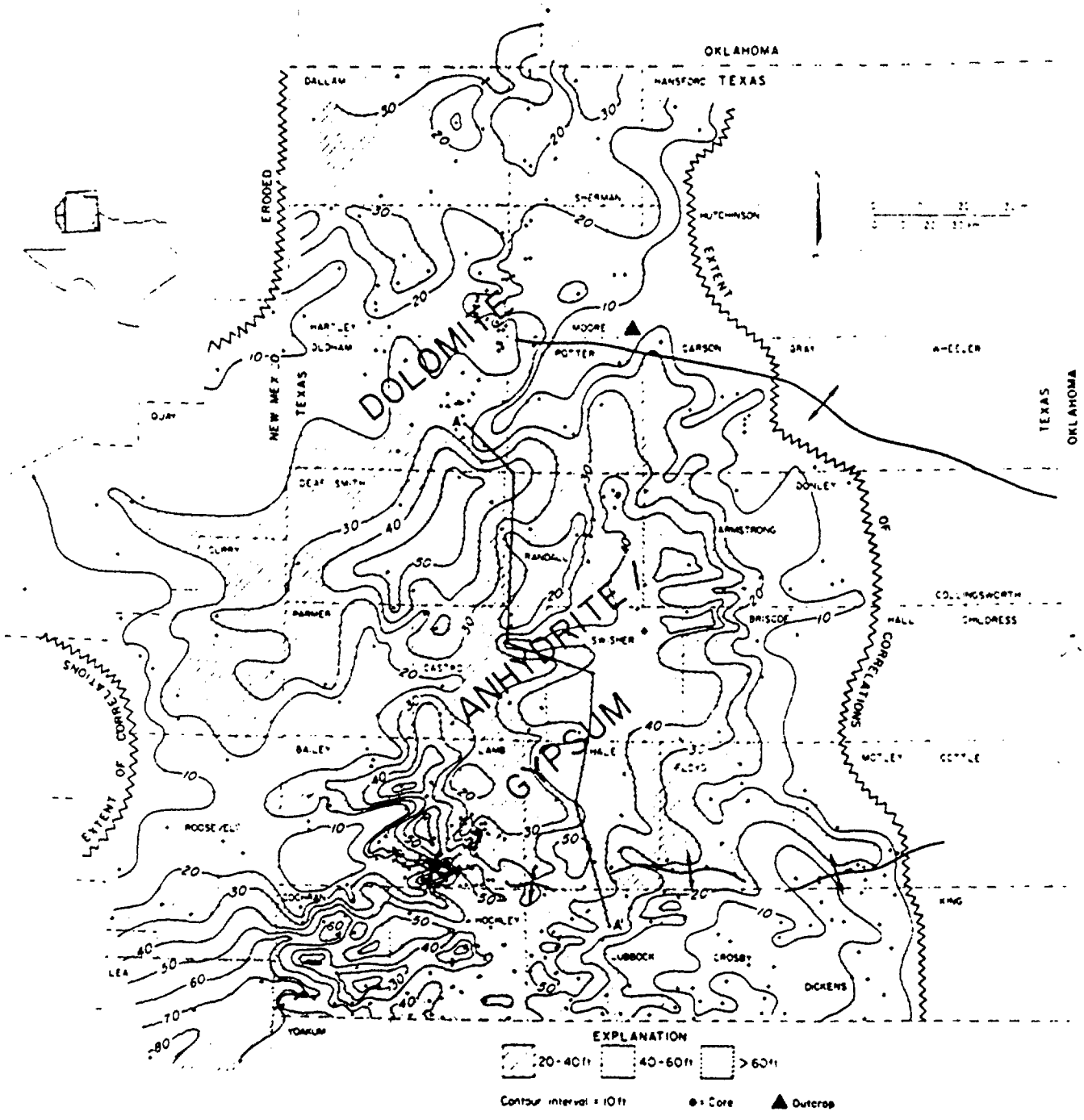


Figure 10. Isopach map, Alibates Formation. Serrate lines mark limit of correlation and erosional boundaries. Outcrop shown in Moore County. Maximum thickness in central and southern Palo Duro Basin.

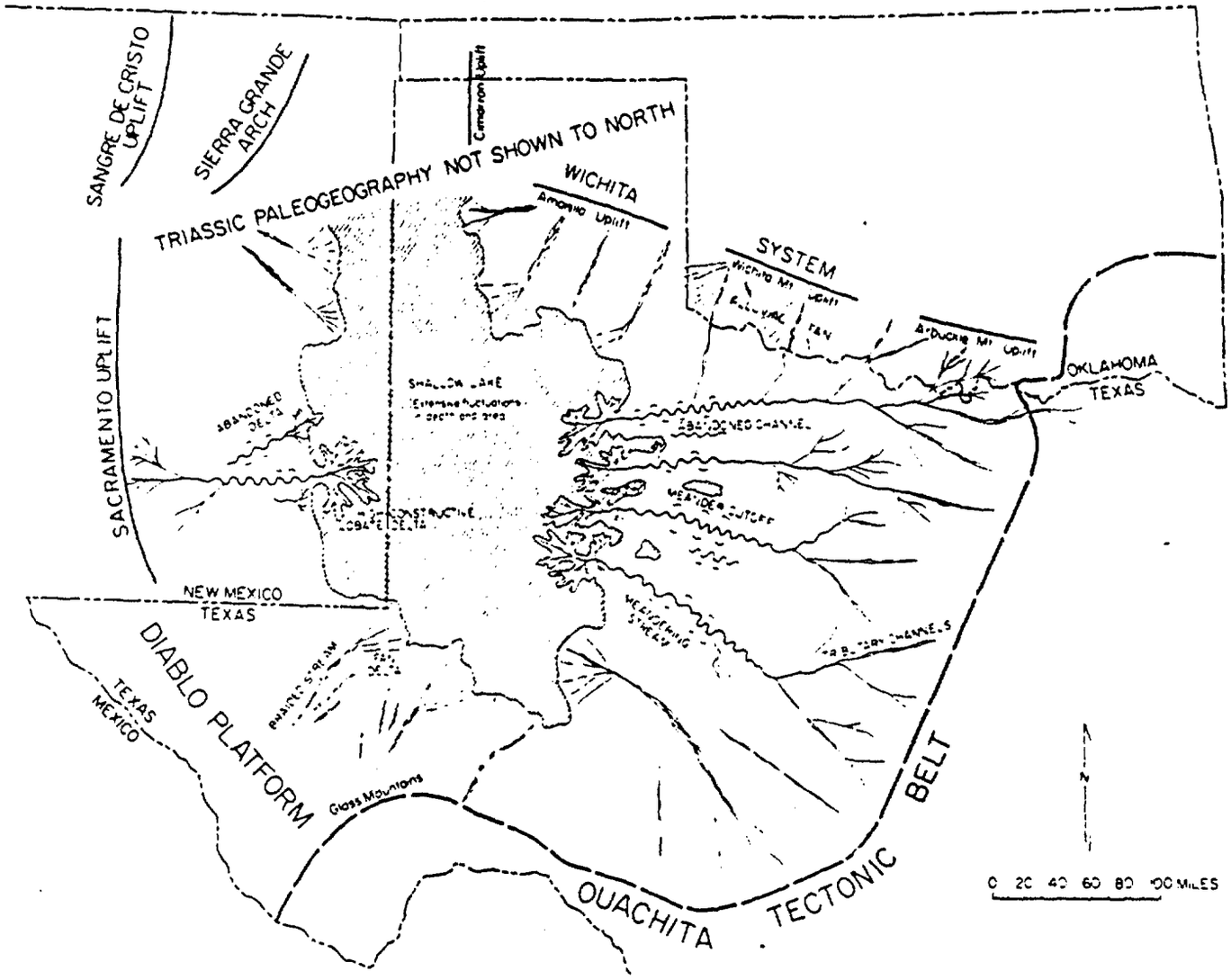


Figure 5. Inferred paleogeography during the initial stage of Dockum sedimentation in the area south of Amarillo Uplift - Bravo Dome. Depositional elements are braided streams, alluvial fans, fan deltas, meandering streams, distributary deltas, and shallow lakes.

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

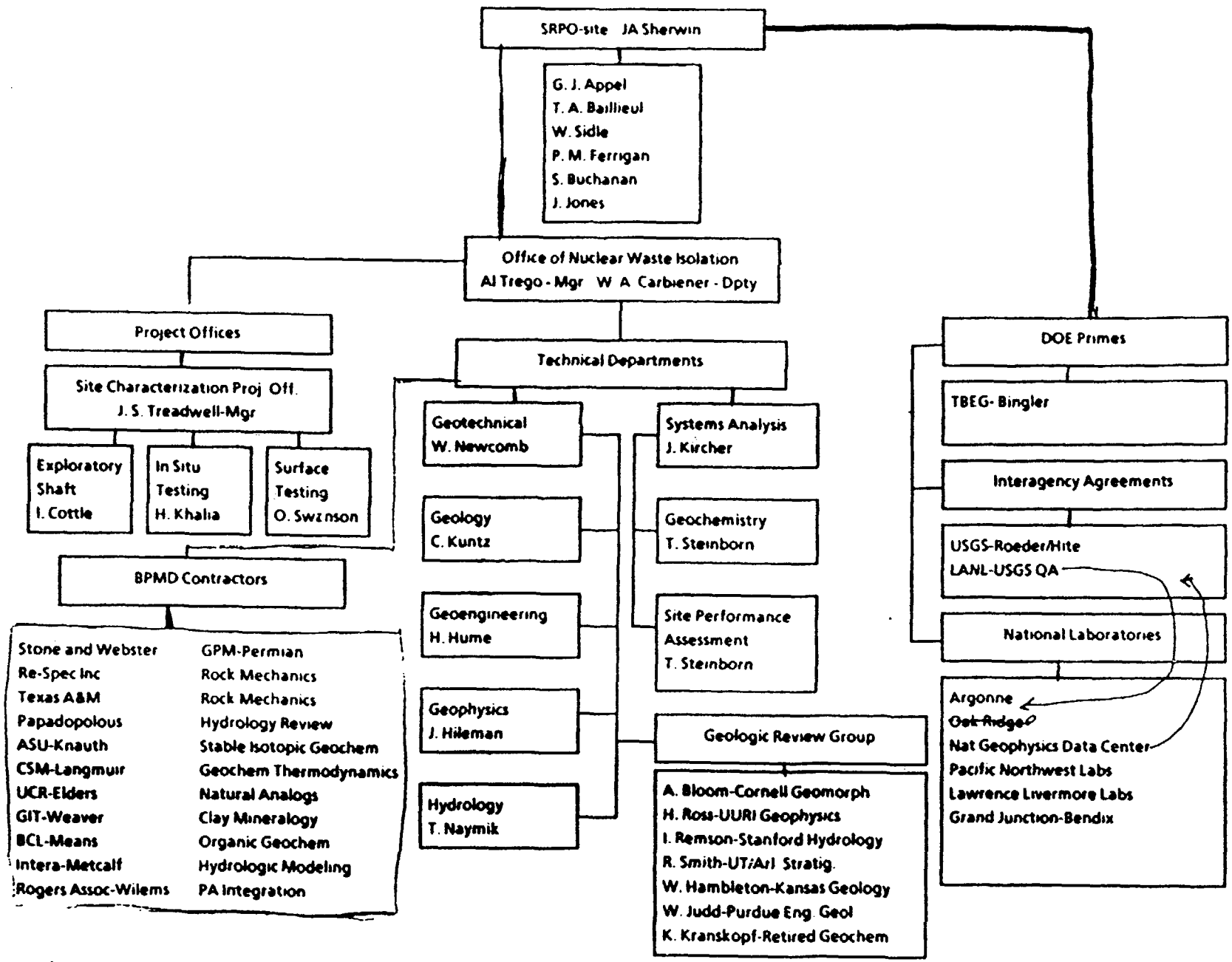
CORE DESCRIPTION

Well locations for core in dissolution zone

Diagnostic features of dissolution

Geographic distribution of dissolution features

DOE–SAIT Repository Project



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

35-41,939

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

85-32,743A

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

83-32,744A

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 PRIOR TO SITE MUNITION

- [illegible]
- [illegible] AND [illegible] ACCOUNTING
- EMPHASIS ON [illegible] TARGET [illegible]
  ABOVE [illegible]
- INVESTIGATE [illegible] OF [illegible]
- INVESTIGATE [illegible] OF MATERIAL
- [illegible] EFFECTS OF [illegible]
  CHANGES (TYPE, [illegible] POSITION, ETC.)
- PRELIMINARY [illegible] DATA FOR [illegible]
- [illegible] DATA BASE FOR PALO DURO [illegible]
- [illegible] WHICH REQUIRE [illegible]
  TESTING AT THE SITE

TESTING FOR SITE CHARACTERIZATION AND LICENSING

- FEWER, MORE SOPHISTICATED TESTS
- CAREFUL SELECTION AND PREPARATION OF SAMPLES
- DETERMINE PROPERTIES INTERNAL TO SAMPLES FOR DESIGN AND CONSTRUCTION
- COMPLEMENT FIELD TESTS
- COMPARE WITH DATA FROM OTHER SITES
- DEVELOP DESIGN PARAMETERS

TYPES OF TESTS

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

83 32 748

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 stratigraphy and geophysical logs.
Water Content	SWEC, SWEC Sub	
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 behavior.
Elastic Constants	SWEC Sub/RE/Spec	
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/TBEC/BFEC	Provide detailed data to assist in interpretation of other tests and as input to geologic studes.
Clay Mineralogy	SWEC Sub, BFEC	
L.O.W. on Heating	SWEC Sub	
Insoluble Residue	SWEC/TBEC	
Salt Water Content	SWEC/TBEC	

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)	16 (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)	-	-

B4-1369713-17

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 (9)	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

B4-1369713-17

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

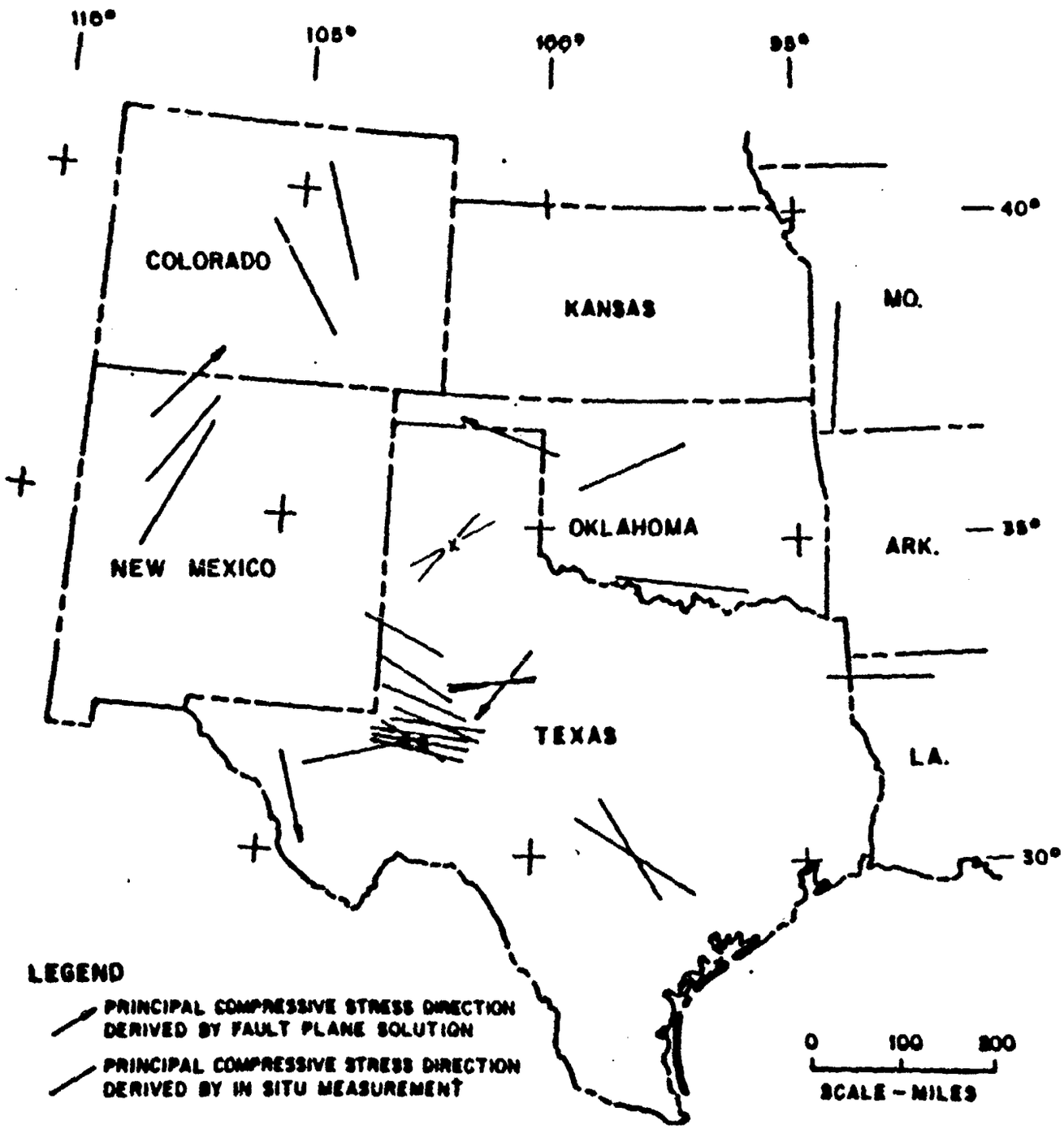
PROPOSED TEST	PURPOSE	RESULTS
CALIPER & TEMP. LOGS PRIOR TO CLEANING WELL	1.) EVALUATE SALT CREEP 2.) DETERMINE AMBIENT DOWNHOLE TEMPERATURES	UNSUCCESSFUL HOLE CONDITIONS PRECLUDE RUNNING LOGS
GEOPHYSICAL LOGS (GAMMA RAY CALIPHER BHC)	CONFIRM TEST ZONES	SUCCESSFUL ESSENTIALLY THE SAME AS PREVIOUS LOGS
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

V-36,137B

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
- Heinsen, 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

85-41,940

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

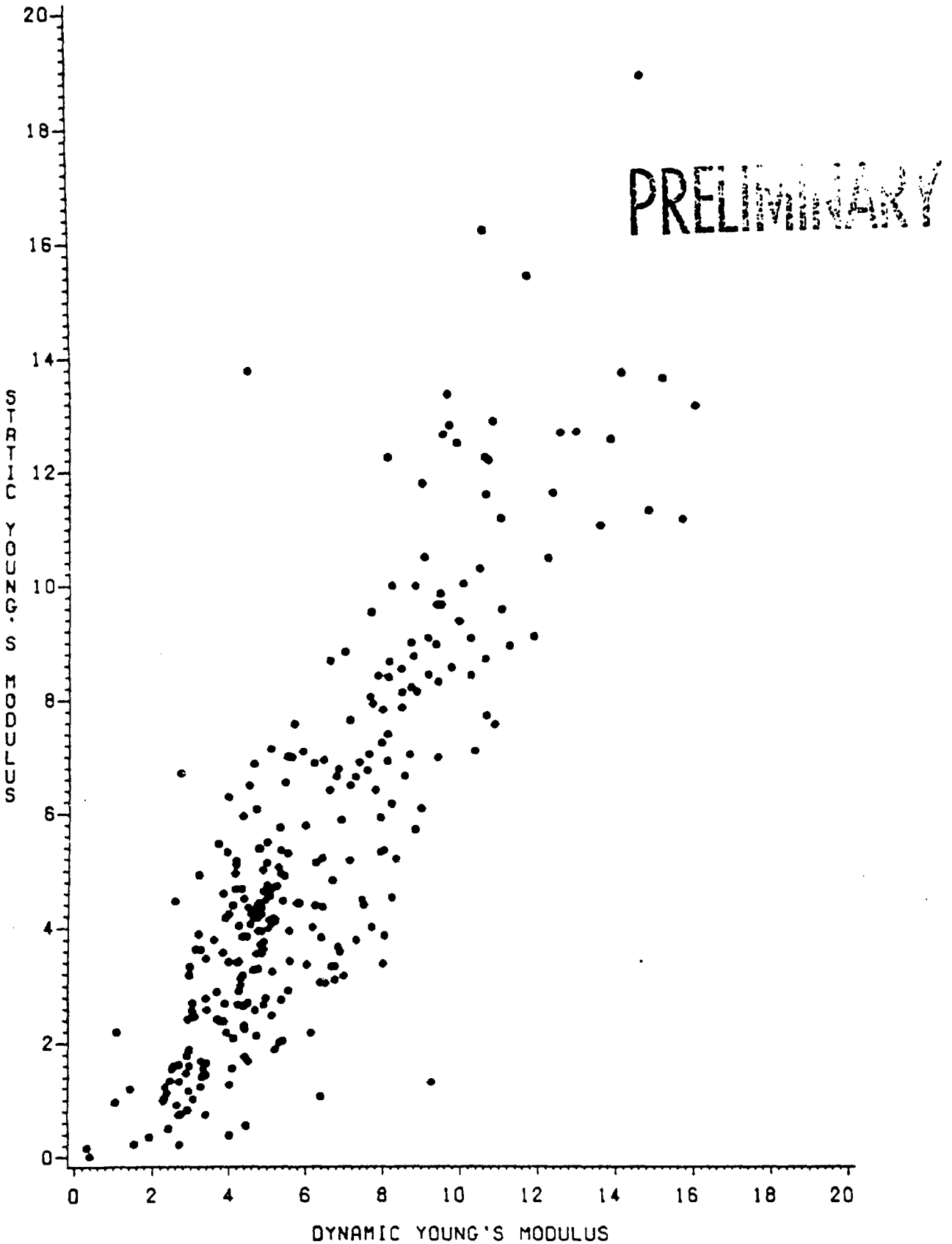
LAB TESTING DATA SUMMARY

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)

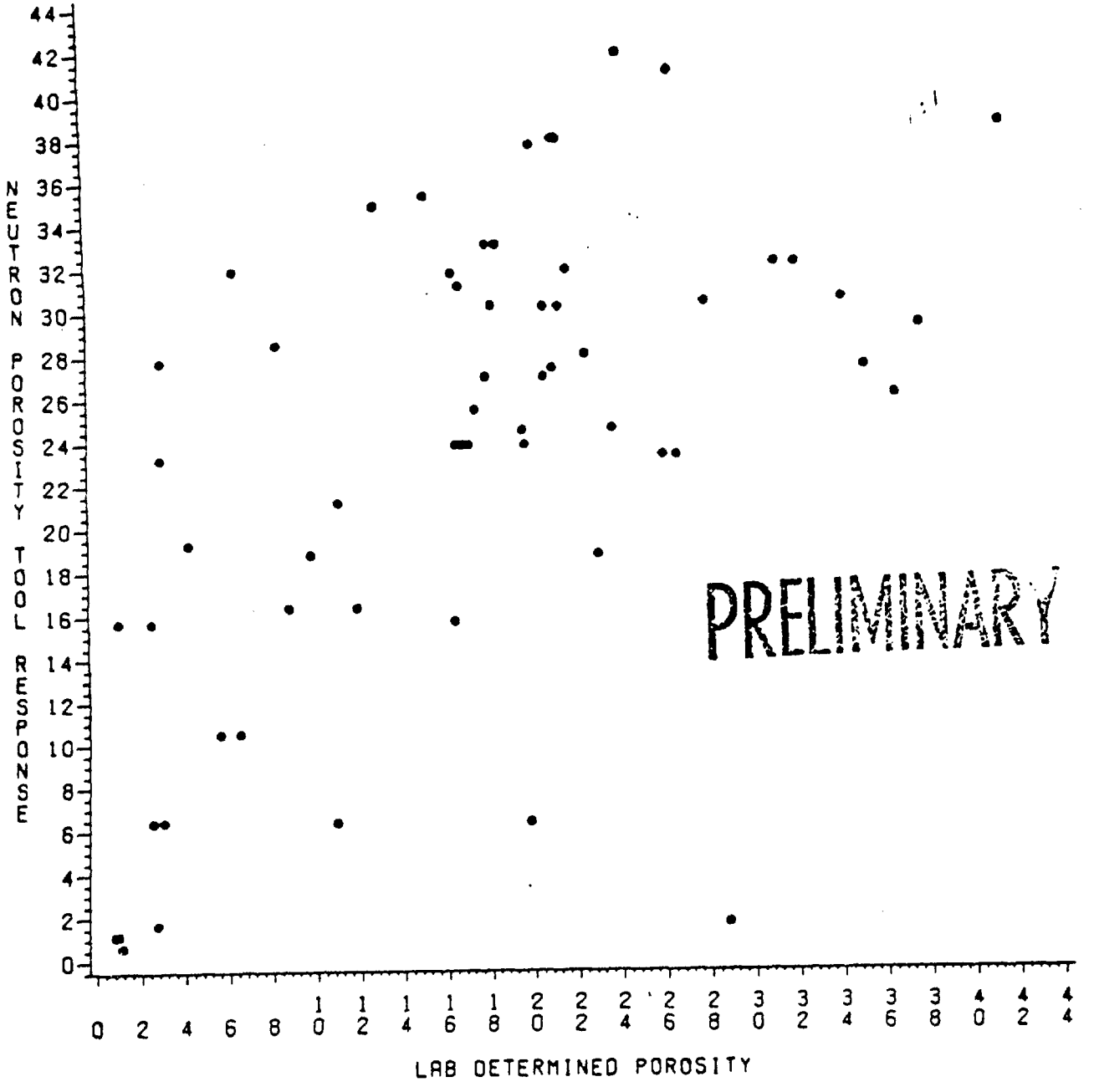
LAB TESTING DATA SUMMARY

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)

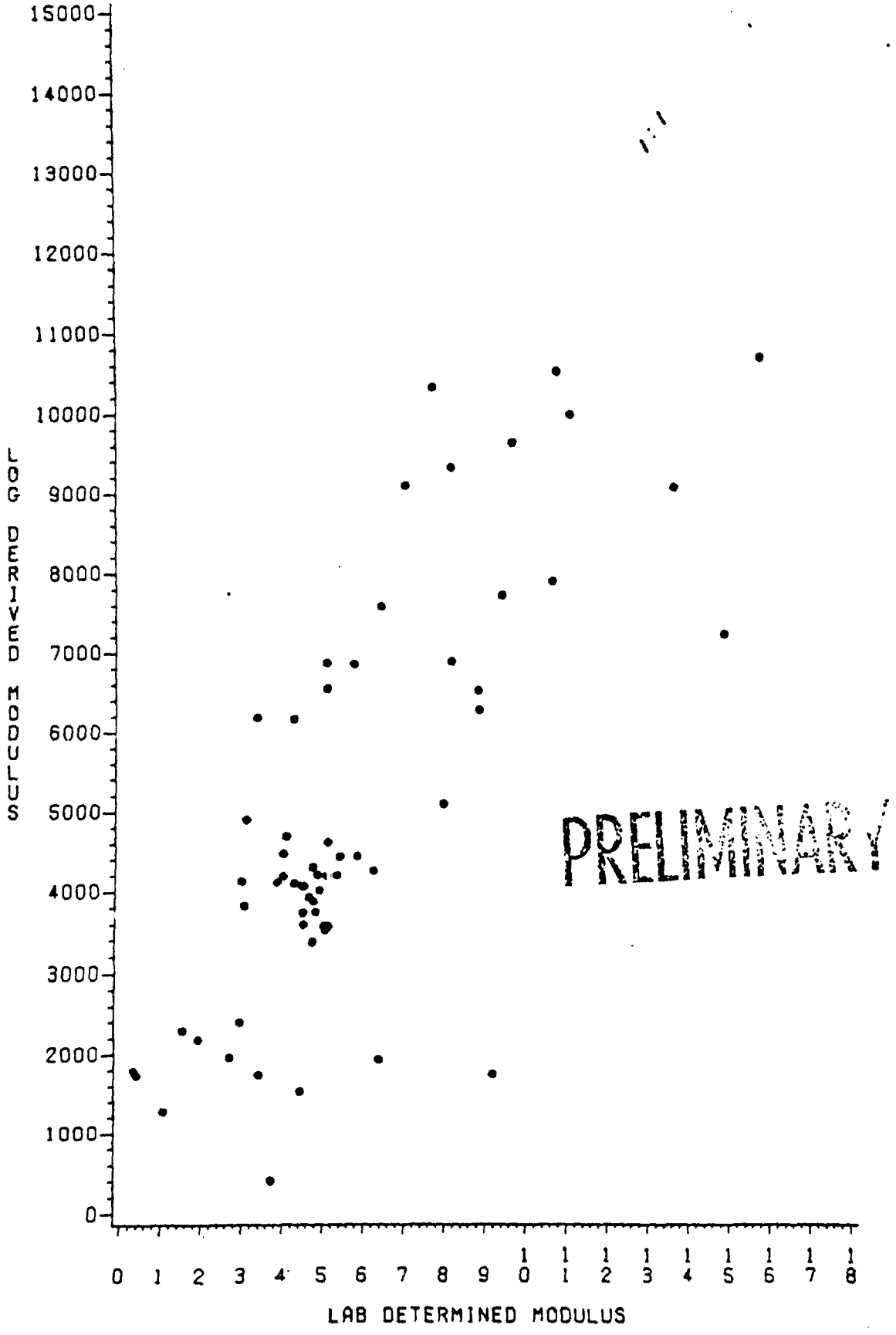
STATIC VS DYNAMIC MODULI CORRELATION



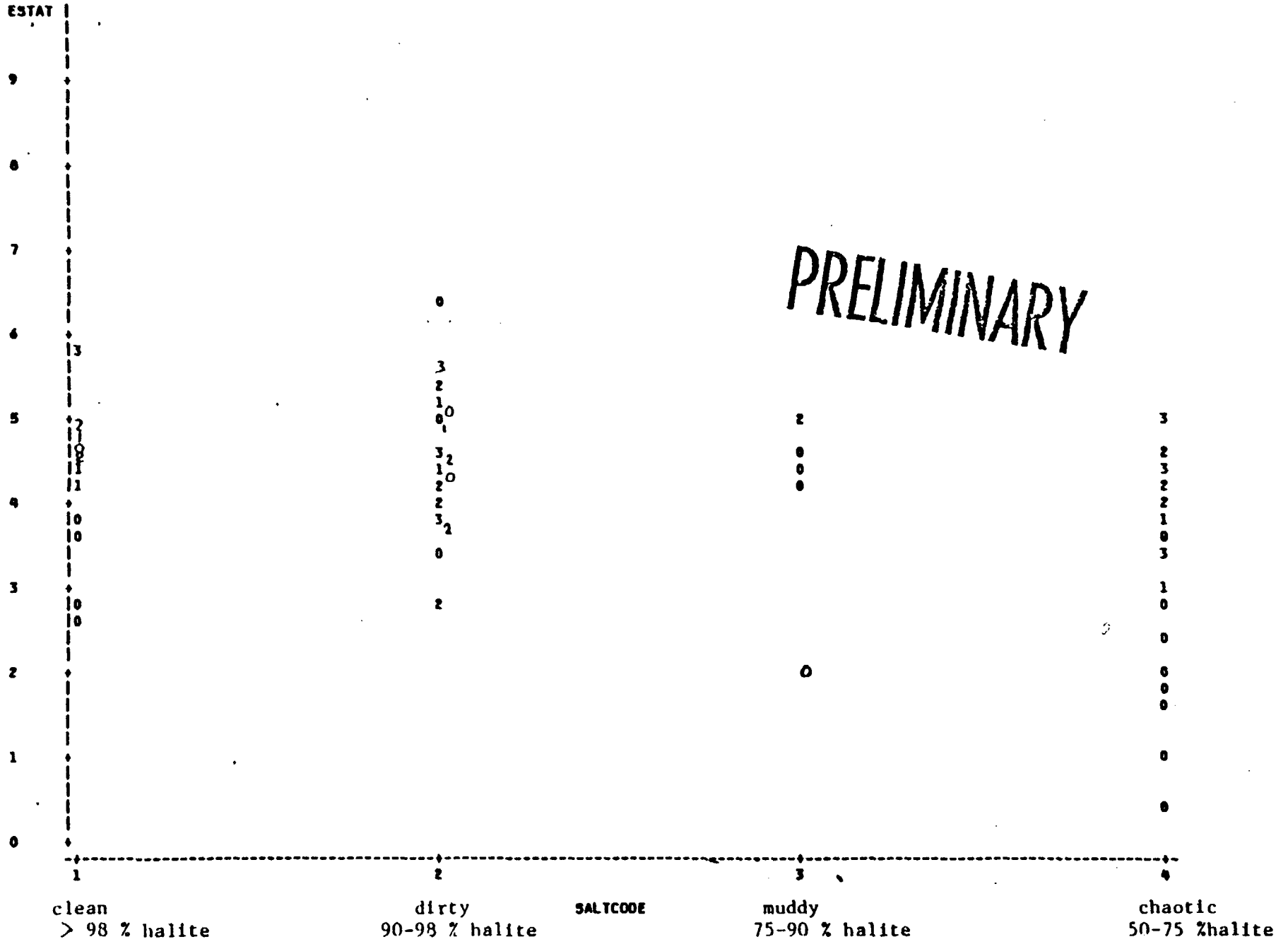
LAB VS LOG CORRELATIONS



LAB VS LOG CORRELATIONS



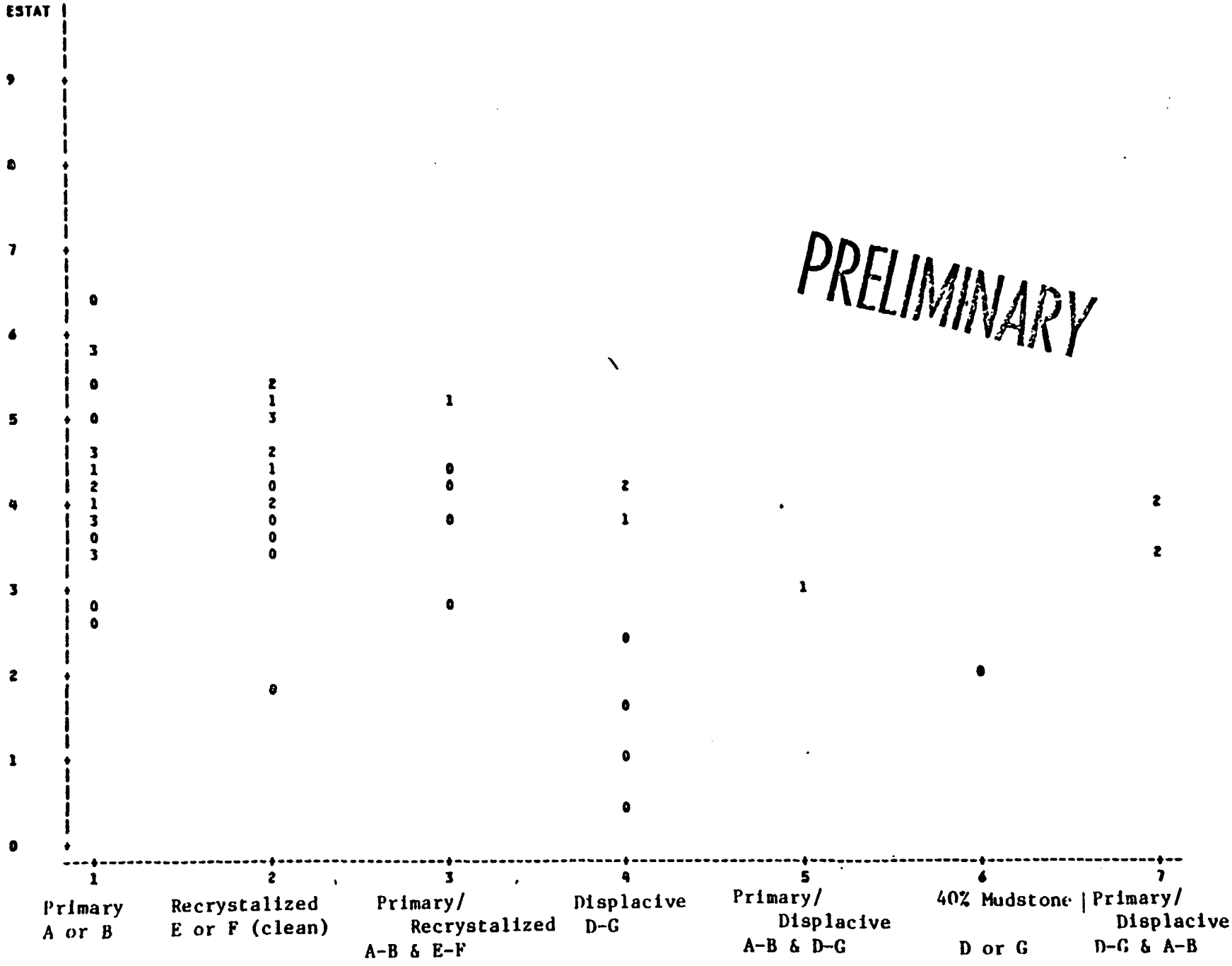
PLOT OF ESTAT*SALTCODE SYMBOL IS VALUE OF SIGMA3



PRELIMINARY

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

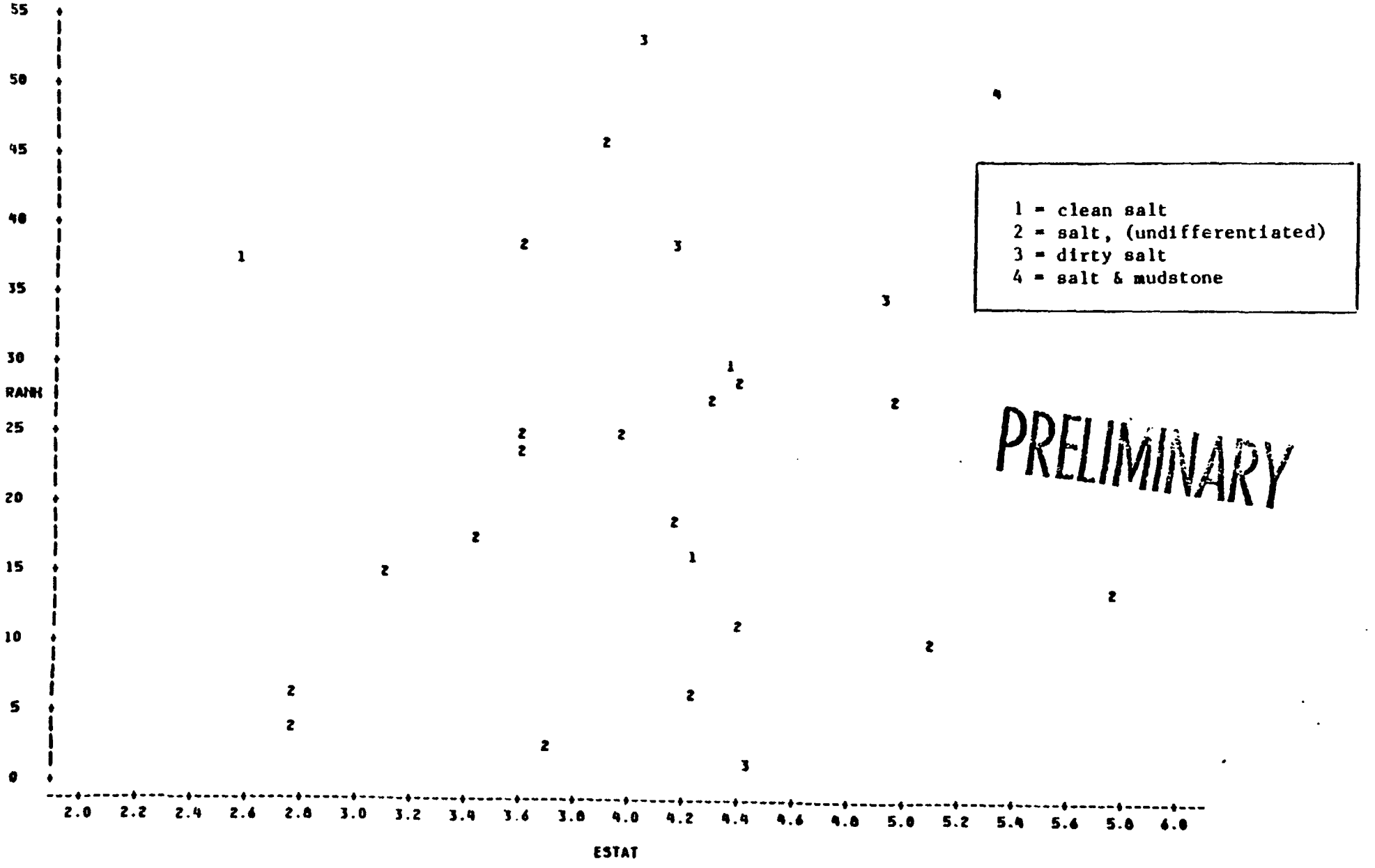
PLOT OF ESTAT*TYPE SYMBOL IS VALUE OF SIGMA3



PRELIMINARY

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

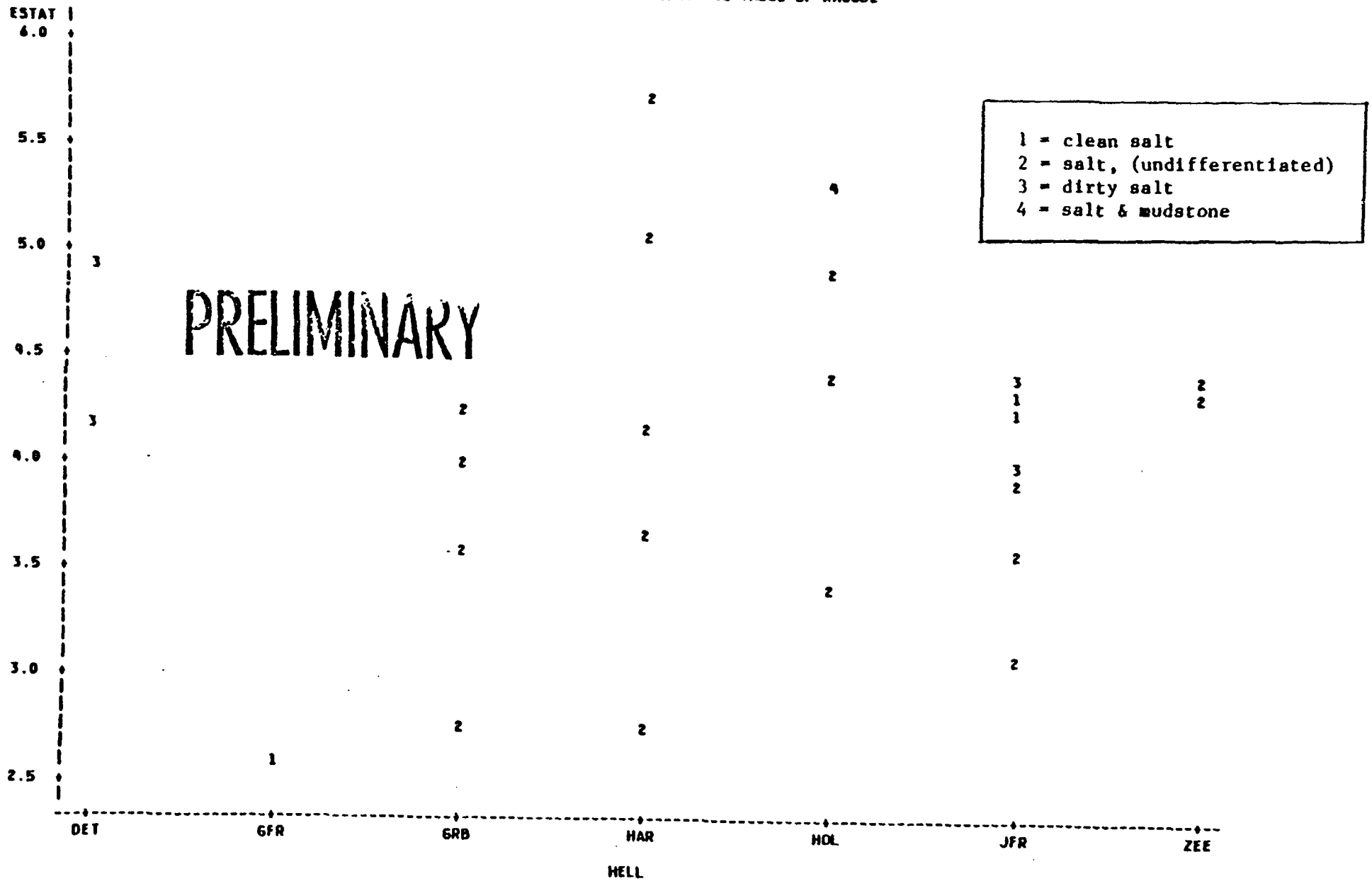
PLOT OF RANK*ESTAT SYMBOL IS VALUE OF RXCODE



PRELIMINARY

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

PLOT OF ESTAT*HELL SYMBOL IS VALUE OF RXCODE



PRELIMINARY

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SAMPLE SELECTION

IMPORTANT HORIZONS

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

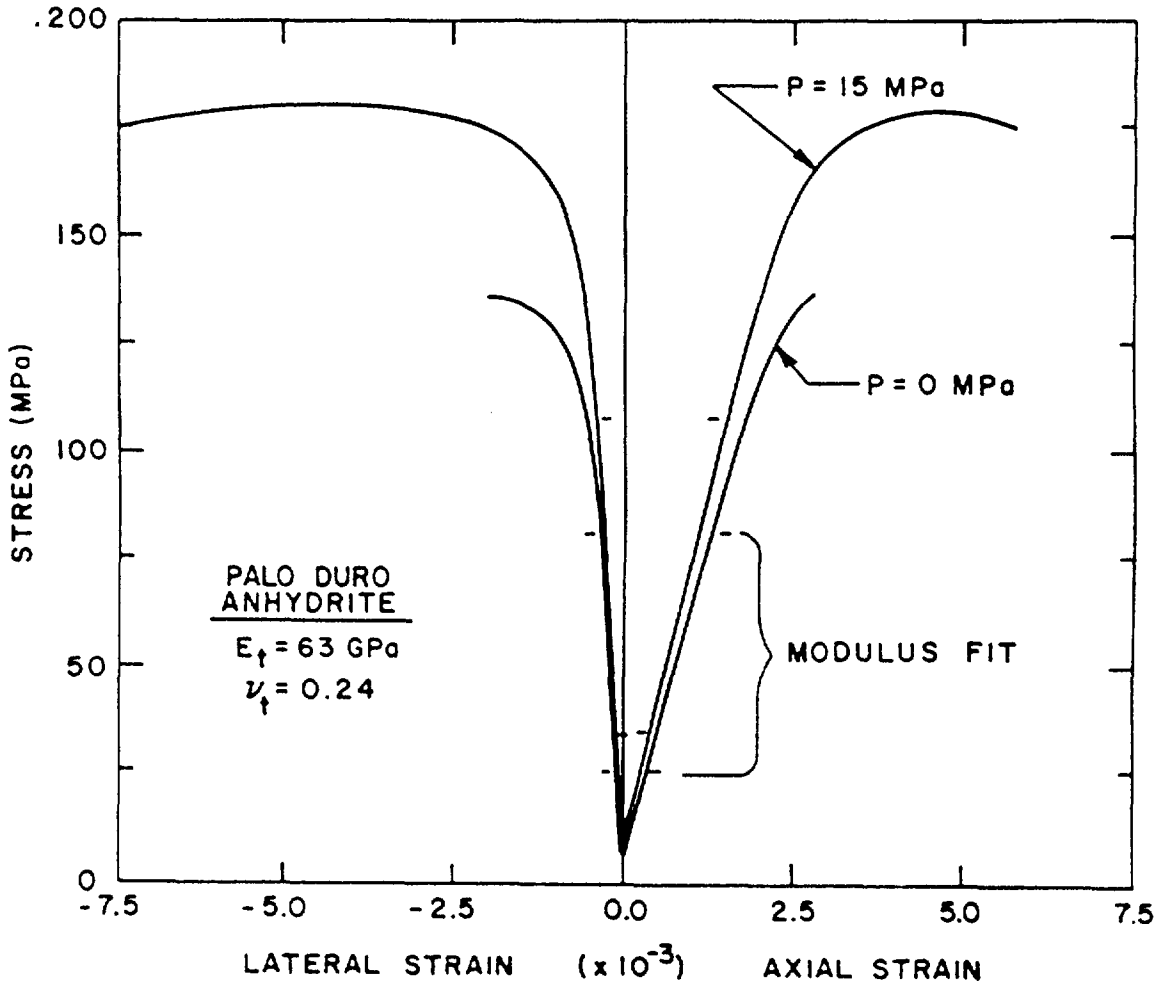
SAMPLING

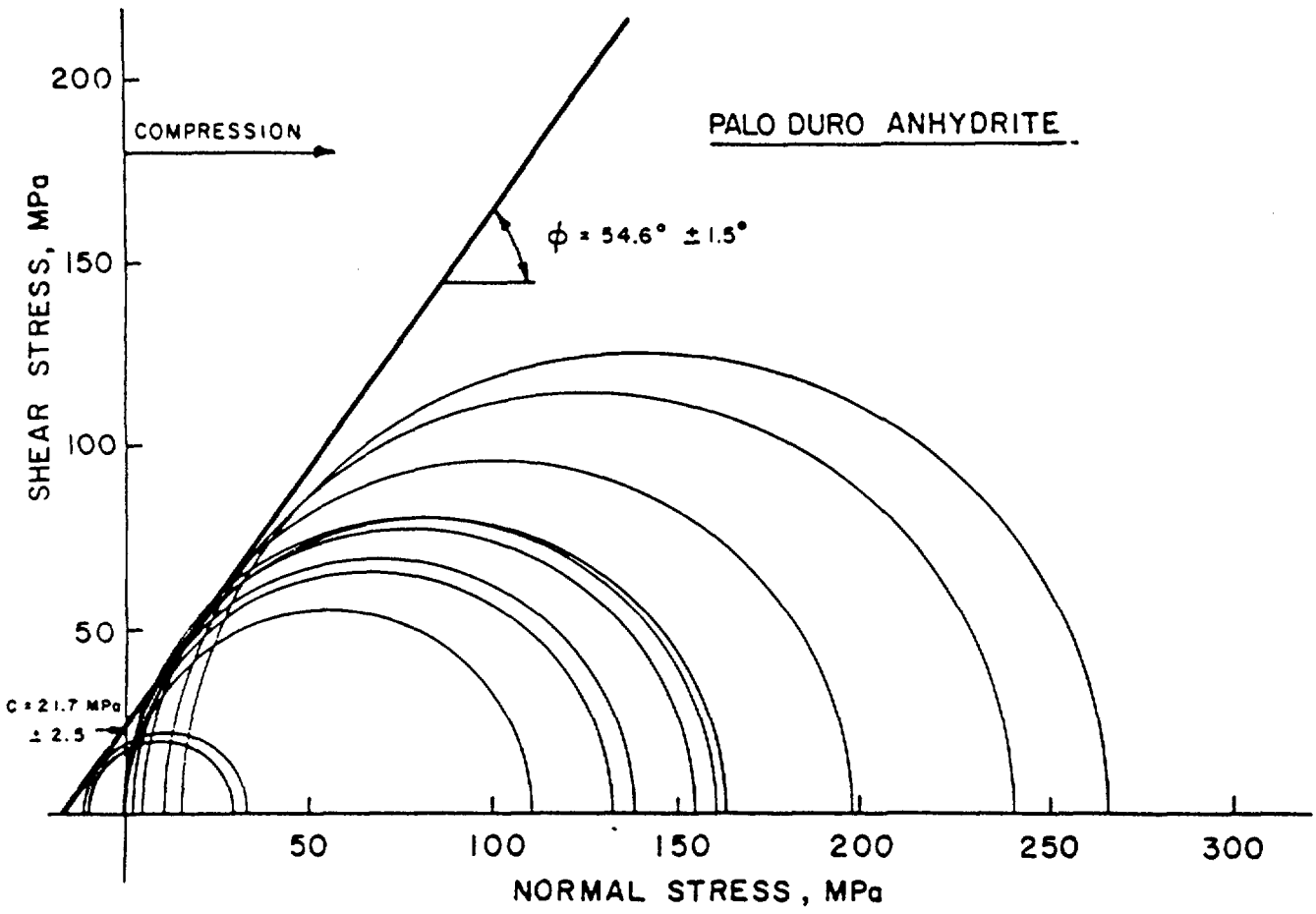
- Somewhat Random
- Representative
- Testable

TESTING

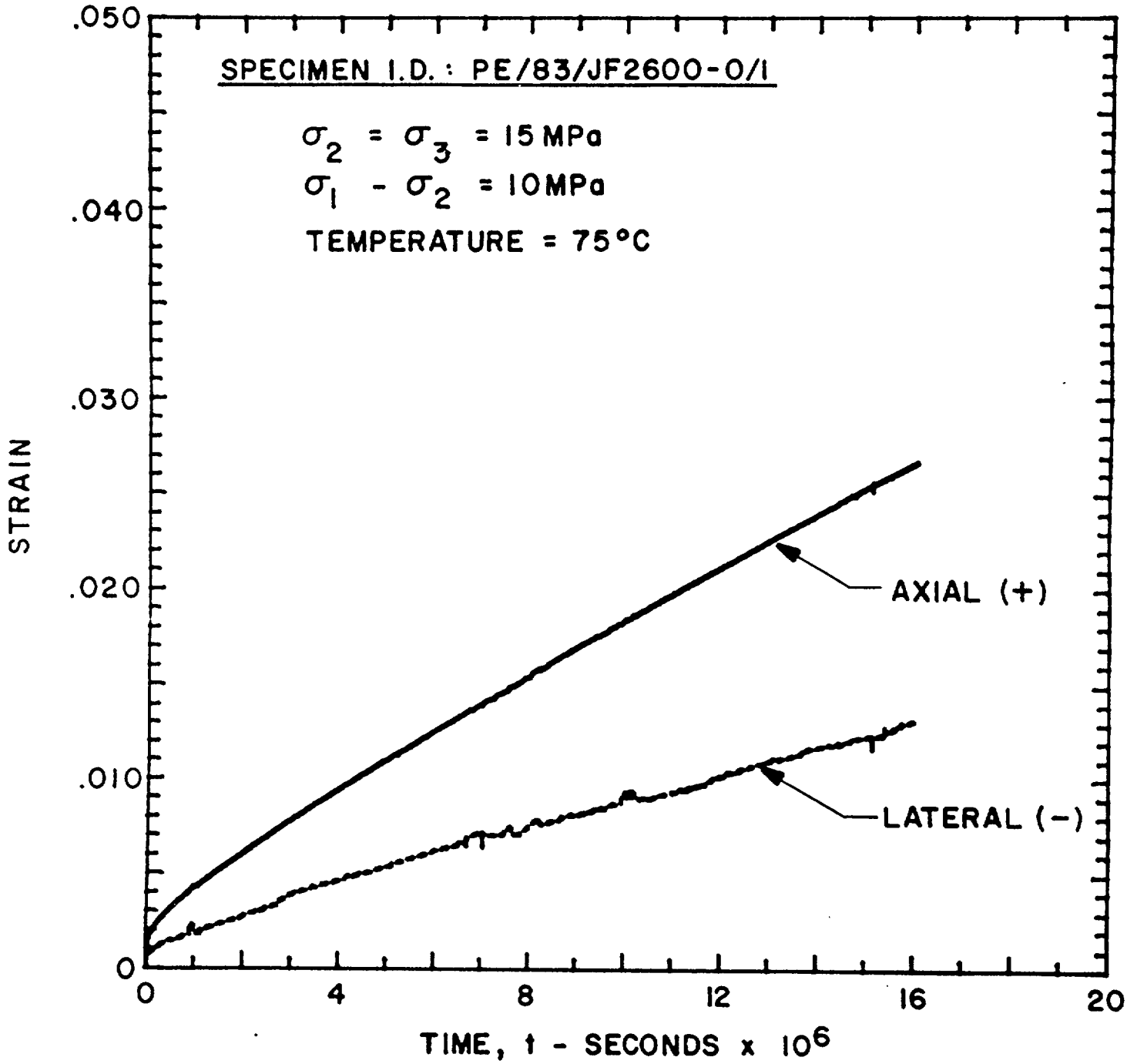
BRAZILIAN:	Tensile Strength
UNCONFINED COMPRESSION:	Compressive Strength; Elastic Constants
TRIAXIAL COMPRESSION:	Envelope of Compressive Strengths Elastic Constants
CREEP:	Time-Dependent Deformation

RSI DWG 001-83-194





RSI DWG 001-83-200


SPECIMEN I.D.: PE/83/JF2600-0/1
$\sigma_2 = \sigma_3 = 15$ MPa
$\sigma_1 - \sigma_2 = 10$ MPa
TEMPERATURE = 75°C
STRAIN
.050
.040
.030
.020
.010
0
AXIAL (+)
LATERAL (−)
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	B, T
	(1141.7	—	1148.5)	
Siltstone	369.9	—	372.4	B, T
	(1213.55	—	1221.7)	
Sandstone	393.9	—	396.5	B, T
	(1292.3	—	1300.7)	
Siltstone	401.62	—	402.9	B, T
	(1317.65	—	1322.0)	
Salt	578.3	—	581.5	B, T
	(1897.2	—	1907.8)	
Anhydrite	637.9	—	639.4	B, T
	(2092.8	—	2097.9)	
Salt	670.5	—	672.7	B, T
	(2199.9	—	2207.0)	
Shale	678.47	—	680.73	B, T
	(2225.95	—	2233.35)	
Salt	683.9	—	686.4	B, T
	(2243.7	—	2252.0)	
Dolomite	694.9	—	696.5	B, T
	(2280.0	—	2285.15)	
Anhydrite	700.9	—	715.7	B, T
	(2299.4	—	2348.0)	
Unit 5 Salt	735.6	—	751.9	B, T
	(2413.4	—	2466.7)	
Dolomite	762.9	—	765.0	B, T
	(2503.0	—	2510.0)	

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

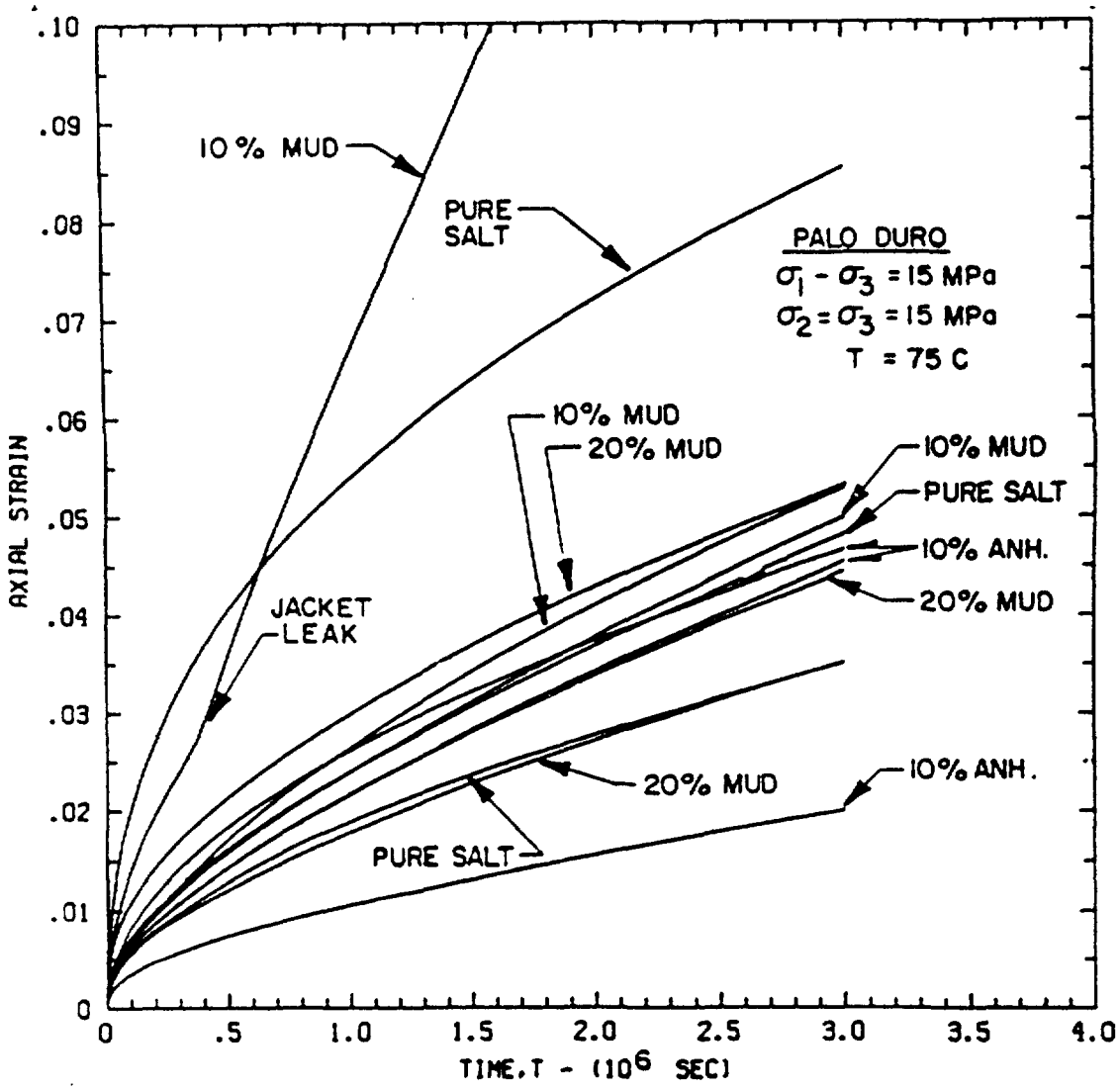

.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
AXIAL STRAIN
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TIME, T - (10^6 SEC)
10 % MUD
PURE SALT
PALO DURO
$\sigma_1 - \sigma_3$ = 15 MPa
$\sigma_2 = \sigma_3$ = 15 MPa
T = 75 C
10% MUD
20% MUD
10% MUD
PURE SALT
10% ANH.
20% MUD
JACKET LEAK
20% MUD
10% ANH.
PURE SALT

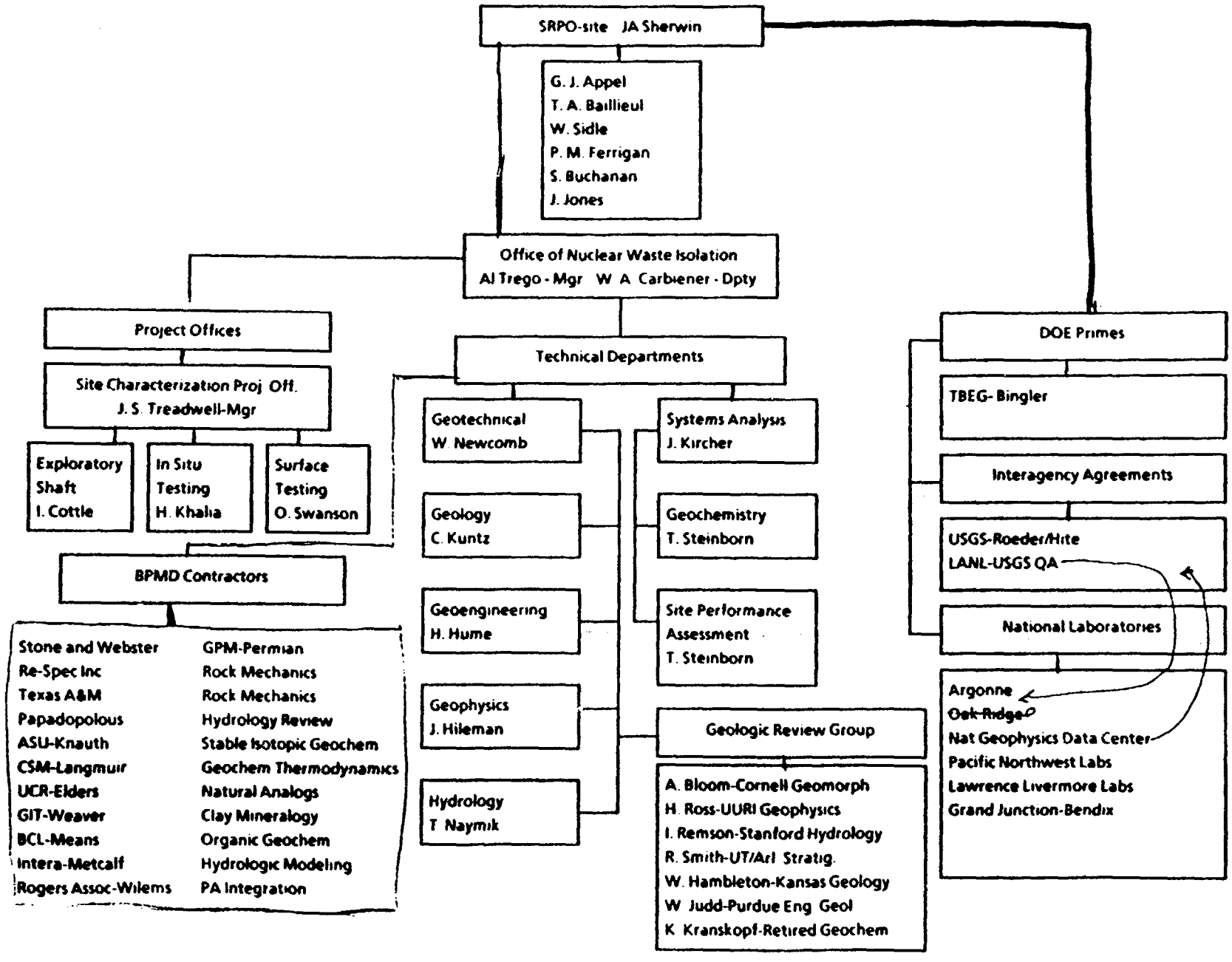
Table 4-2. Comparison of Current and Previous[a] Quasi-Static Parameter Values for Palo Duro Unit 5 Salt

Parameter	Currrent Value	Previous Value
Indirect Tensile[b] Strength, T_0 (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



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

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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 Revised 10/21/83 (T-16)	1.17 1.18
T-2	03/07/83	Topical Report	Maps of Selected Formations Deaf Smith County (Draft)	1.22 1.23
T-3	02/23/83	Well Completion Report	Detten Final Core Log and Core Photographs	1.27 1.28
T-4	04/12/83	Well Completion Report	G. Friemel Final Core Log and Core Photographs	1.32 1.33
T-5	04/25/83	Well Completion Report	Sawyer No. 1 Pumping Test and Fluid Sampling Report Revised 9/7/84 (T-25)	1.37 1.38 1.39
T-6	05/26/83	Well Completion Report	Zeeck No. 1 Final Core Log and Core Photographs	1.42 1.43
T-8	06/17/83	Topical Report	Major Salt Beds (Revision of Report G82-12, 10/29/82)	1.45 1.46
T-9	08/01/83	Well Completicn Report	Mansfield No. 1 Pumping Test and Fluid Sampling Report Revised 7/25/84 (T-26)	1.48 1.49 1.50
T-10	07/07/83	Well Completion Report	Dissolution Zone Water Wells	1.52 1.53
T-11	12/29/83	Well Completion Report	J. Friemel No. 1 (PD-9) Well Completion Report	1.56 1.57
T-12	12/15/83 and 12/16/83	Well Completion Report	Holtzclaw No. 1 Well (PD - 10) Completion Report	2.3 2.4
T-14	05/29/84	Topical Report	Hydrogeologic Investigations Based On Drill-Stem Tests	2.8 2.9
T-15	08/01/83	Well Completion Report	Harman No. 1 Final Core Log and Core Photographs	2.13 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 Intermediate Shaft Liner Seal	2.21 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	Sep 1 85	Topical Report	A Report on Fracturing in the Deaf Smith Area	4.37 4.38
T-44	A. j 85	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

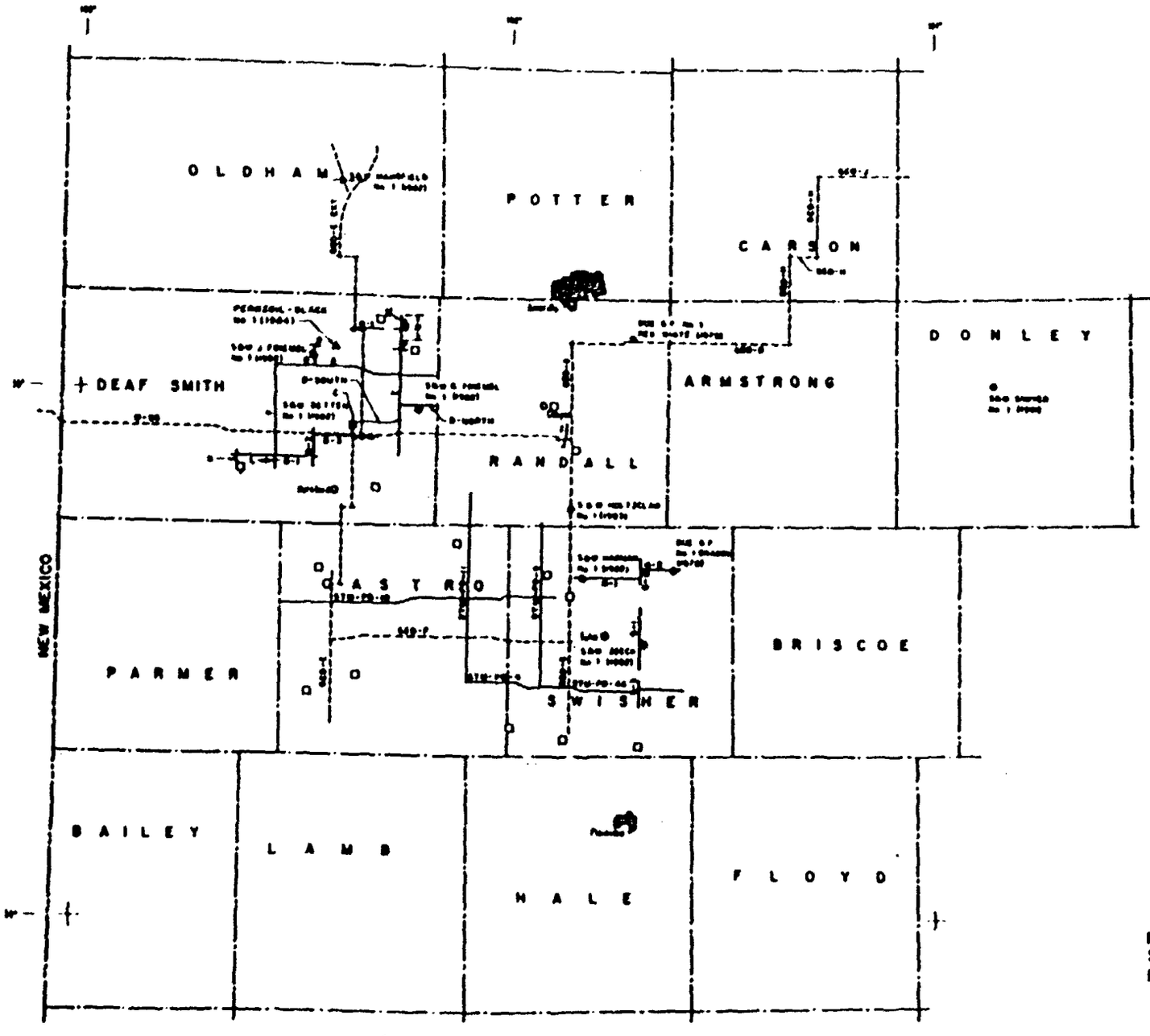
Report Title	Testing Lab	Report No. and Date	Presents Results of:
Laboratory Testing on Rock Core Samples from Mansfield No. 1 Well, Permian Basin Project	SWEC	13A-1 1-6-84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the Mansfield 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

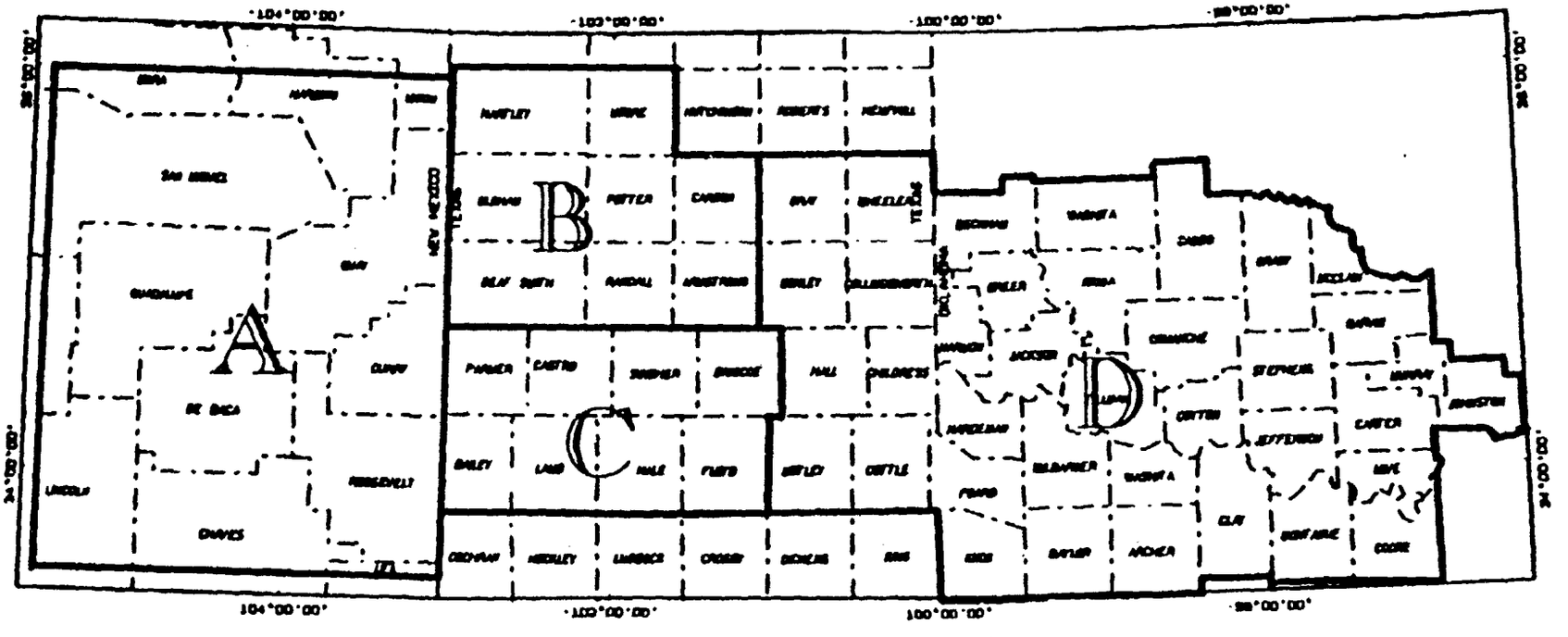
0 10 20
SCALE - MILES

0 20 40
SCALE - KILOMETERS

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

Murphy 3/7

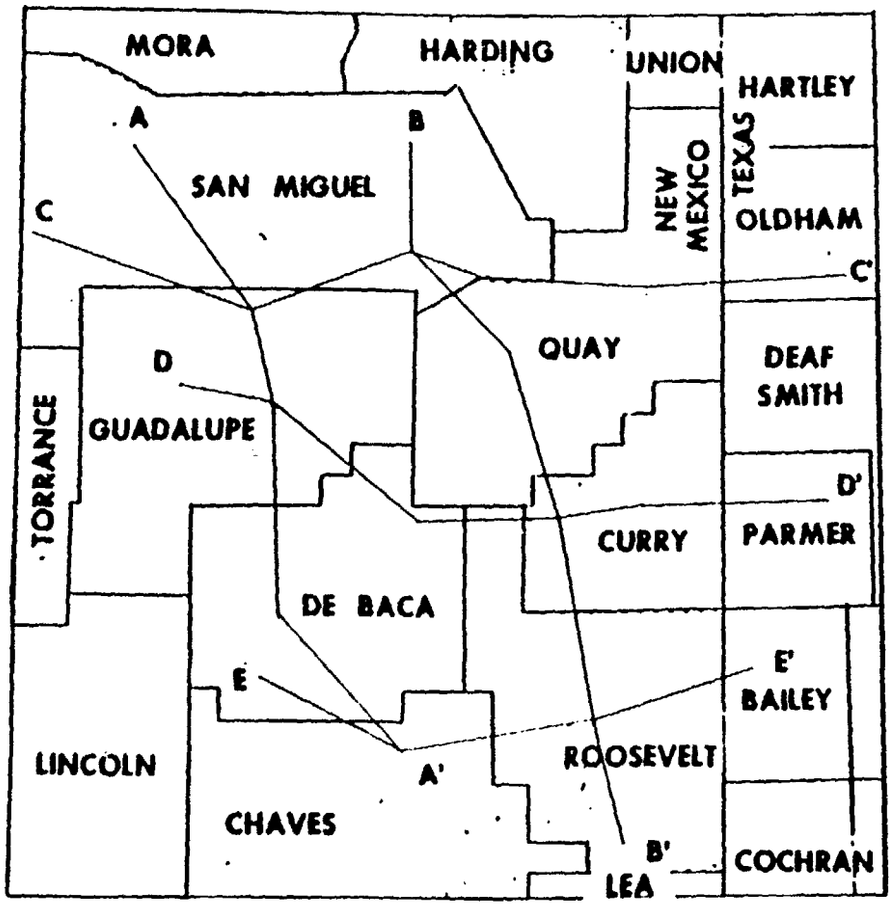
HYDROGEOLOGIC STUDY AREAS



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

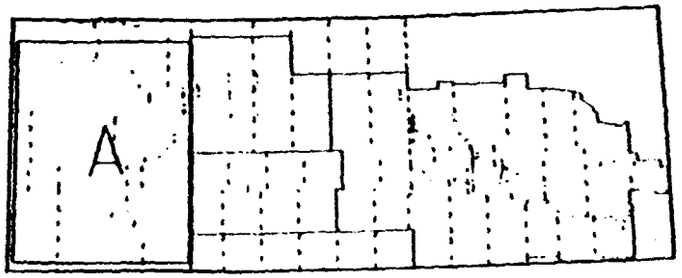
-44,158

LOCATION OF STUDY AREA AND LINES OF CROSS SECTION



Legend.

- Well Control
- Cross Section Line



Hydrogeologic Study Areas

A Eastern New Mexico

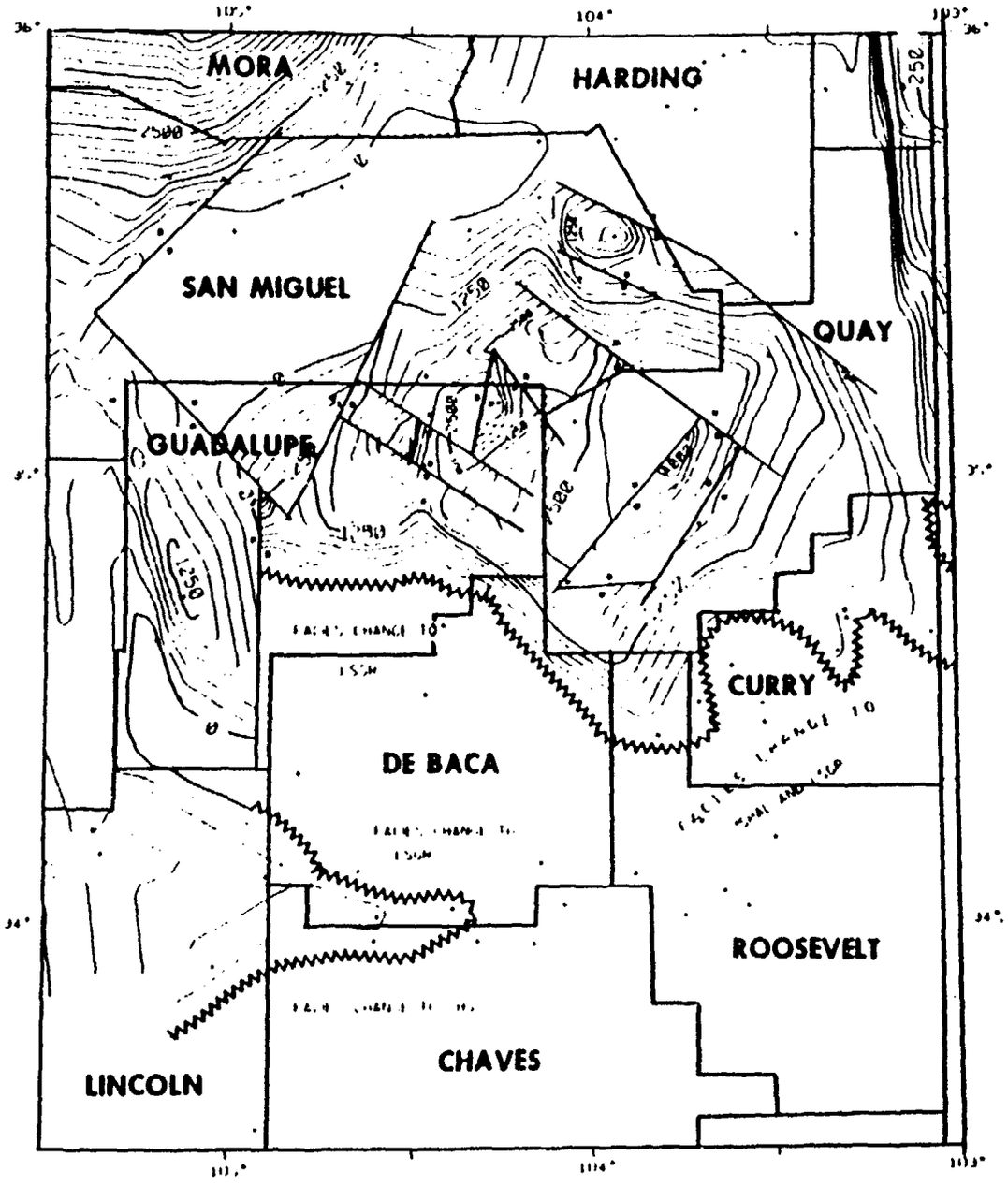
B Deaf Smith

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

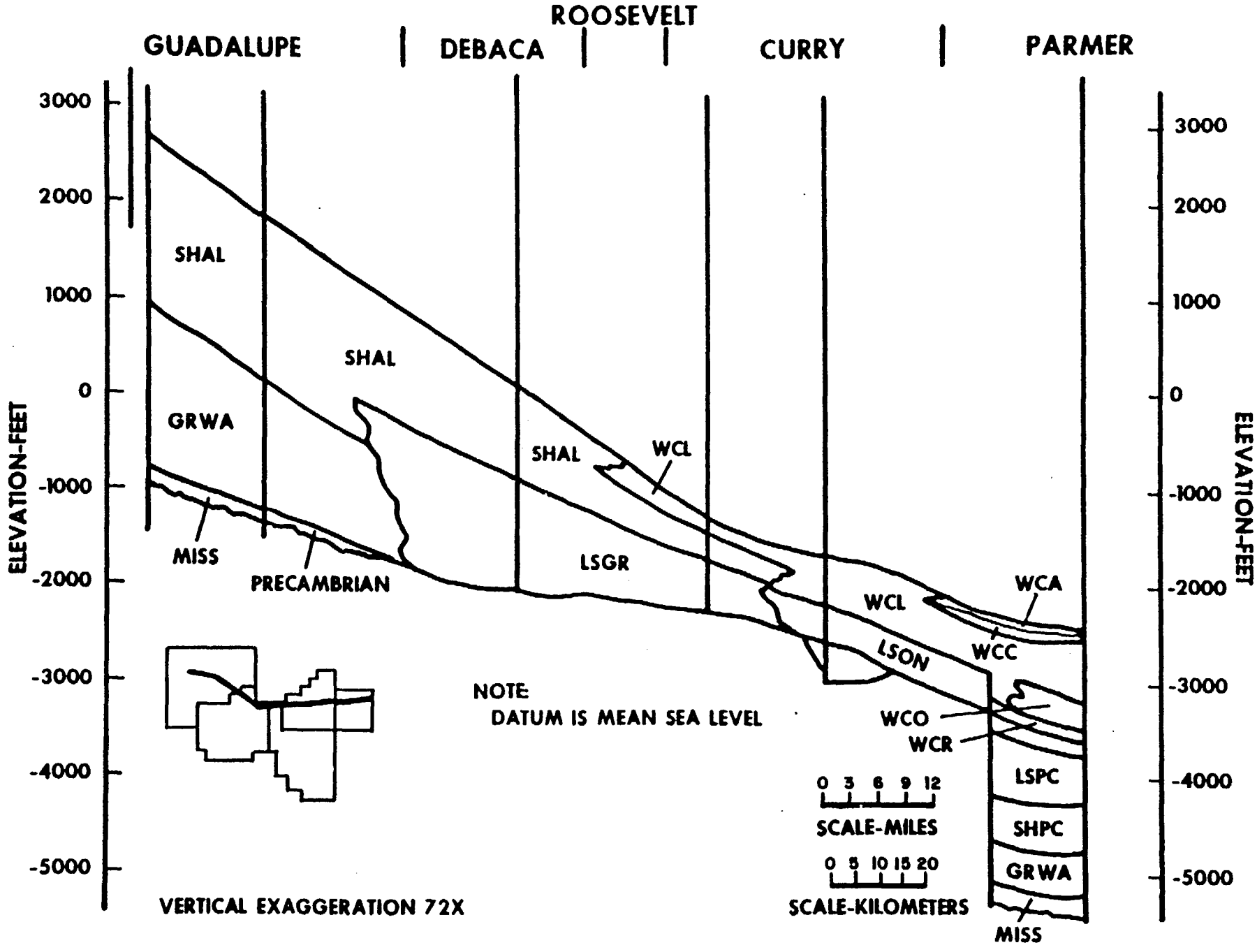
SCALE-MILES

0 20 40 60

SCALE-KILOMETERS

85-44,167

CROSS SECTION D-D'



85-44,010

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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.

Bein, A., and Land, L. S., 1982, San Andres carbonates in the Texas Panhandle: sedimentation and diagenesis associated with magnesium-calcium-chloride brines: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 121, 48 p.

Dutton, S. P., Goldstein, A. G., and Ruppel, S. C., 1982, Petroleum potential of the Palo Duro Basin, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 123, 87 p.

Gustavson, T. C., Bassett, R. L., Budnik, R. T., Finley, R. J., Goldstein, A. G., McGowen, J. H., Roedder, E., Ruppel, S. C., Baumgardner, R. W., Jr., Bentley, M. E., Dutton, S. P., Fogg, G. E., Hovorka, S. D., McGookey, D. A., Ramondetta, P. J., Simpkins, W. W., Smith, D., Smith, D. A., Duncan, E. A., Griffin, J. A., Merritt, R. M., and Naiman, E. R., 1982, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle, a report on the progress of nuclear waste isolation feasibility studies (1981): The University of Texas at Austin, Bureau of Economic Geology Geological Circular 82-7, 212 p.

Presley, M. W., and McGillis, K. A., 1982, Coastal evaporite and tidal-flat sediments of the upper Clear Fork and Glorieta Formations, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 115, 50 p.

Ramondetta, P. J., 1982, Genesis and emplacement of oil in the San Andres Formation, Northern Shelf of the Midland Basin, Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 116, 39 p.

Ramondetta, P. J., 1982, Facies and stratigraphy of the San Andres Formation, Northern and Northwestern Shelves of the Midland Basin, Texas and New Mexico: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 128, 56 p.

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OPEN-FILED CSRs AND TECHNICAL REPORTS

OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
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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

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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 64 pg = 6.90 505 ft x 1.15 = 581.02 $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

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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

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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

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-47 53 pgs x .10 5.30 6 ft x 1.15/ft 6.90 1200 + ship	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 Rep. * 160 +ship	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 $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

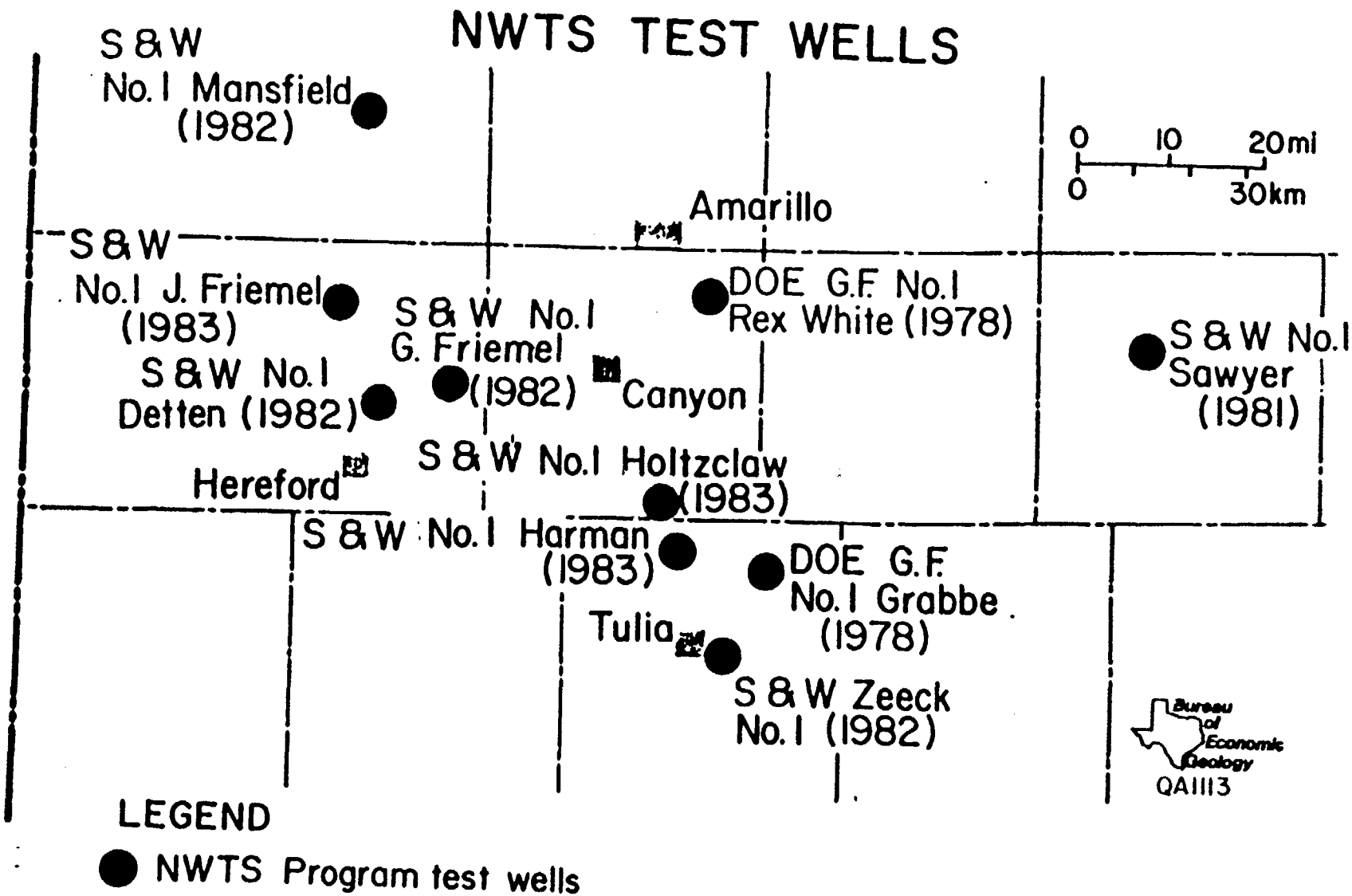
Kreitler 8/7

The Bureau of Economic Geology
The Univeristy of Texas at Austin

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

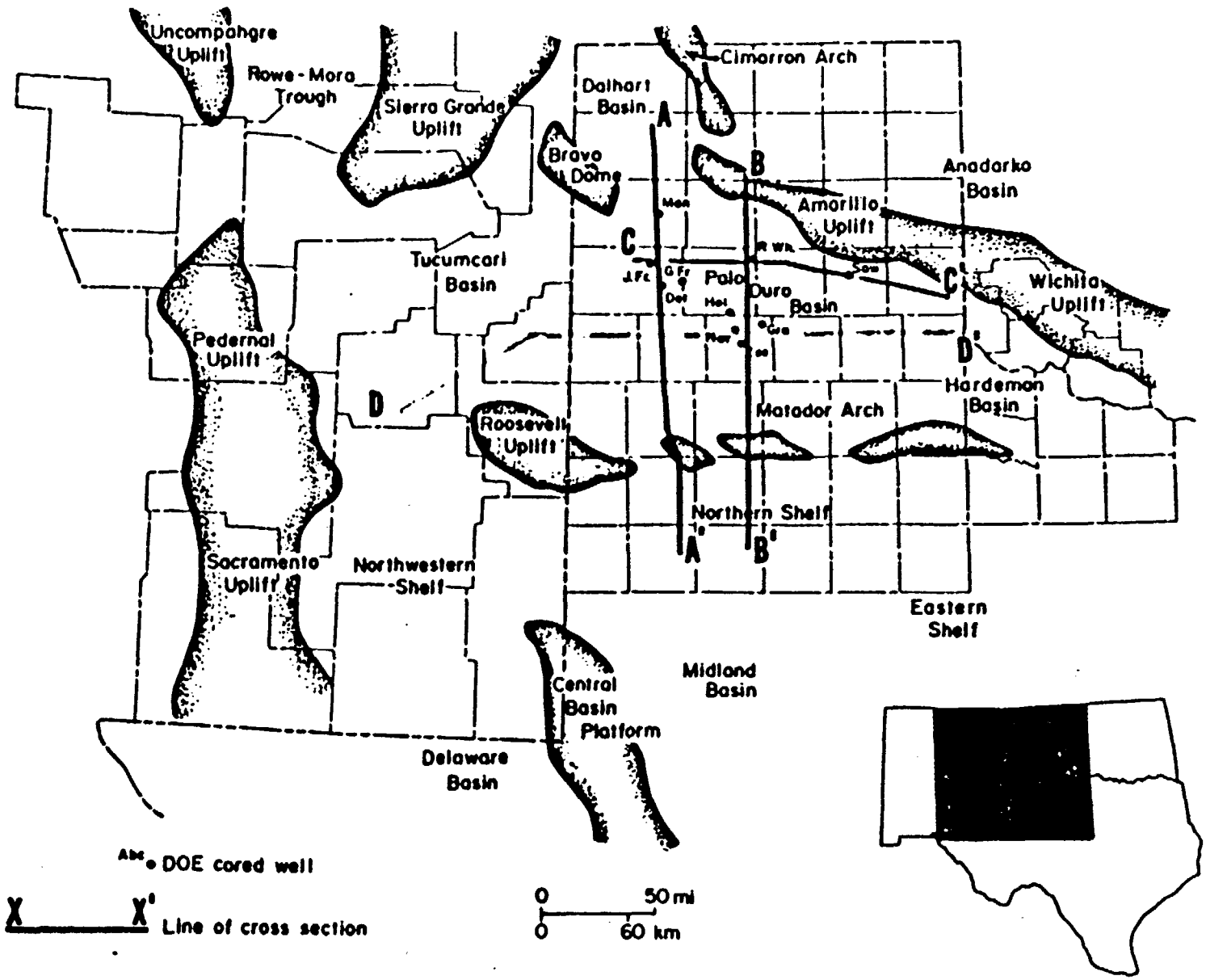
1. Modeling of hypothetical fracture flow, Palo Duro Basin, (Senger) in BEG review
2 Cross-sectional modeling of steady-state and transient ground water flow in the Palo Duro Basin, (Senger) In BEG review
3. Areal modeling of ground-water flow in the Deep-Basin Brine Aquifers, Palo Duro Basin, (Wirojanagud) 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

FORMATION	MANSFIELD	J FRIEMEL	DETTEN	G FRIEMEL	WOODS-HOLTSLAW	HARMON	ZEECK	GRABBE	REX WHITE	SAWYER
OGALLALA		391							30	
DOCKUM	45									
DEWEY LAKE					1090					
ALIBATES						1021	1235			
SALADO-TANSILL	25' missing		1129				1115	25' missing		
YATES				1141						20' missing
UPPER SEVEN RIVERS		1464'	1422	1512	1399	1302				
LOWER SEVEN RIVERS										160' missing
QUEEN-GRAYBURG	42' missing	1741		1731		1901	1995			
UPPER SAN ANDRES	25' missing 1290'		1995							
MIDDLE SAN ANDRES	1290'				2307					
LOWER SAN ANDRES UNIT 5										20' missing
UNIT 4										
UNIT 3		2710	2847	2690	2284					
UNIT 2						3049'				
GLORIETA							3102'			
UPPER CLEAR FORK										
TUBB										20' missing
LOWER CLEAR FORK								4210'		
RED CAVE	3940 4026								3991'	
WICHITA	4123 4393	5519					5309			
WOLF CAMP	4995'	6050					1372' missing 7288			3933'
PENNSYLVANIAN		6[illegible] 231' missing 7[illegible]0								
Total [illegible]	1062'	4139'	[illegible]	[illegible]	815'	[illegible]	2034'	[illegible]	[illegible]	3558


Uncompahgre Uplift
Rowe-Mora Trough
Sierra Grande Uplift
Dalhart Basin
Cimarron Arch
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
A'
B
B'
C
C'
D
D'
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				Shelf and shelf-margin carbonate, basinal shale, and deltaic sandstone
?			?	?	
PENNSYLVANIAN	VIRGIL	CISCO			
	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

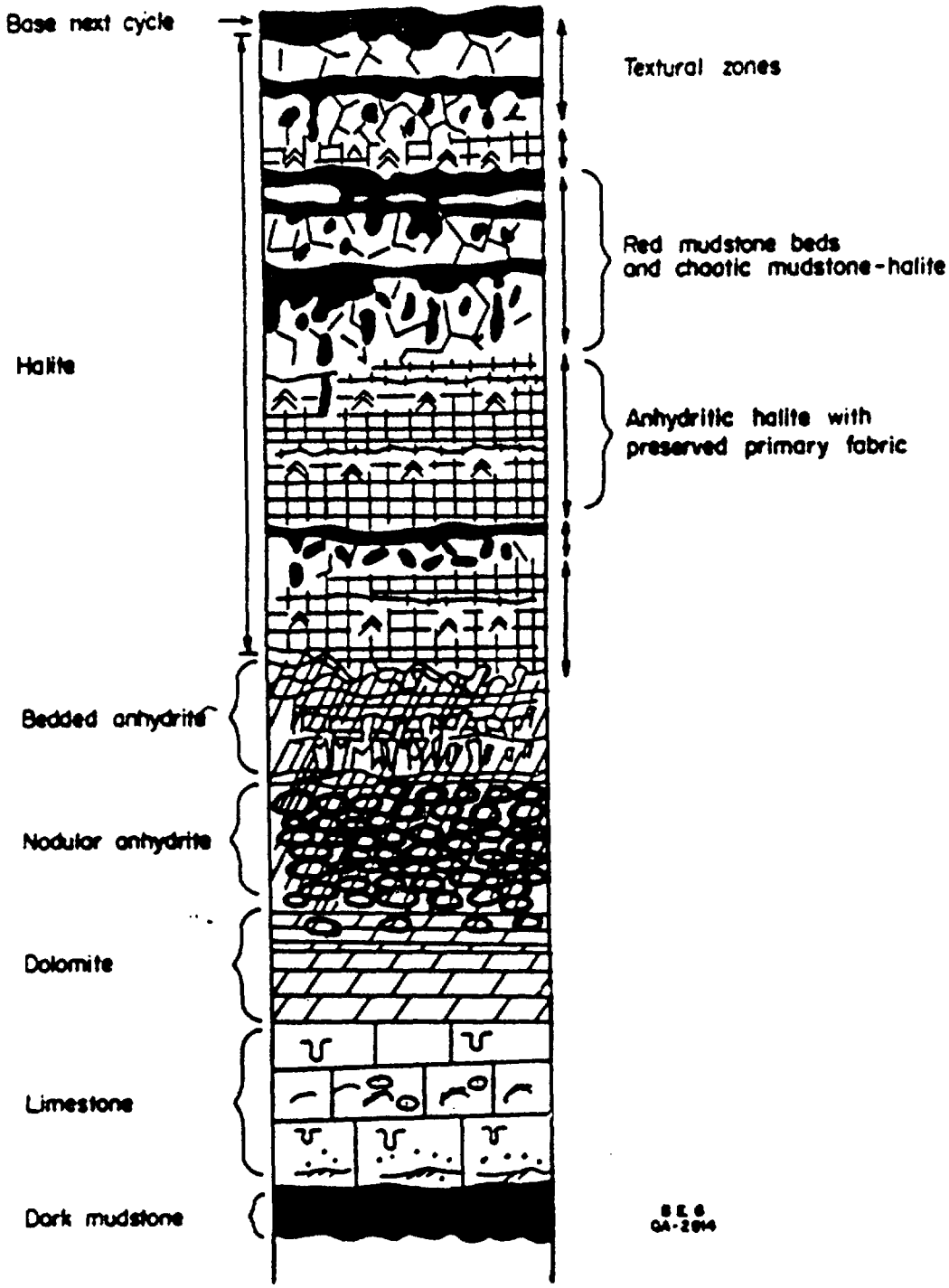
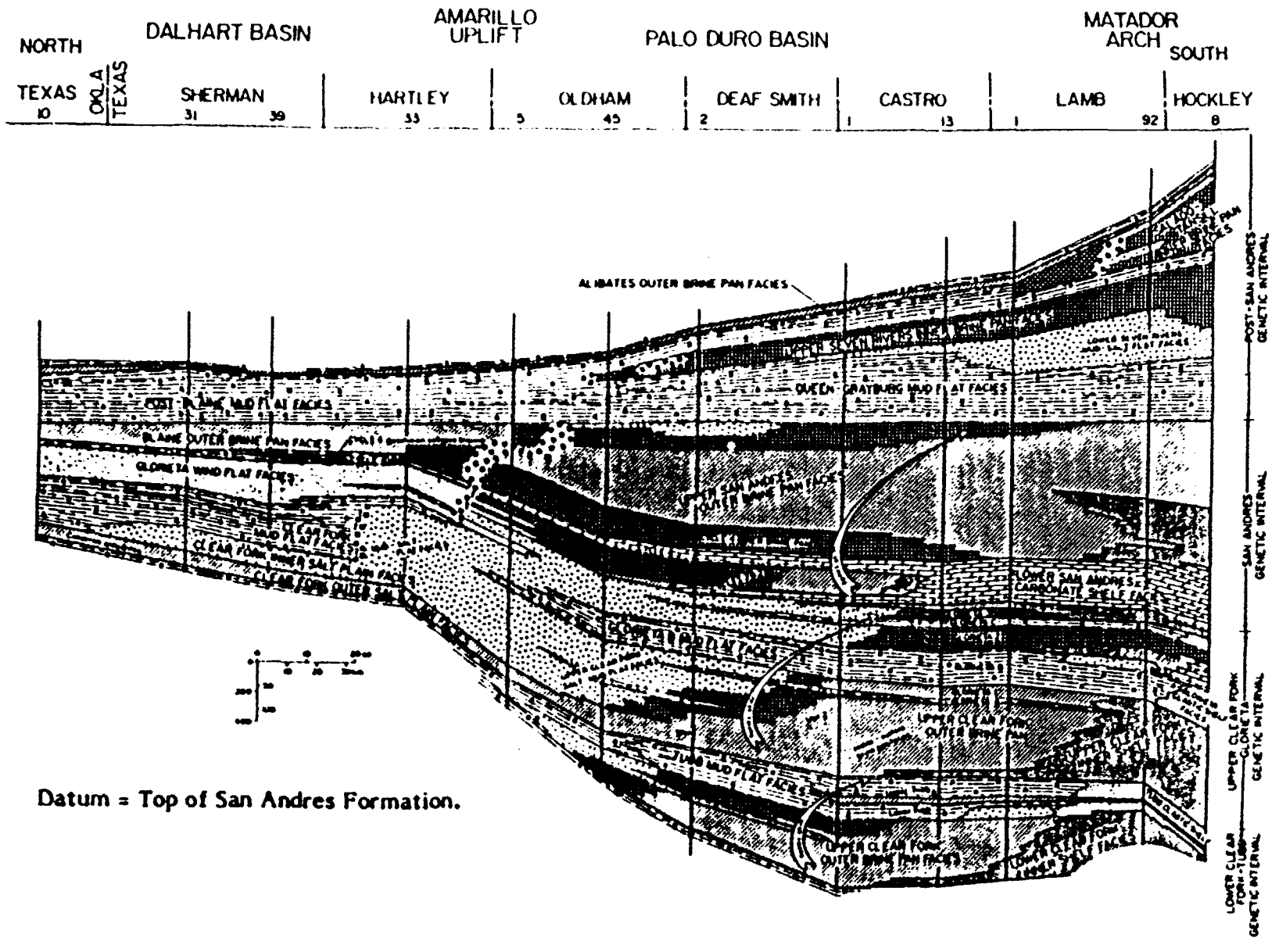


figure 2



Datum = Top of San Andres Formation.

Table 3 Textural classification of halite with genetic significance.

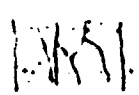
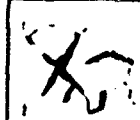
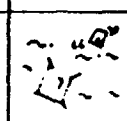
Symbol	A	B	C	D	E	F	G	H	I
halite type	chevron halite rock	color banded/ vertically oriented halite rock	C reserved for another primary fabric not yet recognized	chaotic mud-stone-halite rock	[illegible] muddy halite rock	[illegible] anhyuritic halite rock	displacive halite in other sediments	halite cavity-filling cement	fibrous fracture-filling halite cement
halite crystal size	0 5-5 cm tall	0 5 5cm tall		0 3 to 3 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-		mudstone, minor anhydrite	mudstone, minor anhydrite	anhydrite	mudstone; also dolomite, anhydrite	cavity filling halite is clean but is associ-ated with mud-stone and anhydrite insoluble residues	trace of hema-tite 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 bound-aries, part-ings, mud-stone 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 part-ings, 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 inter-crystalline masses, chaot-ic texture	halite colored red brown or black by 1-10% impurities, no bedding	halite with 1-25% anhy-drite, [illegible], no bedding	euhedral to sub-hedral halite crystals in sediments	exceptionally coarse clear crystals, fill cavity in other salt type	fibrous halite in fracture, many examples red colored
sketch									

fig 6a

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)

- oolites or coated grains
- intraclasts
- fossiliferous (general)
- molluscs
- crinoids
- forams
- brachiopods
- 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)
- annydrite
- 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

o—o	boudinage
⌣	mudcracks
▭	clasts
⁄⁄	faulting
⁄	fractures
ʒ	birdseye-fabric
≈	contorted alminae.
⊂	displacive halite hoppers
«ô»	skeletal displacive halite
◊	filled fracture
ooo	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

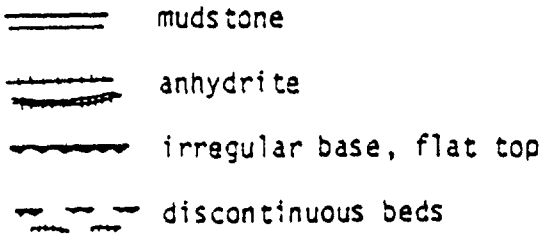
G displacive halite in sediment

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.



C. Comments on interbeds

M indicates mudstone

A indicates anhydrite ≠ indicates siltstone

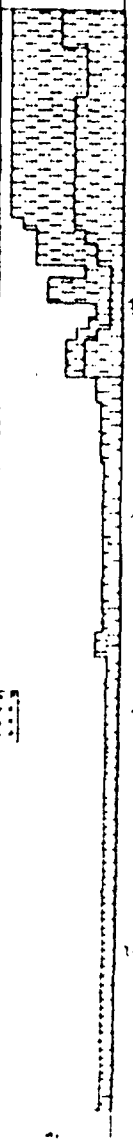
bed thickness shown

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

WELL # 1 GRABBE COUNTY SUISSIER DATE 5/85

INTERVAL 0 100 LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION



logged by DAJ date 5/85

date

checked date

transcribed by date

updated date

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 5/86

INTERVAL 100 170 OGALLALA LOGGED BY DAJ

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
	CORE NOT RECOVERED				
110					
	RECOVERED				
120			3.5 cm. to fragment	3'	Gy-Orng-Pk (5YR 7/2) calc cemented ss, large (3.5 cm) rounded Pk to frag at top with some of caliche/filtration surrounding it.
130	CORE NOT RECOVERED			24'	
140					Base of caliche and most rich soil horizon overlain by Gy-Orng-Pk (5YR 7/2) silty ss with opal-filled frame, abdnt calc nodu (up to 8 cm), better sorted upward.
150				21	
160			Clayey nodules Abundant calc ss nodules Darker bedding? Impact C-14 fracture calc nodules clay aggregates - pedogenic origin? mud cracks Darker bedding calc nodules mudstones Org-bearing zone C-14 fracture	6	11 ft (5YR 5/4) mbsl with about 20% fine to coarse grains, mostly clear to stable; overlain by a 10 ft (5YR 6/4), f grained, clayey, fine to med ss, v little bedding preserved, percentage of red clay is higher, scattered clay clasts (pseudo ped-pedogenic clays, opal-filled) and frame with permeable, better sorting upward, well bedded at about 1 ft
170				19	

logged by DAJ date

date

checked date

transcribed by date

updated date

updated date

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 180-300' OGALLALA, DOCKUM LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 300-420' DOCKUM LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
		climbing ripples & ripple cross laminate Slightly climbing ripples calcite nodules	
		low angle ripples	Dark red-brown matrix with white caliche pebble and mud clast conglomerate, generally fining upward from clast to matrix supported (1 ft.). Increases rapidly upward from pale red to almost purplish. Parallel laminated fine sandstone with some scours, clay clasts and cross-beds at the base to parallel laminations with rare ripples at top. All very micaceous with darker intervals extremely rich in biot. Scattered large (3cm) calcareous nodules in upper portion
		low angle ripples wavy laminate	
		Basal red-brown to gray-green caliche pebble and mud clast conglomerate with fine sandstone matrix with imbricated clasts and stratified pebbles. Grades upwards into gray-green ripple cross-bedded fine sandstone with scattered mud-rich zones and some mud clasts and soft sediment deformation(11.5 ft.). Grades upward into a dark red-brown coarse siltstone to very fine sandstone with parallel cross beds, low angle ripples and climbing ripples. Also contains x-bars, soft sed deformation and reduced lenses in coarse or better sorted zones and calcite nodules (11.0 ft.).	
			Calcite cement concentrated in reduced zones. At 332-338 feet having pronounced mud-filled fractures surrounded by calcite nodules Several purple-red zones, probably recent or incomplete reduction with greener (more reduced) zones
			Red brown cross laminated and ripple laminated siltstone or scattered reduction zones, coarse caliche lag in some ripples also having fractures seen in section
			Basal dark red brown, generally massive mudstone with [illegible] and gray-green [illegible] mud [illegible] upward into pale reddish brown mottled [illegible] [illegible] upward into moderate orange pink mottled [illegible] large white green [illegible] spots and occasional fractures filled with [illegible] (1.[illegible]). Grading upward into pale reddish brown mottled [illegible] fracture or a [illegible] fracture between [illegible] fracture [illegible] and [illegible] fine grained calcareous mud [illegible] having calcareous nodules and some fine sands [illegible]
			Dark red brown burrowed and disrupted [illegible] with [illegible] mud [illegible] upward [illegible] calcite nodules

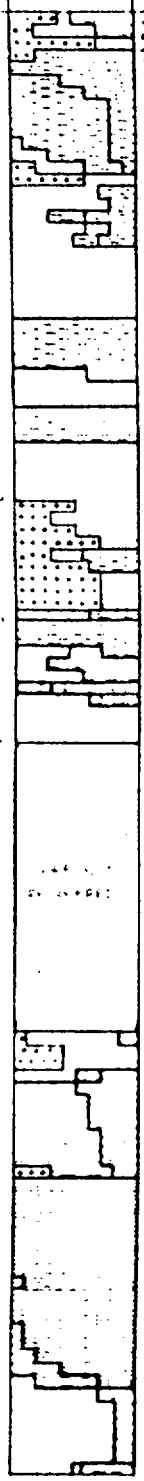
WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 420-510' DOCKUM LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
CORE MISSING			

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 540-660' LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
			

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 660-780' DOCKET LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
CORE NOT RECOVERED			
			Brown silty coarse to medium sandstone with generally large scale structures. Contains probable cross bedding and parallel laminae. 2 zones of coarse sandstone with mudclasts, and, scattered organic. Sandstone is loosely packed (cemented), grains are subangular and base of unit is poorly sorted. Sorting improves upwards with no coarse grains present, but some chert fragments.
			Red brown to gray green medium to siltstone with large and small scale disrupted bedding present at bottom where structures are [illegible] scale grades into small scale with some parallel laminae and [illegible] laminae seen in precise fine upper section. Several thin [illegible] are present increasing in number upwards. They generally have large well rounded sand at the base which fines upwards. Sorting is poor.
			Brown to gray green coarse well rounded sandstone at base grades upwards to cross laminated very fine sandstone (ripples) with grades to [illegible] and parallel laminated very fine sandstone to siltstone which is capped by mudstone.
			Red brown to gray green at ground, fine sandstone, siltstone and mud stone. Very disturbed but at base grade upwards to horizontal ripple laminated siltstone with abundant [illegible] with numerous other deform structures. Unit contains reduction zones and shows [illegible] more permeable horizons and scattered mudclasts and burrows.
			Red brown massive, very fine sandstone with scattered [illegible] and is [illegible] throughout. [illegible] with abundant heavy minerals [illegible] holes. These probably [illegible] [illegible] well rounded light green sand [illegible] Base of bedding plane unit [illegible] with [illegible] Red sand grades up [illegible] laminated mudstone and [illegible]

Logged by Date

Checked Date

Checked Date

Reviewed by Date

Updated File Date

Updated Date

WELL # 1 GRABBE COUNTY SWISHER DATE 3/79

INTERVAL 770 - 900 DEWEY LAKE LOGGED BY WPS, RAM, CS, SH

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
CORE NOT RECOVERED				
		stacked channel sequence		
		channels		

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

checked date

transcribed by date

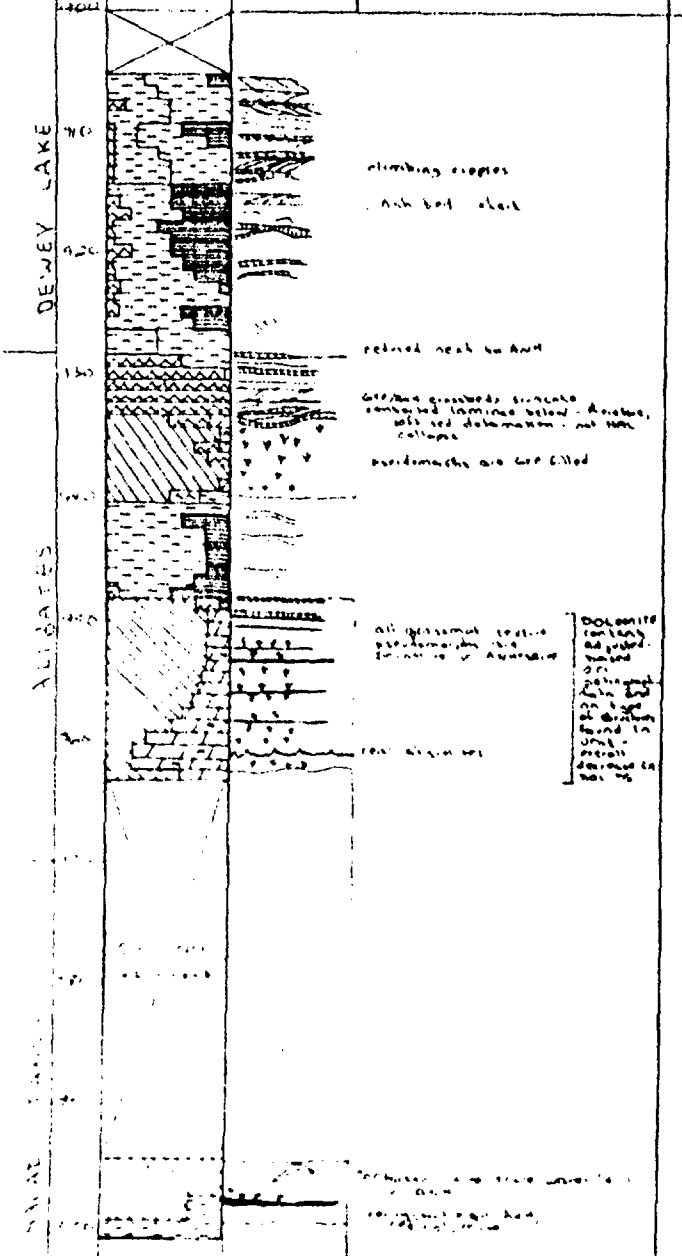
updated date

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 5-24

INTERVAL 900 - 1000 DEWEY LAKE, ALIBATES, SAN ROSA - TAMMI LOGGED BY KAM, PE, SH

Ft	LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION



Logged by _____ date _____

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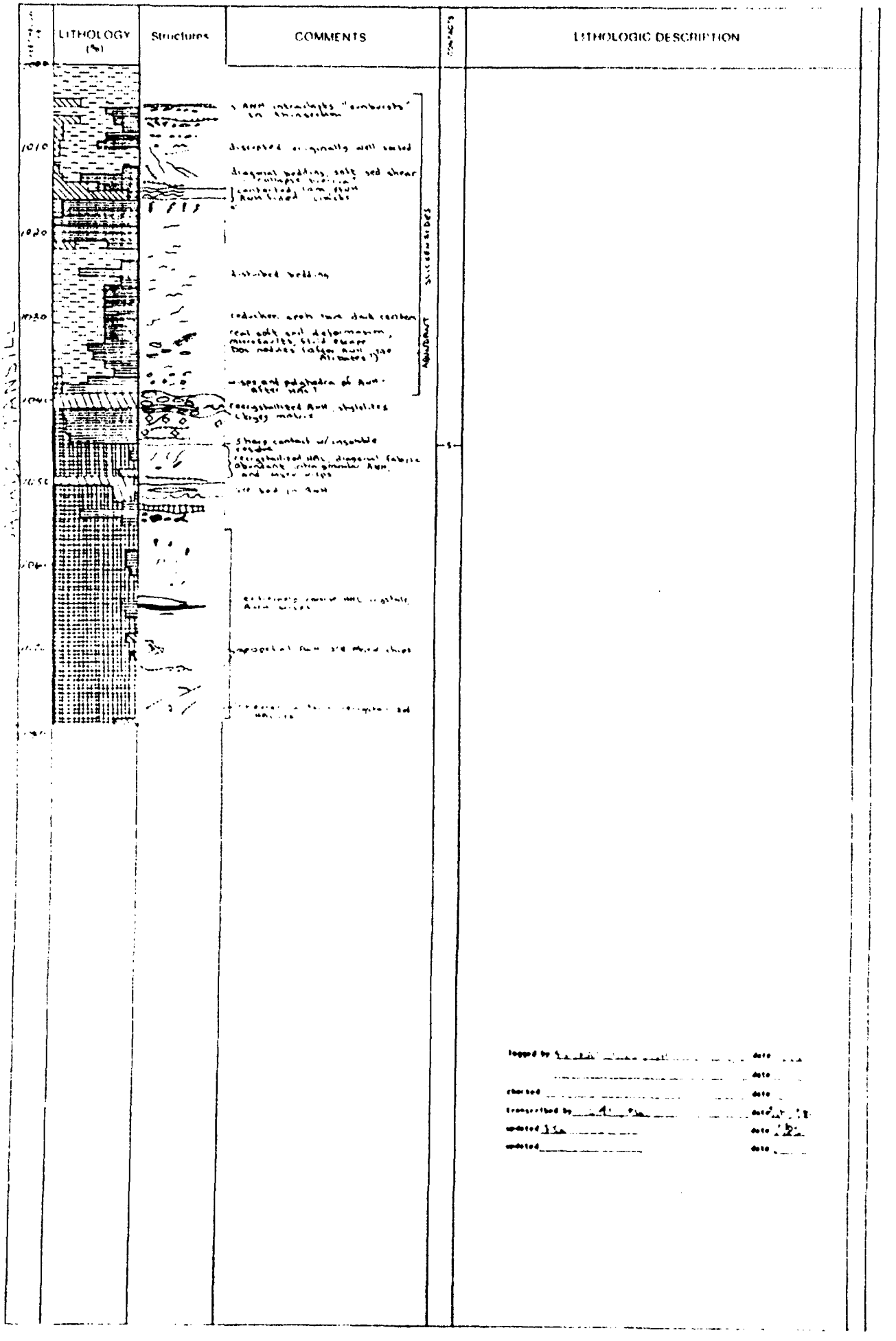
WELL # 1 GRAPPE COUNTY SWISHER DATE

INTERVAL SALADO-TANSILL LOGGED BY



logged by date

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transcribed by date

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WELL # 1 GRABBE COUNTY SWISHER DATE

INTERVAL 1079 1140 YATES, UPPER SEVEN RIVERS LOGGED BY SAI

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
1080					
1090					
1100					
1110					
1120					
1130					
1140					

SEAN DIDN'T FINISH THIS DUE TO MOVING WSL - COULDN'T GET BACK UP

logged by SAI date

date

checked date

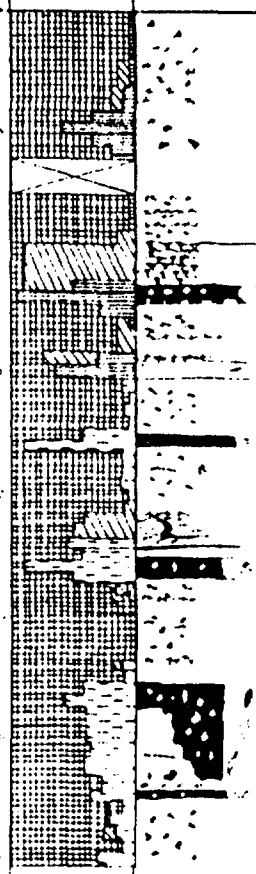
transcribed by date

updated date

updated date

WELL #1 GRABBE COUNTY SWISHER DATE

INTERVAL 1170 - 1260 UPPER SEVEN RIVERS LOGGED BY

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
			

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checked _____ date _____

transcribed by _____ date _____

updated _____ date _____

updated _____ date _____

WELL #1 GRACE COUNTY SWISHER DATE

INTERVAL 1260 - 1381 UPPER SEVEN RIVERS LOGGED BY SW

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION

logged by date

checked date

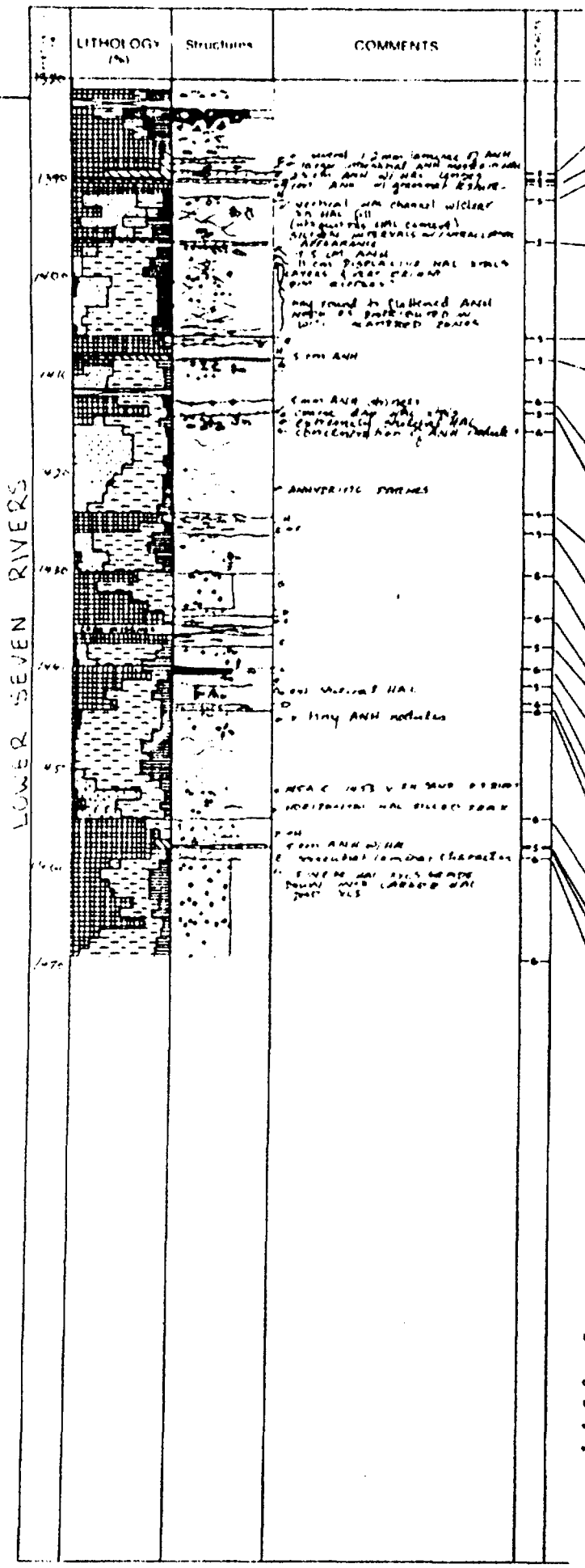
transcribed by date

updated date

updated date

WELL #1 GRABBE COUNTY SWISHER

INTERVAL 1371 - 1469 LOWER SEVEN RIVERS



Clear, coarsely sln hal with abundant insitl anh as both thin laminae and irregular, flattened nessiel plus other insitl PP mud, sparse relict chevrons abundant to insitl 7 cm of hal.

Pinkish to yellowish, lt Gy, vaguely lam and with irregular flattened lenses and nodules; remnant grainstone texture in the more bedded hal.

White, and sln hal with other insitl anh, rare remnant chevrons

PP PB, coarse siltsto with displacive hal in patches approximately 17 cm "clotted" hal and siltsto, grading down into less abundant fine, displacive hal, at 1393.5', a vertical channel with clear, coarse hal fill appears, also patches of coarse, displacive hal filled fractures, small hal sln and tiny anh nodules, irregularly scattered in section, small Gy Gn reduction spots scattered throughout

Reddish Gy anh, lower 1 cm with abundant PP muddy material, granular appearing.

PB, and to coarse siltsto and very fine ss with abundant disturbed texture of clay dissipation features; from 1397.0 - 1397.2' has rare stringers of hal with some vertically oriented, simple sln associated, also thin vertical hal-filled fractures; small hal sln and tiny anh nodules irregularly scattered in section; small Gy Gn reduction spots scattered throughout.

Upper .8', a large, chaotic mudball - filled pit in muddy hal, thin (1 - 3 cm) anh laminae at 1408.9'; lower 1.2' clear coarse sln hal with other insitl anh and white

Reddish - lt Gy anh (5 cm thick), lower contact slightly interbedded with white.

PP PB, and to coarse siltsto, coarse silt in flattened patches, disturbed ripples(?) in upper .5', large displacive hal sln grading down into extremely skeletal hal happens there tiny hal sln, lowermost .5' with increasing hal, disturbed texture and grading into chaotic mudball topping next unit.

Upper .8' of chaotic mudball overlying clear, coarsely sln hal with insitl and increasing in abundance toward the bottom, 5 cm of contorted anh at base.

Upper 1.0' of unit has large irregular hal sln, stringers and masses grading down into extremely skeletal hal happens sln, rest of unit PP coarse siltsto to very fine ss with abundant clay dissipation features, and numerous small Gy-Gn reduction spots; anh nodules at 1415' and anhydritic patches at 1420.9' and 1421.8', lowermost .8' with intra clastic texture.

Chaotic mudball filled solution pit (minor anh in floor) at top of unit, underlain by .8' clear coarsely sln hal with minor PB mud associated, the lowermost 1' of chaotic mudball with minor anh, grading from somewhat laminar to more chaotic downward.

PP PB and to coarse siltsto and very fine ss, horizontally stratifiedness, fine to large anh nodules floss than 1 cm to 3 cm) widely scattered throughout; extremely skeletal hal from 1429.8 to 1429.5', small Gy Gn reduction spots common.

Clear, coarse displacive hal sln in PB, silty white with associated minor anh as flattened nodules and discontinuous stringers, increasing hal content and larger sln downward in section, grading into unit below

Clear, coarse hal sln with abundant insitl PB white and minor hal

PP PB and to coarse siltsto and very fine ss with abundant insitl hal sln, few larger hal masses, rare tiny anh nodules, slightly coarser-grained at top.

Upper .6' of coarse displacive hal in a silty, PB white, minor anh, underlain by .3' of clear, coarsely sln hal in a solution pit, the remaining .9' of resid hal with intersitial PB white and minor hal

PP PB, coarse siltstone with extremely coarse, skeletal hal sln, disturbed texture and tiny anh nodules.

Chaotic mudball of PB silty matrix, flattened anh nest at 1441.7'.

PP PB, coarse siltsto with extremely fine, skeletal hal happens and small hal sln, texture at top of section vaguely laminar, grading down into more disturbed texture, coarser and silt concentrated in patches (ripples?); rare small reduction spots, lowermost 2.5' has increased hal content, rarelled patchy area at 1452.4', 1451.3 1451.5', and coarser patch at 1454.8-1454.3', abundant clay dissipation features

Chaotic mudball with minor associated anh grading downward into cleaner, more coarsely sln hal with insitl PP white and minor anh, grading into unit below.

[illegible] anh, 5 cm thick with hal sln [illegible]

Fine to coarse grained hal with fine black [illegible] of PB white and minor anh, grading into unit below.

PB siltsto to very fine ss with displacive hal, sln finer and more abundant at top of unit, becoming larger and more widely spaced down into unit; skeletal hal sln throughout, clay dissipation features common

logged by VDM date 11/84

date

checked SH date 11/84

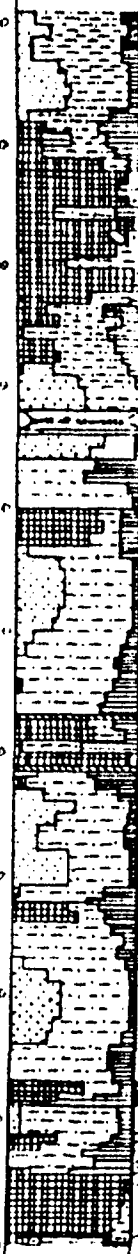
transcribed by CAC date 5/85

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

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
1470			1m ANH nodules 1-4mm 2m ANH nodules 1-4mm		
1480			"clotted" mud w/ heavy HAL cmt D-E		
1490			D-E, F		
1500			Anhitic nodule at 1495' w/ HAL hoppers Anhitic irregular flattened masses @ 1495.5-96' extremely mottled HAL hoppers and flattened ANH nodule @ 1498-499 @ clay-rich interval (12cm) @ narrow vertical HAL filled fractures clay rich interval (6cm)		
1510			D		
1520			5m HAL shale @ masses, silty lenses 5m HAL shale @ masses, silty lenses		
1530			@ 9cm ANH layer D @ more clay-rich @ bottom 17cm ANH layer, w/HAL & red clay shales 5m poorly developed ANH nodules and thicken wire appearance of HAL & MDSTN		
1540			@ 5cm ANH & HAL xls found rarely @ 4cm rare HAL filled fractures D-E interbedded HAL hoppers & ANH blebs anhydrite (?) cmt'd, soft sed. deformation		
1550			8cm horizontal layer, reduced 94.9'		
1560			lg displacive HAL shale 1555.3-5' @ 8cm slightly silty clay intvl G G @ 6in pit w/ chaotic mudsalt & interbedded ANH		
1570					

LOWER SEVEN RIVERS

5 — Dk BR raw silt to v fine sd, basically structureless with few dark specks (predominantly hal cemented?) and about brighter B clay disintegration features, also about 1-2m fr fn reduction spots scattered throughout, few v small anh nodules and hal sls scattered within, entire section hal cemented lowermost 6" of unit with clotted appearance due to inc hal, grades into unit below.

6 — Chaotic mudcoat with BR silty mbrn matrix.

6 — Dk BR silty mbrn with med-large disp hal sls and skeletal hal hoppers, sln anh blebs.

6 — Coa silty clayey hal with about (most) BR mbrn and lt Gy anh, largely dissolution pit fill with chaotic mudcoat.

6 — Dk BR mbrn with large disp hal sls and small vert hal filled fracs, small flattened and reduced siltstone clasts at top, scattered reduction spots.

6 — Coa silty clayey hal with small (most) BR mbrn and anh, largely dissolution pit fill(?), 4 cm layer of anh at 1487.6", upper part lt Gy, lower 5-6 cm very BR mud-rich, sharply bounded both contacts.

6 — Dk BR silty mbrn with disp hal hoppers, small reduction spots.

6 — Clayey, coa silty hal with about (most) BR mbrn and sln anh, largely dissolution pit fill with chaotic mudcoat(?)

6 — Dk BR silty mbrn with slightly lower part to siltstone, clayey part skeletal hal hoppers, sln anh in lrr to mod amount, intermittent small reduction spots, occasional for silt-rich lenses, dark splot, clay disintegration features throughout.

6 — Dk BR raw silt to v fine sd, basically structureless with about clay disintegration features and occasional silt rich lenses (dark splot?), scattered Gy Gn reduction spots.

Brighter BR clayey, fine silt mbrn at 1501.5-1501.8" and 1504.1-1504", lower interval with vert hal-filled fracs (1-2 cm wide), few silts (predominantly hal cemented) lenses, dark splot?) and clay disintegration features.

6 — Chaotic mudcoat of large clayey hal sls with about (most) Dk BR mbrn.

6 — Dk BR med to raw siltstone to v fine sd, basically structureless, especially in lower intervals, some silt rich lenses (dark splot?) in lower intervals, scattered tiny to large reddened Gy Gn reduction spots, locally mbrn in rare, replacement hal as small to med sls or narrow vert/horizontally bn masses at 1522-1523" and 1526.3-1527", section generally coarsens upward.

Red Gy anh layer from 1527-1527.8", filled contact top and bottom.

5 — Chaotic mudcoat with about BR silty mbrn matrix, hal sls 1 mm to 5 cm.

6 — Dk BR silty mbrn with few large hal sls + sln hal fracs fill.

6 — Clayey v rarely silty hal with minor BR mbrn matrix.

5 — Red Gy anh from 1531-1531.1", small amount intergrown hal + BR mbrn, faintly lam with pale Ylw lam.

Dk BR v fine sd to brighter BR med to raw siltstone, structureless with other clay disintegration features, upper 2.5" with small hal sls + blebs and several poorly defined anh nodules, hal strongly in mod gleaming gnd cristals wire structure here, otherwise rare small anh and hal sls, scattered tiny reduction spots, locally more about in lower intervals, rather abrupt basin also change flow/mding contacts of hal cement at 1541.2", patchy clayey hal cement.

6 — Chaotic mudcoat with abundant squeezed + dter anh nodules and (most) Dk BR silty mbrn.

6 — Dk BR med + raw siltstone to v fine sd, more clay rich at top and bottom, mit + dark anhydrite(?) nod at 1544.5-1545.2", flattened anh nodules 12 cm t. 5 rel to apparent flow direction, clay disintegration features throughout, also small Gy-Gn reduction spots, few large hal sls in lower flow interval (as noted at left).

6 — Dk BR silty mbrn with large disp hal sls and narrow vert hal filled fracs.

6 — Dk BR raw siltstone with about clay disintegration features and small Gy in reduction spots scattered within.

6 — Dk BR silty mbrn with large disp hal hoppers, silty lenses with reduction spots.

6 — Brighter BR raw siltstone with about clay disintegration features, few large disp hal sls + small reduction spots.

6 — Clayey rarely silty hal with small amount of (most) BR mbrn grading downward into raw hal with (most) anh as residue in bound into silts, at 1561.1' hal becomes less rarely silty with about Dk BR mbrn (mostly), + minor anh.

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

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION

QUEEN - GRAYBURG

logged by SW date

date

checked date

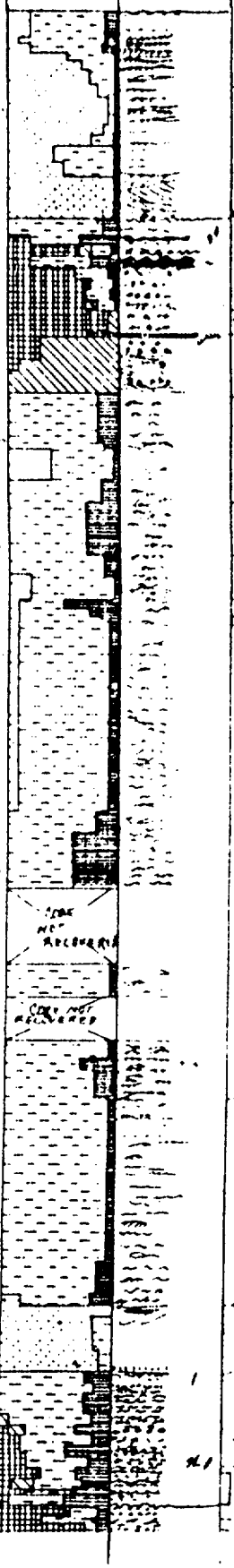
transcribed by GAC date 5/85

updated PG date 7/85

updated date

WELL #1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL 1710 – 1850 QUEEN GRAYBURG, UPPER SAN ANDRES LOGGED BY [illegible]

Depth	Lithology (%)	Structures	Comments	Cores	Lithologic Description
1720					
1730					
1740					
1750					
1760					
1770					
1780					
1790					
1800					
1810					
1820					
1830					
1840					
1850					

Logged by [illegible] date 10/84

date

Checked date

Described by CAC date 5/85

Edited PG date 7/85

Edited date

WELL #1 GRABBE COUNTY SWISHER DATE 10-24-84

INTERVAL 1950-1990 UPPER SAN ANDRES LOGGED BY JV

Depth	LITHOLOGY (%)	Structures	COMMENTS	Depth	LITHOLOGIC DESCRIPTION
1950	CORE NOT RECOVERED		MISSING SECTIONS 1952-1957'		Banded hal with trace inert and ∢ anh, missing footage from 1952-1957'
					Anhed hal with trace inert and.
1960			interbed apparent from backside of core		Anhed hal with inert silt ∢ anh ∢ a silty mbrn interbed (0.5') with small anh clasts ∢ anhed hal with abdnt patches of siltstone ∢ banded hal with inert silts within pieces ∢ anhed hal with abnnt inert and ∢ anh ∢ hal with patches of silty mbrn ∢ silty mbrn interbed (0.4') with inert hal.
1970			curved slickensided surface		Anhed hal with inert and ∢ silt and with an area of very crushed large patches of BB silty mbrn presumably associated with a large plane ∢ thin clastic interval with patches of anh ∢ mbrn ∢ mbrn ∢ siltstone interbed with abdnt dkp hal and abnnt hal frac fill, interbed changes from massive silty mbrn at base up into a chaotic siltstone ∢ mbrn fabric with abdnt small anh clasts, then up into a dark rpl lam muddy siltstone.
1980			banded ESTN interbed caps ANH		Anhed hal with abnnt inert and ∢ silt lm upward ∢ anhed hal with abdnt small patches of muddy siltstone ∢ banded hal with subvert stn and abnnt inert and ∢ anh; unit capped by 5 thin (1 cm) siltstone interbed, large stt with little and random arrows in lower portion of unit.
			coarse xyls		Anhed hal with mbrn inert and ∢ anh ∢ thin clastic mbrn/hal interval banded hal with occasional chevron structures ∢ anhed hal with ∢ ∢ of anhydritic mbrn along frac interbed and with mbrn inert and and anh ∢ muddy siltstone interbed (0.1') with abdnt dkp hal.
1990			1 5' long vertical fr. 1/2" 2 cm wide fr. in interbed filled w/ fibrous HAL non-axial speckling area interbed and disturbed (contact with sediment)		Anhed hal with inert anh ∢ mbrn ∢ BB silty mbrn interbed (1.4') with a 1 cm vert frac filled with fibrous HAL, upper part of interbed is a anhydritic, overlying this is banded hal with abnnt inert anh ∢ and and interrupted by a thin mbrn interbed and a chaotic mbrn/hal interval ∢ muddy siltstone interbed (1.5') with dark structures and dkp hal in upper part.
			1-2% ANH		Anhed hal with abdnt patches of muddy siltstone and clastic material lm upward ∢ muddy siltstone interbed (about 0.8') with ∢ ∢ dkp mbrn/hal hoppers and small clasts of anh ∢ mbrn; interbed lens are usually bleach with ∢ in preservation of original and structures, especially at top of interbed where siltstone hal will developed rpl lam.
1910			1% ANH		Anhed hal with abdnt clasts of BB silty and ∢ containing a ∢ 1 cm thick silty mbrn interbed ∢ ∢ silty mbrn interbed (0.5') with abnnt dkp hal ∢ frac fill ∢ anhed hal with abnnt inert and and silt ∢ anhed hal with abdnt silty mbrn patches ∢ silty mbrn interbed with dkp hal
			core missing 1916.0-1916.9'		Anhed hal with inert silt ∢ trace and ∢ anh ∢ anhed hal with abdnt small patches of muddy siltstone ∢ abnnt anh ∢ ∢ muddy siltstone interbed with abnnt frac filled with fibrous hal ∢ another siltstone interbed with rpl lam ∢ a small rmnt anh clast ∢ anhed hal with abdnt patches of muddy siltstone lm upward ∢ siltstone interbed interrupted by missing footage
1920			large vertical fr. w/ HAL coat with through interbed		Anhed hal with inert silt and anh with a thin interval containing abdnt well developed chevron structures ∢ BB muddy siltstone interbed (1.0') with abnnt anh clasts and a long, vert or ∢ hal filled frac cutting across; thin and lam rpm interbed, interbed has dark rpl lam structures, dissolution features arrow in lower part of section.
1930			1% ANH		Anhed hal with inert silt and trace anh ∢ anhed hal with abdnt patches of dark lam muddy siltstone and anhydritic siltstone, clastic ∢ abnnt lm upward throughout unit, several dissolution features, especially pits, arrow in lower part of section.
1940			1% ANH		Anhed hal with abnnt inert silt ∢ trace and ∢ ∢ in area of anhed hal with abdnt patches of BB muddy siltstone ∢ anhed hal with inert silt ∢ anhed hal with abdnt patches of siltstone which quickly grade upward into a chaotic siltstone interbed with abdnt dkp hal ∢ and small clasts of and ∢ anh, dissolution features are rare, especially in lower part, upper contact is gradational with overlying B hal, beginning of cyclic nature of clastics
			slickensides in MIDSTN		
1950			zone outlined by green track of small clasts of ESTN and ANH		Anhed hal with mbrn inert and, silt and trace anh ∢ anhed hal with abdnt small patches of muddy siltstone ∢ containing a thin (0.2') fin rpl lam to dark silty mbrn interbed ∢ BB silty mbrn interbed (0.1') with dkp hal, core missing from 1955-1958'.
	CORE NOT RECOVERED				
1960					Anhed hal with inert and ∢ anhed hal with abdnt small patches of muddy siltstone ∢ rpl lam muddy siltstone interbed.
					Interbed of interlam siltstone ∢ anh with abdnt dkp hal ∢ anhed hal with abdnt patches of muddy siltstone ∢ anhydritic mbrn.
1970			0.5' thick interlam ANH ∢ ESTN interbed w/ HAL coat ∢ discontinuous HAL, ANH at base		Banded hal with abnnt inert hal ∢ mbrn, unit has several zones and also is uniting in areas of anhed hal with inert and (? hal), hal accordings to usually gradational between subvert and anhed.
			pink irregular interbed of MIDSTN ∢ ANH clasts		
1980			8 cm wall xyls irregular interbed of ANH ∢		Anhed hal with abnnt inert hal ∢ mbrn, and occasionally patches of siltstone in upper portion ∢ dark to rpl lam muddy siltstone interbed with dkp mbrn/hal hoppers, a frac filled with fibrous hal near the top, and occasional small clasts of mbrn scattered throughout.
			slickensides fx.		Banded hal with abnnt inert anh, large pit rmn arrows upper part.
1990			1.5 cm thick MIDSTN interbed		Mbrn interbed with large hal filled frac and vertical hal hoppers, interbed grades upward into siltstone ∢ anhed hal with abn inert and ∢ ∢ reddish silty anh interbed (2.1') with frac in lower part ∢ dkp hal in upper part, anh consists mostly of very small anhs, upper part is rpl lam, sharp dissolution upper contact.
					Banded hal with abnnt inert and, lower part containing a thin siltstone interbed and occasional patches of muddy siltstone.

Prepared by JV date 10/84

date

Reviewed SH date 10/84

Transcribed by CAC date 3/85

Reviewed PG date 7/85

date date

UPPER SAN ANDRES

WELL #1 GRABBE COUNTY SWISHER DATE 10/84

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

Depth	LITHOLOGY (%)	Structures	COMMENTS	Cores	LITHOLOGIC DESCRIPTION
1990			[illegible]	1	Anhed hal with minor lmstl and l silt and trace anh, several dissolution features present, unit capped by rpl lam siltstn intbd, sloping contact from 1996-1997'.
2000			2% MUD (1% MUD) DISSOLUTION BOUNDARY	1	Anhed hal with minor lmstl anh & trace of DD mud, chevron stratification occur locally near the base and top of the unit, unit capped by a 1 cm thick felted anh intbd.
			DISSOLUTION CONTACT	1	Anhed anhydritic hal with occasional chevron stratification in thin channel; mbrn/hal rock in thin zone (about 0.6') of banded hal with subcent sil and a chevron stratification in anhed hal with minor small patches of muddy siltstn.
2010			HK DOLST/ TRUNCATION SURFACE [illegible]	1	Bedded hal with minor small wvl gyp pseudomorphs with hal cement which originate from bedding plane (about 2.5') in stratum of anh & hal that becomes chaotic near the top of the unit, upper contact is a dissolution surface with anh residue.
			[illegible]	1	Chaotic anh & hal siltstn (0.5') & anhed hal with occasional pst bed of DD muddy siltstn and several intbds of rpl lam DD muddy siltstn intbds, 0.2' thick interlam mbrn & siltstn intbd caps unit.
			[illegible]	6	Anhed hal with several large patches of muddy siltstn and thin anhydritic mbrn and anh intbds in lower part, an 18.5' m thick dark muddy siltstn intbd with some disp (?) hal occurs at top of unit.
2020			[illegible]	1	Anhed hal with minor lmstl and and silt and occasionally anh, small pft occurs in lower part.
2030			[illegible]	1	Silty DD mbrn intbd (0.5') w rpl lam silty anh (0.5') with well developed rpl laminae w anh with large chaotically oriented gyp pseudomorphs with bed altered lime and filled with hal (about 6") w mbrnlm of crinkly lam anh and gyp pseudomorphs (about 1.5') w reticulate lam anh with occasional gyp pseudomorphs (about 1.5') w every lam anh with small gyp pseudomorphs, originating from bedding planes (about 1.5') w anh with a large, generally wvl gyp pseudomorph (about 1") w massive anh (0.25') that caps the unit with a sharp, for upper contact with overlying hal
			[illegible]	1	Anhed hal with minor, usually be eliminated, patches of DD silty mbrn, lmstl and l occasionally anh in olm minor, unit appears to have originated from bedded hal, sharp contact with overlying lmstl intbd
2040			[illegible]	6	Banded, clear hal with minor lmstl anh and minor chevron stratification w DD banded hal with lmstl DD muddy silt and minor anh, well oriented hal cts, though not well developed, are present throughout the section, occasional pipe stem occur in unit, banding within hal occurs on a 2.5-5.0 cm scale
2050			[illegible]	1	Anhed hal with minor patches of DD mbrn and muddy siltstn, amount of lmstl clastics increase upward, number of rpl lam clasts also increase upward, upper contact marked by intbd of mbrn with disp hal w siltstn.
			[illegible]	6	Anhed hal with lmstl anh & minor mud, basal portion shows contact to a clast
			INTERGRANULAR VERTICAL DISSOLUTION BOUNDARY	6	DI Gy anh with occasional mnbs and blocks of more bedding which formed in matrix is mostly replaced by anh w anh with minor gyp pseudomorphs filled with hal cement, pseudomorphs grade from rather large chaotically oriented sil at base (min smaller sil that originate from more long condition) & disp planes, upper 1.6' represents a vert dissolution boundary between anh with pseudomorphs and anhed hal with minor patches and lm & muddy anh & anhydritic mud, upper contact is an irr, by dissolution boundary between anh with pseudomorphs and anhed hal with minor patches and lmstl muddy anh & anhydritic mud, upper contact is an irr, by dissolution boundary which cuts across the earlier dissolution event
2060			[illegible]	1	DD DD clastn/mbrn (1.2') with few l patches anh w 1.0' rp mt in that l w rpl laminae siltstn/mbrn upward w 0.5' thick mbrn with large vert sil filled frac, upper contact marked by a bottom of desiccated(?) thin mbrn interclasts.
			[illegible]	1	DI Gy anh with thin mbrn matrix, at 2070' the anh becomes brecciated & disappear as hal becomes the lmstl component, hal is upward in in 3-4 cm dec; the fabric in this section is a somewhat chaotic mixture of anh & hal, the upper 1' is massive anh with some red stain and possible for chicken mnbs, the upper contact is sharp with the overlying DD clastn.
2070			THOUSANDS OF U SHAPED HAL CUBE MOLDS WHICH PRODUCE PLANES	1	Rpl lam mbrn intbd with minor w small hal cube molds along bedding planes
			FINE CLASTICS SIMILAR TO P1 MARKER RESIDUE	1	Dark to rust lam DD siltstn with minor clasts of DD and l mm anh, gr siltstn Gy siltstn in 0.3' thick Gy flocculo muddy siltstn with several small flattened anh nodes.
2080			[illegible] LAM MUDSTN INTERBED	1	Anhed hal with minor patches of rust lam muddy siltstn and anh, several silty mbrn intbds occur in the interval.
			2096 - 2097' MISSING	6	Anhed hal with lmstl and occasional patches of anh & minor mud, unit contact for upward, portions of section appear banded as in P hal, but hal, though similar to el olm, is unbnd; sloping contact from 2096-2097'
2100			[illegible] CONTORTED LAM ANH FILTY MUDSTN INTERBED TO BRECCIA [illegible] SILT [illegible] ANH 2cm THICK ANH MUDSTN INTERBED [illegible] MUD	5	Anhed, silty hal with minor lmstl anh & mud with minor wvl chevron, and for upward to where it outlines 3 cm thick bed of hal.
				6	Anhed hal with DD mud and silt and minor anh.
				6	Anhed, silty hal with lmstl anh & wvl chevron stratification, upper contact is gradational with overlying mbrn intbd.
				5	Anhed hal with lmstl anh and DD mud and silt, relative proportions vary upward

logged by JV date 10/84

checked SH date 10/84

transcribed by CAG date 5/85

updated SG date 11/85

updated _____ date _____

WELL # 1 GRABBE COUNTY SWISHER DATE [illegible]

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

Depth	LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION
2110			THIN (1cm) ANHYDRITIC MUD INTERBED LARGE ANH-LINED PIT >5% MUD IRREGULAR 2-4cm THICK ANH INTERBED SKELETAL HAL HOPPERS	1 2	Anhed hal with abdnt patches of mudst silt overlying thin clastic interb. Anhed hal with (most) anh, BB mud and silt, from the base (most) component changes from clastic to anh to a mixture of clastics + anh, occasional pits and pipes noted in the interval.
2120				3	Thin (1") vaguely lam and mud anh (up 3" to rest of anh/hal mixture) exhibiting a diagenetic fabric, hal appears to be replacing anh by filling abdnt small vugs(?) and sometimes leaving only a vestigial network of anh, overlying this is a 3" interval of disp and skeletal hal within anh.
			HAL-LINED FRAC PORE DEVELOPMENT (INTERPORES, MOULDS) IN THE BEDDING GRADUAL OR DISCONTINUOUS CONTACT 5% HAL BLACK HAL SOME HAL ON ANH, ANH MOULDS INTERMIXED AREA OF LARGE BADGER SALT (HALITE) AND MUDDY ANH NODULES COALESCE TO FORM A MASSIVE TEXTURE	4	Lam dolo mdstn with scattered anh nodules (up this dolo mdstn up 2" thick) forms, mold, polyhedral gnsnts with anhdrite generally usually filled with hal (no finely rpl lam dolo mdstn with anh nodules dev upward from lithocoral hal-filled frac at 2127.4').
2130				5	Bl-Gy and mossy anh at base, small anh nodules with minor (most) dol (up smooth anh with faint remnants of mud fractures and a little or no clastic matrix, at 2137' is a thin (0.2') wavy lam interval (up 0.4' thick dolo interval) (up mud anh, upper 1' differs from rest of unit by having slightly dolo, muddy siltstn matrix, upper contact is a dissolution contact with overlying dolo.
2140				6	Bl-Gy anh with poorly defined, randomly oriented gyp porphyroblasts filled with hal cement (up wavy rpl lam anh with fewer but slightly better developed gyp porphyroblasts filled with hal cement
				7	Bl-Gy and mossy anh with (most) dolo, dolo matrix dev upward from about 1% to less than 0.5%.
			FORMER ANH/HAL CONTACT 10 cm MUDDY ANH	8	Bl-Gy wavy rpl lam anh (up 0.8' thick, slightly muddy siltstn (mud), siltstn grades from BB upward to Gy, thin bottom of small anh nodule and elongated fibrous hal filled frac in Gy siltstn, siltstn to rpl lam
2150			INCONSPICUOUS MUDDY INTERBED HAL (MOST) AND [illegible] MOTTLED THICK 1% INSOL ANH	9	Anhed hal with abdnt patches of BB muddy siltstn (almost (most) anh), anh patches have (most) in dolo lam, several dissolution features present, relative and contact appears to be upward, on 11 cm thick siltstn interb (mud rope hal unit).
			LARGE MUDDY SILTSTN PATCH W/ CONTORTED LAM 1% ANH	10	Anhed hal with minor (most) anh, silt and mud, anh contents dec upward with silt and mud content inc upward.
2160			1% MUDDY SILT	11	Con anhed hal with abdnt patches of BB muddy silt and minor (most) BB mud, large patches are usually associated with intbds and dissolution features (pits and pipes), several siltstn intbds in interval.
			3 cm THICK MUDDY SILTSTONE INTERBED 5 cm THICK SILTSTONE DISTURBED LAM MUDDY SILTSTONE INTERBED 1.5 cm THICK SILTSTONE INTERBED (1-2%) INSOL MUD	12	Anhed hal alternating with poorly developed wavy orientated bended hal, minor (most) BB and Gy mud, anh and mud/anh thermohaline and not usually exceeding 5%, small chevrons in anhed hal at 2173.2'.
2170			SMALL MUD CLASTS	13	Anhed hal with (most) BB silty mud, this unit intbd marks share upper contact.
				14	Bl-Gy and B stained (slightly muddy) anh with chaotic texture, some very thin bedding + (most) hal cement, sharp wavy upper contact
2180				15	Wavy lam anh with occasional a small bedding plane gyp porphyroblts, lam anh consists of alternating lam (to cm scale) lam of Bl-Gy and Gy anh, lam anh (up anh with chaotic or semi-oriented poorly developed gyp porphyroblts filled with hal cement.
			TRACE OF DOL	16	Wavy-looking anh with interior "nods" of anh and radiating masses of anh blades, hal to minor cement between the spherules.
2190			ABOUT 1% INSOL DOL MINOR ANH BADGER REPLACING DOL	17	Bl Gy anh nods with (most) dolo, dolo is very bended at 2191-2194', (most) matrix dev upward and is replaced by a lt B anh which is an aggregate of blades in contrast to the massive texture of the nods.
			20 cm about 1% INSOL DOL MOSTLY DOL WITH LAM ANH REPLACED GRAD CONTACT FROM DOL TO MOSTLY ANH 3 cm OF MOSTLY, MINOR ANH [illegible] cm MISSING WERE ANH [illegible] cm MISSING 1 cm MASSIVE BLACK ANH INTERBED [illegible] cm REPLACED [illegible] cm RESIDUE DOL PORE FILL PATCHES & DISTURBED DOL PATCHES OF SILTY MUD	18	Bl-Gy and mossy anh (up 0.3' thick dolo mdstn to wkstn contains minor lam nods, insolts include peloids, pellets(?), dolo has sharp upper contact and lower contact, erosional or dissolution?
2200				19	Gy silty mdstn (1.0') (up 2.2' lt B dolo mdstn (up 0.2' of mdstn replaced by anh + hal, dolo mdstn is fairly structureless except near top where there is possible cross bedding, dolo is somewhat silty near base.
				20	Cont, interbed BB silty mdstn + anh along basal contact (up 0.6' of this (most) lam BB muddy siltstn (up 0.15' anh intbd (up 0.4' dark (up BB silty muddy siltstn with a small elongated anh blades near base, showing fractures from 2205-2205.5', 0.5' wavy to dolo lam anh with some B siltstn (up 0.6' of sly anhydritic silty mdstn which marks gradational contact with overlying unit
2210				21	Anhed hal with abdnt patches of BB silty mud and occasional anhydritic mud, and contact inc upward, especially near gradational contact with overlying mdstn unit.
				22	Anhed hal with minor (most) mud and anh, and + anh vary in relative abundance with some sections mostly anh and some mostly (most) mud, both are usually present, occasional small pipes are present as well as a partial chevron in an anh zone, (most) material generally inc upward.
				23	Anhed hal with minor (most) mud + occasional [illegible] of muddy siltstn (up anhed hal with some patches of BB muddy siltstn + minor (most) mud.
2220			RB MUD INTERBED, ANH IS MUDDY WELL FORMED CARST PITS	24	Con anhed hal with minor (most) anh, anh content inc upward; in lower part a thin anh intbds are rare and hal shows occasional bands with traces of (most) BB mud, middle unit contains occasional partial chevrons, it also contains some sidewall hal etc, upper unit has a more chaotic fabric with several dissolution features, traces of mud are present and mud content inc upward near top hal has (most) muddy anh.
			TRACE OF BLACK INSOL MUD MOSTLY WHITE ANH INTERBEDS HEAVY TUBE WELL PIPE		
2230			THIN, TINTED LAM ANH AT TOP OF ANH WITH MOULD VESTIGES IN ANH [illegible] DOL [illegible] CM REMARKABLY INSOL DOL ASSEMBLAGE [illegible] cm THICK IRREGULAR ENTERED BANDS ALMOST PURPLE FABRIC 60 % PORE FILLING ANH	25	Bl-Gy and anh with varying amounts of dolo mdstn matrix, mdstn inc slightly in size upward until 2232' where nods are suddenly small and mostly inc in size upward, dolo matrix then dec quickly and anh nods contain no lam remains massive texture, in upper 2' anh has not texture (the patches in Bl-Gy anh with hal beginning to appear, hal inc upward, yielding a chaotic fabric, sharp upper contact.
			MUDDY POROSITY-FILLING HAL [illegible] cm ZONE OF DR BR + PENDE DOL MOSTLY THIN ZONE OF PORE FORM MOLDS OF HAL ONLY FILL [illegible] DOL MOSTLY ALIGNED OF LOWER ABOUT ANH NODULES V FUSILE, LOADSTONE UPWARDS [illegible] MOTTLED [illegible] DOL [illegible] SEDIMENT ALIGNED LAYER V FUSILE	26	B, rpl lam to massive dolo mdstn with Bl-Gy, slightly flattened anh nods, nods are commonly rare in zones, minor hal cement to occasional (most) mdstn.
2250					

UPPER SAN ANDRES

MIDDLE SAN ANDRES

logged by JV, LE date 10/84

date

checked SH date 10/84

transcribed by CAG date 8/85

updated TG date 7/8[illegible]

updated date

WELL #1 Grabbe COUNTY Swisher DATE 9-84

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

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CYCLES	LITHOLOGIC DESCRIPTION
2250			dolomite interbeds	5	[illegible]
			fan intraclast grainstone		Dolo is shelly with anh filled moldic porosity and anh replacement of dolo, anh nodules present below sloping zone are large - [illegible] and random
			dolomitic breccia with anhydrite cement		Above sloping zone bedded and anh with abdnt inert dolo and tarbd dolo, from 2261-2258' dolo with scattered large anh nodules and persistent silt partings
			silt partings		Dolo micro with sloppy organic rich lam, tight with pores with anh filled moldic porosity, massive 0v-0 anh with dolo inclsds and sloppy lam within anh.
2260			silt partings		
				5	Mb siltstone, slope of dolo + anh, disrupted texture grading in tarbd anh + siltstone, flexible from 2270-2270', burrowing zone indicated as dolo fm
2270			anhydrite after secondary halite		dolo is lt B with Mb B lam, rpt and burrowed interv.
			rippled fabric modified by wispy laminae, anhydrite microstylolitization microdrapes		Anh filled skeletal hal molds in upper dolo section.
			packstone grainstone layer		Bl-Gy anh, mod, bedded, grading to massive anh at top.
			fossil claystone		
2280			bedded dolomitic anhydrite	5	Mb Gy anh with slope of siltstone, grades in Mb siltstone with anh nodes and stringers, dolo, lrr bedding to 2281'.
					Anh nodes with inert dolo and dolo inclsds, Mb Gy bedded nodes with Mb or lt B inert mottled; nodes grade in massive anh with indistinct bedding.
					Dolo beds have extensive anh replacement of siltstone
2290			anhydrite - impeded dolograinstone		
			dolomitic mudstone		
			22909 - 22910 missing		
			gradational anhydrite mudstone transition, compressed nodules	6	Mb, flexible anh matrix grading to dolo in basal 1', dolo matrix has hal + anh-filled moldic porosity similar to below, anh nodes with inert dolo, Mb Bl-Gy, becomes lighter upward with dev dolo, and dev in size and grade to bedded, massive anh.
2300			light brown dolomite		
			black anhydrite mudstone	5	Mb, flexible matrix with small anh nodes at base - burrowing dolo toward top, grading to dolo at 2311', rpt lam gnsts, anh-replaced siltstone in dolo, dolo grades into mod bedded anh - Bl Gy anh with inert lt B dolo
			anhydrite with disrupted texture		
			dolomitic anhydrite		
			laminated anhydrite + dolomite		
			truncated by anhydrite nodules pseudomorphs		2315.5-2311.5' Gy-B-Mbr anh, mot with rotter B bedding, grades vert to hal anh inclsds, stratmpts anh to hal, grades to B Gy bedded hal, burrowing dolo mod with inert dolo.
			dolomite bed		
			brecciated gradational contact		Dolo beds have hal + anh filled moldic porosity.
			dolomite packstone grainstone/packstone		
			subhedral nodules may be pseudomorphs after gypsum		2305-2300', bedded massive anh with dolo inclsds
2310					
				5	Gradation of dolo into siltstone, lor siltstone and dev dolo separation with anh remnant + beds, grades to dolo anh, massive bedded with dolo stringers, becomes mod at top with inert dolo.
2320			Gas detect water	4	lt B dolo, slopy to well lam, cross bedding and burrows at 2322-2319', [illegible] anh nodes at 2320, top 1' is interlam anh and dolo to lrr 1 in m lam, hal filled moldic porosity.
2330				6	Bl Gy bedded mod anh with inert lt B dolo, lrr mod siltstone
				6	lt B dolo gnsts, cross bedded + plane lam, hal filled moldic porosity, lrr throughout dolo, lam mod anh beds, silty rpt dolomitic at base.
2340				5	Stat lam to massive siltstone, Mb with slope of inert, grades to massive bedded anh, top 1' Mb siltstone with anh nodes, hal-filled pores
				6	Hal, cycle 5.
					Lor in siltstone vert, anh cement and cross nodes at base, dolo throughout, includ siltstone + clayson.

Lithology

2322.0 - 2323.2

2322 -

2323 -

- wispy clay stringers
- enterolithic ANH
- Fluid escape?
- interbedded ANH/DOL

logged by PG date 9.84

date

checked SB date 9.84

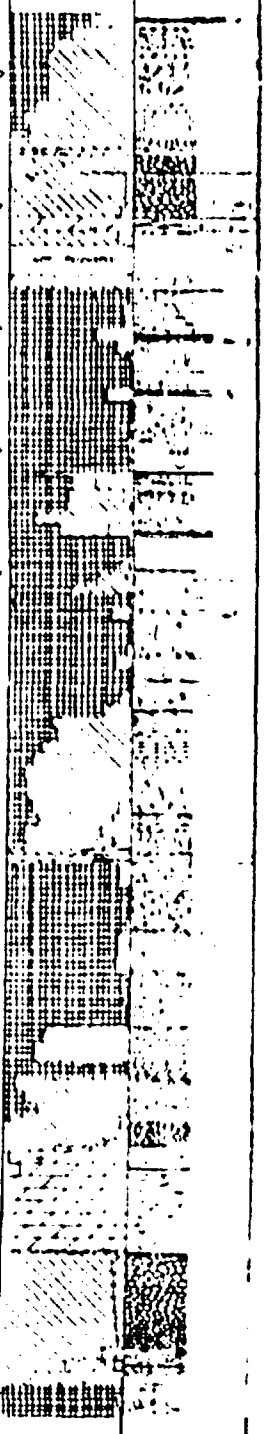
transcribed by CAC date 5.85

updated 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

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
			[illegible]

logged by ST date 5.83

checked SH date 5/83

transcribed by CAC date 5.85

updated TG date 7/93

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 8/85

INTERVAL 2460 - 2580 LOWER SAN ANDRES UNIT 5 - UNIT 8 LOGGED BY S. THOMAS

Depth	LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION
					Chevron hal in varying degrees of disintegration and recrystallization
					Hal B, cy, Dmg and Bl recrystallized ash with hal stringers and structureless reasonable carbonate texture.
					Bed ash with inset Bk clay and dolo grading upward to ash Bk and B sand ash with disseminated hal.
					Ash with large inset solids filled with hal
					Hal replacing gypsum; also gyp, pseudomorphs 1 mm (1/2 cm), grades to ordered mosaic ash in [illegible] grading back to gypsum texture, replaced with hal
					Finely lam ash and Bk clasts/nodules, horizontally oriented.
					Chevron hal, an oval oriented sta above where [illegible]
					Alternating B mosaic and disp hal beds capped by B/C B-type hal.
					Hal replacing gypsum; also gyp, grades upward to [illegible] (5 cm to small 1) hal pseudomorphs in abundant [illegible] ash/hal matrix
					B/B-type hal with large B8 mosaic inset hedles, sta added [illegible] rabbit to 7 cm, are less than 1 cm, capped by B-type hal, sta added, greater than 4 cm.
					Typical B-type hal, lat [illegible] and dark impure, grading to B/B hal, Bk and clasts hal Bk [illegible], other B mosaic inset dered from above through place.
					Predominant sequence of hal types, inset ash and mosaic in roughly equal proportions throughout, except top [illegible] capped by four mosaic layers, mostly inset appears highly dolo, rare sta at base.
					Typical B type hal, sta added to 1 cm
					Slightly banded bedded hal with zones of [illegible] a grayish tint restilled zones remnant of polygonal hal sta 1 cm to clay, inset and ash highly disseminated and [illegible] of growth.
					Generally typical rhombic mosaics with zones and patches of primary bedding, remnant sta hedle mosaic inset, sta up to 1 cm, inset and to highly disseminated and [illegible] hedles and stringers.
					Tufted ash with inset hal hedles and [illegible]
					Cy ash with hal pseudomorphs after gyp
					Few B-type hal with B-type top 1 cm, inset and less [illegible] sta added 1 1/2 cm.
					A and B type hal with high % of finely disseminated material, rhombic zones associated with mosaic inset.
					Predominantly B-type hal with zones and patches containing primary bedding features, sta added, range from [illegible] cm, finest sta top 1", capped by rel low inset
					Clastic B-type hal cut by thin organic partings, horizons for gypsum and dark impure, hedle B-type from 1 [illegible]
					Bedded hal cut by [illegible] resembling ash partings also other clastic [illegible], hal to [illegible]
					Bedded B-type hal with high % of finely disseminated inset Bk mosaic, capped by Bk dark, intermittently mosaic/clastic inset.
					Highly restilled zone with some primary bedding features in upper 1", hal inserted in B type interest hal are tal [illegible] and polygonal in shape, smallest sta in upper 1", are tal [illegible]

logged by S.T. date 8/85

date

checked SH date 8/85

transcribed by CAC date 5/85

updated PKo date 7/85

updated date

WELL #1 GRABBC COUNTY SWISHER DATE [illegible]

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

Depth	LITHOLOGY (%)	Structures	COMMENTS	Depth	LITHOLOGIC DESCRIPTION
[illegible]				[illegible]	Slightly bedded A type bed, becoming [illegible] upward, capped by an interval of typical A type bed associated with the adobe lenses, and is reduced at the lenses.
					Two successive bed units grading from [illegible] partially leached A type bed, the second [illegible] ra, each unit capped by dark adobe siltstone lenses [illegible] the upper % is reduced
					Cr ash, bottom B cm to massive, becomes bedded bed pseudomorphed and later leached.
					Lenses, leached bed capped by A type [illegible] sharply for upward shape lenses
					Cr ash with bedded bed paper drapes [illegible] 17 cm to lamed ash to bed
					Bedlined B and B type bed, grades to bedded bed with [illegible] oriented sta and preserved [illegible] bedded bed [illegible] from and to heavily leached.
					B type bed to varying degrees of disturbance, [illegible] lenses, [illegible] to ash upward.
					A and B type bed with well developed bedding, beds grade from [illegible] to [illegible], bed becomes [illegible] upward by [illegible] adobe lenses.
					Bedded bed becoming [illegible] upward, grading to A type bed
					Chaotic bed not be mud filled pipes, [illegible] and [illegible] upward.
					Typical B type bed, becoming [illegible] and not be [illegible]
					Phenomenal [illegible] drape like ash lenses [illegible] bed
					Bedlined B type bed grades to B type with [illegible] lenses bedded, greater than [illegible]
					Drag B bedded bed with [illegible] adobe lenses
					Bedlined leached/pulverized, [illegible] upward to chaotic bed, sharply capped by [illegible]
					Well bedded A and B type bed, ash lenses [illegible] organic debris [illegible] bed.
					Alternating units of B and B type bed, [illegible] with adobe lenses, and [illegible] upward
					Dark B type bed, [illegible] and [illegible] ash stringers
					Minor to mud filled B and B type bed, [illegible] of B, B, and B type bed associated with adobe lenses
					Generally a highly dark B type bed capped by a [illegible] drape, bed relatedness bed bedding [illegible] B type bed associated with adobe lenses.
					Chaotic outcrop cut by thick adobe lenses, adobe lenses [illegible] small dip to [illegible] bed bed underlies
					Bedded bed with ash lenses becoming [illegible] upward
					B type bed showing varying degrees of [illegible]
269[illegible]					

logged by [illegible] date [illegible]

date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL [illegible] - 2900 LOWER SAN ANDRES UNIT 4 UNIT 3 LOGGED BY [illegible]

Depth	LITHOLOGY (%)	Structures	COMMENTS	Depth	LITHOLOGIC DESCRIPTION
2600					
2700					
2710					
2720					
2730					
2740					
2750					
2760					
2770					
2780					
2790					

Logged by [illegible] date [illegible]

date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

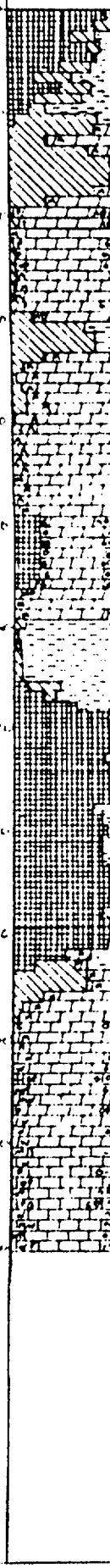
updated [illegible] date [illegible]

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE Nov 1981

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

UNIT 2

??	LITHOLOGY (%)	Structures	COMMENTS	EVENTS	LITHOLOGIC DESCRIPTION
2800					
2810					
2820					
2830					
2840					
2850					
2860					
2870					
2880					
2890					
2900					
2910					
2920					

LOWER SAN ANDRES - UNIT 3

LOWER SAN ANDRES - UNIT 2

logged by _____ date _____

_____ date _____

checked _____ date _____

transcribed by _____ date _____

updated _____ date _____

updated _____ date _____

WELL #1 GRABLE COUNTY SWISHER DATE 11/84

INTERVAL 2320 3040 LOWER SAN ANDRES - UNIT 2, LOGGED BY LE GLORIETA

Depth	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
2300					
2330			Diagonal open fracture Large gray fault cemented mudst	8	The 8 limestone white, fabric fine to coarse fine, small burrow. The white fossils are small and difficult to identify, with hollow elements. Fabric caused by differential cementation, this cementation appears to be controlled by burrowing in the same location.
			Red Chert and fracture Left of fault terrigenous matrix	7	The 8 clayey fine dolo mdst, a small burrow diameter fine, this matrix fracture into left.
			Fine fracture and cement Effective this cementation in replacement Clay alter change color of mineralogy change Clay irregular contact with fracture of terrigenous matrix	6 5	70 Cy 40 to Cy 60 fine carbonate mdst/gnsts, upper 1" [illegible] and pelecypods, source of calcite bal cement in replacement of [illegible] 2936.5'.
2340			Red Chert and fracture		80 Cy 80 crinoid mdst with dark intraclastic fabric, lower [illegible] gradational to unit below but is characterized by [illegible] unit upward, sub mdst, slate & disc and rest [illegible] fracture in a dolo matrix, top preserved at 2940' and [illegible] and deformed, red fibrous bal filled fract at 2940', [illegible] fracture, splits easily along subhor partings.
			Clay mdst, more intermed	4	80 crinoid mdst with dark intraclastic fabric, small [illegible] in disc crystallized sub intraclasts, large pseudo [illegible] area, 8 fibrous bal fract [illegible] appear to [illegible] happens, unit is pseudo cemented and splits easily along [illegible] fract elements of calcite cem along edges of sub fract are [illegible] filled cavities.
2350			Red Chert and fracture and calcite oriented Radiation zone		
				3	Uppermost bedded unit of Glorieta.
2360					
2370					
2380					
2390					
2400					
2410					
2420					
2430					
2440					
2450					
2460					

logged by LE date 11/84

date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL # 1 Grimes COUNTY Swisher DATE

INTERVAL 3040 3160 GLORIETA LOGGED BY

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
3040					
3060					
3080					
3100					
3120					
3140					
3160					

WELL #1 GRABBE COUNTY SWISHER DATE

INTERVAL 3160 - 3270 GLORIETA LOGGED BY

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

WELL CRAPPEL COUNTY SWISHER DATE

INTERVAL 3270 - 3550 GLORIETA, UPPER CLEAR FORK LOGGED BY

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION

logged by date

date

checked date

transcribed by date

updated date

updated date

WELL # 1 GROBBE COUNTY SWISHER DATE 2/85

INTERVAL 3380 - 3500 UPPER CLEAR FORK LOGGED BY PG

Depth	LITHOLOGY (%)	Structures	COMMENTS	Depth	LITHOLOGIC DESCRIPTION
3380			IRR. cement		Interclast dolo mbstn & hal with drop hal to dol, overlain by bedded hal and chaotic mudcrk.
	MISSING 3383-3395				
3390					
3400					9 large & fibrous hal filled frac running length of dolo and into mbstn at 3410.5', dolo to 0.5 with rpl lam and hal replacement of dolo. Interclast mbstn, dolo & hal mbstn lam, mound shaped mbstn with pores structural grp pseudomorphs. Chaotic mudcrk with rolled bedded textures, underlies 80 siltstone with fine sand lam and clasts breccia, lam to dolo with crumbs, field recipe and sandgp microbolling. Siltstone to sharply overlain.
3410			very hole 50 laminae structural disruption structures		
3420			fracture dism mbs conglomerate		
			fibrous red HAL fracture filling; conglomerate of core, clasts & lines of core,		
			cover laminated base of mudcrk possible disruption from conglomerate mbs	5	Chaotic mudcrk with rare sections of bedded hal, 80 mbstn lamina with dol & hal, mbstn mudc, bedc, 80 at top of unit, becomes dolo and has large frac filled with & fibrous hal
3430					
3440					
3450					
					Lt & rpl dolo mbstn, hal replacing dolo along bedding planes, lam pores or every few cms. Mbstn mud with dolo insert at 3456.5', lining dolo upward, and to more lam with dark texture, hal replacement. Hal defines large multiharell grp pseudomorphs. Top of mbstn is lam to rippled with overlying hal.
3460			Thin clay fracture HAL rep alternate of Dol.	6	Predominantly chaotic mudcrk with rolled hal, 80 mbstn, and in lamina with dark bedding, mbstn mudc, drop hal, some mbstn of & lam hal. Dolo bands are mud-rich - very altered mbstn dol. Occasional pits and pipes. 80 mbstn at top with rolled hal in rounded, elongate masses, mbstn mudc, dark and brecciated bedding, fissile - mottling clays. Grade from 80 to 40 % lam, fissile at top.
3470			PLACE HAL		
			vertical HAL mudcrk-cages, fissilation		
3480					
3490			Rust Brown HAL		
3500			3498.5 - 3500 MISSING		

logged by PG date 2/85

date

checked PG date 2/85

transcribed by CAP date 2/85

updated PG date 2/85

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 2/85

INTERVAL 3500 - 3620 UPPER CLEAR FORK LOGGED BY PG

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
3500	MISSING		3499.5 - 3503.5 MISSING		
	MISSING		3503.0 - 3509.6 MISSING		Interlam RB mdstn, hal, anh, thin steps lam with zones of brecciated [illegible]
					Hal is dominantly bedded with some recrystal and chaotic textures near mdstn beds.
3510			Residue HAL hoppers, ANH nod		Boxwork-like mdstn at 3510.5' to 8 Cg, mot with disp hal and stars in [illegible] clasts(?) anh, immediately overlain by a reversals alter hal, then by bedded B-type hal.
					RB mdstn with disp skeletal hal at 3507-3509'.
3520					
3530			trace MDSTN		
			interbedded HAL thin spicular beds and thick coarse xl beds		
3540				-5-	RB siltstn with clasts clasts, a few sand lam and pockets, lam to a dist with flame structures and fluid escape, top is Cg mdstn with slightly dist lam, doth by disp hal growth, hal-filled fract.
					Hal has frequent mdstn laths, some chaotic mdstn near laths, about [illegible] of bedded hal.
			TRACE ANH as nodules		
3550			highly contorted bedding, possible collapse, ANH as nodules & CLAST/NODULES, very lamination possible dissolution DOOR RECOVERY	-5-	Lt B dolo mdstn & gmstn, spic, algal-bone are mottles, 3551.5 to 3552.5' is mold gmstn with hal-filled lam, fenestral fabric, about 3557.5' to [illegible] lam dolo mdstn & gmstn with skeletal hal hoppers and anh laths, hal is sharply overlain by chaotic mudstn, hal is dominantly a stitial and chaotic within some of over aligned at bedded B type hal.
3560					Mdstn are RB with anh and a hal hoppers, anh and to hal at 3563' have gleam stringers at contact with hal.
			ANH & HAL		
	MISSING		3566.2 - 3569.9 MISSING		
3570			ANH & HAL		
			3 mdst intervals		
3580			oold grainstone with skeletal fabric	-5-	Thick brecciated mot steps lam RB mdstn with disp hal in 3580.5', overlain by bedded hal, then chaotic mudstn.
					Mdstn laths typically overlain by 2-3' of B type hal, then 1-2' of chaotic mudstn.
3590					
3600					
			trace ANH		
3610			vertical contorted MDSTN/ANH stringers	-5-	Anh sharply overlies mdstn, lam with poorly preserved grainst texture and selenite xls in hal. gleam fine fers texture, RB mdstn with large hal cubes overlies anh - textd chaotic mudstn and mdstn.
			trace RB MDSTN		Hal is bedded with some anh above 3610', recrystal hal with mdstn & anh from 3613' to top.
3620			3613.0 - 3613.5 MISSING		

UPPER CLEAR FORK

logged by PG date 2/85

date

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transcribed by CAC date 2/85

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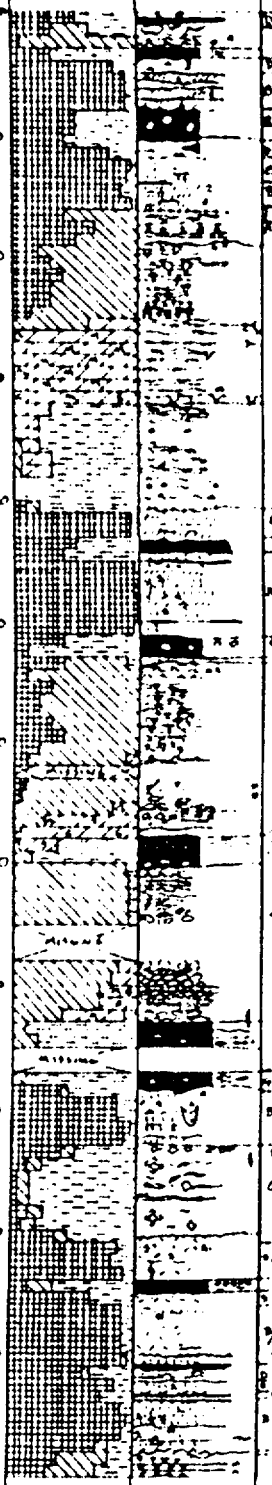
updated date

WELL #1 GRABBE COUNTY SWISHER DATE 1/85

INTERVAL 3620-3740 UPPER CLEAR FORK LOGGED BY PG

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
3620					
3630					
3640			INTERBEDDED ANH, HAL DOLOMITE PARTING		
3650					
3660					
3670					
3680					
3690					
3700					
3710			RED SINUOUS HAL FILLED FRAC		
3720					
3730					
3740					

Lithologic description (excerpts):

Perceptibly long, well developed calcite [illegible] with sharp flat bedding, Cy mbsta contacts sharply with DB mbsta, massive to brecciated, dark tan, 6 to above 3630', textured and soft, [illegible] Cy above 3630' with Cy and DB mst, grade to clayey dolo.

Dolo is rpl tan with burrows, dark bedding, lt B mbsta and mbsta with hal filled molds after gypsum, Cy mst to B dolo, skeletal hal [illegible] contact with anh.

Anh is tan at base with well developed gyp pseudomorphs preserved in hal, [illegible] single sla as large as 9x7 cm, tan zone through some sla, [illegible] to dark with mst anh, hal interlam.

Anh lathes with hal at 3637' to 3638'.

Hal is DB banded with the vert elongated sla, black and [illegible] chevrons.

Mbsta bed at 3639', has large hal hoppers, drop hal capped by banded hal at series of thin mbsta beds.

DB mbsta bed at 3676.5' sharply overlies hal.

DB mbsta with drop hal, massive, sharply overlain by banded hal with muddy intervals at 3668' and 3665'.

DB mbsta lacked at 3663.5' grades to Mb Cy dlst sub intervals, [illegible] drop hal

Banded hal, vert oriented sla, thin mbsta [illegible] sub carrying, grades to anh at top.

Cy mbsta with anh mud, friable, grades to DB mbsta [illegible] with anh mud, sharply overlain by rpl dolo gmsta with isolated hal [illegible] lathes with mud anh.

Red anh becomes poorly bedded with dark tan hal after gyp pseudomorphs poorly preserved - little or no primary textures preserved

Above 3687' - well-preserved tan anh with prominent gyp texture, grades to tan anh with large gyp pseudomorphs cutting across lam, pseudomorphs preserved in hal.

Top 1' is tan anh with small gyp pseudomorphs.

Muddy and hal rich at top.

Lt DB mbsta with sloppy anh, breccia, tan clasts, interlam anh, Mb Cy at top of mbsta.

Dolo overlies mbsta, gradational contact(?), dolo grades to red anh with fnrl dolo and dolo lathes, mode poorly defined above 3698.5'

Dark anh dolo between 3694-3693', tan anh with dolo defining lam in top of mst.

DB mbsta with Cy reduced areas, sloppy, dist bedding, rip up clasts, brecciated small anh mud, large skeletal hal hoppers, Cy Mb tan mbsta at top with [illegible] filled with hal, overlain by rhomb mudcrk, long section of B type bedding hal with remnants of mbsta pods, massive hal, thin mbsta lathes.

Lt DB mbsta with sloppy tan breccia, skeletal hal overlying anh has well preserved gyp pseudomorphs and prominent texture.

Anh grades to hal with thin mbsta bed at 3730', hal is dominantly B type bedded hal with rehed vert aligned sla with mbsta lam and fnrl, and rich B type remns within B.

B-type hal with relict B below mbsta at 3725', mbsta overlain by muddy bedded hal and rhomb mudcrk.

logged by PG date 1/85

date

checked PG date 1/85

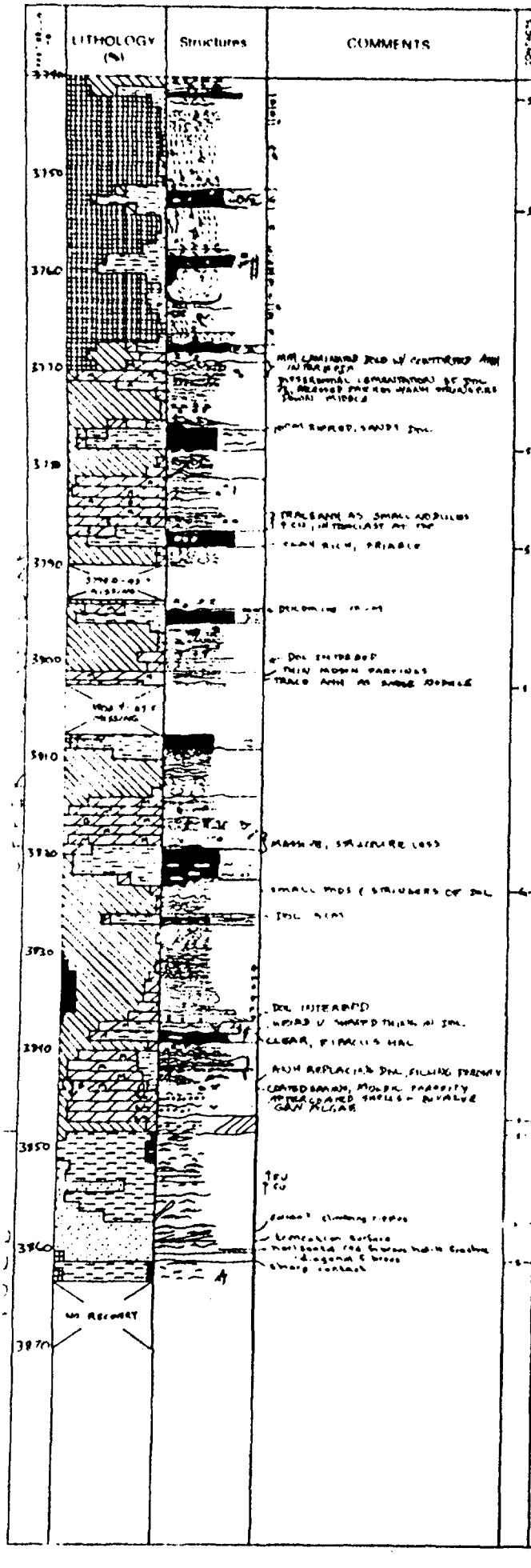
transcribed by CAC date 2/85

updated PG date 1/85

updated date

WELL #1 GRABBY COUNTY SWISHER DATE 1/85

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



LITHOLOGIC DESCRIPTION

[illegible]

Lamination Surface

Horizontal red brown hard to fissile diagonal cross

Sharp contact

Laminated Dol.

Gray laminated Anh.

Mixed rippled and disturbed laminated siltstone and sandstone.

PB ripple and cross-laminated and grained sandstone.

See next sheet.

logged by PG, BL date 12/24/84

date

checked SH date 1/85

transcribed by CAL date 2/85

updated PG date 7/85

updated date

WELL # GROBBE COUNTY SWISHER DATE 12/84

INTERVAL 3870 - 3990 TUBB LOGGED BY B. LUNEAU

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
3870					
3880			mud cracks / halite casts on [illegible] sequence with clay drapes molds of hoppers		Mixed dark and tpl lam DD siltstone.
3890			small, isolated euhedral halite truncation surface mudcrack		
3900					
3910			tabular divergent banding		
	core not recovered				
3920			dolomite rims displacive halite	5	Zones of transitional B to G type halite lacked with dark lam and interclastic siltstone.
3930				6	
			breccia molds of halite rafts		Tpl lam DD siltstone mixed with dark and interclastic [illegible] dark squared, containing pockets of halite and a zone of [illegible]
3940					
3950			"Pockets" of HALITE		
3960				5	Dark and interclastic siltstone lacked with B type halite
3970			nice hopper and molds of hoppers	5	
3980					Halite, primarily bedded B type with some F at base, associated with molds of halite, lacked with lam siltstone and anh.
3990					

logged by BL date 12/84

checked SH date 12/84

transcribed by CAC date 2/85

updated DC date

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE [illegible]

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

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
3980					Massive Cy anh.
			grainstone with abundant fenestra		Tlw B dolo grstn, bioturbated and spl lam, fenestral porosity at top filled with hal cement
4000					Lt Tlw-B to Cy dark dolo mdstn with anh nods and B hal veins
			core does not match up		Pale Gn with BB ant, finely lam siltstn, contains some [illegible] clay [illegible] mpligaly features and liesegang banding, dark at top with [illegible]
4010					
4020			Liesegang banding		
	No RECOVERY				
4030			intraclasts of clay drapes		Lt BB lam siltstn with clay drapes, texture is dark and contains intraclasts of clay drapes.
4040					Dy intraclastic and dark mdstn at the base, grades upward to lam dolomitic grstn overlain by mdstn -- a massive Tn anh [illegible] bedded hal lined with mdstn and anh with resulting texture at top
			Base of small cycle		
4050					Hal - B stained with B, P and O in lower portion and stained with [illegible] half, lined with dark and spl lam siltstn, B hal [illegible] lathes.
4060			abundant anhydrite nodules extensively replaced by halite		
4070					
4080			intraclastic		
			very finely laminated clean salt		Pale Gn to Tlw-B siltstn, dark, intraclastic texture at base, grades upward to finely lam pale Gn and BB ant siltstn.
			clay drapes		
4090			halomorphated salt		
4100					Hal lined with lam siltstn, hal remnants of B [illegible] and B [illegible] hal, P and B-type hal are associated with the bases of lathes, lathes have dark texture at base and are spl lam at top, also contain detrital hal [illegible] and hoppers.
4110			large displacive selenite hedgehogs 1/2 in diam bedded 3/inches at top		
4120					

Logged by [illegible] date [illegible]

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checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL [illegible] LOWER CLEAR FORK LOGGED BY [illegible]

Depth	LITHOLOGY (%)	Structures	COMMENTS	Samples	LITHOLOGIC DESCRIPTION
[illegible]					[illegible]
[illegible]			red and green mudstone with interclasts of mudstone, [illegible] HAL		[illegible]
[illegible]			[illegible] CALCITE CEMENT		[illegible]
[illegible]			[illegible]		[illegible]
[illegible]			[illegible]		[illegible]
[illegible]			[illegible]		[illegible]
[illegible]			[illegible]		[illegible]
[illegible]			[illegible] HAL [illegible]		[illegible]
[illegible]			AHH filled pipe.		
[illegible] TD			[illegible]		

logged by [illegible] date [illegible]

date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

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

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

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
CORE NOT RECOVERED			Light red brown fine ss, poorly sorted, well rounded grains
			Red brown ss overlain by light gray fine ss poorly sorted [illegible] rounded grains
CORE NOT RECOVERED			Red brown fine ss, slightly [illegible] poorly sorted [illegible] rounded grains [illegible] 1 inch diameter chert clast
			5 Calcareous, light red brown siltstone, [illegible] red clay rich and red [illegible] stringers surrounding clast.
			6 Light to medium red brown siltstone, horizontal [illegible] red clay rich stringers. Mildly calcareous because more [illegible] contains calcareous fragments [illegible]
NOT RECOVERED			Pale reddish black to dark yellowish orange silty mudstone moderately horizontal (5 or modified) small [illegible] than [illegible] calcareous [illegible] in 5 near horizon, mud [illegible] horizon pale olive color
			15 Blocky fracture, [illegible] or clasts in horizon
			Carbonate cement
			4
			Pale reddish brown fine siltstone [illegible] positive horizontal stratification [illegible] white
			Carbonate cement
NOT RECOVERED			
			Alternating cross bedded coarse siltstone & horizontally laminated mudstone [illegible] lenses. Top 5 reduced
			Moderate yellowish black massive to well cross bedded, [illegible] fine to very fine ss, calcite cementation poor to moderate. Hematite staining often defines bedding surfaces & cross bedding
			Carbonate cement
			Scattered small 1 x 1 cm calcareous nodules
			Climbing ripples
			Sequences of rounded glauconite clasts (up to [illegible]) overlain by fine ss. Clasts imbricated, scattered large (1.5 x 2 cm) calcareous [illegible] Bottom 1.0 reduced
NOT RECOVERED			35' of reduced sandy mudstone or calcareous nodules up to 1 x 1 cm

Logged by [illegible] date [illegible]

[illegible] date

checked [illegible] date [illegible]

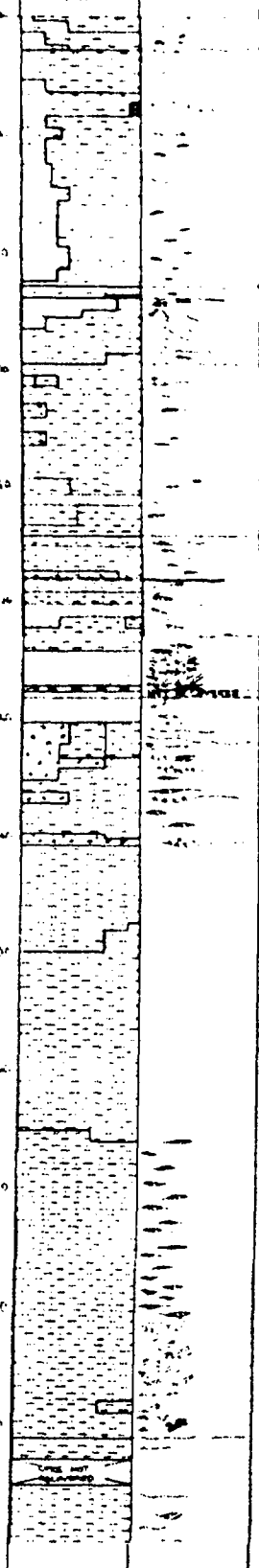
transcribed by [illegible] date [illegible]

updated [illegible] date

updated [illegible] date

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

INTERVAL [illegible] DOCKUM LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
		[illegible]	Reduced cycle of brown surfaces, st & siltstn w. well developed [illegible] cycle grades upwards to gray red mdstn w. siltstones.
		[illegible]	Micaceous gray red siltstn w. scattered 2 x 2 cm rol [illegible] grading up section to gray red mdstn
		[illegible]	Gray red mdstn full of lense shaped siltstn laminations. [illegible] tions
		Reduced. [illegible] carbonate cement. Reduced.	Ripple laminated coarse sandy siltstn & silty [illegible] carbonate cement. Beds dip steeply from [illegible] and helms these footages. Thin [illegible] mdstn seams.
		[illegible] carbonate cement. [illegible] sandstone. [illegible] sandstone. [illegible] carbonate cement. [illegible] sandstone.	Gray red mdstn w. very fine st. siltstn interbeds marked by scattered [illegible] grading upwards back to mdstn. Scattered siltstn laminations [illegible] ripple laminations. Lower half is very micaceous but contains silt throughout.
		[illegible]	Alternating units of [illegible] mdstn, siltstn & st, and [illegible] st & st. Few angle siltstn [illegible] mdstn. Carbonate cement throughout. SS very well cemented. Siltstn/claystn poorly cemented. Colors gray red & light olive gray not unique to any [illegible]
		[illegible]	Black ripple laminated siltstn.
		[illegible]	Pale green to red brown fine grained [illegible] laminations. Grades upwards to overlying unit [illegible] grains.
		[illegible]	Pale green coarse sand to granule size [illegible] siltstn matrix [illegible] silt bedding planes marked by lignite. Organic debris.
		[illegible]	Stacked [illegible] cycle of pale green basal [illegible] size congl. grain supported w. siltstn matrix [illegible] pale green ripple laminated siltstn. [illegible] contain lignite grade organic fragments.
		[illegible]	Red brown mdstn which grades upwards to very fine siltstn [illegible] reduction spots & green mottling. Also contain scattered [illegible] size grains throughout, some are calcareous. Texture is [illegible] contains dendritic stringers of dark brown clay or mud.
		2 [illegible] height up to 2 cm	Red brown & pale green ripple laminated micaceous siltstn, ripple set [illegible] 2 cm, fines upward to overlying mdstn. A & B type ripples.
		[illegible]	Red brown cross stratified coarse grained siltstn w. [illegible] rip up clast basal lags. Stratification sets up to 5 cm thick.
		[illegible]	Red brown & pale green rippled & burrowed siltstn w. contorted bedding which grades upward to mdstn.
		[illegible]	Red brown & pale green mdstn to very fine siltstn w. few horizontal silty laminae. Grain size changes are gradational. Internal structure is not well preserved.

logged by [illegible] date [illegible]

[illegible] date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated [illegible] date [illegible]

WELL [illegible]

INTERVAL [illegible] 120 DOCKUM

COUNTY Deaf Smith

DATE [illegible]

LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
[illegible]	[illegible]	[illegible]	Red brown & pale green white to very fine siltstone w/ few horizontal [illegible] laminae. Grain size changes are gradational. Internal structure is not well preserved.
[illegible]	[illegible]	[illegible]	Pale green stacked sequences of a basal caliche grained sand w/ [illegible] fragments (10-40cm thick) overlain by cross laminated & ripple laminated siltstone (15-30cm thick). The basal contact of sand beds is a scour surface & the contact is sharp to gradational.
[illegible]	[illegible]	[illegible]	Pale green & red brown white contains cross laminated silt laminae [illegible]
[illegible]	[illegible]	[illegible]	Red brown ripple laminated siltstone, calcareous, [illegible]
[illegible]	[illegible]	[illegible]	Red brown medium ss w/ a mud rich matrix, granule size at the base [illegible] grains well rounded, poorly sorted.
[illegible]	[illegible]	[illegible]	Red brown w/ a caliche grain conglomerate below interbed, no apparent structure in unslabbed core.
[illegible]	[illegible]	[illegible]	Mixed pale green & red brown white w/ rounded & subangular grains of [illegible] & minor sand. Grains are matrix supported. Caliche granule [illegible]
[illegible]	[illegible]	[illegible]	Gray green ripple laminated fine ss, calcite cement, abundant [illegible] & [illegible] organic material mixed w/ sand. Low relief ripple sets at base, [illegible] to much larger at top (about 2 feet). Changes upward to red brown ripple laminated siltstone w/ calcite cement, lower to be evenly laminated in angle w/ ripples increasing at top. Surrounding & abundant soft sediment deformation w/ some brecciation & faulting grading into gray green ripple laminated siltstone sharply overlain by black low angle ripple laminated white.
[illegible]	[illegible]	[illegible]	White cross bedded caliche pebble conglomerate about 3 thick grading rapidly [illegible] soft sediment deformation grading to brown red ripple laminated [illegible] white w/ possible burrows.
[illegible]	[illegible]	[illegible]	Two fining upward sequences, lower set is gray green cross bedded [illegible] medium ss, large scale [illegible] grading rapidly into finely laminated ripple laminated fine ss which grades to finely laminated [illegible] fine [illegible] (old ripples) w/ small climbing ripple sets [illegible] thick grading to finely laminated silty white. Top set is gray green ripple laminated siltstone grading to ripple laminated white.
[illegible]	[illegible]	[illegible]	Gray green ripple laminated fine ss w/ [illegible] in thin clay bed.
[illegible]	[illegible]	[illegible]	Gray green poorly sorted fine ss w/ clay clasts at base, structures [illegible] possible large cross beds.
[illegible]	[illegible]	[illegible]	[illegible] caliche pebble conglomerate about 3 thick [illegible] poorly sorted subangular-subrounded ss w/ silt containing [illegible] about 1.5 [illegible] thick. This is overlain by a parallel laminated [illegible] section a clay drape is truncated by a ripple laminated fine ss [illegible] ripple fine ss w/ soft sediment deformation. Overlain by [illegible] fine ss matrix.
[illegible]	[illegible]	[illegible]	Gray green to red brown to brown sequences of white granular conglomerate [illegible] to 12cm thick grading to ripple laminated silty white to parallel laminated silty white from 1-4 feet. [illegible] to 4 feet thick, calcite cement, soft sediment deformation.
[illegible]	[illegible]	[illegible]	Gray green ripple laminated fine sand grading to gray orange pink ripple [illegible] sandy siltstone grading to brown white grading to gray orange pink [illegible] sorted medium ss w/ clay clasts & calcite cement grading to gray green ripple laminated parallel laminated fine ss w/ abundant mica & organics in ripples which grades to gray orange pink ripple laminated sandy siltstone.
[illegible]	[illegible]	[illegible]	Brown white w/ trace of silt.
[illegible]	[illegible]	[illegible]	Gray green apparently medium fine ss, moderate sorting subround to round grains w/ white intraclasts at base, interbedded organic and or opaque minerals. Soft sediment deformation just below unconformed interval, [illegible] bedded ripple laminations & parallel lamination sequences. Abundant mica flakes.
[illegible]	[illegible]	[illegible]	Gray green cross bedded grain supported pebble conglomerate, abundant calcite cement, larger pebbles flattened. 10% siltstone fragments, medium ss & silt matrix, subround to round grains.
[illegible]	[illegible]	[illegible]	Gray green cross-bedded medium ss grading upward to pebble conglomerate grading to fine ss w/ calcite cement. 80% silt pebbles.
[illegible]	[illegible]	[illegible]	Gray green matrix supported pebble conglomerate grading upward to medium ss, occasionally medium grading to fine ss, mica very abundant, calcareous cement & fine organic or opaque minerals common.
[illegible]	[illegible]	[illegible]	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.

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WELL

COUNTY

DATE

INTERVAL

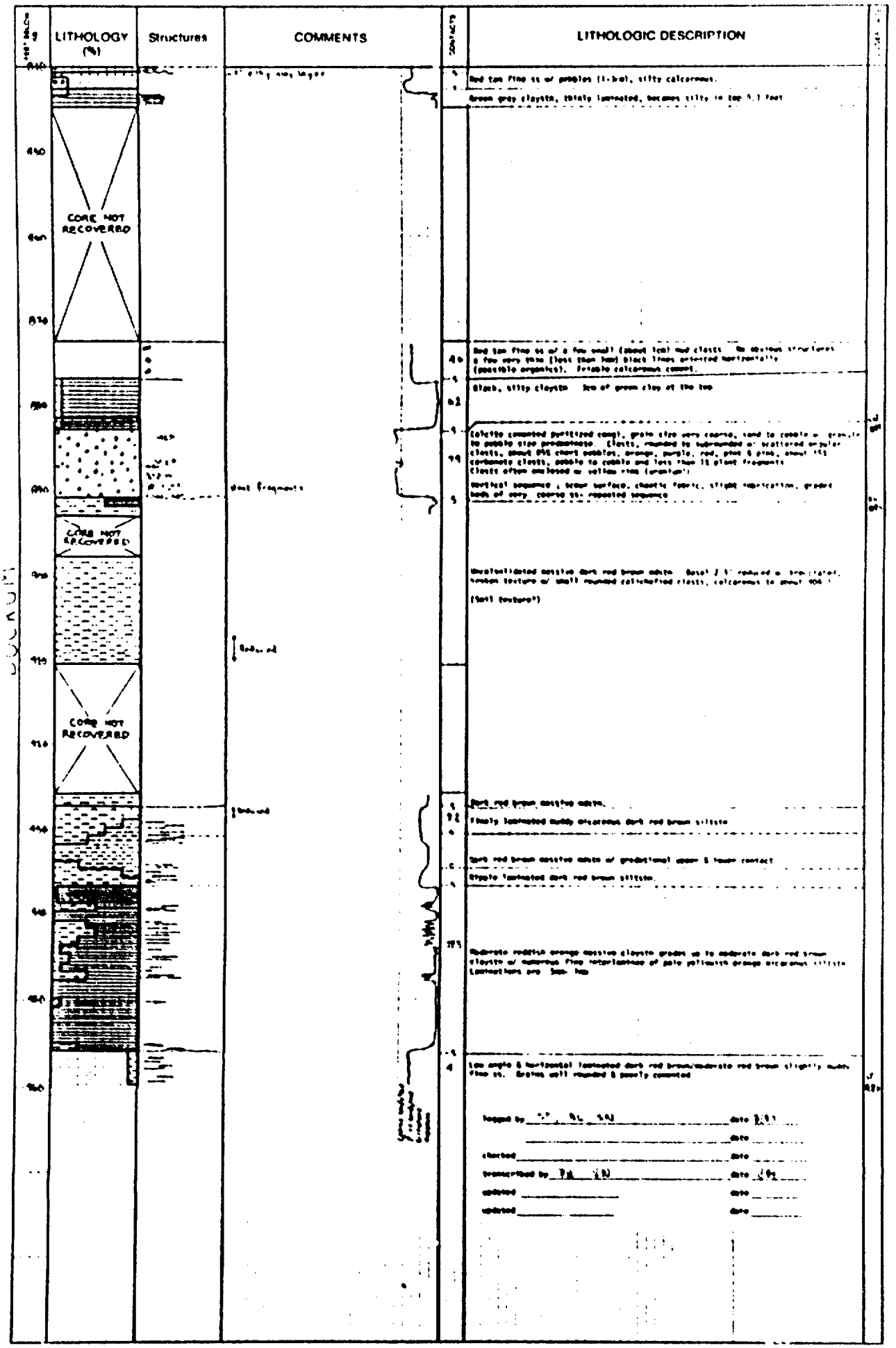
DOGRAM

LOGGED BY

	LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION

WELL J. Friemel COUNTY Deaf Smith DATE August 1985

INTERVAL 840-960 DOCKUM LOGGED BY [illegible]



WELL J Friemel COUNTY Deaf Smith DATE August 1983

INTERVAL 960 - 1080 DOCKUM, DEWEY LAKE LOGGED BY [illegible]

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
960					See Previous Page
			[illegible] climbing ripple sets		
970			[illegible] angle cross strat fracture	15	Laminated, silty, moderate red brown/dark red brown very fine ss. Laminations well defined by thin black organic layers on bedding surfaces & by color variations w/in the sand. Coarser sand stained yellow
					Laminations; ripple sets, planar/horizontal & low angle cross stratification
					Grains well rounded & sorted, poor to moderate cementation
				2	Interlaminated yellowish ss & gray black claystn.
980	CORE NOT RECOVERED				
				78	Massive siliceous, very fine ss. Grains well rounded. Bottom foot reduced grading to non-reduced (reddish) sediments. Carbonate cement.
990					
					Dark red brown mdstn.
					Cross bedded carbonate cemented ss. Grains rounded, well sorted. Degree of cementation decreases up section capped by 7' dark red brown mdst.
1000			[illegible]	4	Poorly consolidated muddy fine ss, grains well rounded & sorted. Patchy carbonate cement found to hematite stained areas otherwise grains supported in mud rich matrix. Scattered reduced zones.
					Pale green medium ss, poorly sorted, mud rich matrix.
					Purple laminated claystn.
					Pale green & red brown ss grading to purplish siltstn, laminated
1010	CORE NOT RECOVERED				
1020			[illegible]		Dark red brown sandy siltstn containing clay clasts, laminated at top
					Light red brown laminated ss, medium grained, poorly sorted which fines upward
			[illegible]		Red brown laminated mdstn
1030					Red brown, cross laminated, poorly sorted medium grain ss
					Red brown laminated mdstn
				42	Red brown cross laminated, poorly sorted medium grained ss grading to ripple laminated siltstn.
					Red brown mdstn, poorly bioturbed, possibly laminated
1040					
				112	Red brown & pale green medium grained ss, poorly sorted, low angle cross laminated
			[illegible]		
1050					
			[illegible]		Red brown poorly sorted sand w/ a mud rich matrix which fines upward to mud rich silt sharply overlain by fine grained well sorted ss.
			[illegible]		
1060					
				31	
1070			[illegible] of coarse sand [illegible]		Red brown ss that fines upward from coarse ss to siltstn, strict not also fine upward. Base contains coarse sand grains scattered in a fine sand matrix becomes cross laminated upward w/ thin, single grain laminae of well rounded coarse sand at the base of cross sets. Ripple laminations upward in silty portions
				4	
1080				84	Red brown mdstn w/ no apparent structures becomes silty upward

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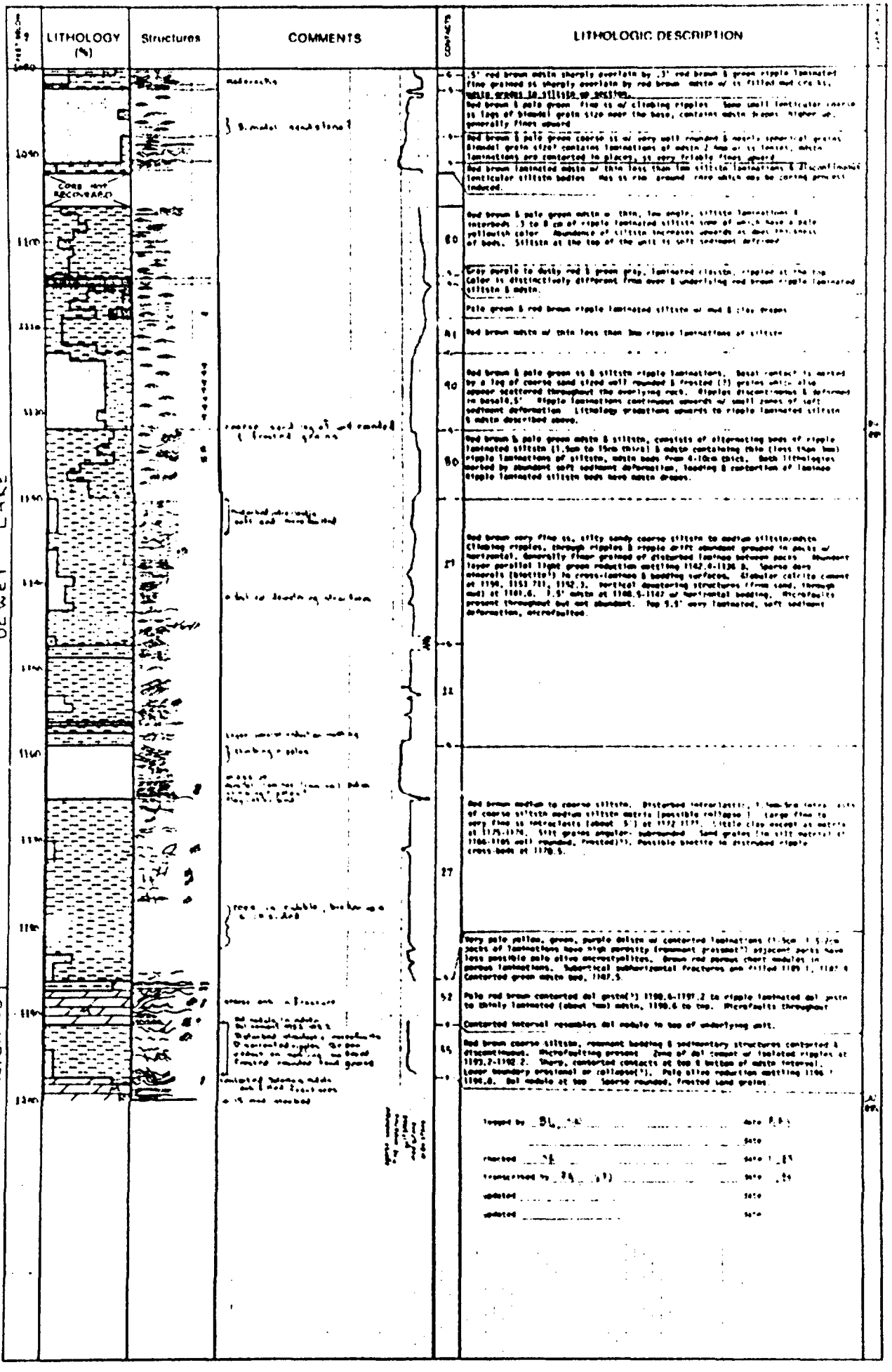
WELL J Friemel COUNTY [illegible] DATE [illegible]

INTERVAL 1080 - 1200 DEWEY LAKE, ALIBATES LOGGED BY [illegible]



WELL [illegible] Friemel COUNTY Dea[illegible] Smith DATE [illegible]

INTERVAL 1200' - 1317' ALIBATES, SALADO TANSILL, YATES LOGGED BY [illegible]

Depth	LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION
ALIBATES					Pale red brown to gray yellow green ripple laminated hal ostra w/ thin mud drapes at 1200.0 -1200.4. mud interbed at 1200. Red hue decreases up from interbed. Top is contorted, collapse of mud interbed into ostra. Discontinuous parallel fractures (ooh ? filled) in hal. Subvertical to collapsed ostra. Upper 1' pale gray red purple.
					White dolomitic ostra to intraclastic ostra. Mud cracks? at 1296.8 1296.4 & 1296.0 separated by contorted & microfaulted intraclastic ostra. Porosity well developed in intraclasts. Gray olive microstylolites & abundant discontinuous well developed along microstylolites, could be truncated intraclasts. Primary textures obscured by diagenetic alteration.
1210					
1220	CORE NOT RECOVERED				
1230					
1240					Moderately dark reddish brown ostra w/ numerous fractures infilled w/ gyp, small gyp blebs & discontinuous contorted gyp laminations, sand sized mineral gyp crystals scattered evenly throughout ostra. 1' ostra (1242') shows evidence of brittle deformation
					Light medium reddish brown siltstone w/ numerous fractures infilled w/ gyp & small gyp nodules; 1' ostra interbed at 1251.5. Lower 1' has disturbed intraclastic fabric w/ contorted laminations.
1250	CORE NOT RECOVERED				
1260					Light medium red bedded ash w/ gyp fractures parallel to bedding & gyp nodules throughout.
					Light dark reddish brown ostra w/ gyp infilled horizontal fractures & bedded nodular ostra ash interbeds, disturbed intraclastic fabric & disrupted gyp laminations at 1271-1272, sand & silt size mineral gyp crystals scattered through ostra at top & bottom of unit; hal cement. Ostra/gyp/ash insoluble residue.
1270					Light bluish gray bedded ash w/ parallel wavy laminations, gyp nodules scattered throughout. Subvertical vertical gyp at base
1280					Medium dark reddish brown siltstone w/ disturbed intraclastic fabric. Fabric is accentuated by zones of preferential hal crust from 1290 & 1291.5, zones from 1288.5-1286.0 is composed of very fine siltstone transitional to ostra & is fractured, low porosity
					Medium dark reddish brown very fine ss w/ wavy laminations, wavy vertical upper contact w/ unit above; hal cement
1290					Medium dark reddish brown very fine ss w/ disturbed intraclastic fabric, fabric is accentuated by zones of preferential hal cementation
					Light dark reddish brown siltstone w/ ostra interbeds; wavy laminations & disturbed intraclastic fabric are common in siltstone, ostras have disturbed intraclastic fabric & numerous hairline fractures, reduction zones & iron banding are common, hal crust
YATES 1300					
1310					Light medium reddish brown siltstone w/ vague wispy lens shaped peds of darker siltstone; vague wavy laminations, hal crust
1320					

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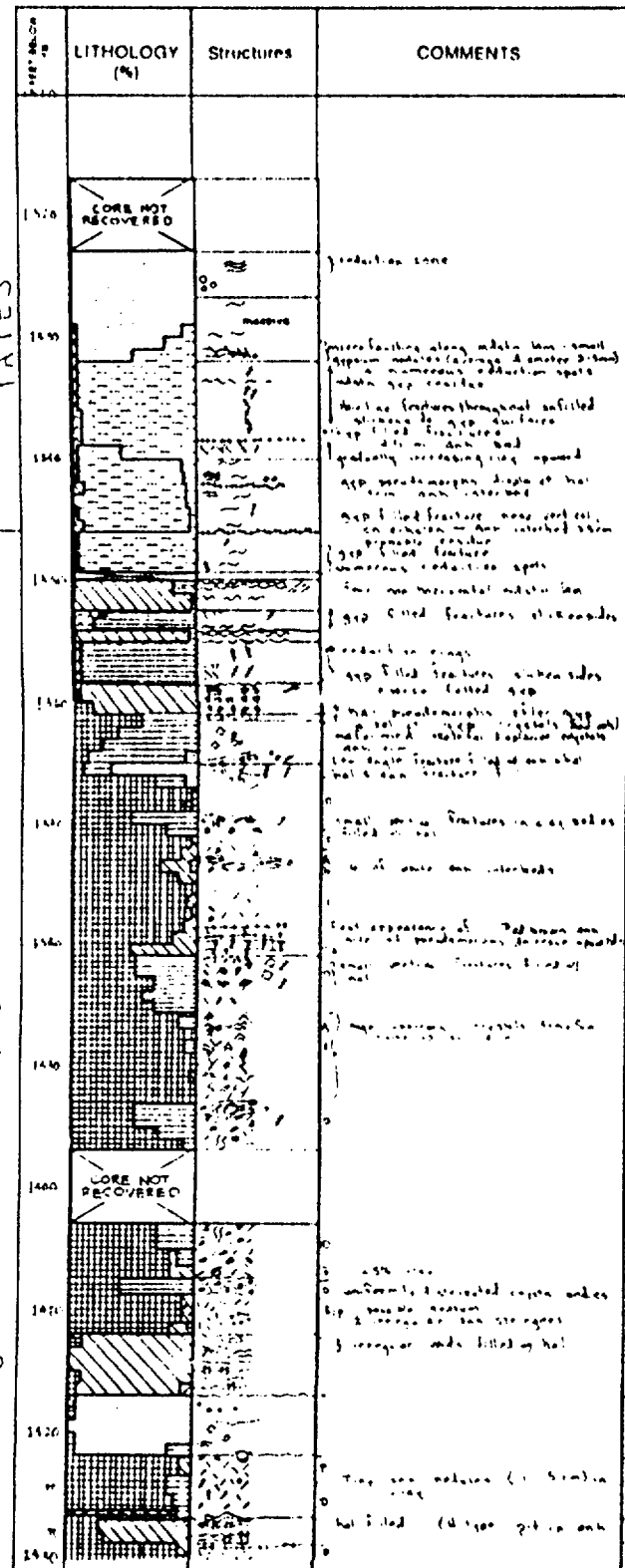
WELL J. Trammel COUNTY Deaf Smith DATE August [illegible]

INTERVAL 1317'-1430' YATES, UPPER SEVEN RIVERS LOGGED BY [illegible]



LITHOLOGIC DESCRIPTION

Light dark reddish brown wavy laminated very fine ss/mdst, isolated lens-shaped pods of mdstn & slumpfaulting along mdstn 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 [illegible]

Dark reddish brown mdstn w/ disturbed intraclastic fabric, gradual increasing clay content to top of unit, core is highly fractured, bottom 6 crumbly w/ slickensides, fractures filled w/ gyp, hal crust

Light dark reddish brown siltstn w/ wavy to contorted lamination, thin wispy lens shaped pods of dark reddish brown mdstn & disturbed intra clast fabric, [illegible] infilling small fractures, one anh interbed, hal crust, gradual well upper contact into mdstn

Light dark mottled reddish brown mdstn w/ disturbed intraclastic fabric, [illegible] gyp infilling fractures, poorly cemented & crumbly, nodular & nonnodular

Light medium bluish gray bedded anh w/ 2-20% claystn present as wavy to contorted laminae; collapsed & disturbed intraclastic fabric at 1340'

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/ slickensides, 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 20% hal, claystn content greatest at top & bottom of bed, clayste intraclasts (2-4mm) in sandy matrix at base of unit; 10cm of recrystallized hal at 1361'

Red brown claystn/hal, minor anh in nodular brecciated & ripple laminated fabric present in some claystn clasts

Colorless, cloudy, recrystallized anh/hal rock (1 lower 4.5' [illegible] 5 anh interbeds) grading to pinkish recrystallized anh/hal rock (upper 1.5'). Except for interbed anh tends to occur as thin subhorizontal, radially undulating surfaces & as irregular bodies w/ thin hal, giving cloudy appearance & becoming pink-ish in upper [illegible]. Chevrons & hal pseudo/gyp abundant in lower 1.5'; small (1-2.5cm) hal crystals have jig saw like appearance becoming clear & larger towards top; hal 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. (2-15% interstitial clay at top & 1386'. 55 interstitial anh at 1390'. Lesser amount of interstitial anh & mdst throughout. Probable not cavity fill (no well defined walls or floors). Hal crystal size increases upward (2-4mm)

Red brown chaotic mdstn-hal rock (D, 40% hal) small claystn bodies uniformly distributed.

Red brown recrystallized anh hal rock (1 lower 2.5' is chaotic mdstn hal rock (D) upper 10.5'). 15-40% interstitial clay. Generally hal crystal size, claystn interstitial bodies, size & clay abundance increase upward. Type F hal irregular anh bodies w/ offshoot stringers defining grain boundaries within surrounding hal matrix

Red brown muddy hal (about 40% hal, D type). Interstitial clay about uniformly distributed in small bodies (1mm-1cm)

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 [illegible] 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 the thin silt & clay layer coarsening up section at base.

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

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WELL J. Friemel COUNTY Lea & Smith DATE Nov 83

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

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
			Cavity filling pure hal grading up to recrystallized anh hal
			Reddish brown chaotic anhy-hal. Top 30cm fine (4mm) anhy clasts, hal within fine anhy w/ displacive hoppers. Lower 22cm coarse (2.5cm) hal-anhy
		anh blades replace anh matrix	Mostly anhydritic hal w/ about 25 anh within crystals. Anh is in large interstitial bodies (1.5-4cm) between hal crystals & is being replaced by gray large crystals of gyp (1-3cm) long.
		white fibrous hal filled fracture	
		pink & white wavy laminated anh bed 1.7 thick, potential gypsum hal filled fractures, diagonal in plan view at 1.5cm	Reddish brown chaotic anhy-hal. Hal & clay content increases up section fine anh interbeds. Rudstone at top 1 inch is composite of mostly parted anhy masses functions as cement
			Clear coarse crystalline anhydritic hal (1 4cm) w/ several [illegible] recrystallized reddish muddy hal. H typ hal fills pits. Chevrons are abundant at the base of the unit.
		1/4	
		1/4	
		1% anh [illegible]	Reddish brown chaotic anhy hal. Somewhat coarse recrystallized [illegible] & within crystals. Contains few displacive hal [illegible] fissile in [illegible] masses
		Anhydrite & fractured fill hal	Reddish brown chaotic anhy-hal, white & gray anh occurs in the form as the angular & rounded bodies (2 4cm) or clay which are within & between crystals
			Reddish brown mostly massive hal cement fine & very fine [illegible] evidence of cross laminae in a few zones. Contains a homogenous distribution of greenish gray reduction spots (1-15cm in diameter) covering 1% of the rock
		12 ANH	
		12 ANH	
			Reddish brown massive to disturbed intraclastic, white & [illegible] gray reduction spots (1-15cm in diameter) Clear fibrous hal fills vertical fractures occur throughout the unit.
		2% ANH	
		many hall laminae, probable insoluble residue	Reddish brown chaotic anhy hal & anhydritic hal [illegible] as laminae & fine nodules [illegible] throughout the unit
		ANH [illegible] laminae. 4%ep 2% mud	Reddish brown, brown and dark gray recrystallized hal. Alternating between anhy white hal & muddy hal rock. Faint dark banding occurs near the top of the unit along w/ some vertically oriented crystals

Logged by [illegible] date [illegible]

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UPPER SEVEN RIVERS

QUEEN GRAYBURG

SAN ANDRES

1450 1500 1550 1600 1650 1700 1750 1800

WELL [illegible] COUNTY Deaf Smith DATE [illegible]

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

Depth	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
1840			1% anh		Brown & yellowish brown calm banded hal w/ vertically oriented crystals & [illegible] by numerous recrystallized pits. [illegible] of chevron hal occurs at [illegible]. A pale orange hal filled fracture notes up about 50% of a white siltstone interbed near the base of the unit.
1900			Fracture filled w/ E type hal		
			1% anh pmm No hal dissolution		Reddish brown massive to contorted mdstn contains several tiny anh nodules (less than 5cm), numerous irregular reduction zones and isolated bodies of D & E type hal
			Dipping anh beds		Mostly chaotic mdstn/anh hal rock. Lower 3' shows bedded hal cross cut by a [illegible] pit
1910			1-2mm anh nodules		Yellowish brown siltstn w/ disturbed interlaminated fabric & zones of large displacive hal hoppers (1-3 cm). E-hal type filled fracture 10 cm long & 1 cm wide in the center
1920			Dipping 45° 2% anh		Dark reddish brown & brown chaotic mdstn/hal w/ some muddy & anhydritic hal rock. Small anh nodules (2-5cm) occur with mud near 1919'. Pinkish clear chevron hal is found near 1930'. Several muddy interbeds occur throughout this unit from 2to [illegible] interbeds contain either or both vertical orange hal filled fractures & displacive hal hoppers
			mdstn filled fractures/joint structure		
			1% anh		
1930			black, crazed		
			5% mud		Dark reddish brown & brown chaotic mdstn, hal w/ some muddy & anhydritic hal rock. Small anh nodules (2-5cm) occur w/ in mud near 1919'. Several muddy interbeds occur throughout the unit from 2 to 7 cm thick & contain varying amounts of anh and hal filled vertical fractures.
1940			1% anh		Dark reddish brown highly contorted to massive very tiny (1-2cm) anh nodules (2-7cm) & a few very tiny hal hoppers (2cm). Pass [illegible] desiccation structures in lower half
			1% hal numerous tiny [illegible] pseudomorphs [illegible] hal		Mostly dark brown muddy hal, chaotic mdstn hal & anh hal w/ numerous muddy interbeds 1-15cm thick. Interbeds contain either or both vertical orange hal filled fractures & displacive hal hoppers, mud content generally increases up section. A few small anh nodules (1-5cm) are found near 1966 ft
			3% anh		
1950			2% anh reduced gad nodules		
			hal filled fracture 2cm x 2cm		
1960			2% anh		
			1cm mud [illegible] mottles		
			CORE NOT RECOVERED		
1970			5% mud [illegible] clay stringers		Reddish brown siltstn coarsening up section to very fine [illegible] & an 11 cm long, 3cm wide, vertical hal filled fracture [illegible]
			1% anh		Dark brown recrystallized anhydritic hal
					Dark reddish brown & yellowish brown mdstn [illegible] & a few small gray anh nodules
1980			1% anh		
			Gilpin hal mdstn interbed		
			orange E hal filled fracture		
1990			5% anh		Brown muddy & anh coarsely crystalline hal w/ numerous mdstn interbeds which commonly contain orange fibrous hal in vertical fractures and or displacive hoppers.
			abundant orange hal filled polygonal fractures - 5cm long irregular fractures 2 cm		Brown & slightly reddish brown muddy & anh hal. Mostly recrystallized zones, bending, vertical crystals & chevrons. A deep pit (local scour) at the base of the unit.
2000			1% anh		
			Thin fracture in interbed		
			55 cm deep pit orange hal		Reddish orange & light brown chevron hal associated w/ E type hal
					White felted anh & hal. Bottom 15cm becomes reddish gray & brown [illegible] hal pseudomorphs after gyp (1-3cm long at the base)
2010			2% anh [illegible] interbed		

UPPER SAN ANDRES

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WELL J Freemal COUNTY [illegible] Smith DATE [illegible]

INTERVAL 1810 2130 UPPER SAN ANDRES LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
		[illegible]	[illegible]

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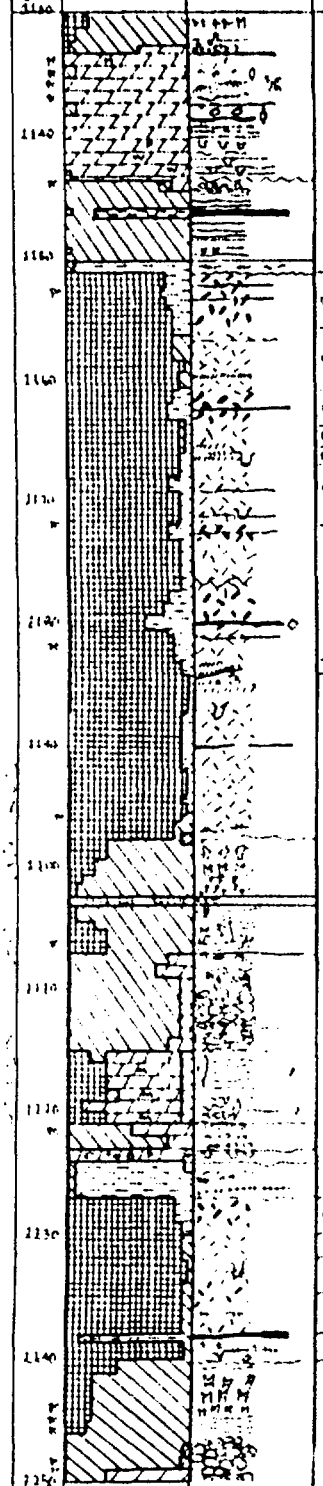
INTERVAL [illegible] UPPER SAN ANDRES LOGGED BY [illegible]



LITHOLOGIC DESCRIPTION

Gray thinly bedded anh w/ tiny hal pseudomorphs after gyp. Bottom 6" highly contorted dol & anh nodules (.1-1cm) & laminations.

Blue light olive gray & grayish yellow white horizontally laminated hal cemented dolostn. Contains isolated zones of fracture filling hal & anh & anh nodules (.2-2 5cm). Some black algal laminations, bioturbation & crinoids. Top 1.5' becomes highly fractured. Fractures randomly vertical orientation 5-1cm long.

Gray bedded anh contains numerous reddish brown laminae. Top 1' becomes nodular in a dol matrix.

Black dark gray & reddish brown mdstn w/ moderately contorted anh stringers.

Chaotic mdstn hal, reddish brown mud bodies .2-2 5cm

Mostly dark gray to brown recrystallized anh hal but sharp color change to moderate orange pink from 2157.6-2159.5'

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) is crossed at by a 1cm deep pit at 2165'.

Very muddy recrystallized hal. Mud grades up section reddish brown to dark gray.

Recrystallized hal w/ dark gray mud between crystals & reddish mud in crystals.

Recrystallized hal w/ large pieces of reddish mud (1-5cm) between & in crystals. Mud becomes grayer at the top.

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.

Recrystallized hal grading up section from dark brown to light yellow. Top 1' contains traces of hematitic mud.

Felted anh in hal matrix; trace mdstn at top.

Numerous large (1-4cm) anh & hal pseudomorphs after gyp cutting 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 contains contain crystallotopic anh.

Nodular anh (.1-4cm) w/ mostly dol matrix. Nodules at base have yellow green or reddish centers.

Reddish blue to gray laminated dol mdstn w/ long vertical fractures filled w/ orange fibrous hal. Tiny anh nodules (less than .5cm) throughout but more in top portion. Bottom half is well bioturbated, top silty.

Gray anh nodules become supported in dol matrix. 10cm

Dol mdstn (tan) & pstn (gray) burrowed.

Dark gray anhydritic mdstn, disrupted intraclastic texture.

Dark muddy recrystallized hal w/ angular mud bodies (2-4cm).

Mostly recrystallized hal w/ some relict bedding of mud & anh.

Dark banded hal w/ numerous fractures 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.

Hal sparse chevron, discontinuous anh partings, anh cavity fill?

Horizontal laminated anh grading up to interlaminated hal & anh (contorted) grading up to large scale herringbone hal & anh after gyp pseudomorphs.

Med gray nodular to nodular mosaic anh w/ intranodular dol matrix. Dol proportion decreases up section.

Yellow brown ripple laminated pstn/mdstn, abundant anh nodules.

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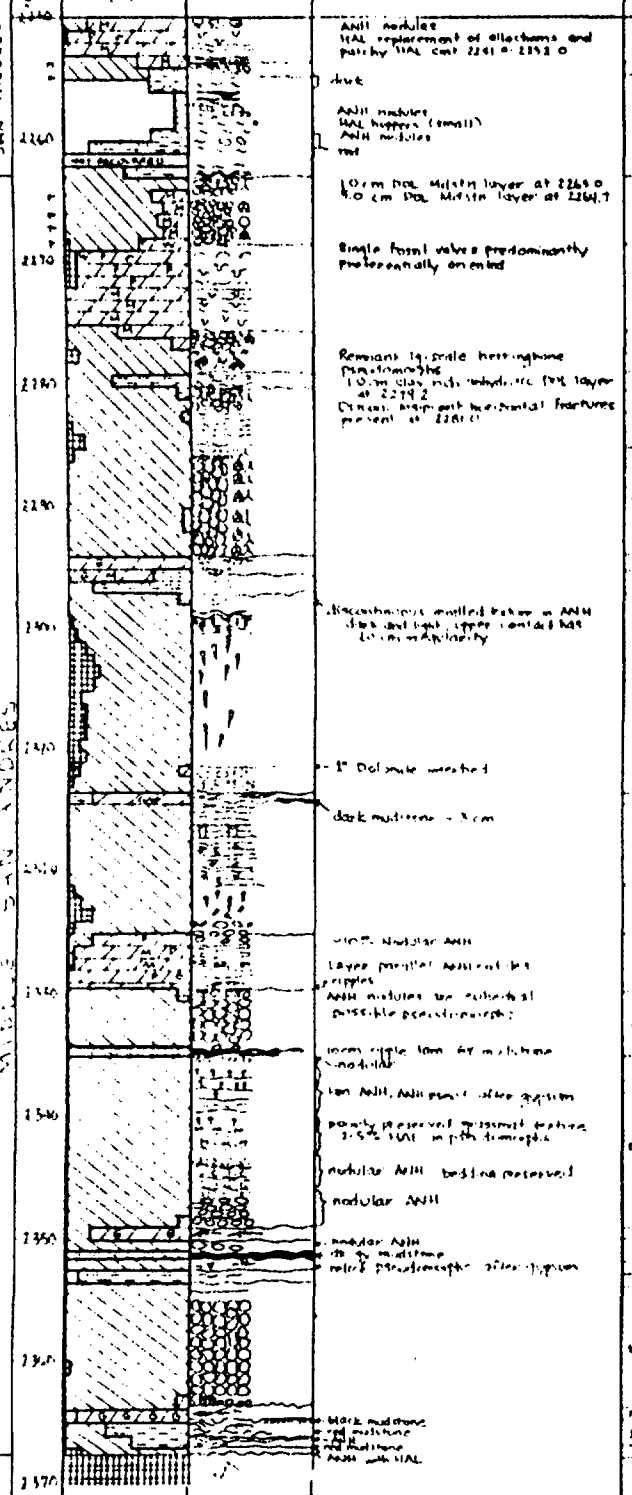
WELL [illegible] COUNTY Deaf Smith DATE August [illegible]

INTERVAL [illegible] UPPER SAN ANDRES, MIDDLE SAN ANDRES, LOWER SAN ANDRES-UNIT 5 LOGGED BY [illegible]



Contacts	LITHOLOGIC DESCRIPTION
55	Yellow white gray dol mstn & pstn. Burrowing present throughout in certain concentrations
5	Medium gray bedded anh, nodular mosaic anh in upper portion
85	Highly disturbed mstn/siltstn interbeds grading to fil cemented very fine [illegible] mstn interbeds also highly disturbed. Mstn interbeds less than [illegible] cm thick. Mostly gray medium gray at top, intraclastic
5	
57	Medium gray nodular, nodular mosaic & mosaic anh w/ intermodular dol mstn
5	
90	Wispy laminated olive gray dol mstn w/ abundant compressed horizontal burrows 1.0cm x 0.5cm. Patchy hal cement, controlled by location of burrows. Fracture up section to pstn.
5	Nodular mosaic anh w/ intermodular dol
6	Anh & hal pseudomorphs after gyp, remnant large scale herringbones.
5	Highly disturbed and dark gray anhydritic mstn
0	Medium gray mosaic anh.
5	Minor dol & hal define layering in anh. Layering horizons disturbed & truncated
6	by nodular growth in upper portion
85	Mosaic & nodular mosaic anh w/ dol mstn present in intermodular areas
5	Dol mstn underlying dol mstn composed of unidentifiable sil[illegible] 1cm in diameter. Anh filled vertical burrow present at 2[illegible] 2 - 0.2cm anh nodules present.
10	Dark gray mstn dolomitic at the top strongly disturbed & [illegible] at base
5	
5	Gray massive anh w/ irregular voids filled w/ hal & gray thinly laminated anh. Somewhat nodular in lower 2 feet
5	Light to dark yellow brown interbedded gsnst & mstn, ripple laminated [illegible]
5	olive gray mstn at base
8	Light brown, gray black thinly laminated anh (about 1cm thick). Laminae defined by subparallel horizontal layers of colored anh. Abundant nodule preserved small anh pseudomorphs after gyp
6	Gray massive anh w/ irregular vertical cavities (up to 2 cm) filled w/ hal, could be pseudomorphs after gyp
5	Light brown hal cemented thinly laminated dol mstn w/ isolated layer possible anh nodules.
51	Gray nodular mosaic anh, top 10cm & basal 25cm dol matrix
5	Gray anh, nodular w/ dol laminae at base, nodular fabric grades toward laminated fabrics w/ pseudomorphs after gyp at top
145	
5	Yellow brown thinly bedded dol w/ ripples, anh nodules at top
5	Interbedded dark gray anhydritic mstn & nodular to bedded anh. Anh is stained red at contacts.
10	Gray crudely bedded anh
5	Red brown mstn disturbed intraclastic texture
5	
60	Yellow gray, white nodular mosaic anh. Less than 5% NaCl. Nodules in the finer less than 1 cm anh nodules in dol matrix 25 cm at base
5	Yellow gray ripple cross laminated dol bedded mstn, laminations up to 1cm thick
5	Dol mstn at top.
5	Moderate brown mstn w/ chaotic texture, anh interbeds, soft sediment deformation
5	& ripple cross laminated. Dark mstn top 15cm slightly dolomitic
5	Light gray felted anh in hal matrix, hal masses, relict pseudomorphs after gyp

Logged by [illegible] date [illegible]

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WELL J. Eremel COUNTY Deaf Smith DATE

INTERVAL 2310 - 2490 LOWER SAN ANDRES - UNIT 5 LOGGED BY

INTERVAL	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
2340				41	Extremely coarse (8cm +) euhedral cavity fill. Fluid inclusion rich
				5	
				19	
				4	Bedded/banded hal cut by large pipe, cavity crystals 1 x 1 cm
				17	Bedded (B type) hal 30% recrystallized to recrystallized muddy hal (type F)
				9	Grades to 100% type F at 2279.1. Crystals subhedral polygons 1 x 1 cm. Grades up section to mudstone w/ increasing mud
				5	Typical chaotic mudstone, crystals generally coarse (up to 2 cm), euhedral
				5	to subhedral w/ large interstitial bodies of mudstone
2360					
				19	Nodular/nodular mosaic anh w/ patchy interstitial hal. Grades up section to grassseed texture w/ hal replacing gypsum pseudomorphs first as semi herringbone patterns then as well formed blocks & laminarsts. Pseudomorphs up to 1/2cm, average 7 mm. Pseudomorphs display growth bands, minor mdstn at top, pseudomorphs preserved but most becomes anhydral mixture. Interbed comprised of claystn & siltstn. Ripple lamin
2380					
				1	Coarse euhedral cavity fill, less than 1% disseminated mdstn, crystals sub
				1	Recrystallized anhydritic hal w/ fairly irregular hal bodies, hal has reddish hue
				1	Typical chaotic mudstone.
				15	Bedded hal grades up section to recrystallized (about 40%) muddy hal w/ some remnant primary bedding grading up section to 100% recrystallized hal
				5	Typical chaotic mudstone (crystals anhedral/subhedral to 2 cm) interbedded w/ hal in
2410				4	interbeds. Recrystallized muddy hal w/ some vertically oriented crystals, minor disseminated mdstn laminations.
				4	Bedded hal w/ mostly very dark impurities outlining crystal growth, some slight banding.
				51	Recrystallized muddy hal; crystals from 1-10cm subhedral/anhedral polygonal in form. Mdstn finely disseminated throughout. Some vertically oriented crystals in top 2 feet
				5	
				1	
2430				5	Bedded hal w/ scattered zones of chevron concentration becoming increasingly disturbed & recrystallized from 2320 ft. Pipes & pits common throughout
				4	Fatty, crinkly anh bodies in a matrix of clear type I hal (some small clear then lamel hal replaced gyp pseudomorphs
				6	
				40	Recrystallized hal becoming increasingly muddy up section. Basal foot contains chevrons & some vertically oriented crystals, & minor interstitial mud
				5	Massive bedded anh w/ lenses of highly disseminated hal replacement material
2450				19	hal top 5'
				6	Typical chaotic mudstone.
				5	Chevron hal cut by numerous pipes filled w/ red brown mdstn, becomes increasingly recrystallized up section.
				5	
				17	Bedded hal w/ interstitial dark reddish brown up section to black mdstn as numerous partings and interstitial material outlining vertical crystals.
				4	Recrystallized hal; crystals anhedral/subhedral reddish brown mdstn with
				4	in crystals and as interstitial bodies.
				1	Extremely coarse euhedral pure cavity fill (type A) Crystals 5 cm, fully
				1	muddy (type B hal.
				50	Bedded/banded hal w/ some beds containing chevrons. Dark bands defined by mud, anh, and organic impurities; bands become reddish top foot
				1	Recrystallized anhydritic hal & cavity fill w/ irregular anh bodies. Bottom
				1	.5' increasing mud up section. Grades to bedded hal
				41	Chevron hal in varying degrees of recrystallization. (B going to F) pipes, pits and thin anh partings common.
				5	Recrystallized muddy hal (black reduced? mdstn), crystals subhedral up section
				5	(subhedral cubes to 1 x 1 cm.
2470				65	Recrystallized muddy hal (reddish brown mdstn) w/ rheobic zones near interbeds at 2456-2457 mdstn laminated interbed cuts core at angle to horizontal (see split whole core description 2456.5-2456.9), crystals anhedral & coarse.
				5	
				10	White chevron hal cut by numerous pipes & pits, large pipe in upper half partially filled w/ red mdstn. Interbeds general broken irregular zones. Anh heavily outlines vertical crystal growth throughout.
				5	Recrystallized muddy hal w/ the interstitial mud in varying degrees of anhydritization (type C going F). Some vertically oriented crystals top foot.
2490				94	Crystals generally anhedral/subhedral typically .5cm-1.5cm, the larger ones in bottom 2/3 of the unit
				5	Contorted anh w/ interstitial hal finely disseminated throughout, also present in lenses & irregular bodies. Grades to tilted grassseed texture, hal after gyp
				16	pseudomorphs contorted ripple laminated siltstn at 2484.0. Fatty anh w/ hal skeletal growth top 1'
				1	Extremely coarse hal cavity fill (up to 8 x 4 cm) w/ contorted anhydritic interbeds,
				1	large fluid inclusions.
				5	Recrystallized anhydrite hal (crystals subhedral-anhedral) grades to banded banded
				5	hal, yellowish impurities in bottom foot.
				6	Recrystallized anhydritic hal w/ irregularly shaped interstitial anh bodies. Crystals sub-anhedral, some possibly vertical orientation
				15	Medium gray nodular mosaic & mosaic anh, dol mdstn w/ occasional hal cement present intermodularly.

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

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WELL J. Fremel COUNTY Deaf Smith DATE [illegible]

INTERVAL 2410 2610 LOWER SAN ANDRES - UNIT 5 UNIT 4 LOGGED BY [illegible]

Depth (Feet)	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
2410					See Previous page
				5	
				5	Light olive gray to yellow white gray burrowed (?) mstn/wstn
				5	Medium gray nodular mosaic anh w/ dol as intermodular material
2420				5	
				5 4	Yellow/white gray limpy hal w/ patchy hal cement, comprised of burrows [illegible] fragments hal replaced
				5	
				5 5	Light gray to medium light gray nodular mosaic anh w/ dolomitic terrigenous claystn present as intermodular material
				5	
2430				5 0	Olive gray dolomitic terrigenous claystn, laminated. Very fine sandstone [illegible] disturbed intraclastic at base
				5	
					Bedded, massive anh w/ minor terrigenous clay defining bedding
				5	
				6	Grassmat hal after gyp pseudomorphs w/ nanodomorphs up to [illegible]
2440					Medium gray mosaic anh w/ dol present on some sides of the nodules
				5	
				5	Grayish olive to yellow white gray dol mstn overlain by mstn [illegible] underlain by dark gray anhydritic mstn
				5	
					Medium gray to medium dark gray anh w/ yellow gray crypto laminations composed of dol
2450					
2460					
2470					
				7	
				4	Gray black anhydritic claystn. Contorted intraclastic texture
2480				7 7	Banded B type hal w/ well developed interstitial disseminated bands of mstn & minor anh; vertically oriented crystals are 1 to 1 cm high. Bedding is transected by pipes & pits. The unit contains an interbed unit less than 1') of D type hal.
				4	
					Anhedral hal w/ interstitial bodies of mstn 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.
2490					
				6	Banded B type hal w/ vertically oriented crystals about 1cm [illegible]
				5 5	large pipe filled w/ hal & irregular bodies of red brown mstn
				5	
				4	Mixed C & F type hal w/ pipes at the base protruding into underlying A
				7	Type A hal w/ chevron fluid inclusions & vertically oriented crystals 2 cm [illegible]
2500				4	Predominately F type hal of anhedral crystals w/ discontinuous, irregular anh
				7 2	laminations mixed w/ vertically oriented crystals w/ chevrons at the base & also
				4	mixed w/ C type hal throughout.
					Clear coarse crystal mosaic of H type hal w/ minor interstitial anh & a [illegible]
				4	contration of anh at the base
				5 7	Type O hal, chaotic mudsalt w/ interstitial bodies of contorted & discrystal laminated illitic & mstn. The unit contains in lesser patches of banded B type hal
2510				4	
				8 1	Bedded & banded B type hal w/ vertically oriented crystals & bedding marked by disseminated bands of anh & mstn. At 2610 5 there is a planar cross about 4 deep filled w/ gray mstn. 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.
				5	
				4	Bedded A type hal w/ chevron fluid inclusions & anh stringers & pipes
					See Next page
2520					
2530					
2540					
2550					
2560					
2570					
2580					
2590					
2600					
2610					

LOWER SAN ANDRES - UNIT 5

LOWER SAN ANDRES - UNIT 4

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

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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 [illegible] that has horizontal bedding. At 2609 it contains an interbed of D type hal & at the [illegible] center it is mixed w/ some crystals containing chevrons
				Red brown & pale green siltstn w/ mdstn drapes ripple laminated & 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 some pink salt
				D type hal, chaotic mudsalt, anhedral hal w/ interstitial bodies of red mdstn containing anh nodules.
				Banded B type hal going to F type, crystals anhedral. Bands [illegible] w/ vertically oriented crystals, contains interbeds
				Red brown mdstn disrupted & contorted textures w/ orange fibrous hal filled fractures.
			88	Anhedral hal w/ interstitial mdstn bodies; D type, chaotic mudsalt w 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 [illegible] of mdstn & anh, laminations are discontinuous & fluid inclusions are few. These zones occur predominately bordering interbeds. Many mdstn beds are rippled
			5	
			9	Anhedral hal w/ interstitial laminations of anh, little internal structure
				Banded B type hal w/ pits & pipes filling w/ clear hal, banded hal has vertically oriented crystals & disseminated interstitial material
			19	
				Chaotic mudsalt, D type hal, anhedral crystals w/ interstitial bodies of mdstn.
			23	Banded, B type hal w/ vertically oriented crystals & dark disseminated mdstn throughout
			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
				Bedded & banded B type hal, at the base 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
			40	
			40	Orange/yellow hal, interbedded B & F hal types, [illegible] thick, w anh partings & drapes. Stringers of anh completely surround vertically oriented crystals, chevron fluid inclusions are poorly preserved
				Bedded B type hal w/ vertically oriented crystals, disseminated anh bands & pipes transecting bedding. Contains a one foot interbed of A type hal w/ chevron fluid inclusions & small zones of recrystallized hal
			60	
			40	Bedded hal w/ well developed chevrons fluid inclusions pipes cutting bedding & anh drapes & partings.
			5	
				Predominately bedded B type hal w/ local zones of recrystallized anhed. hal w/ interstitial anh & mdstn
			55	
			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	
			40	Milky white bedded A type hal w/ abundant & well developed chevron fluid inclusions. Crystals are vertically oriented, bedding [illegible] thick marked by anh drapes. Bedding transected by few pipes.
			5	
			40	Anhedral hal w/ angular & irregular shaped interstitial bodies of red brown mdstn in D type hal, contains irregular & undulate mdstn interbeds cut around by orange fibrous hal filled fractures
			5	
			50	Bedded & banded B type hal w/ vertically oriented crystal, some heavyweed A type hal near top, chevrons poorly developed. Bands, transected by pipes of recrystallized hal, contains drapes & partings of anhydritic mdstn
			5	
			10	D type hal anhedral w/ interstitial bodies of dark red brown mdstn w/ disturbed silt laminae-chaotic or disorganized texture
			5	
			155	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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updated date

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

INTERVAL [illegible] LOWER SAN ANDRES - UNIT 4 UNIT 3 LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION
		[illegible]	46	Medium gray nodular mosaic anh & interlaminated anh & dol
			5	Oolite-fossil fragment grnst w/ oolites well sorted, ranging locally from [illegible] size of 0.04mm to 0.6mm. Abundant anh & hal replacement of allochems. Mollusk fragments are up to 1.0cm in length
		[illegible]	44	
			5	Mollusk fragments mdstn/wkstn, light olive gray in color
			49	Oncolites at 2754.2-.5 Intraclasts ? 2750-51
			5	
			60	Medium dark gray nodular mosaic & mosaic anh w/ dol mdstn present in intermodular material.
		[illegible]	5	
			36	Yellow gray oolite grstn w/ anh nodules & brachiopod fossil fragments. Oolites are 0.2mm.
		[illegible]	5	
			44	Yellowish gray to grayish olive mdstn grading up section to wkstn. Patchiness of color variation suggests patchy hal cement.
			5	
			32	Light olive gray to grayish olive burrowed wkstn. Burrows contain lower concentration of fossils, (Brachs/bivalves).
		[illegible]	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 pavilioid algae (?) pkstn-grstn grading up section to a foram-mollusk grstn w/ mdstn interbeds. Possible encrusting algae or bryozoans variably present.
			6	
			50	Light olive gray mdstn w/ occasional organic wisps, compressed horizontal burrows. Patchy color variations define hal and calcite cement variations. Brachiopods abundant
			6	
			41	Light olive gray bryozoan mollusk fossil fragment packstn, hal cement [illegible] lighter patches. Grading to wkstn then mdstn
			5	
			81	Light olive gray bryozoan-mollusk packstn grading upward to finely dol mdstn [illegible] wisps present. Burrows slightly compressed. Wisps laminae present in [illegible] concentrations, up to highly concentrated. Brachiopod shells abundant
			6	
			40	Light olive gray to yellow white gray dol mdstn grading to packstn w/ [illegible] 0.1cm burrows. Allochems are mollusk fragments and unidentifiable [illegible]
			5	
			110	Medium gray anh w/ intermodular yellow gray dol mdstn
			8	Yellowish gray sparsely wispy laminated bedded mdstn. Bedded nodular anh present, small nodules.
			70	
			5	
			47	Poorly indurated grayish black claystn w/ disturbed lithstn 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 1.0cm, 1.0mm fluid inclusions abundant
			5	
			32	Bedded & hal w/ mdstn laminations & vertically oriented [illegible]
			35	Brown to light red brown ripple laminated mdstn w/ interbedded [illegible] lenticular bodies of hal & hal hoppers, laminations are contorted at the top

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Date

Checked [illegible] Date [illegible]

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Updated Date

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

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

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION
CONVENTIONAL CORING [illegible]			
			Gray nodular mosaic anh
			Olive gray to gray dol mstn arranged in four gradational sequences [illegible] of wispy laminated burrowed mstn overlain by parallel laminated mstn. Laminations in uppermost sequence are slightly wavy & disturbed by vertical fenestral tubes
			[illegible]
			4.5 cm of wavy laminated & mud cracked dol mstn overlain by [illegible] of regularly laminated dol pstn w/ burrowing in abundance up section, spacing of laminations increasing up section also gradational
			[illegible]
			8' dark olive gray fissile (mapletely broken apart clayste sharply overlying gray nodular mosaic anh w/ interstitial clayste at the base & yellow gray dol pstn upwards, upper most .3' consists of anh nodules in disrupted laminated dol pstn
			.3' gray green silty terrigenous mstn sharply overlying mottled yellow gray & gray dol, dol ranges from mstn to pstn, grains are either very indistinct or not visible. There is a thin faintly laminated zone about 2 cm near [illegible] & micro stylolites & thin stylolite occur throughout as well as crystallotopic anh, anh nodules are scattered. Near 5510 there are some fractures that are [illegible] stylolites as they approach a vertical orientation
			.3' gray nodular mosaic anh overlain by a 20 cm bed of finely [illegible] laminated dol mstn w/ mud cracks overlying gray bioturbated dol(?) pstn [illegible] overlying dark dol pstn overlying 1.1' finely to moderately laminated dol mstn
			2' gray dol (?) mstn/wstn variably bioturbated w/ abundant crystallotopic anh overlying 6' mottled faintly laminated mstn w/ anh nodules grading to 2' of variable bioturbated dol mstn w/ wispy laminated micro stylolites, & crystallotopic anh overlying .1' of faintly to moderately developed laminated dol mstn w/ a broken up ground-like structure
			Gray nodular mosaic anh w/ interstitial zones of dol pstn nodules & intraclasts in an argillaceous dol mstn matrix w/ pyrite also
			Light gray buff mstn w/ vague wavy horizontal laminations, highlighted by crystallotopic anh, grades to pstn upwards w/ horizontal bedding
			Gray blue dol (?) pstn - extreme etching shows prisms w/ burrows along the sutures, microstylolites, crystallotopic anh, anh nodules, vague wavy horizontal laminations
			Zone of mottled yellow gray & gray bioturbated microstylolitic dol overlying .1' cm yellow gray vaguely horizontally laminated dol [illegible] intermediate overlain by 1cm nodular mosaic gray anh
			Medium gray dol, highly recrystallized, no grains visible, vague laminated microstylolites present
			Mottled yellow gray & gray heavily bioturbated dol, bioturbated in lower up section.
			Yellow gray dol mstn w/ abundant microstylolites, grade to intraclastic [illegible] texture upwards, bioturbated in uppermost portion
			Mottled gray & yellow gray dol w/ a "worm" or "curdled" texture
			Medium gray dol mstn w/ interbedded (?) about 5 cm thick of [illegible] pstn w/ indistinct ghosts of grains, contains abundant burrows
			Yellow gray to olive gray dol pstn w/ indistinct ghosts of grains, wispy laminations, microstylolites, & crystallotopic anh. Upper most 6 cm is an intraclastic dol pstn w/ vague horizontal laminations & well developed crystals
			Gray nodular mosaic anh w/ interstitial dol pstn
			Olive gray dol (?) pstn subspheroidal grains distinct in places & indistinct in others, contains small black wispy laminations of organic material, possible burrows & crystallotopic anh; basal 0.1' contains intraclasts possibly from the underlying unit.
			Bands of gray nodular mosaic anh w/ interstitial olive gray dol [illegible] mstn w/ indistinct laminations. Sequence is capped by laminated mudstone [illegible]
			Yellow gray solite gnost w/ crystallotopic anh
			Medium gray dol (?) pstn, grains are poorly defined ghosts, contains crystallotopic anh, mottling & wispy laminations.
			Yellow gray dol w/ a horizontal mottled texture defining a diffuse lamination, contains crystallotopic anh along laminations.
			Gray nodular mosaic anh w/ interbeds of yellow gray dol mstn w/ laminations defined by microstylolites.
			Yellow gray dol, pstn sheets sub-spheroidal, poorly defined pellet (?) pstn contains crystallotopic anh, microstylolites, capped by [illegible] of yellow gray slightly mottled mstn.
			Yellow gray dol pstn of oblate rounded grains squashed [illegible] & [illegible], abundance of fossil increase up section burrows occur throughout upper 0.2' is heavily bioturbated, contains some microstylolites, anh nodules & crystallotopic anh.
			Mottled light medium gray & yellow gray dol, no grains visible, contains possible burrows or root traces, anh nodules & abundant pyrite, microstylolites have lamination.
			Yellow gray dol gnost of squashed pellets (?) micrite at the base
			Light olive gray dol pstn which grades up section to wstn/mstn, both extensively bioturbated, containing anh nodules & crystallotopic anh, stylolites & microstylolites
			Light olive gray dol mstn wstn, wispy laminations of organic matter, highly bioturbated upwards. Contains anh nodules.
			Yellow gray to gray blue dol gnost, extensively recrystallized, fossils not identified. Contains fossils replaced by anh, also anh nodules. Contains one interbed of dol mstn, laminations otherwise unidentifiable
			Very pale to pale yellowish brown dolomitic pstn, mottled burrows & vaguely laminated textures, anh is present as finely disseminated clusters

WICHITA

WOLFCAMP

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 [illegible] COUNTY [illegible] DATE [illegible]

INTERVAL 5620 5740 WOLFCAMP LOGGED BY [illegible]

Footage	LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION
			[illegible]		
			[illegible]	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 dolomitized. Groundmass is massive, cut by stylolites & microstylolites.
			[illegible]	41	Dark gray massive dol w/ dark blue angular anh nodules (2-[illegible]cm) & anh filling numerous fractures. Fusulinid molds filled w/ anh are dispersed throughout. Massive, no bedding defined.
			[illegible]	110	Gray massive dol w/ numerous thin fractures & abundant fossils disseminated 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
			[illegible]	60	Yellowish gray dol wstn/pkstn w/ abundant anh disseminated throughout
			[illegible]	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 thin vertical fractures 1-10cm long. The top 1.5' appears less porous
			[illegible]	45	Dark gray, porous coarse crystalline dolomitized wstn/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
			[illegible]	45	Massive partially dolomitized grst/pkstn w/ fusulinids, crinoids, coarse brown dol crystals & isolated anh, chert or chalcedony nodules [illegible]. Lowermost dolomitized zone show contorted laminations at 5707.2'. The contact is an erosional surface
			[illegible]	75	Dark gray & yellowish gray, contorted & wispy laminated, mostly dolomitized pkstn/grst. Contains isolated coarse crystalline anh nodules [illegible] & a very large chert nodule at base which contains mollusk fragments. Very coarse crystalline dol occurs near the chert
			[illegible]	18	Yellowish gray, coarse partially dolomitized pkstn. Contains fusulinids, crinoids, dol pellets & silicified grains. One anh nodule [illegible] at 5[illegible]
			[illegible]	42	Dark gray dolomitized Pkstn. Remnant allochems are fusulinids, crinoid columnals & bryozoans. Includes isolated silicified nodules & anh filling 4-8 cm fractures at 5722'
			[illegible]	41	Coarse fusulinid pkstn/grst w/ some dolomitized zones, chert nodules, & a few silicified grains. Fabric shows wispy laminations & is mostly stylolitized in bottom 15cm
			[illegible]	69	Dark gray wispy & contorted laminated dolosts 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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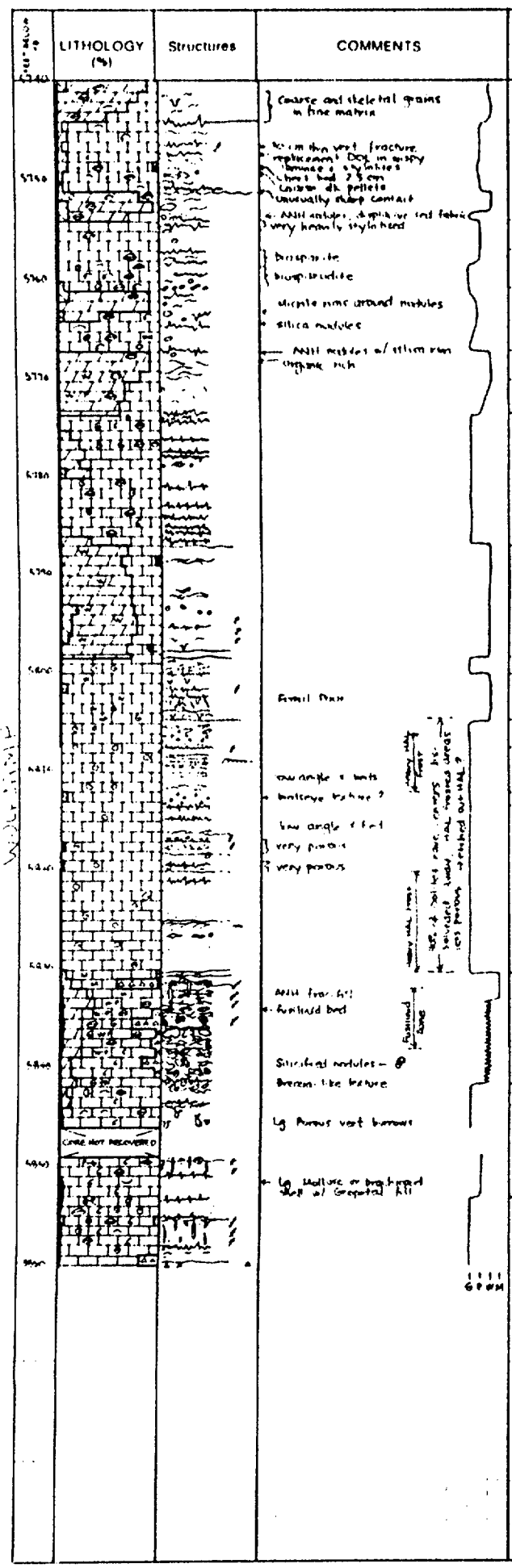
WOLFCAMP

WELL J Fremel COUNTY Dea Smith DATE

INTERVAL 5740 5860 WOLFCAMP LOGGED BY



CONTACTS

LITHOLOGIC DESCRIPTION

see description sheet p 10

Massive fine grained pelsta w/ coarse dark crystalline sol grains dispersed throughout, becomes more fossiliferous at the top

Yellowish gray fine grained pelsta/gnsta w/ skeletal hash, silicified grains & a few sparse crystalline sol pellets. A chert bed at 5744.6' "Fusial" dolomitization occurs in wispy laminae & near stylolites

Dark gray dolomitized fusulinid pelsta grading up section to fusulinid wkstn forams are calcite, matrix is crystalline dol. Partially silicified anh nodules are up to 6 cm

Fine grained pelsta.gnsta w/ isolated partly silicified anh nodules

Allochems are fusulinids skeletal fragments & silicified grains. Contains replacement dol scattered throughout.

Coarse gray fusulinid gnsnt grading up section to less fossiliferous pelsta/gnsta lower 1cm contains abundant small anh nodules.

Gray fusulinid dolomitized wkstn/pelsta w/ 2-5cm anh nodules & silica nodules which are rimmed w/ mud. Fusulinids are all calcite. Down section sol at base shows nodular ghost dol displacing some fabric

Lighter colored fine grained massive pelsta/gnsta w/ a few tiny silicified grains.

Dark gray dolomitized wkstn w/ calcite fusulinids to 1mm. Pelsta to wkstn up section becoming increasingly dolomitic & fossil poor. Fossils are calcite. Allochems include fusilinids, other forams, small snails & debris. Scattered anh fill (nodules?) 2 cm

Light gray to brown stylolitized gnsta. Allochems are generally small (less than 1 mm) & include multi-chambered globular-like forams, fusulinids, shell debris, gastropods, crinoid stem & unidentifiable coated grains. Grainstone is homogenous giving unit massive appearance but some stratification may be present. Silica replaces many allochems.

Dark Gray dol wkstn, fossil allochems generally small (less than 1mm), calcareous & predominately shell debris, bottom 2 feet contains fusilinids & rugose coral (heads to 1 5cm across). Anh in middle portions occurs as vord fill nodules up to 5cm & possibly as a replacement mineral in interstitial areas. Unit contains scattered vertical fractures, wispy laminations & mud seams

Stratified oolitic/foram gnsnt w/ zones of shell hash. Numerous fusulinid fossils & wkstn filled w/ spar

Disturbated light tan/blue wkstn [?] w/ fossil allochems ranging from small (less than .5mm) spar filled, coated round grains, to large fusulinids structures, to 1mm "mud" filled burrows, forams lower 1'. Matrix has a grainy disturbed texture which appears to be composed of finely ground shell hash but individual grains difficult to discern unit may therefore be gnsta. Tan/blue porous oolitic gnsta w/ large amount of different cementation. "splotchy appearance". Brown areas less well cemented & contain larger void spaces

Light tan blue Porous oolitic gnsta w/ low angle cross stratification & nearly horizontal hal frosted stringers in lower half that grade up section from crinkly nonparallel & discontinuous to even parallel & continuous. Bottom 1 foot contains scattered birdseye like voids. Stratification defined by differential cementation & hal frost in lower half

Light tan porous oolitic gnsta w/ numerous void spaces to 1mm in diameter giving it a texture? Anh fills some of these interstitial areas. There is a hint of stratification

Hal frosted (cemented?) light tan porous oolitic gnsta w/ scattered stylolites and low angle cross stratification defined by variations in cementation and white grain size (.2-1mm). What appears to be scour surfaces generally contain grains on the large end of the scale and sometimes occasional forams. Entire unit is porous w/ some very porous intervals which generally lack hal frosting

Wispy laminated wkstns interbedded w/ disturbed pelsta, contains numerous silicified nodules often w/ anh filled fractures. Unit capped by wispy laminated wkstn also w/ silicified nodules.

Gray highly porous poorly sorted disturbed pelsta/gnsta. Allochems range in size from .25 mm to 4cm & includes forams,crinoids, mollusk/brachiopod shells often w/ geopetal fill & general debris. Unit has disturbed, disturbated texture & contains a long (7.5') vertical burrow-like structure filled w/ darker & more porous material than surrounding area. Contact w/ overlying unit is broken & brecciated w/ dolomitic interstitial areas containing dark orange material.

Gray porous gnsta; allochems are homogenous in size up to 1mm average .5-1 mm & include forams, crinoid parts, coated grains & general debris. Contains zones of stylolitization, fractures & patchy anh replacement.

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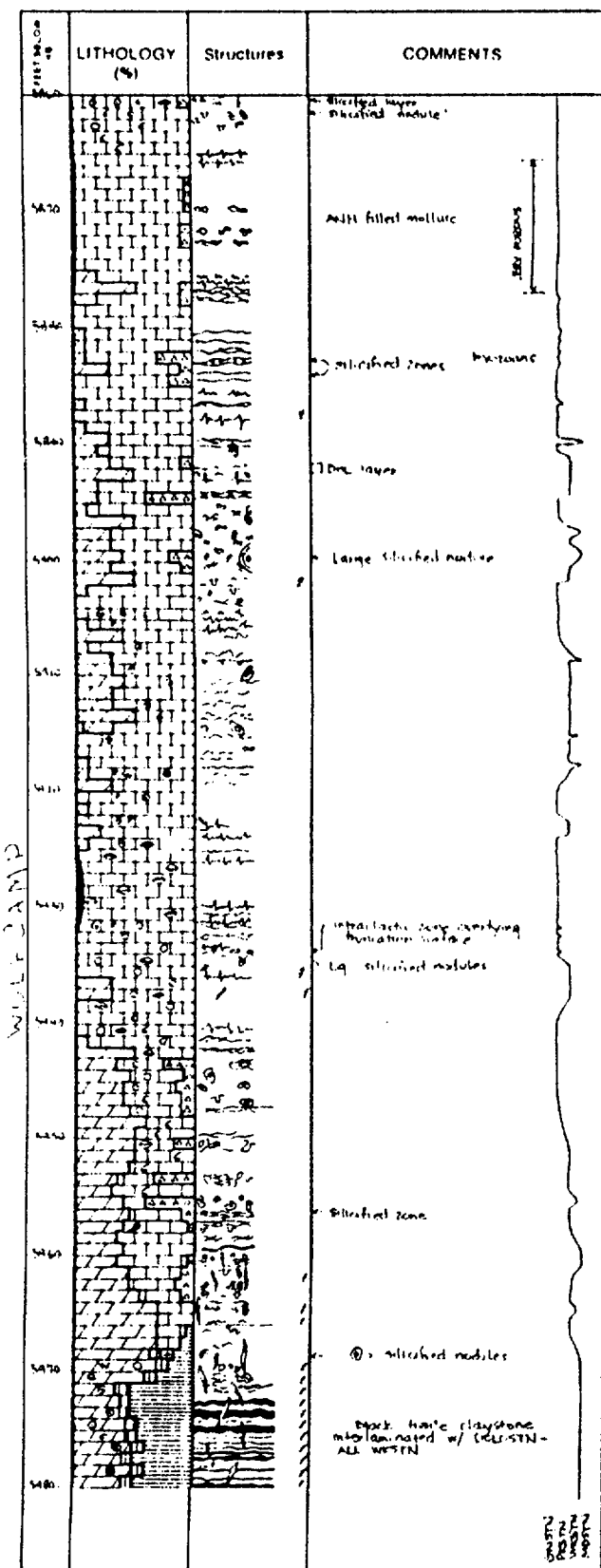
WELL J. Tremel COUNTY Dea S. Smith DATE

INTERVAL 5460-5480 WOLF CAMP LOGGED BY



CONTACTS	LITHOLOGIC DESCRIPTION
6.5	Gray coarse gnstn grades up section to less coarse burrowed brown pkstn w scattered thin organic stringers. Grains grade from 3mm to less than 1mm up section. Allochems, fossil hash, crinoid stems & forams scattered silicified nodules & zones.
8.2	Porous foram/oolitic gnstn. Grains highly homogeneous throughout, size .5mm-1mm circular to tubular in shape. Allochems appear to be small forams and/or oolites. Scattered pore filling zones of anh & silica. Moderate porosity.
9.7	Series of coarsening upward sequences in light tan gnstn; coarsest grains between 5477.7-5479.5 & 5484-5485. Grains to 4mm. Contains two silicified zones 11cm & 13cm thick. Allochems; shell hash, crinoid columnals, brachiopods commonly silicified.
10	Light tan gnstn; allochems less than 1mm but scattered larger silicified crinoid columnals; generally fines up section vertical fractures upper foot
11	Wispy laminated organic rich wkstn/pkstn. Common large silicified bodies & zones throughout up to 15cm thick. Dolomitization patchy. Hal frost roots silicified areas. Decreasing organics up section. Allochems silicified crinoid stems, fusilinids, fossil has
26	Light tan gnstnt w/ anh filled voids. Increasing burrows & organic rich clay up section.
5	Highly fractured zone of light brown pkstn/gnstn. Slightly dolomitized lower foot.
19.5	Wispy laminated slightly dolomitic gnstn to wkstn. Wispy laminations disseminated throughout w/ common zones of concentrated dolomitization generally associated w/ wispy laminations. Concentrations fossils. Also occurs as concentrically zoned nodules w. increasing dol inward to a silicified core. Allochems, predominately crinoid pieces, fusilinids, & general fossil hash. Large crinoid parts generally silicified
6.2	Porous foraminifera gnstnt w/ scattered concentrations of organic material (i.e. wispy laminations). Two anh filled fractures associated w/ nodular tubular zones of dolomitization inward to silicification. Fusilinids show some moldic porosity
24.7	Tan wkstn & gnstns w/ scattered large silicified nodules up to 25cm long. More organics lower half. Allochems(1) from 5468 up section core is peppered w/ small (1 x 1 cm) silicified crinoid columns, also contains forams (some fusilinids), fossil debris and small round unidentifiable grains. (2) below 5468 scattered crinoid parts, some forams & unidentified grains.
14.5	Wispy laminated dol wkstn/pkstn becoming increasing calcic up section. Common large (7cm-10cm) silicified nodules w/ dol rims. Allochems still visible in nodules. Allochems; shell hash & crinoid columns average 1mm to 3mm grains. Much smaller than those found below.
10.7	Interbedded dol wkstn & dol wkstn. Organics become increasing disseminated & better indurated up section. Organic poor intervals well indurated. Unit highly fractured-vertical. Allochems large (1cm x 1cm) crinoid columns & shell has partially silicified

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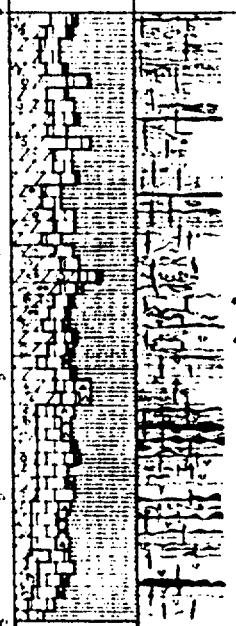
WELL [illegible] COUNTY Deaf Smith DATE [illegible]

INTERVAL [illegible] WOLFCAMP LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
		Tilting debris flows Slickensides Large pyrite nodules Common silicified layers Silicified nodules Calcite-lined voids Crinoidal fill with spinny calcite & pyrite shaley breaks mdstn wkstn pkstn wkstn	49	Dolomitic, fairly well indurated, black mdstn/claystn to argillaceous dolostn w/ 10-20% fossil allochems primarily crinoid columns & brachiopods often w/ geopetal fill. Fossils are generally partially silicified. Contains scattered zones & pockets of dolostn some w/ silicified edges. The entire 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	
			10.7	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 silicious 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 Pkstn at 6010-6012.8 high diversity, small fossils average 1mm & never 2 feet contains tilting, graded crinoid debris flows in lime mud matrix
CONVENTIONAL DRILLING				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.
		1.5cm brachiopod	39	Black dolomitic clayshale becoming somewhat better indurated from 6442.5 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 %.

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WELL J Fremel COUNTY Deaf Smith DATE [illegible]

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

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
				Dolomitic & calcareous black mud shales, small horizontal burrows throughout section.
		well indurated CAVERN (not hasite)		
		Pecten shell fish shells lying in stable settling position		Laminated gray mdstn well indurated
		Poorly indurated wet?		
		5 small (5 mm-5 mm) horizontal continuous white brite, mas. calc rusty yellow mottles may indicate silica precipt. Also contains numerous green minerals. Rich bed?		Unusual breccia w/ black mdstn matrix. Clasts are angular, up to 5cm in size & generally calcic. Clasts include broken & whole fossil debris (crinoid parts, mollusk/brachiopod shells & fusilinids) & carbonate - clastic mdstn fragments & pieces which are the largest & most abundant clast type, unit fines up section. Dark gray to black dol moderately well indurated mud/clay shale, unit is heavily burrowed but decreasing sharply from 6525 up section. Burrows are horizontal, small (1c 3mm) thin shelled brachiopods fragments are present throughout. Entire section is vertically fractured. Section is slightly calcareous.
CONVENTIONAL DRILLING		Top Penn (7200 (SPD)		
		calcite cmt		Black calcareous mdstn sharply overlain by broken muddy mdstn/psstn w/ scattered gravel. Fossil allochems diverse but difficult to identify; pyritic Gray fine ss w/ greenish mdstn base; grains subrounded; not as k-spar rich as ss below. Interbedded arkosic, gravely fine to coarse sands & sandy gravels. Gravel beds as well as individual gravel grains increas in size up section. Beds are about 5 degrees from the horizontal. Grains subangular to subrounded (Beds maybe preserved back sets of large migrating ripples or bars) Ripple cross bedded brown very fine/ fine ss w/ greenish (glauconitic?) zones, interbedded w/ pink coarse sand & gravel composed of subangular k-spar & white quartz grains; arkose abundant soft sediment loading & deformation

WOLFCAMP

PENNSYLVANIAN

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WELL J. Friemel COUNTY Neal Smith DATE [illegible]

INTERVAL [illegible] PENNSYLVANIAN LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PENNSYLVANIAN

Note: In J. Friemel drilling deviated in dip/dip by 10 degrees. This would effect bedding angles and dips may be drilling induced. (Rushit personal communication)

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

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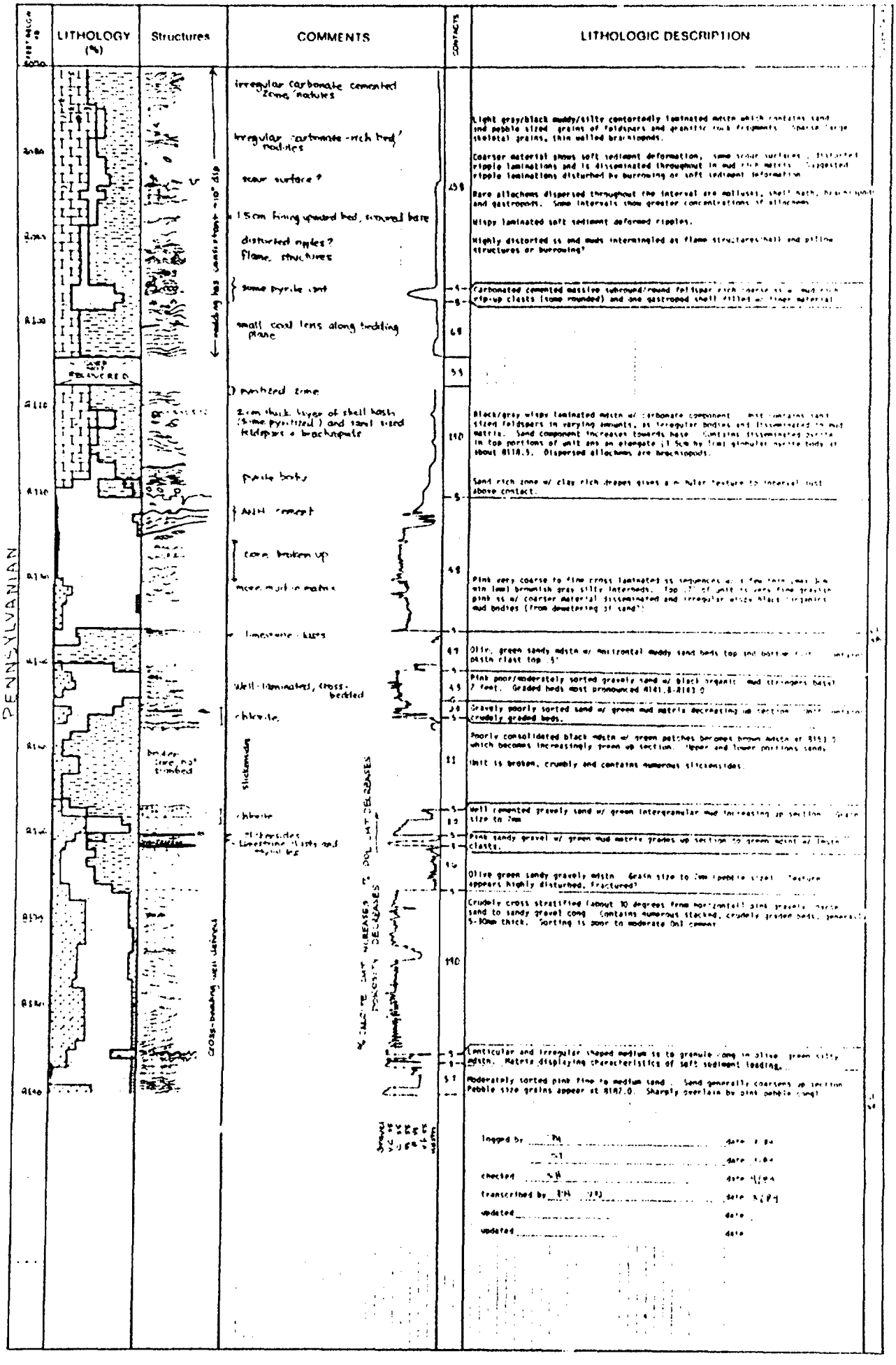
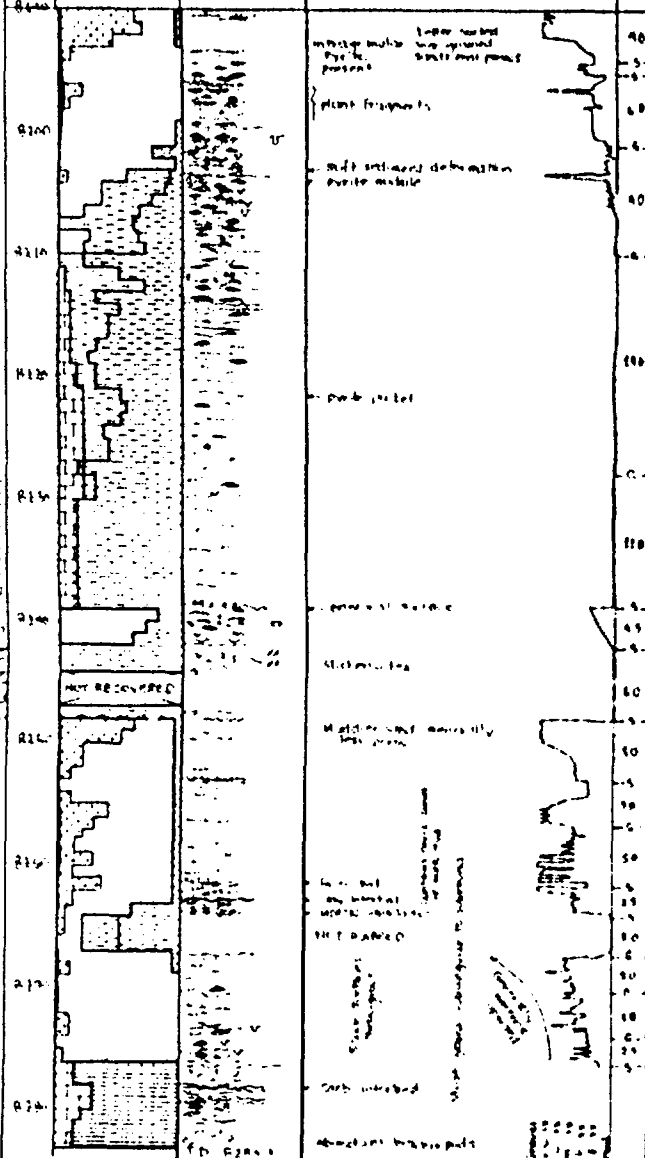
INTERVAL [illegible] PENNSYLVANIAN LOGGED BY [illegible]



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

INTERVAL 8090 – 8193.5 PENNSYLVANIAN LOGGED BY [illegible]

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Well sorted fine sand grades up section to pinkish sandy gravel, gravelly sand [illegible] 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. [illegible] sharply bounded gravel bed at 8106.6. Dol cement?

Finely interlaminated ss/siltstone and black mdstn. Sedimentary structures [illegible] fine parallel and ripple laminations and climbing ripples. [illegible] often forms small discontinuous lenses, 1cm long by 1mm high. [illegible] thinning 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 siltstone. Common horizontal partings occur along bedding planes. Siltstone grades from discontinuous lenses to continuous horizontal beds. [illegible] bed thickness and percentage silt increasing up section. Few bivalves [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.

Grayish 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 grayish red and grayish green in color. Slickensides throughout.

Poorly sorted gravelly 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 silty fine matrix fine ss. Carbonate cement.

Repeating sequences of sandy gravel grading to coarse to medium ss to [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-kspar ss. Dol cement.

Poorly sorted, submature fine to gravelly coarse qtz-kspar ss. [illegible] 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, kspar ss. Some calcite cement in lower half. Dol cement.

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

Note: In J. Friemel drilling deviated [illegible] degrees. [illegible] 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 1127-1240 SALADO - TANSILL LOGGED BY SI, DH, BL, MW, DP

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	SAMPLES	LITHOLOGIC DESCRIPTION
1130			Gyp fracture fill		Alternating layers of tan laminated dol & fibrous fracture fill gyp. Dol laminated filled w/ scattered nodule like gyp replacing the dol. Bottom 6" contain ghost gyp pseudomorphs after grassmat mudlocatal gyp. Dol laminated, ripple ? algal? fractures about 4 cm.
			Ripples	1.1	Grassmat; gyp & anh pseudomorphs after gyp, upper .6' & lower .7' fine crystalline gyp; mid .5' fine crystalline mixture of anh & gyp contains fibrous gyp fracture fill. Minor impurities.
				5.1	Fine grained crystalline gyp (appears replacive). Ghost laminae present. Minor stringers of tan dol & fibrous gyp fracture fill. Impurities (red mud) gives zone a reddish hue. Scattered "eyes" of clear gyp fill.
				1.3	Ripple laminated very fine ss, well preserved cross bedding, subarkosic, scale of structures about 1mm decreasing up sec ton; Mod red in color. 4 cm of pure fibrous gyp fracture fill at base. Cross beds low angle, gyp nodule, about 2 cm.
1140			Pink stain Fibrous gyp fracture fill	9.3	Moderate reddish brown siltsto/sandy siltsto; Micaceous subarkosic, sand size grains in lenses or pods. Low angle to horizontal gyp (up to 15mm) fracture fill & pore filling nodules, less than 2 cm. Irregular blebs often coalescing reduction zone. Some rounded gyp grains. Basal bed is green clay.
			Pebbly replacement nodule	2.5	Bedded massive anh laminations parallel/slightly wavy; being converted to gyp. Gyp nodules scattered (1-5cm) coalescing & cut cross anh laminations. Upper .8' all gyp, fibrous & nodular. Fracture fill common fibrous gyp (1-5mm) nearly horizontal.
1150				7	Gray nodular mosaic anh, zones of mosaic to bedded nodular mosaic. Bed interstitial mud slightly dolomitic in lower footage. Nodules 1-30mm. Scattered gyp nodules (1-10mm) coalescing into larger nodules & zones. Replacement, structure (white laminations) disrupted by gyp nodules. Common fibrous gyp fracture fill 2-8mm.
				2.6	Gray nodular mosaic to bedded nodular mosaic anh; nodules less than 1mm up to 10mm, average 3-4mm. Interstitial red mud slightly dolomitic. Coalescing gyp replacement nodules 2-10mm scattered & patchy. Anh nodules appear "fuzzy".
				3.5	Laminated dolomitic red anh; fine parallel intrabeds of red mud less than 1mm & tan dol less than 4mm. Upper 1.5' small displacive anh nodules less than 3mm in mud & laminated dol (algal?) matrix.
1160			Anh replacing nod Gyp + Anh fracture fill	2.5	Brown gray dol matrix w/ green clay laminae parallel to wavy, highly stylolitized replacive crystalloblastic anh. Dol matrix may be ripple laminated.
				1.7	Gray dol matrix w/ disturbed & broken bedding, intraclasts, stylolitized, green clay laminations & anh & gyp fracture fill.
				1.6	Laminated anh w/ thin interbeds (less than 1 cm) of gray dol matrix, anh beds .5-1 cm thick, parallel to slightly wavy & lie about 10 degrees from horizontal. Upper boundary stylolitic, anh replacing dol.
1170			Gyp fracture fill	2	Laminated (algal) dol matrix, laminations .25 to 3 mm & contain numerous vertically oriented cracks. Interbeds of anh .25 mm, decreasing up section. Possible ripple laminations. Dol laminations centered & increasingly broken up section until upper .6' contains no laminations, where it becomes intraclastic.
				2	Laminated anh w/ numerous gyp replacement nodules & 1 large fracture filled w/ fibrous gyp (1 cm thick) thin interbeds of gray dol (less than 1 mm) 1mm & 2 cm thick of dol matrix, anh laminations 1-4mm (ripple laminations).
					Gyp. muddy ss, highly disturbed & reduced, entire layers of mud have been reduced. Pods (intraclasts) & lenses of sand sized detrital gyp grains, reduction spots 1-3mm.
1180					Moderate reddish brown siltsto; subarkosic, micaceous; secondary gyp & detrital gyp, sparse reduction spots (1-5mm). Low angle fractures filled w/ gyp. Mud intraclasts present.
					Laminated anh (greater than 1 mm to 2 mm) algal? Gyp fracture fill, large vertical gyp replacement crystals growing upward from top of section.
1190			Reduced zone Gyp fracture fill silicified	12	Moderate reddish brown clay rich, sandy mdstn. Varying % sand & clay. Common gyp crystalloblastic grains often in stringers. Scattered reduction spots 1-10mm. Interbeds of anh w/ nodular gyp replacement, upper bed bedded massive lower bed massive w/ thin interstitial mud layers.
1200				9	Dark reddish brown mdstn. Scattered reductions spots w/ black cores (6-12mm). Contain crystalloblastic gyp & fracture fill. Gyp growth coalescing to form gyp stringers.
				2.5	Dark reddish brown claystn/mdstn, gyp fracture fill, widely spaced reduction spots (.5-22mm). Has beginnings of displacive gyp growth.
			Gyp sand?	3.5	Moderate reddish brown gypsiferous siltsto/mdstn, displacive crystalloblastic gyp crystals coalescing into nodular like morphology. Appears to have contorted possible bedding planes. Nodules about 2-3mm average. Possible detrital gyp.
1210				1.9	Dark reddish brown claystn/mdstn w/ nodular gyp growth up to 15mm also gyp fracture fill.
			Gyp fracture fill silicified	13	Moderate reddish orange siltsto w/ muddy & sandy zones which contain crystalloblastic gyp. Gyp crystals coalescing in bands, nodules & irregular roopy morphologies. Fibrous gyp fracture fill. Gyp grains appear secondary but some may be detrital.
1220					
			Slightly bioturbated	11	Alternating units of dark reddish brown claystn/mdstn w/ wispy bedded micaceous siltsto/sandy siltsto; clay rich units contain minor amounts of gyp via fracture fill & widely spaced black centered reduction spots up to 1.5 cm; average 4mm. Siltstone are moderate reddish orange containing lighter colored silty beds or stringers, possibly containing detrital gyp. Some secondary gyp crystals present. Grains rounded, poor sorting. Numerous reduction spots average 2 cm some w/ black cores. Sedimentary structures, scours, ripple laminations, wispy laminations, deformed beds & rip up clasts.
1230				2.4	Distorted, bedded nodular grades to massive bedded anh w/ interbeds of thin (less than 1 mm) of red clay/mud. Possible ripple lamination in lower foot. Anh is relatively soft possibly reflection lack of complete dehydration.
			Fluid escape structures?	3.6	Highly fractured moderately reddish brown clayey siltsto w/ darker clay/mud zone. Fractures both vertical & nearly horizontal filled w/ gyp. Upper 4' most fractured & contains disturbed & broken bedding, numerous reduction spots up to 1.5cm; clay layer contains few but large reduction spots (2 5cm).
1240					

SALADO TANSILL

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WELL Dethan COUNTY Lea, New Mexico DATE

INTERVAL 1240-1560 SALADO-TANSILL, YATES, UPPER SEVEN RIVERS LOGGED BY BL, DM, KW, DP, [illegible]

Depth (ft)	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
1230				.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.
			Reduction spots	2.2	Insoluble residue: about 2mm anh nodules, 1-2mm 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.
1250					White gray anh w/ pink laminations at 1245.6.
					White gray laminated anh.
					Insoluble residue; mud clasts, disturbed, about 5mm anh nodules. 2mm euhedral gyp crystals present.
			contorted slumped ripples		White gray laminated anh
			Reduction spots		Upper plug 1349'-1339
1260					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 in thick layers) throughout the clastic interval. Mdstn/claystn intervals generally fissile. Minor carbonate cement present throughout.
1270					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.
			disturbed crossbeds 2mm high		Fine to medium very well rounded quartz grains in muddy coarse silt very fine sand matrix at 1270.75.
			biomodules, disrupted placers		
1280			* where textural break, although no visible gypsum or anhydrite		Less than 5% .5mm gyp crystals aggregates present in this interval. Interstitial gyp forms layer at 1280.8, 1279.3.
			Reduction spots		
YATES					
1290				74	Cementation (hardness) increases up section from 1295.3 to 1290.
1300			Reduced zone		
					Very thin clay laminae in mdstn at 1307.7.
1310					Mdstn in disturbed laminations/pockets very well sorted 1310.3-1311.0.
1320			Reduction spots		5mm wide, 65° anh veins present at 1319.3 & 1316.3.
				1.1	5mm claystn clasts present. Randomly oriented gyp & anh veins present.
				1.5	Disturbed bedded nodular anhydrite.
					Mdstn w/ silt size particles predominately gyp. Anh & gyp nodules present.
					2cm claystn clasts in claystn matrix. 1mm gyp crystals present in the mdstn.
1330					Wispy laminated anh, nodular at contact.
					Distorted 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.
			Interval zone		1.5mm distorted gyp anh layer (very finely crystalline) present at 1331.
				5	.3' red disturbed laminated anh, .5' white disturbed laminated anh, .5' crystalline blue anh. Brecciated texture present. Distorted mud lamination at upper contact.
1340			Poorly rounded and poorly define Kilwood nodules		1.5' thick concentration of gyp at 1331.3 clastic grains predominately gyp. Upward increase in clay %. Gyp present as aggregates (.5-3mm) & rare nodules. Red siltstn is 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.
			No Repair		Disruptive nodular (20mm) alldy anh & gyp. Gyp also present as less than 1mm euhedral crystals in veins. Anh transported claystn clasts define disrupted beds within very fine ss. Numerous .5mm reduction spots present. Bed texture disrupted insoluble residue.
UPPER SEVEN RIVERS					Chaotic mud salt. High proportion of anh/gyp at distorted basal contact.
1350					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) nonresistant at base increase up section. Very minor wisps of hematitic mud present at 1342.3-1340.3.
				7.2	Chaotic mud salt, mdstn exhibits remnant bedding. Boundary w/ overlying salt is contorted but sharp. .35 cm nodular mass exhibits abundant cleavage traces & possibly contains a significant amount of anhydrite(?).
			Pourhouite, marcasite		Red brown mdstn w/ hal filled cracks at base, filled w/ crystallotopic anh at top.
1360					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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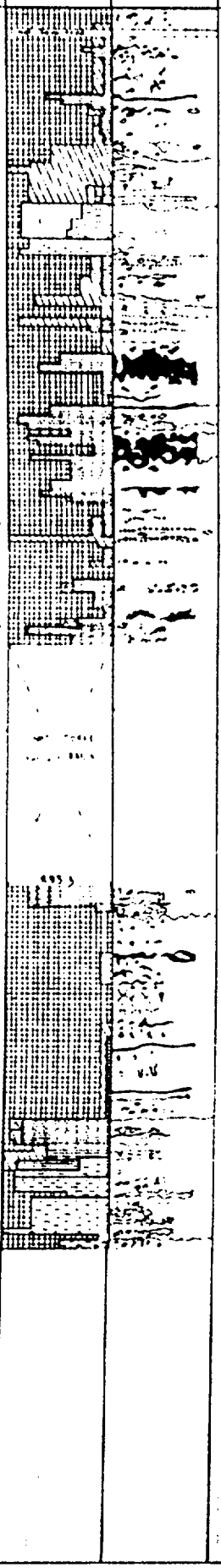
INTERVAL 1360-1920 UPPER SEVEN RIVERS, UPPER SAN ANDRES LOGGED BY DP



LITHOLOGY (%)	Structures	COMMENTS	SAMPLES	LITHOLOGIC DESCRIPTION
			8.	Clear anhedral hal w/ small interstitial bodies of claystn & anh
			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 aggregated by inconsistent size & shape. These aggregates are grouped 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.
	Rare Halite - [illegible]		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.
			3.8	Chaotic mud salt, anh layers present at 1387.8,1387.1, 1386.5. Large replacive 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 horizontal layers & salt aggregates penetrated by anh crystal growth
			1.5	Sparse horizontal anh layers present. Salt crystals average .75 x .75cm
				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
				Chaotic mixture of gyp, anh & claystn present 1392.7, (insoluble residue?)
			3	2 cm recrystallized salt crystals grading upward to chaotic mud salt w/ moderate red brown claystn.
			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. 1mm gyp nodules present in varying sparse concentrations. Subhorizontal salt fracture fill occurs at 1399.8. Upper 7' has claystn w/ about 2cm hal crystals overlain by claystn w/ 4mm euhedral/subhedral salt crystals
			4	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.
		nodules of disturbed and undisturbed layers [illegible] large hal cubes	2	Chaotic mud salt. Clear, subhedral hal crystals up to 2cm x 2 cm. Very disturbed laminations & intraclasts in claystn/mdstn defined by variations in hematite stain. Dispersed small (less than 1 cm) anh nodules
		Color band, no recognizable primary features, may be relicted, but no collapse	11.2	Chaotic mud salt.
		Intergranular porosity		
		primary fabric	9.8	Recrystallized salt w/ banding 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. Bands are alternating between rust color & white
			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 1914.4. Several gyp nodules (up to 1 cm) present, with rugs, at 1911.3. Anh present as .5mm to 6 cm nodules from 1910.8-1909.1. Gyp within gray claystn at 1908.1.
	Clasts mostly preserved		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.
			1.5	Disturbed .1' claystn layer defined lower contact. Hal crystals up to 4cm x 4 cm lower .5'. Very minor anh nodules present.

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D-01B (IMAGE 2 OF 2)

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