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Distribution:
Linehan
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(Precopy sent to PLK 9/6/85)

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

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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1215

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

GS# 481-85

NRC/DOE PERMIAN BASIN CORE
EXAMINATION SUMMARY

Date/Location

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

Attendees/Organizational Affiliation

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

Background/Facts

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

Observations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Geology:

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

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

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

Hydrogeology:

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

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

2. Explanation and examination of hydrochemical and isotopic data.

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

4. Potentiometric head data

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

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

Geochemistry:

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

Rock Mechanics:

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

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

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

Agreements and Open Items

1. NRC and SRP agreed to further discuss ways (in addition to those currently in place) for enhancing the transfer of new interpretative information. A possibility suggested by the NRC is to open-file draft reports produced by contractors and subcontractors.
2. NRC will continue discussions with SRP on the topics, schedules and most effective approach to future interactions.
3. NRC will send SRP follow-up material within one month. This material will consist of the specific observations and any concerns developed during the meeting.

Robert L Johnson 8/9/85

Robert L. Johnson, NRC/WMRP

Jo-Ann Sherwin, DOE/SRP

John S 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 (NRC) [illegible]
2:00 p.m.	Overview of the Palo Duro Basin, current understandings of structural and sedimentological history.	~~TBD (SWEC)~~ J. Peck (SWEC) R. Murphy (SWEC) Steve Ruppel TBEG
3:00 p.m.	Origin of the Permian evaporites, with emphasis on LSA 4.	~~TBD (SWEC)~~
	Core storage/handling/cur	[illegible] 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.	~~S. 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. Senseny
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, Murphy, 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

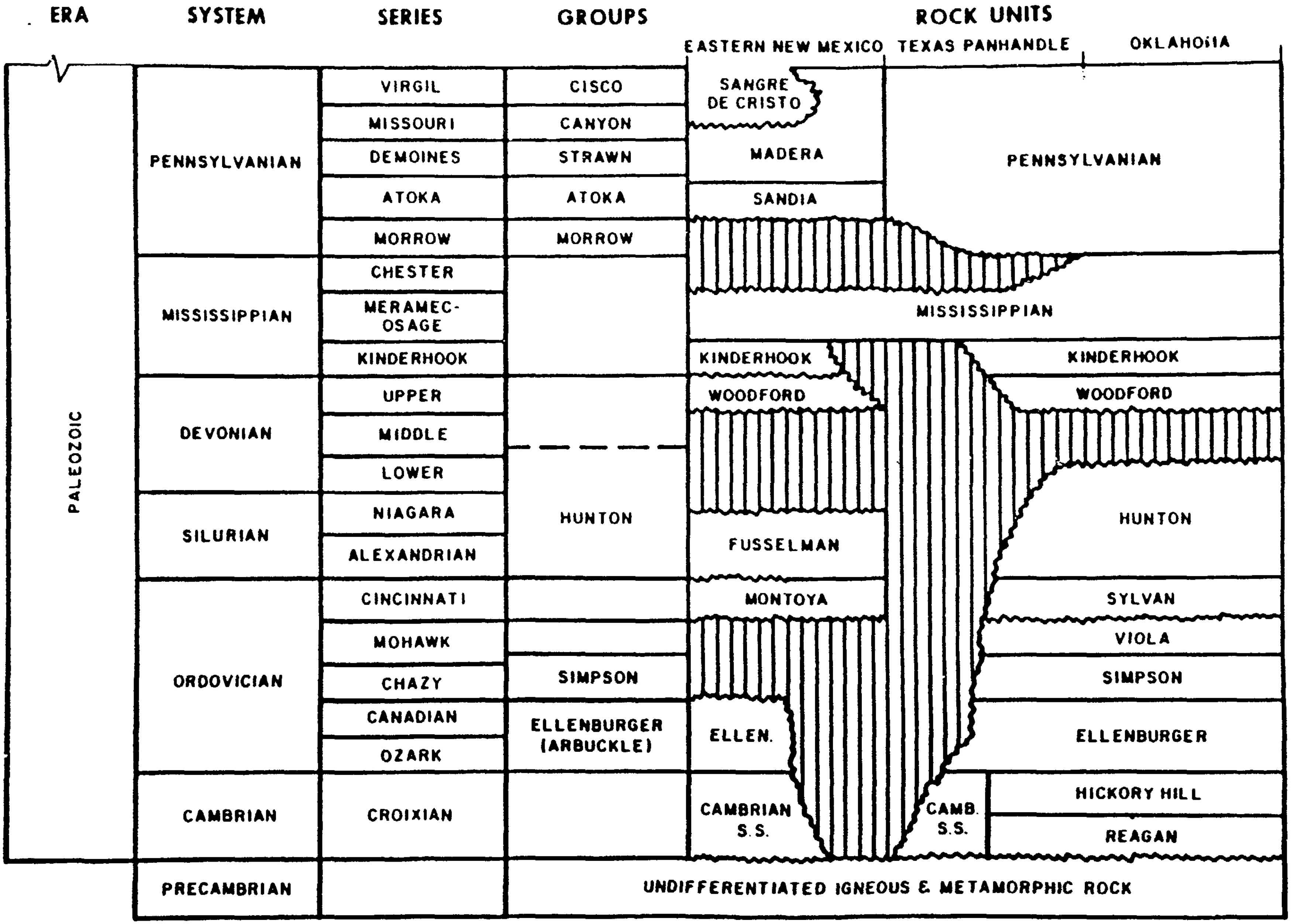
Enclosure 3

Handouts and copies of viewgraphs

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

Peck / Murphy 8/5

STRATIGRAPHIC SECTION CONT.
PRECAMBRIAN TO PENNSYLVANIAN



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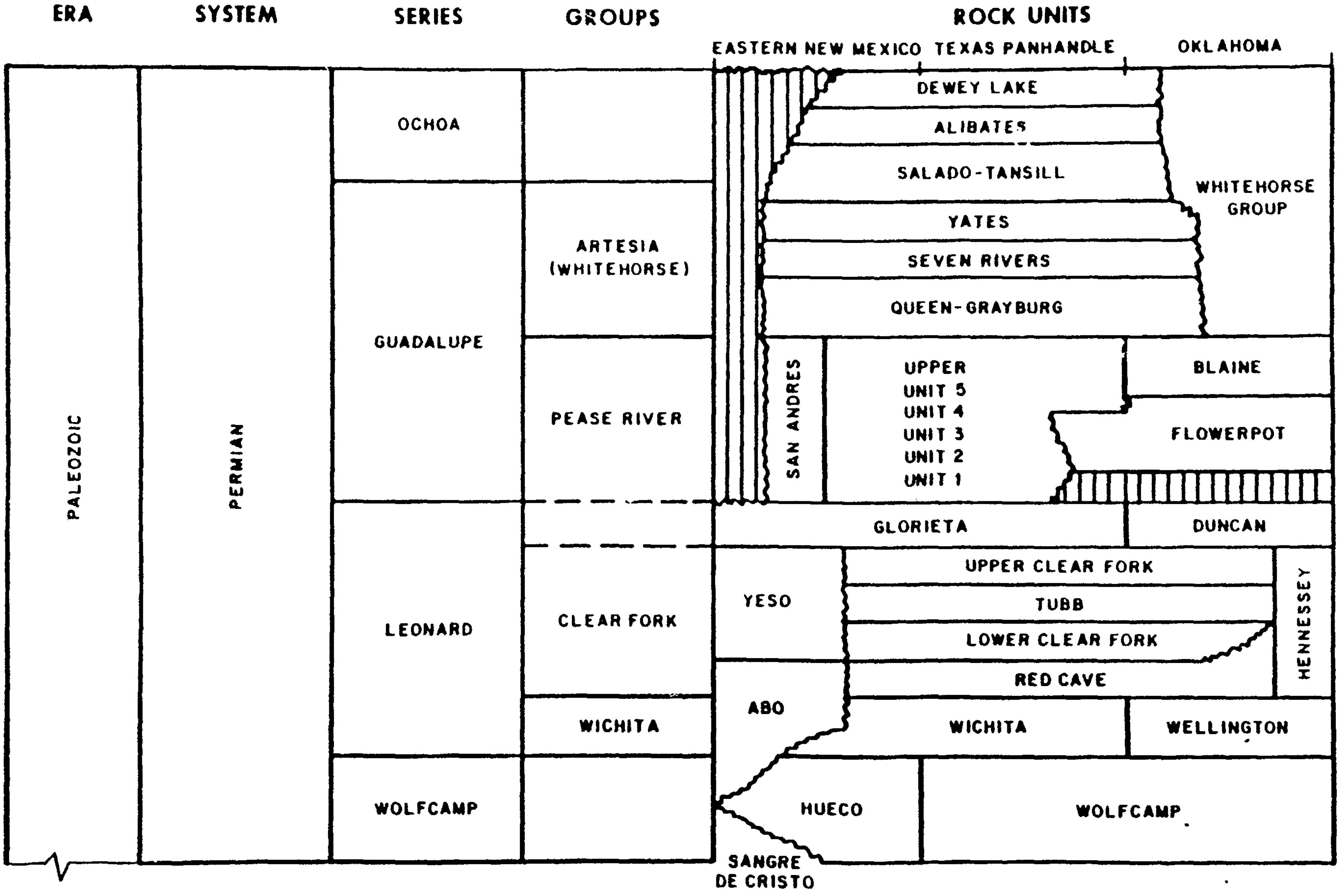
STRATIGRAPHIC SECTION CONT.

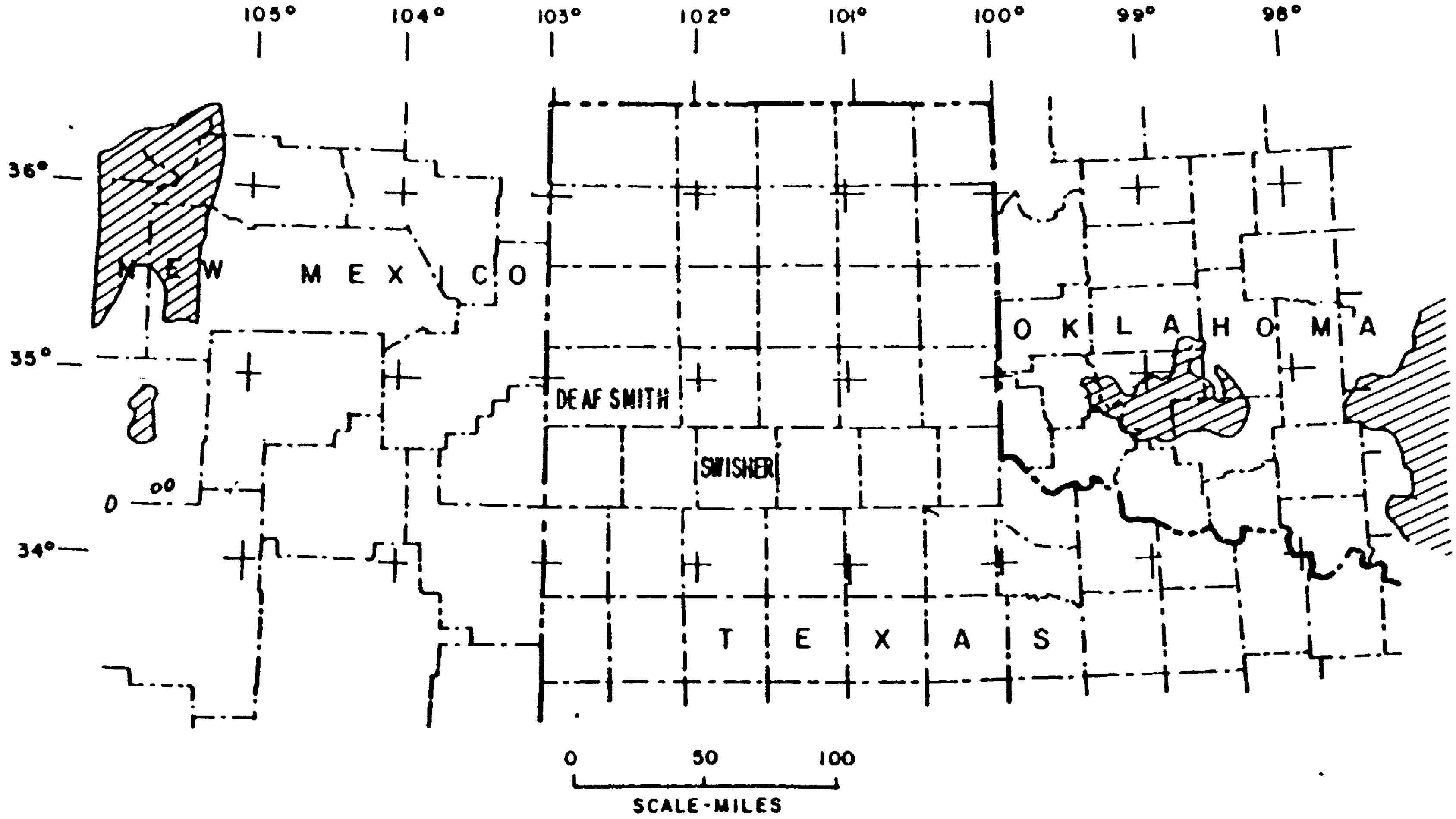
PERMIAN SYSTEM



STRATIGRAPHIC SECTION
TRIASSIC TO RECENT

ERA	SYSTEM	SERIES	GROUPS	ROCK UNITS EASTERN NEW MEXICO	 TEXAS PANHANDLE	 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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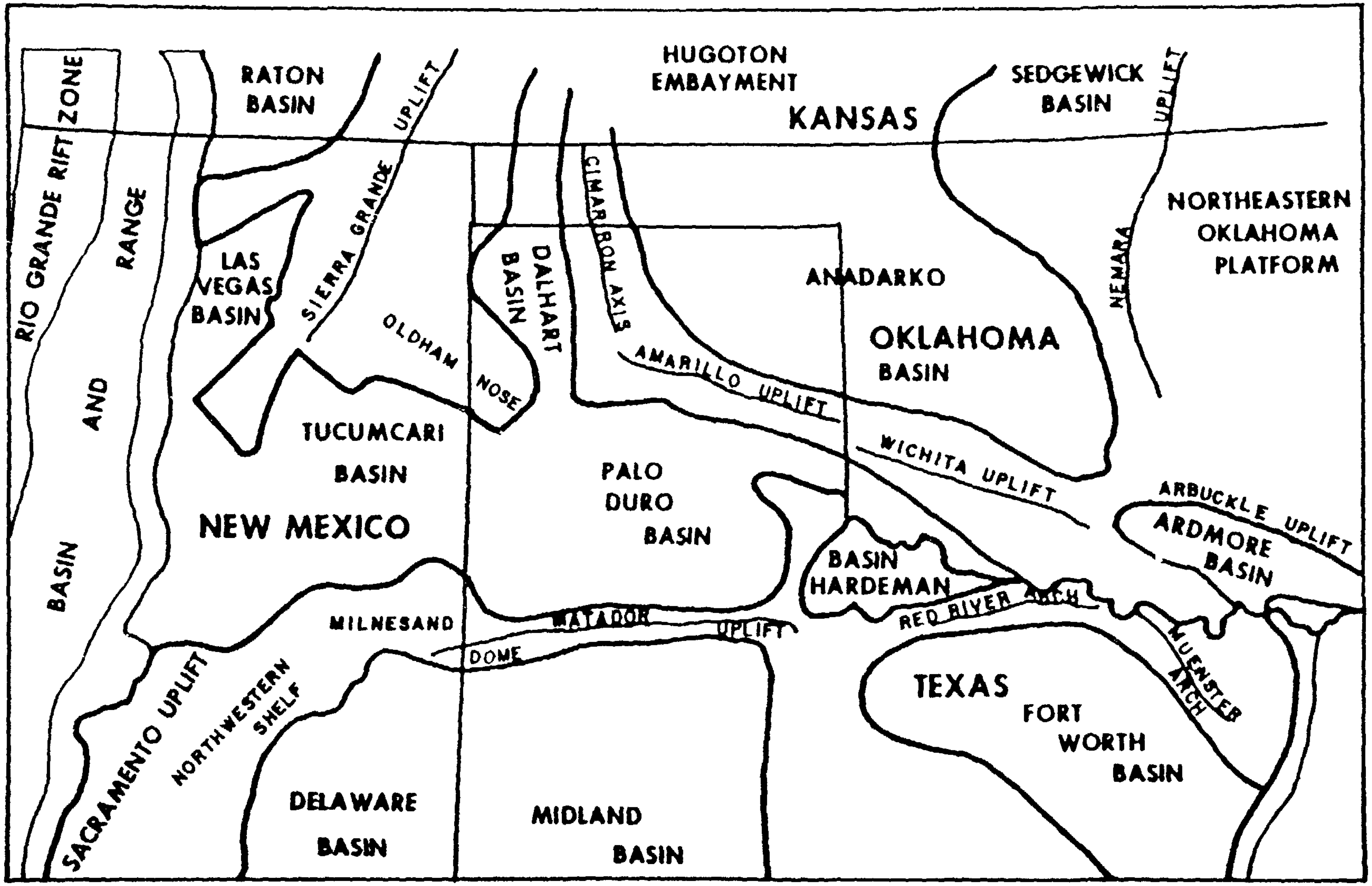
REGIONAL TECTONIC FEATURES



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0 50 100
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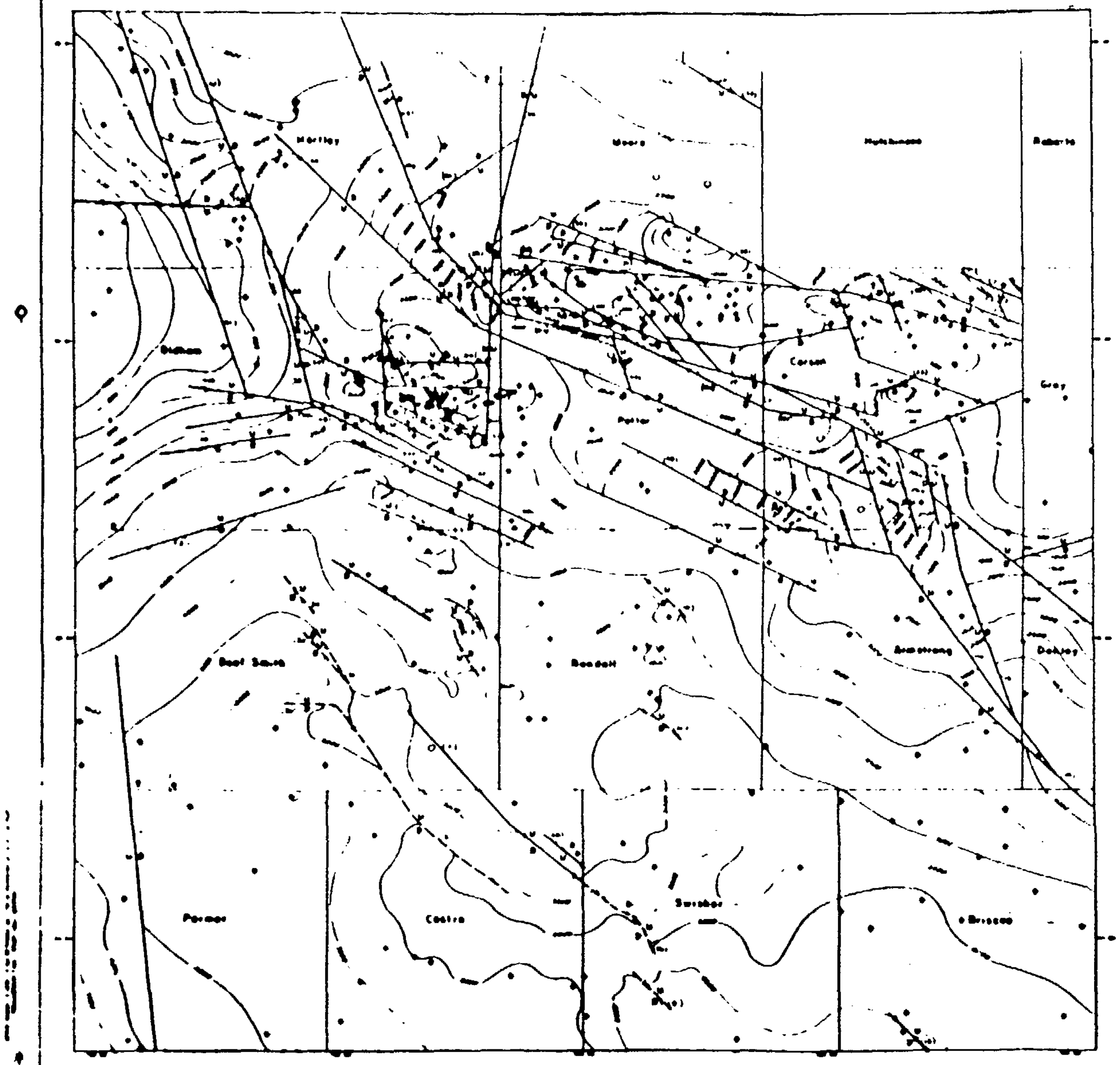

LEGEND

FAULT INTERPRETED FROM GEOPHYSICAL WELL LOG DATA U, UPTHROWN; D, DOWNTHROWN. ARROWS INDICATE AREAS OF MAXIMUM OBSERVED DISPLACEMENT

FAULT INTERPRETED BY LONG (1983) U, UPTHROWN D, DOWNTHROWN ARROWS INDICATE AREAS OF MAXIMUM OBSERVED DISPLACEMENT

STRUCTURE CONTOUR INTERVAL 500 FEET

● WELL CONTROL

○ WELL USED TO CONTROL MAXIMUM ELEVATION OF PRECAMBRIAN SURFACE

(6) FAULT IDENTIFICATION NUMBER

NOTES

1 DATUM IS MEAN SEA LEVEL
2 NUMBERED IDENTIFIED FAULTS REFER TO TABLES 1 & 2
3 SEISMIC DATA FROM LONG 1983

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SCALE MILES

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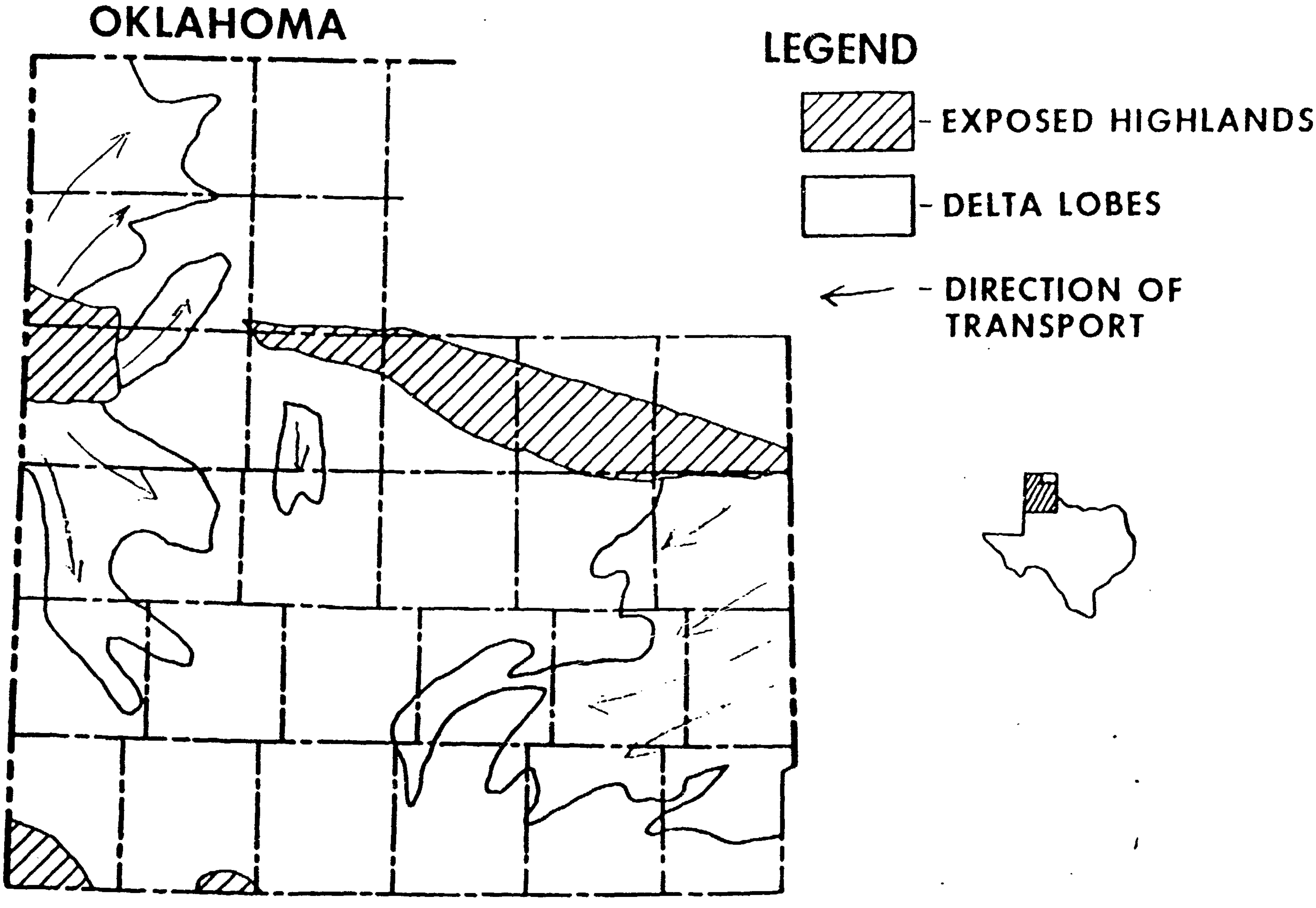
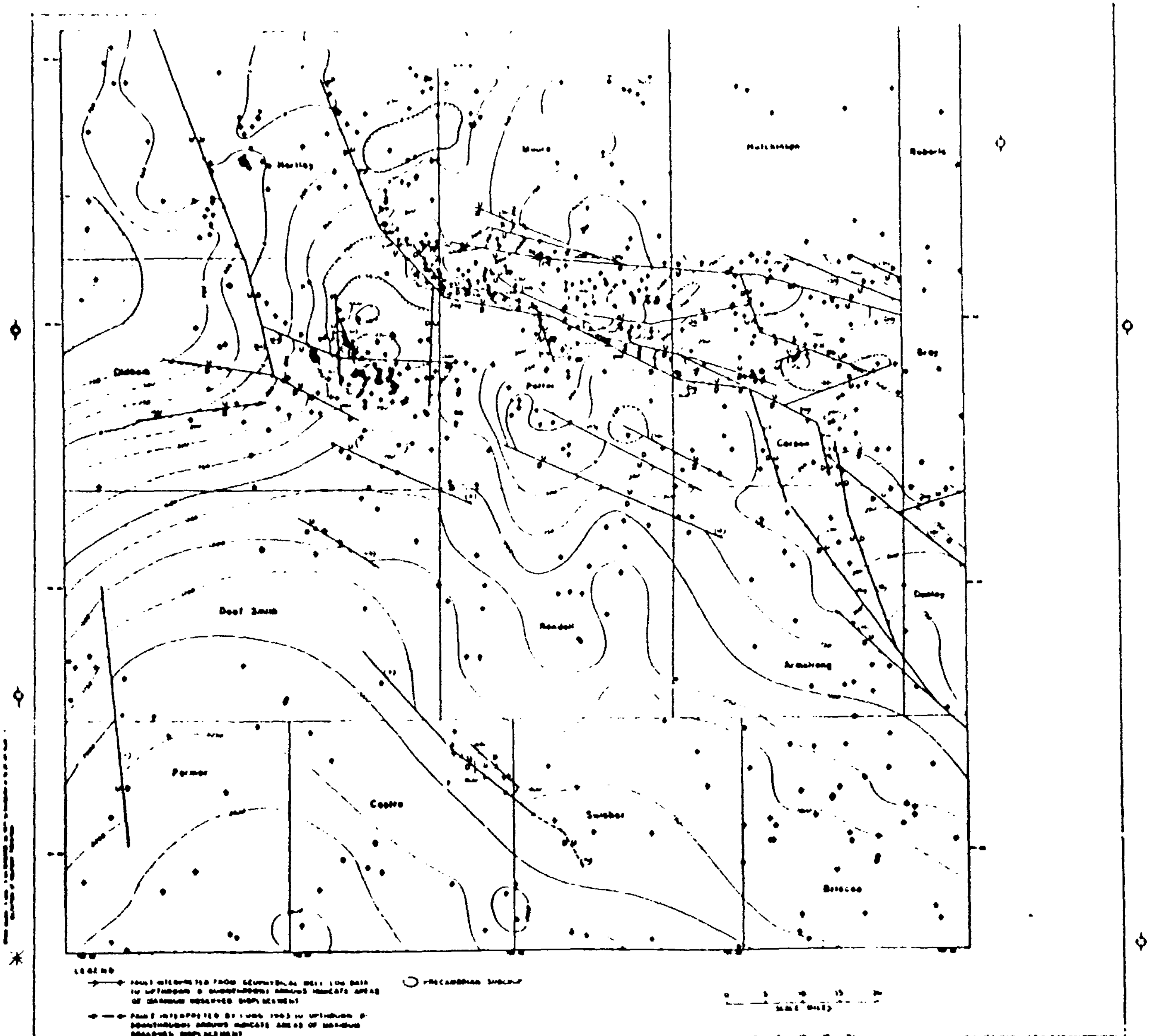
SCALE [illegible]

Structure of Precambrian

Figure [illegible]

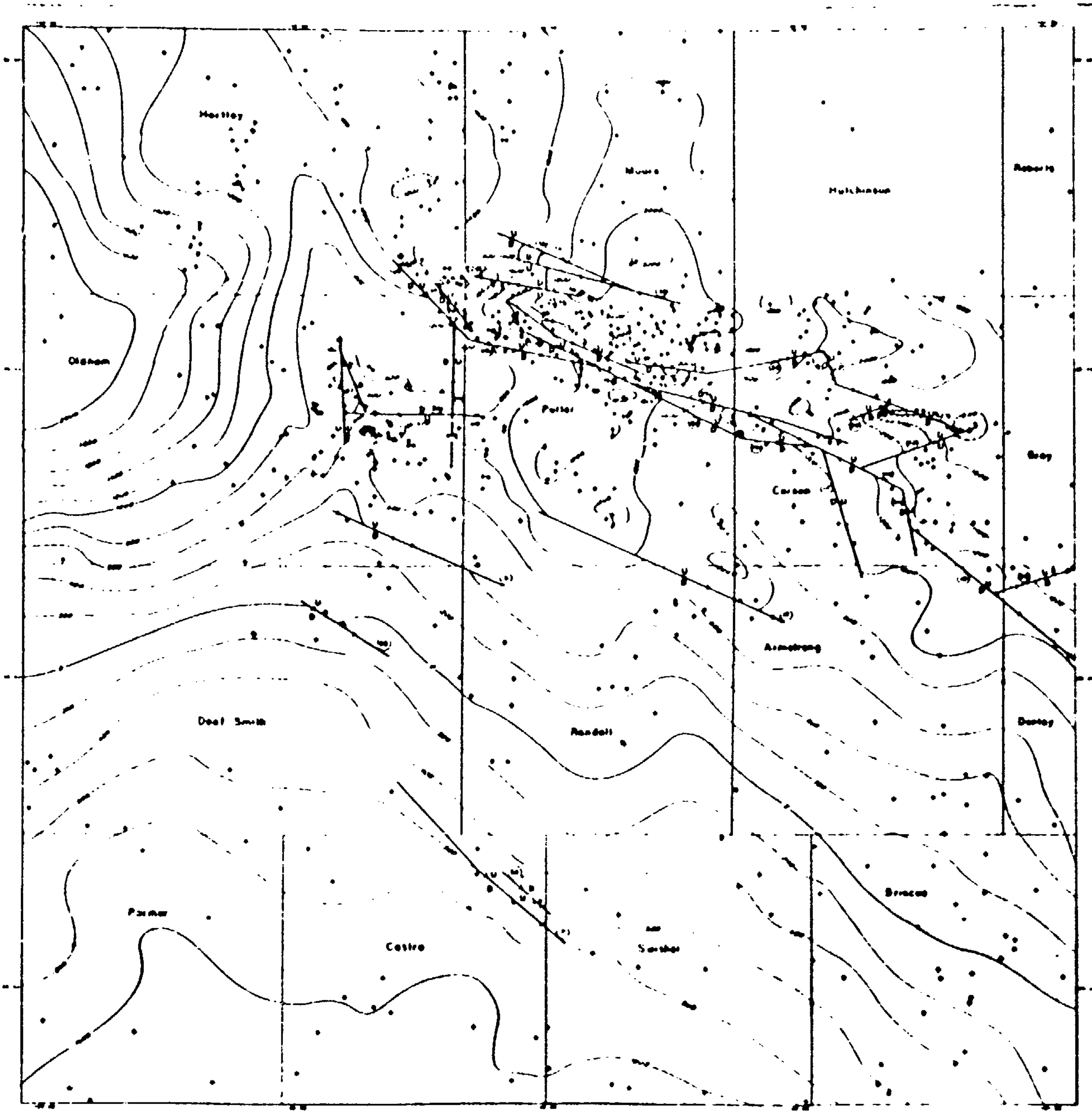
PENNSYLVANIAN DELTAS





Elevation of the Top of the Wolfcamp Series

Figure 6



LEGEND

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- STRUCTURE CONTOUR, INTERVAL 200 FEET
- WELL CONTROL
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NOTES

1. DATUM IS MEAN SEA LEVEL
2. NUMBERS IN PARENTHESES ON FAULTS REFER TO TABLE [illegible]

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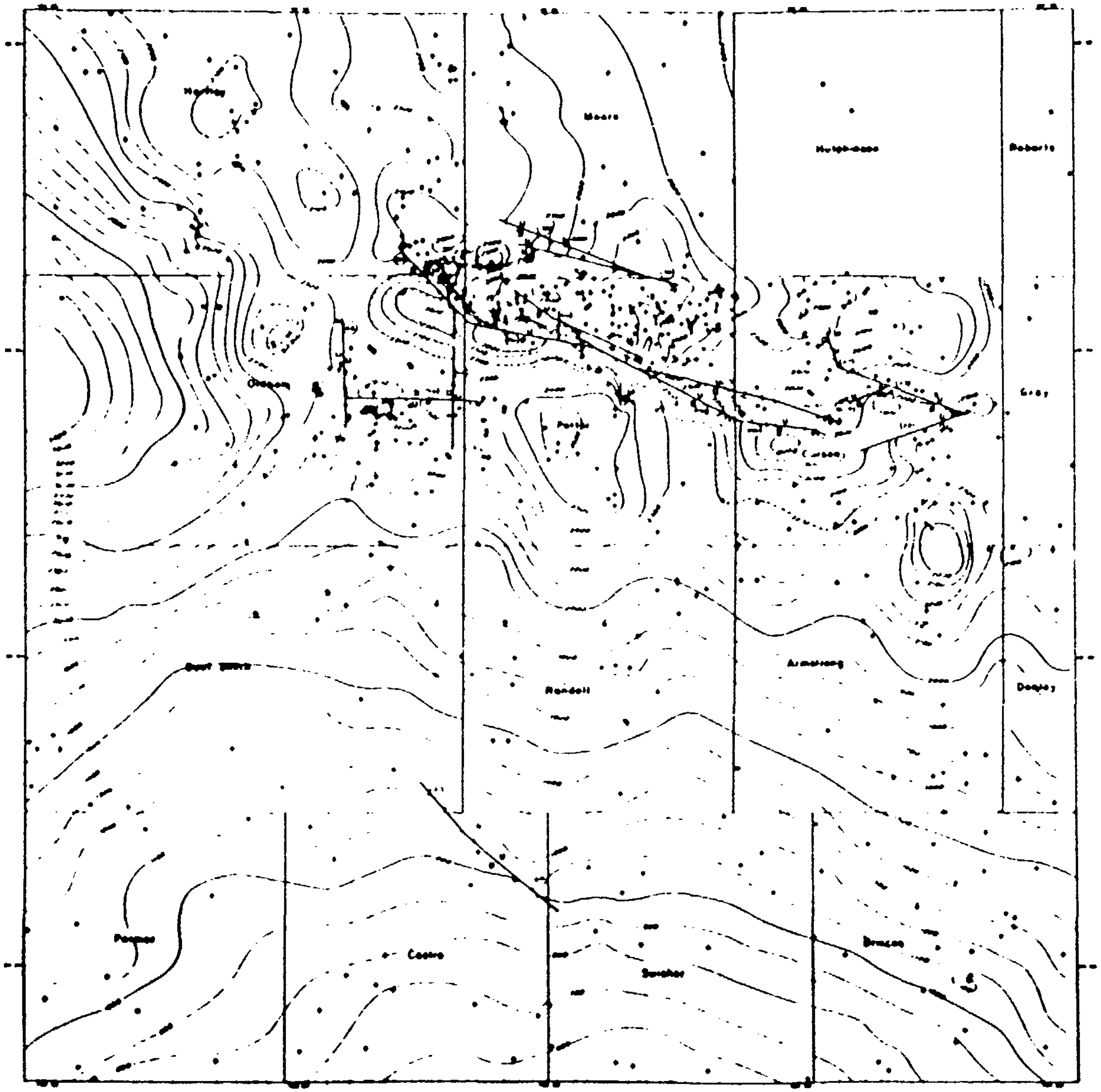
SCALE MILES

Elevation of the Top of the Tubb Formation

[illegible]



LEGEND

- FAULT INTERPRETED FROM GEOPHYSICAL WELL LOG DATA (U UPTHROWN, D DOWNTHROWN) ARROWS INDICATE AREAS WITH MAXIMUM OBSERVED DISPLACEMENT
- -100 STRUCTURE CONTOUR INTERVAL 100 FEET
- ● WELL CONTROL
- ●5 FAULT IDENTIFICATION NUMBER

NOTES

1 DATUM IS MEAN SEA LEVEL
2 NUMBERS IDENTIFYING FAULTS REFER TO TABLES 1&2

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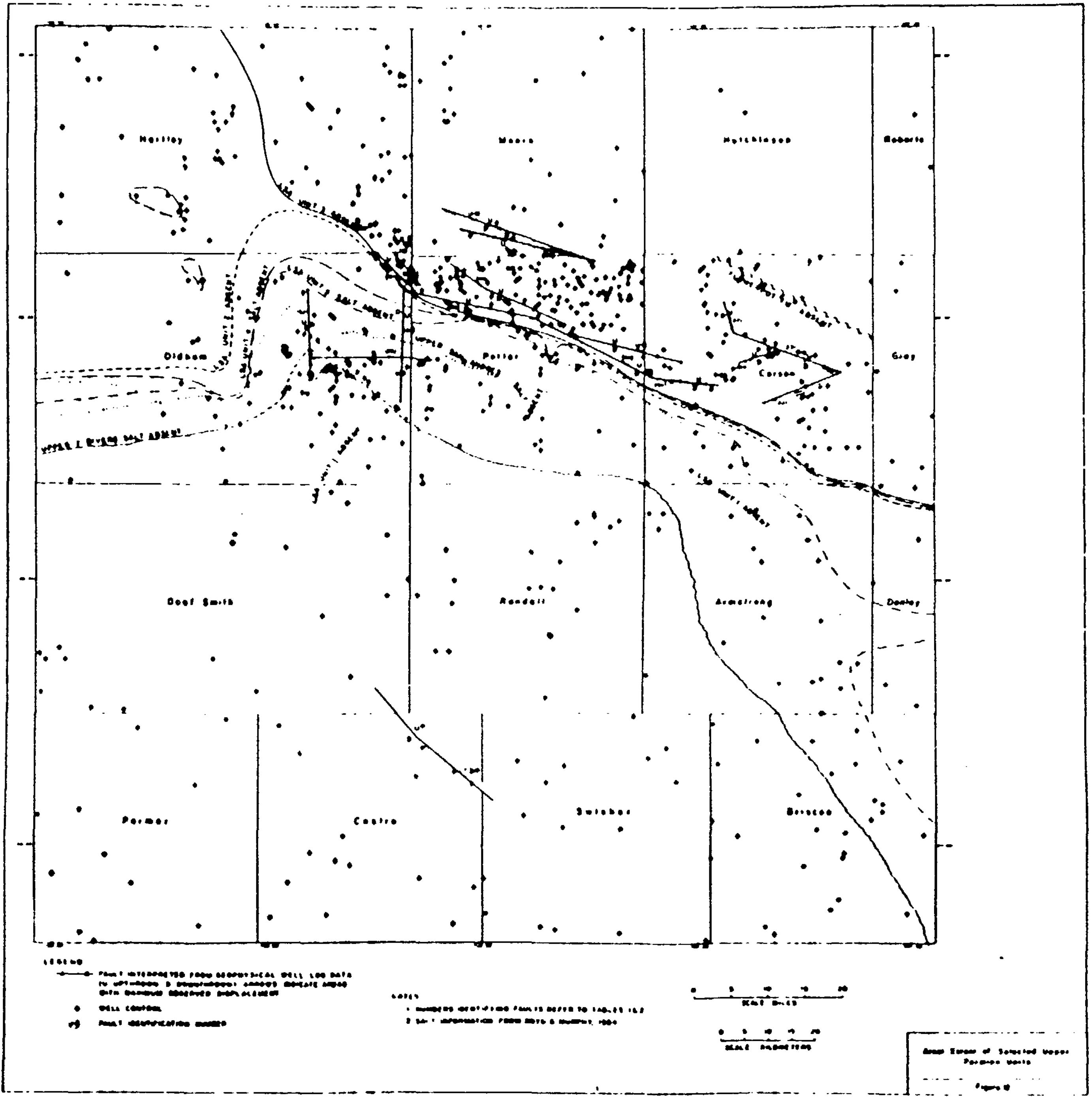
SCALE - KILOMETERS

Elevation of the Top of the Lower San Andres Formation

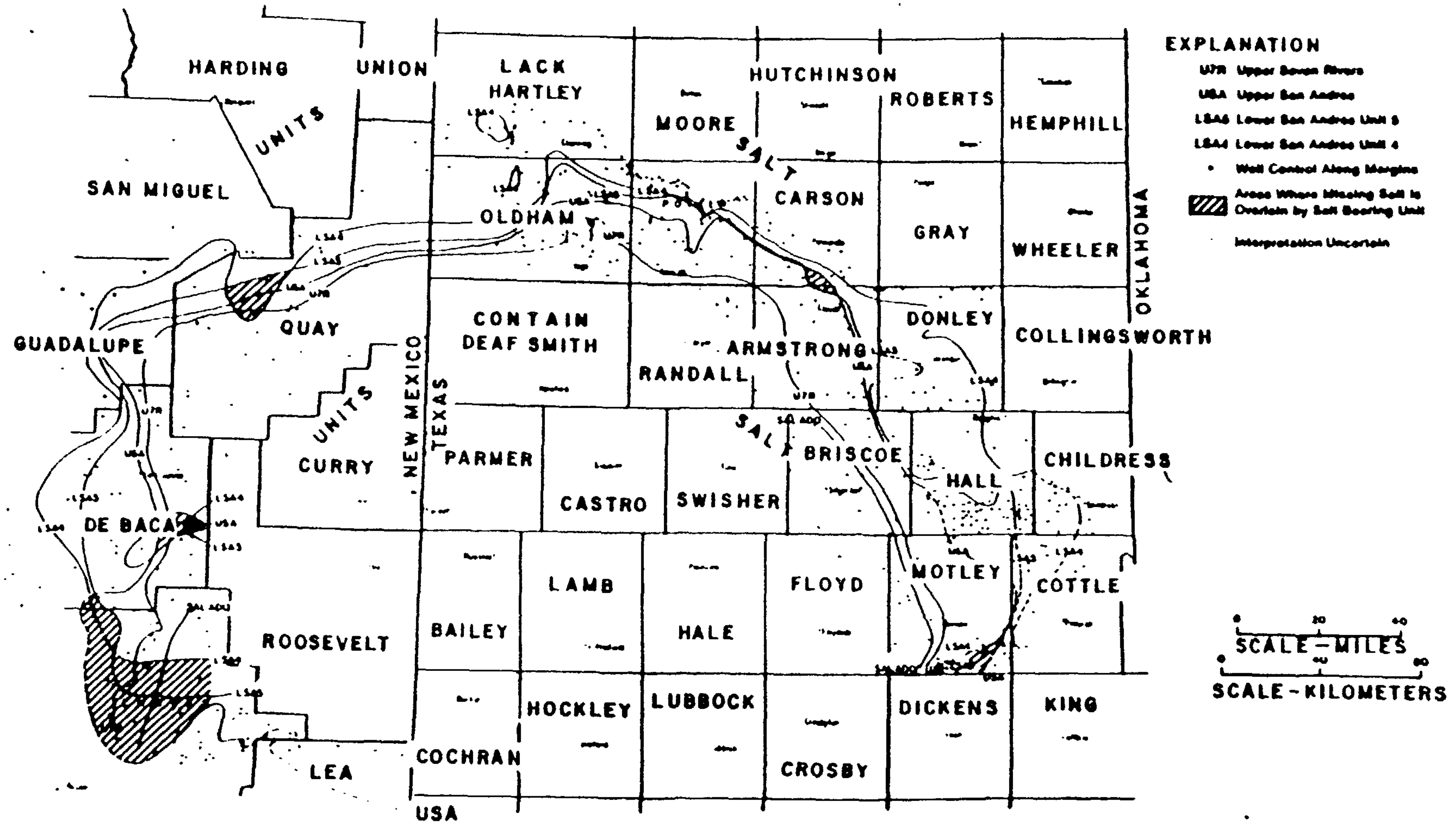
Figure 9



Areal Extent of Selected Upper Permian Units

Figure 8

SALT MARGINS



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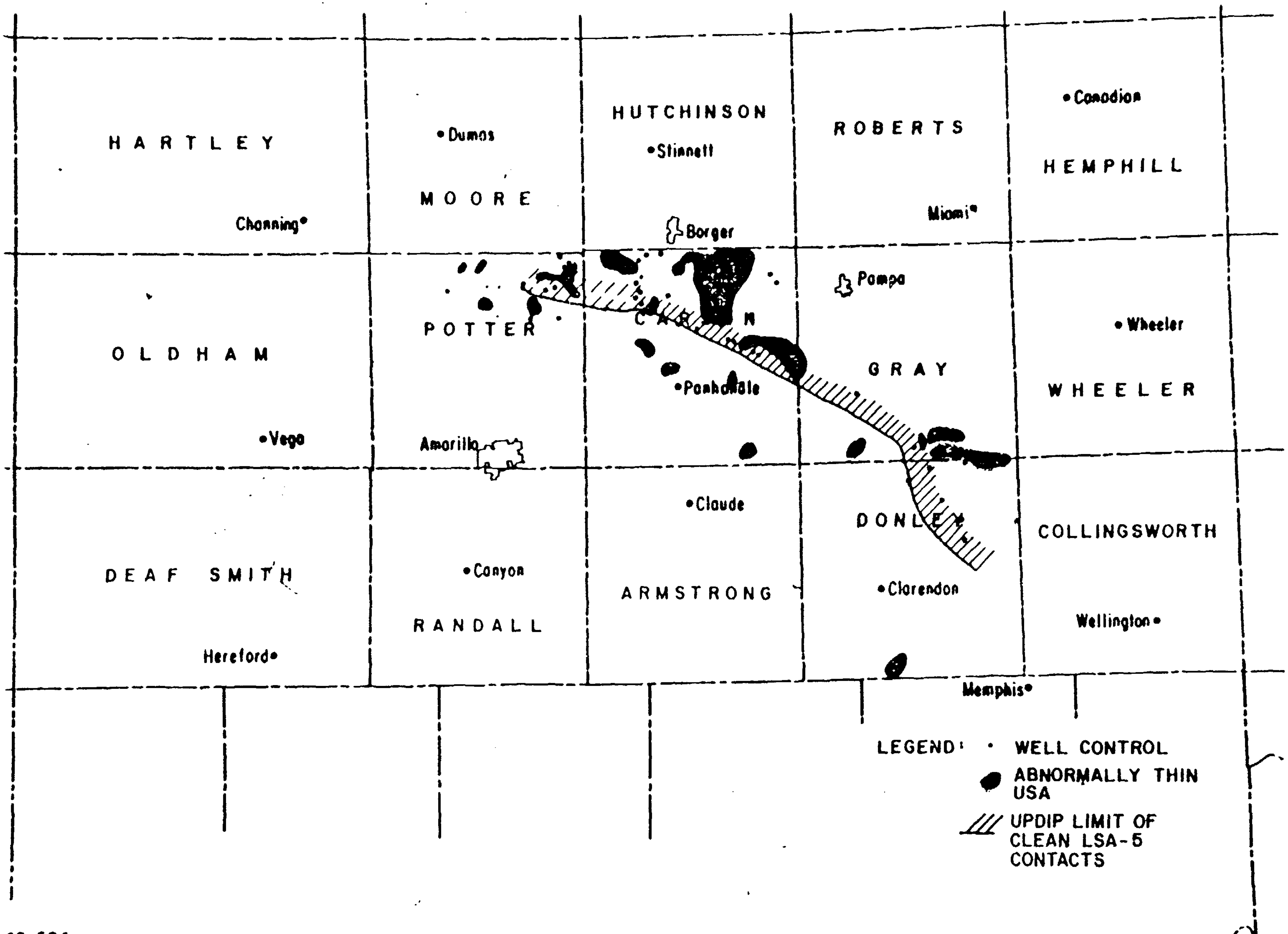
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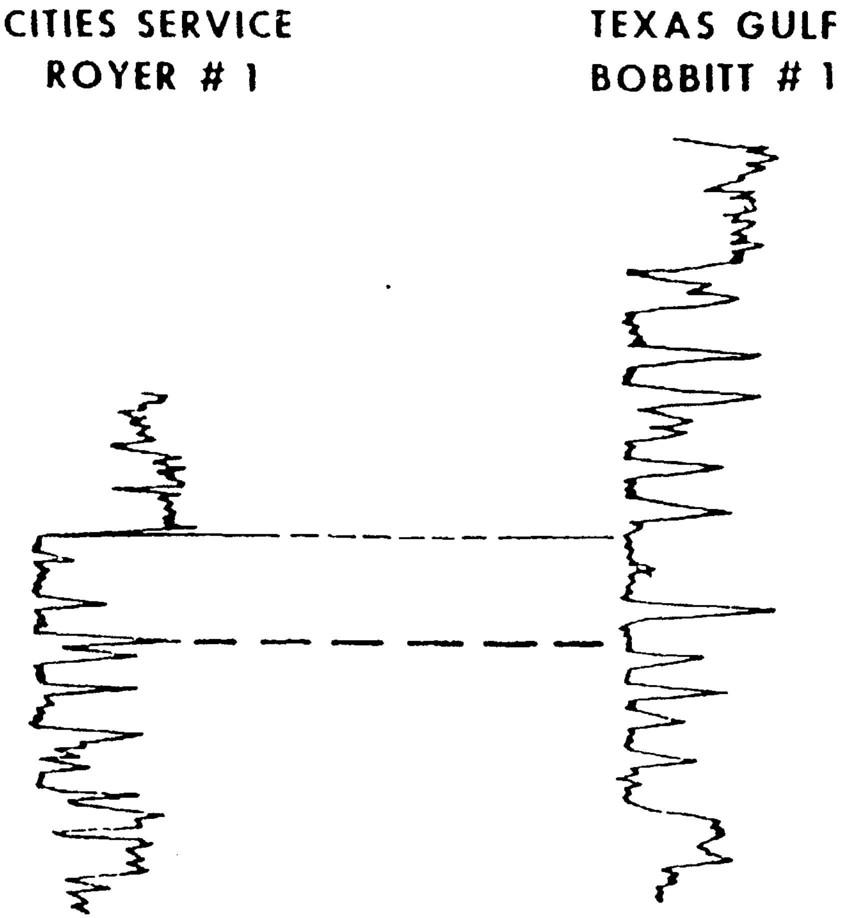
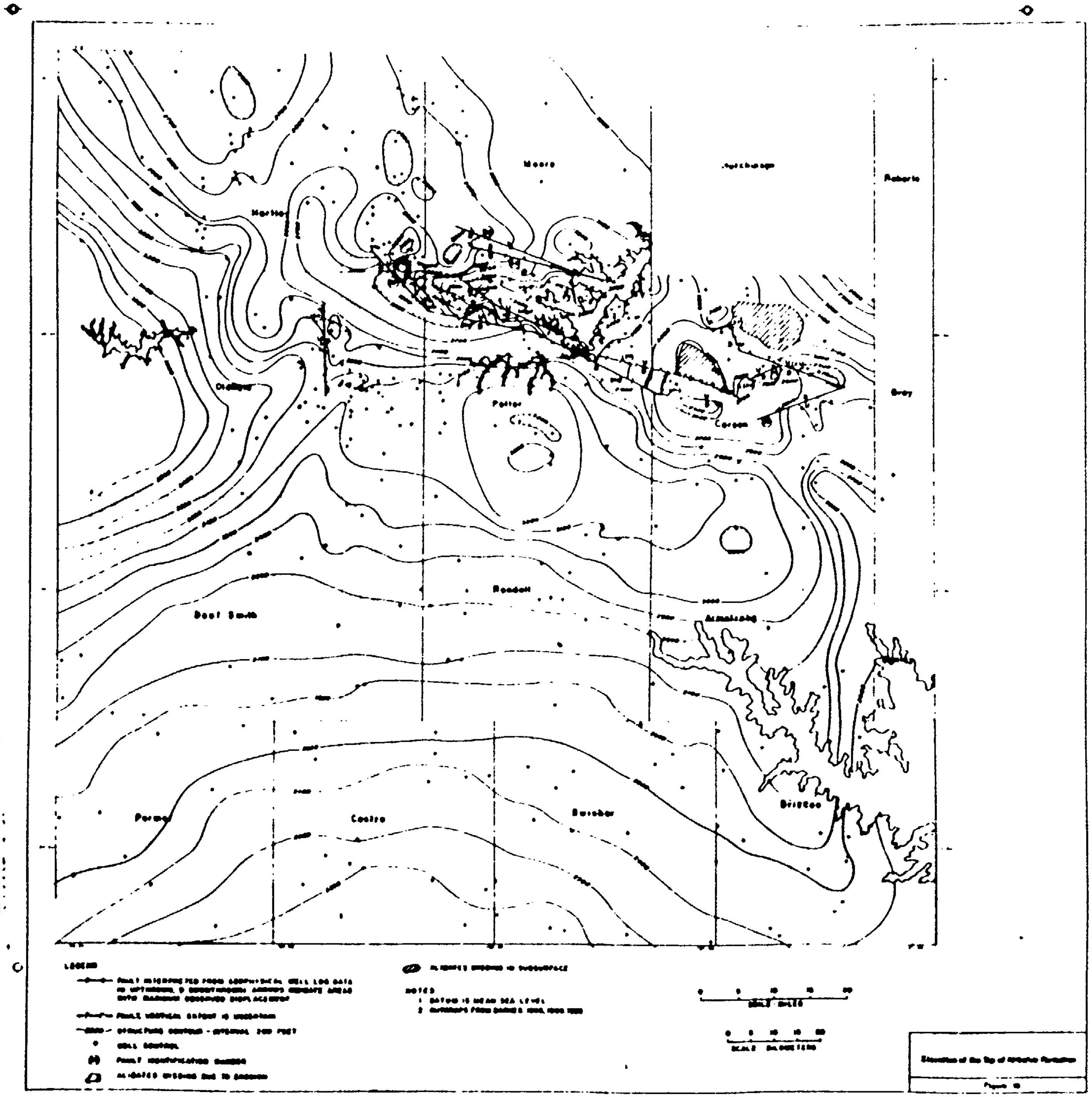
MOORE
HUTCHINSON
ROBERTS
HEMPHILL
Dumas
Stinnett
Canadian
Channing
Borger
Miami
Pampa
OLDHAM
POTTER
CARSON
GRAY
WHEELER
Wheeler
Panhandle
Vega
Amarillo
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
COLLINGSWORTH
Claude
Canyon
Clarendon
Wellington
Hereford
Memphis
LEGEND:
WELL CONTROL
ABNORMALLY THIN USA
UPDIP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

30, 594

SHORT VS. AVERAGE
USA NON SALT SECTION



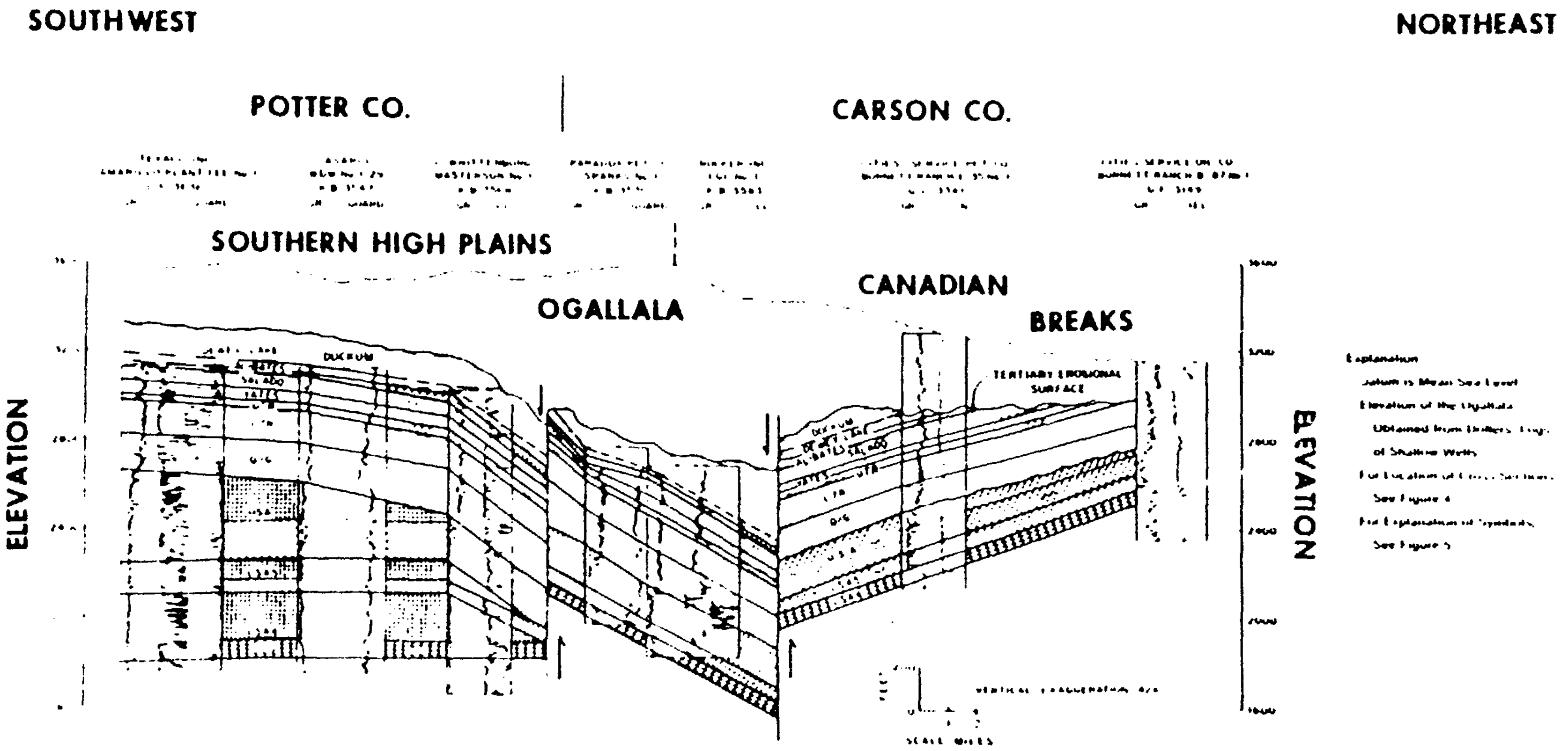
BOTH WELLS IN CARSON CO.

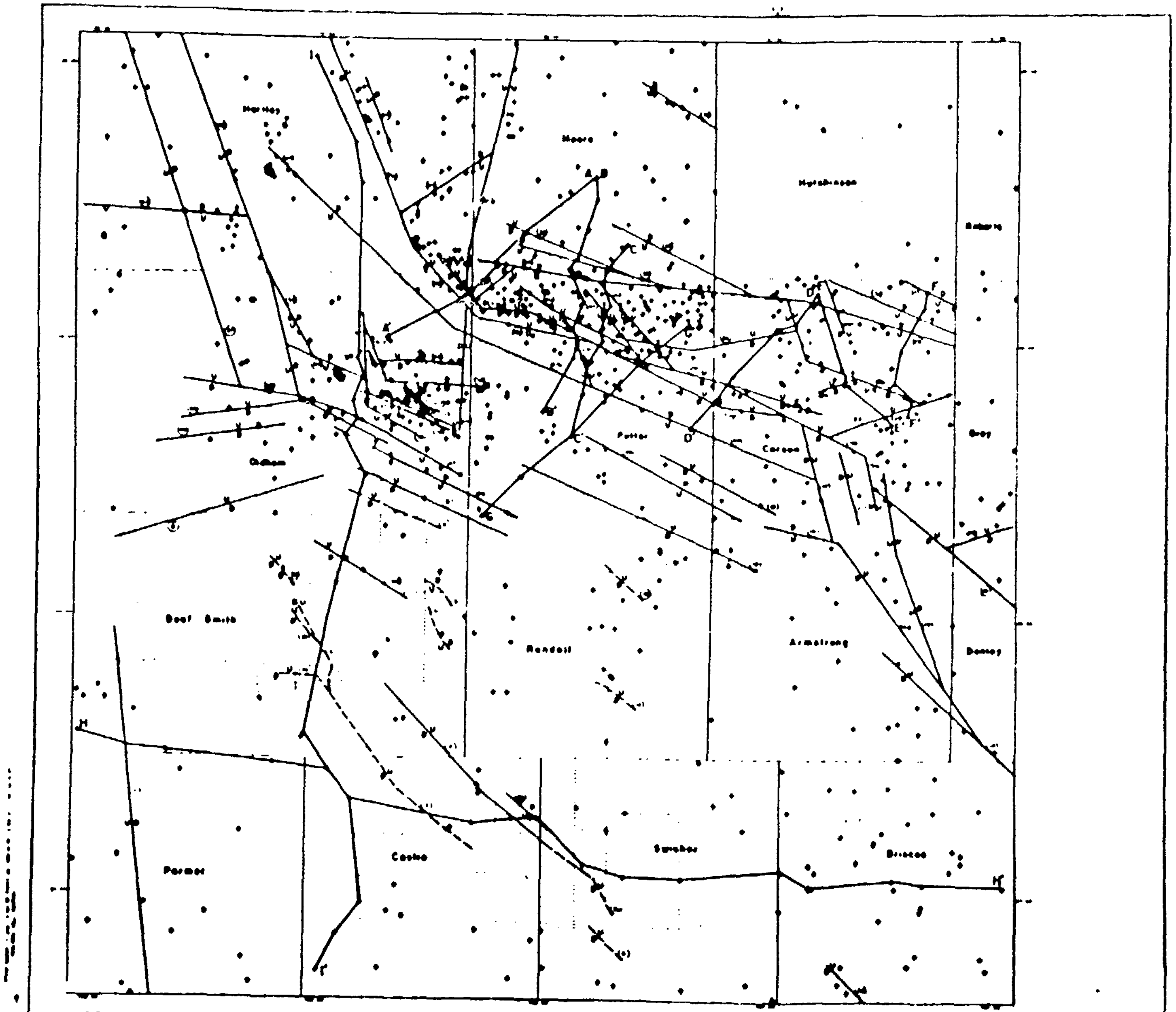


Elevation of the Top of Alibates Formation

Figure 10

CROSS SECTION H





LEGEND

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- WELL CONTROL
- FAULT INTERPRETED FROM GEOPHYSICAL WELL LOG DATA (U UPTHROWN, D DOWNTHROWN)
- FAULT INTERPRETED BY [illegible] (U UPTHROWN, D DOWNTHROWN)
- FAULT IDENTIFICATION NUMBER

NOTES

1. NUMBERED IDENTIFIED FAULTS REFER TO TABLES 1&2

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SCALE MILES

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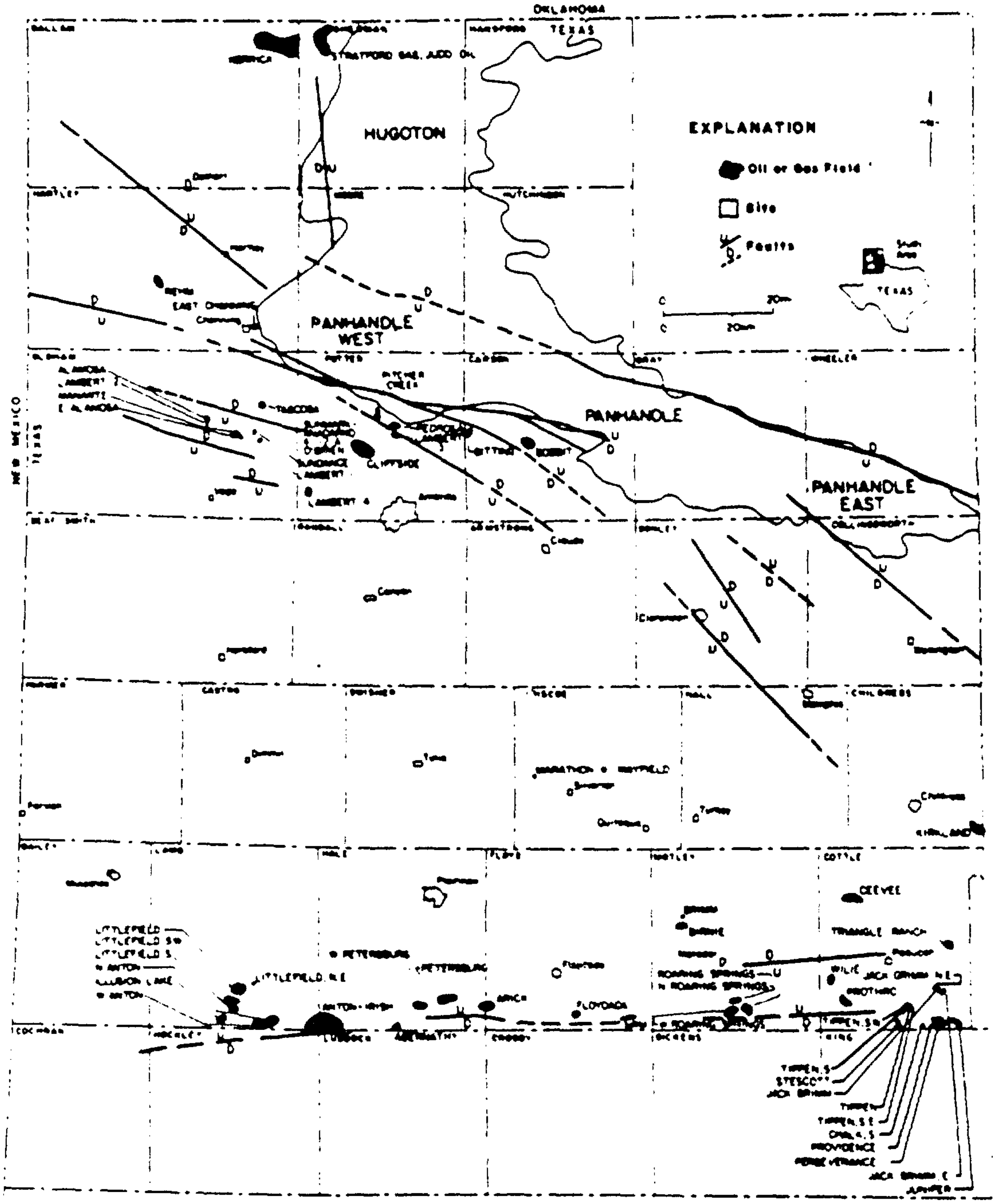
SCALE KILOMETERS

Index Map of Study Area

Figure [illegible]

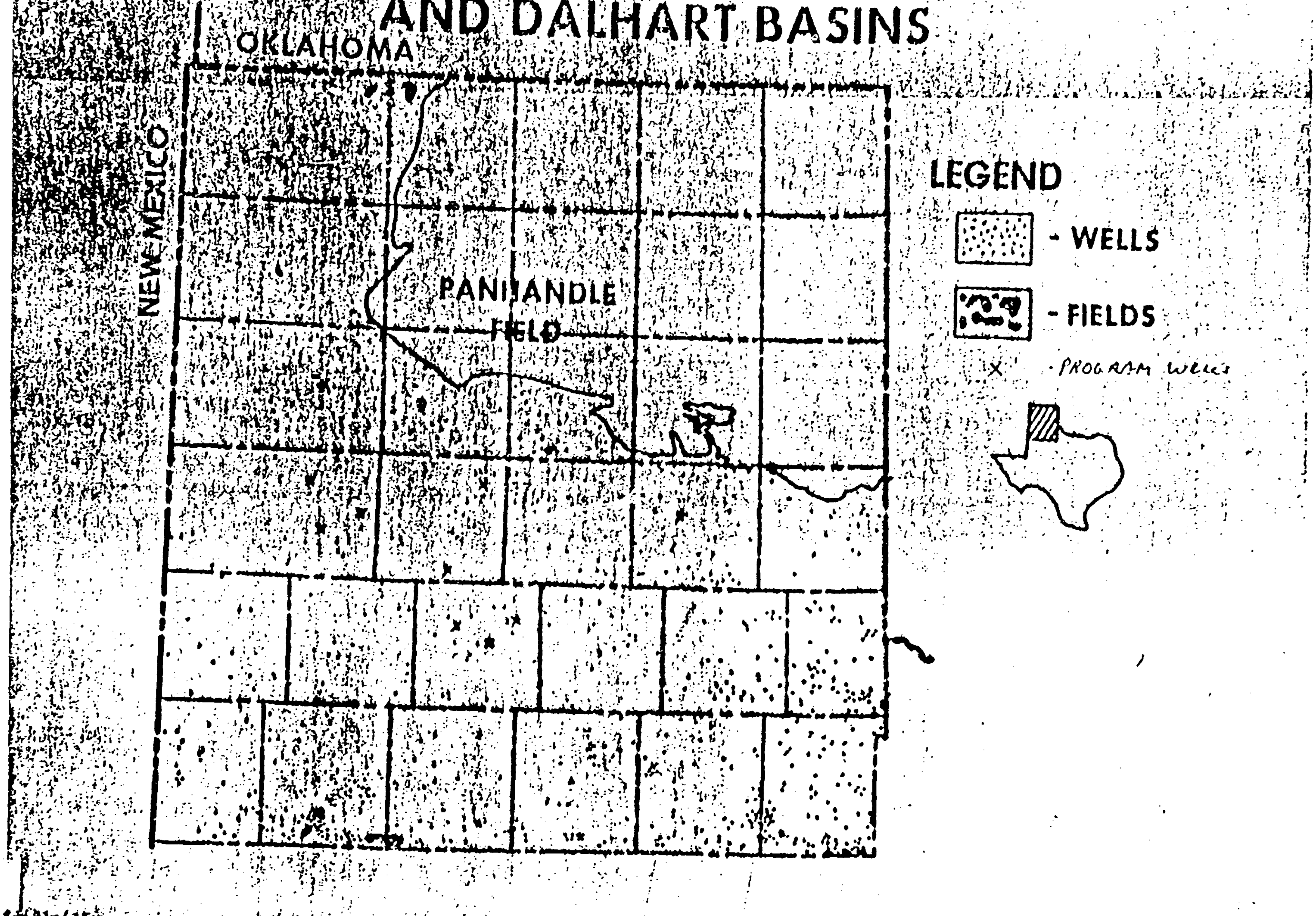


Location of Oil and Gas Fields in the Palo Duro Basin and Surrounding Areas.

Source: Dutton, Goldstein and Ruppel, 1982

Figure 3-3

WELLS IN THE PALO DURO AND DALHART BASINS



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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

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

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

c. Drill Stem Tests (DSTs)

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

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

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

f. Dissolution Zone Water Well

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

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

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

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

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

MAJOR SALT SECTION

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

- 1035 ft to 1144 ft - Salado
- 1885 ft to 3102 ft - Queen/Grayburg, Upper San Andres, Lower San Andres Units 5, 4, 3, and Upper Section of Unit 2.
- 5309 ft to 5780 ft - Wichita/Wolfcamp Contact and Upper Wolfcamp
- 5910 ft to 6058 ft - Wolfcamp
- 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. <u>J. Friemel No. 1</u> - Deaf Smith County, started October 15, 1982, completed March 18, 1983. T.D. 8283 ft, pump testing scheduled to start June 1983..

a. <u>Casing Program</u> - 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. <u>Rock Coring</u> (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

<u>MAJOR SALT SECTION</u>

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. <u>Drill Stem Tests (DSTs)</u>

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. <u>Geophysical Logging</u> - Complete suites of open and cased hole logs.

e. <u>Long-Term Pump Testing and Fluid Sampling</u>

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.

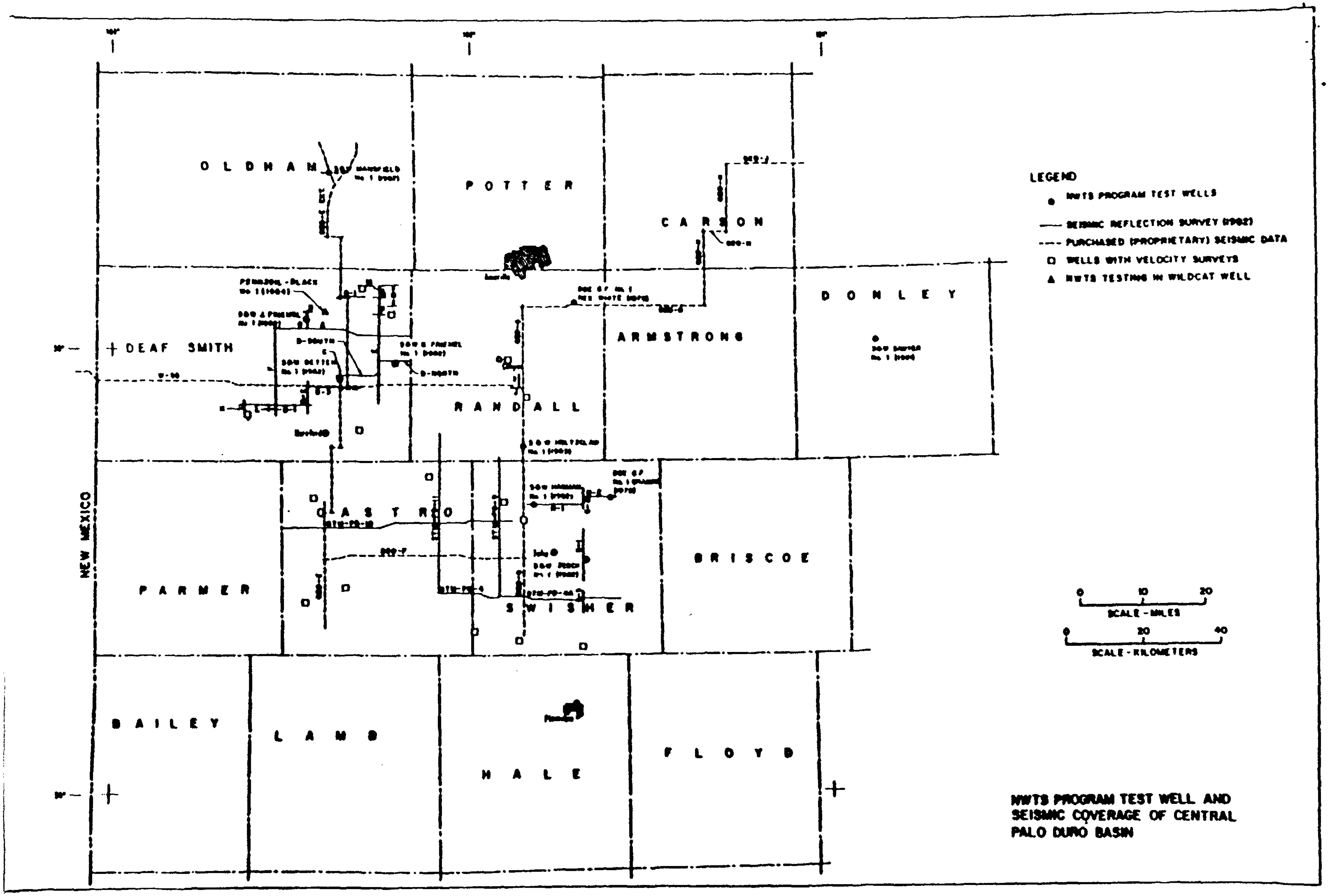
d. Geophysical Logging - Complete suites to T.D. planned.

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

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PALO DURO BASIN STRATIGRAPHIC STUDIES

BUREAU OF ECONOMIC GEOLOGY

UNIT	MAJOR CONTRICUTORS
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

			Palo Duro Basin	Dalhart Basin	General Lithology and depositional setting
SYSTEM	SERIES	GROUP	FORMATION	FORMATION	
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).

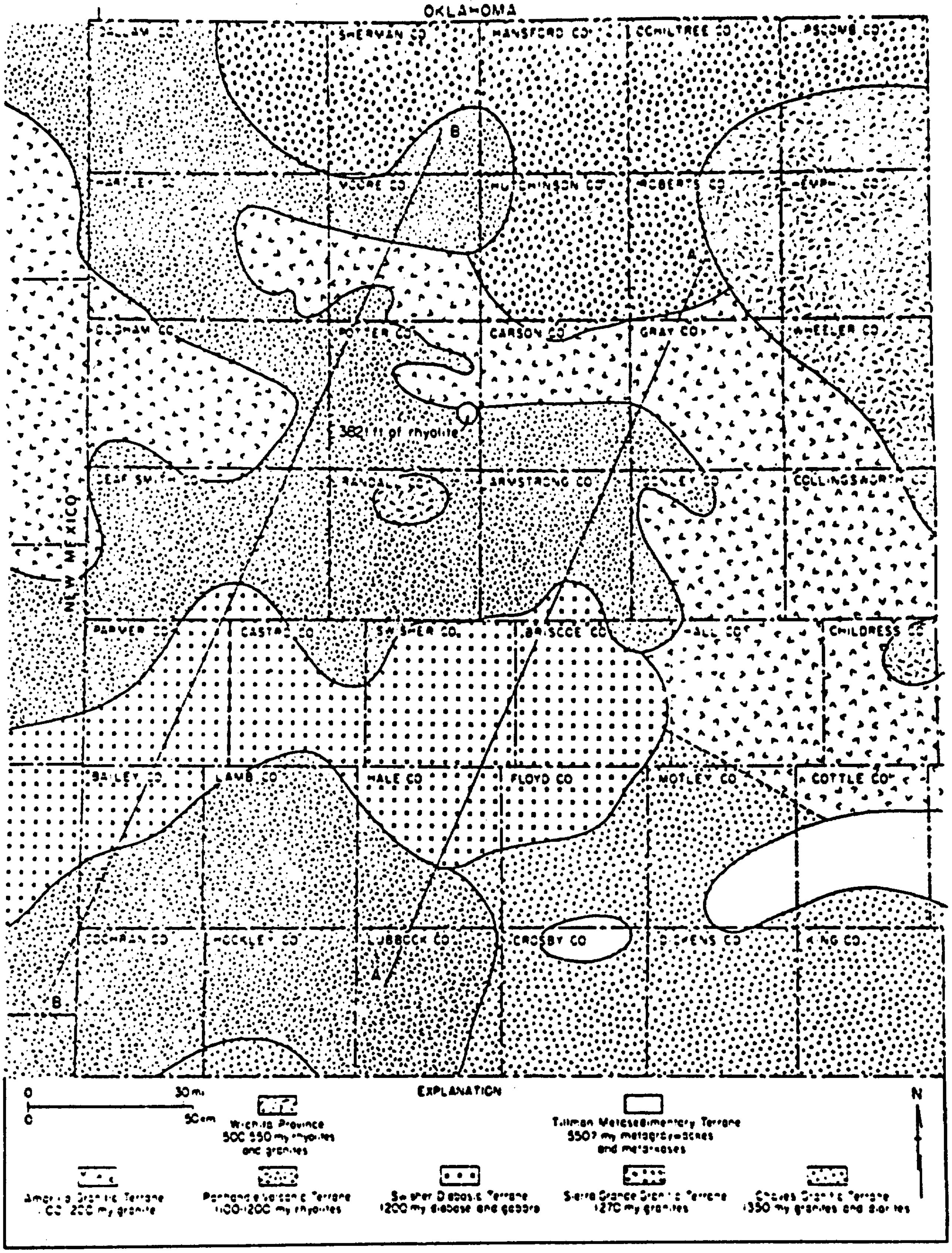
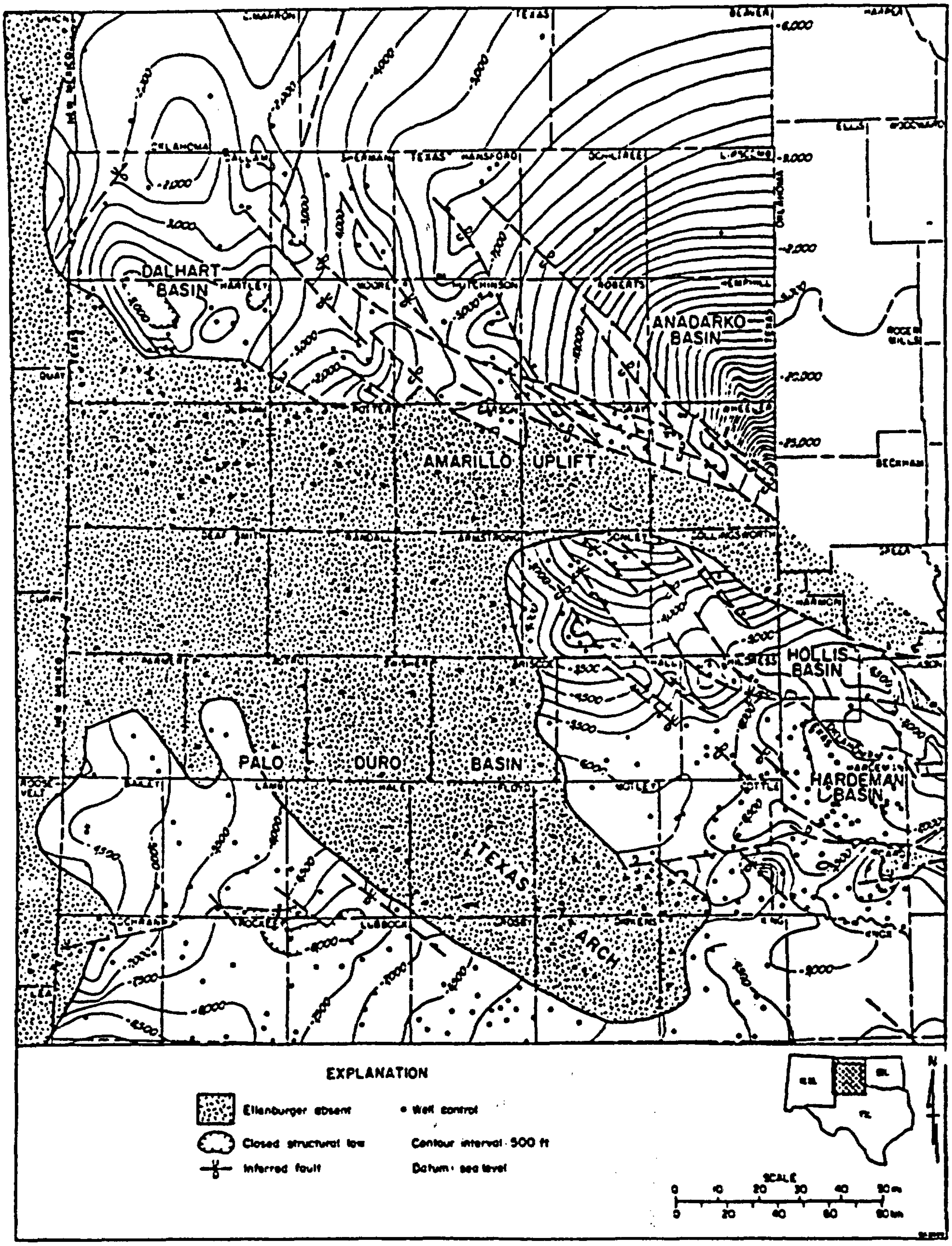
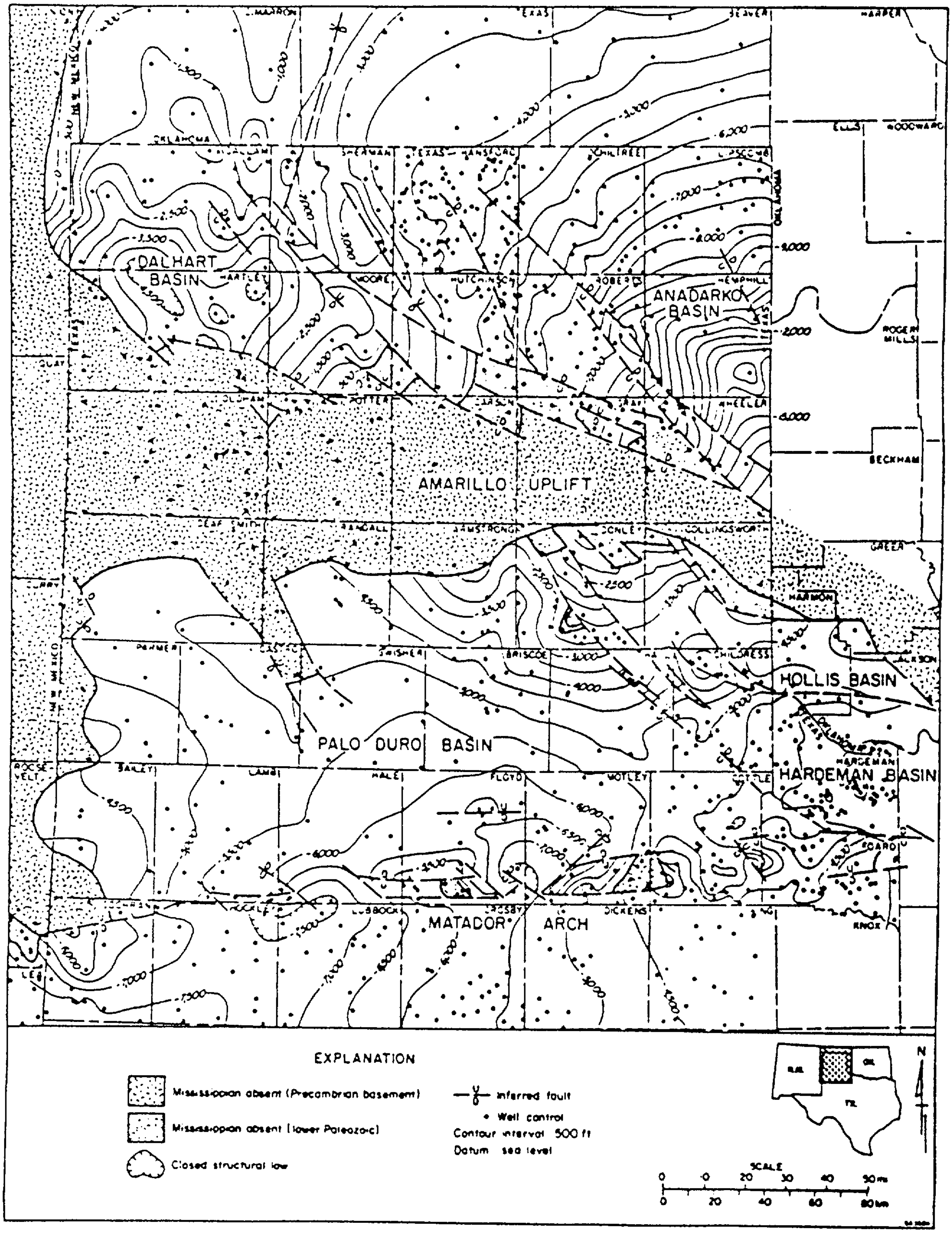


Figure 42. Basement lithologic provinces in the Texas Panhandle (from Muehlberger and others, 1967). A-A' and B-B' are locations of gravity models discussed in this report (see figs. 43 and 44).

ORDOVICIAN ELLENBURGER GROUP: STRUCTURE MAP



MISSISSIPPIAN SYSTEM: STRUCTURE MAP



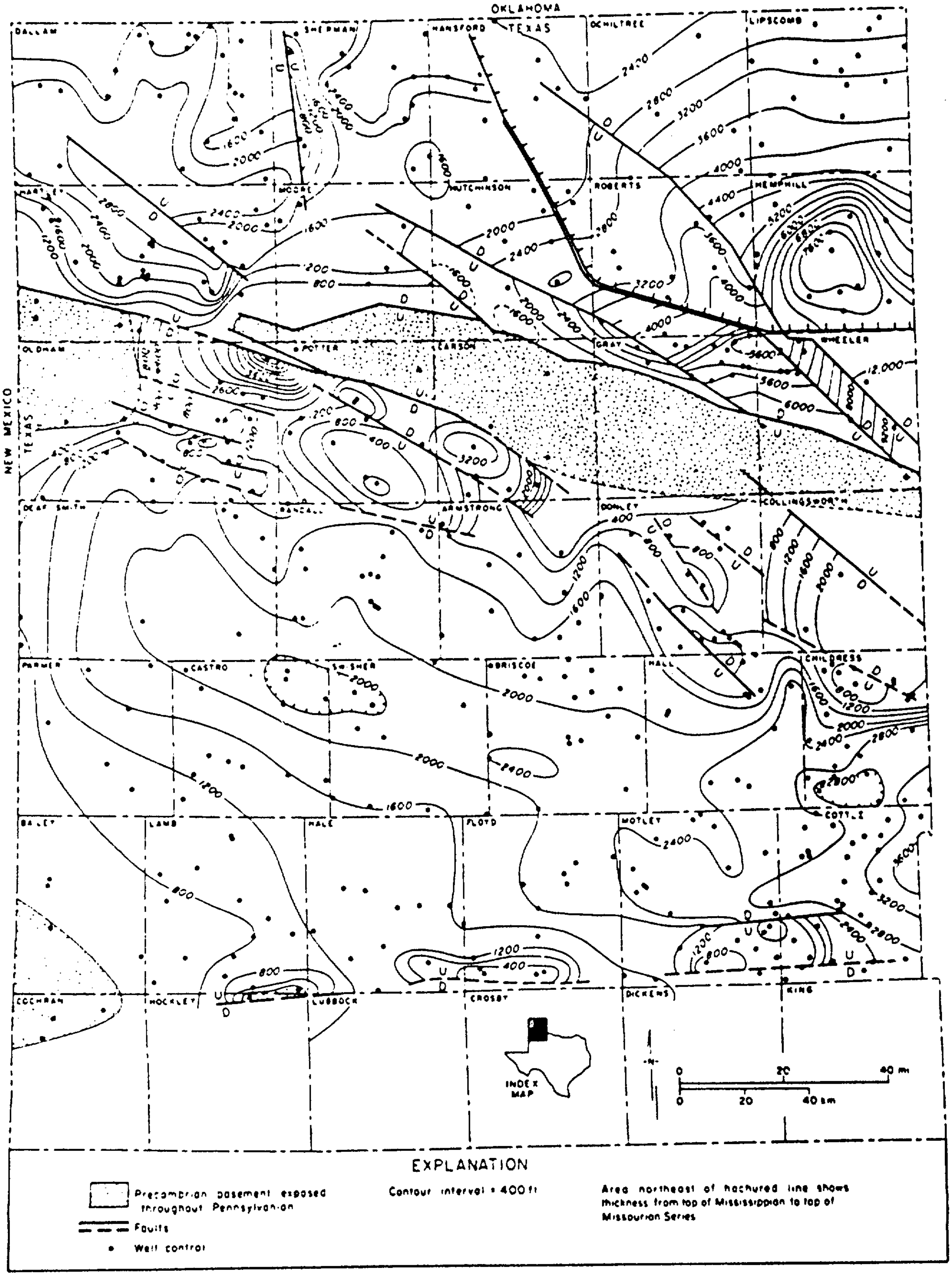


Figure 14. Isopach map of Pennsylvanian System, Texas Panhandle. Sediments thin onto uplifts that were exposed during Pennsylvanian Period.

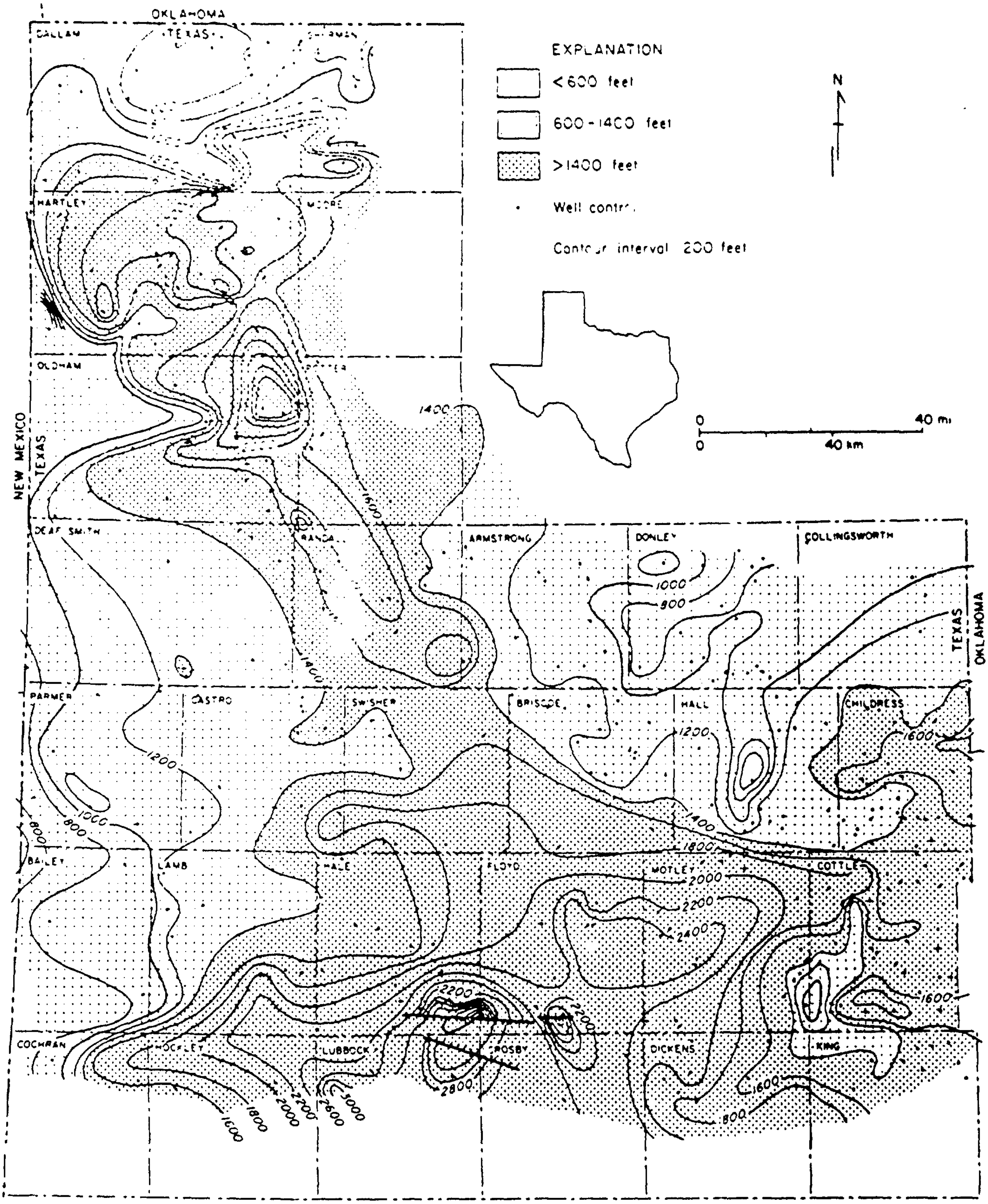


Figure 16. Isopach map of Wolfcampian Series, Palo Duro Basin (Handford, unpublished data).

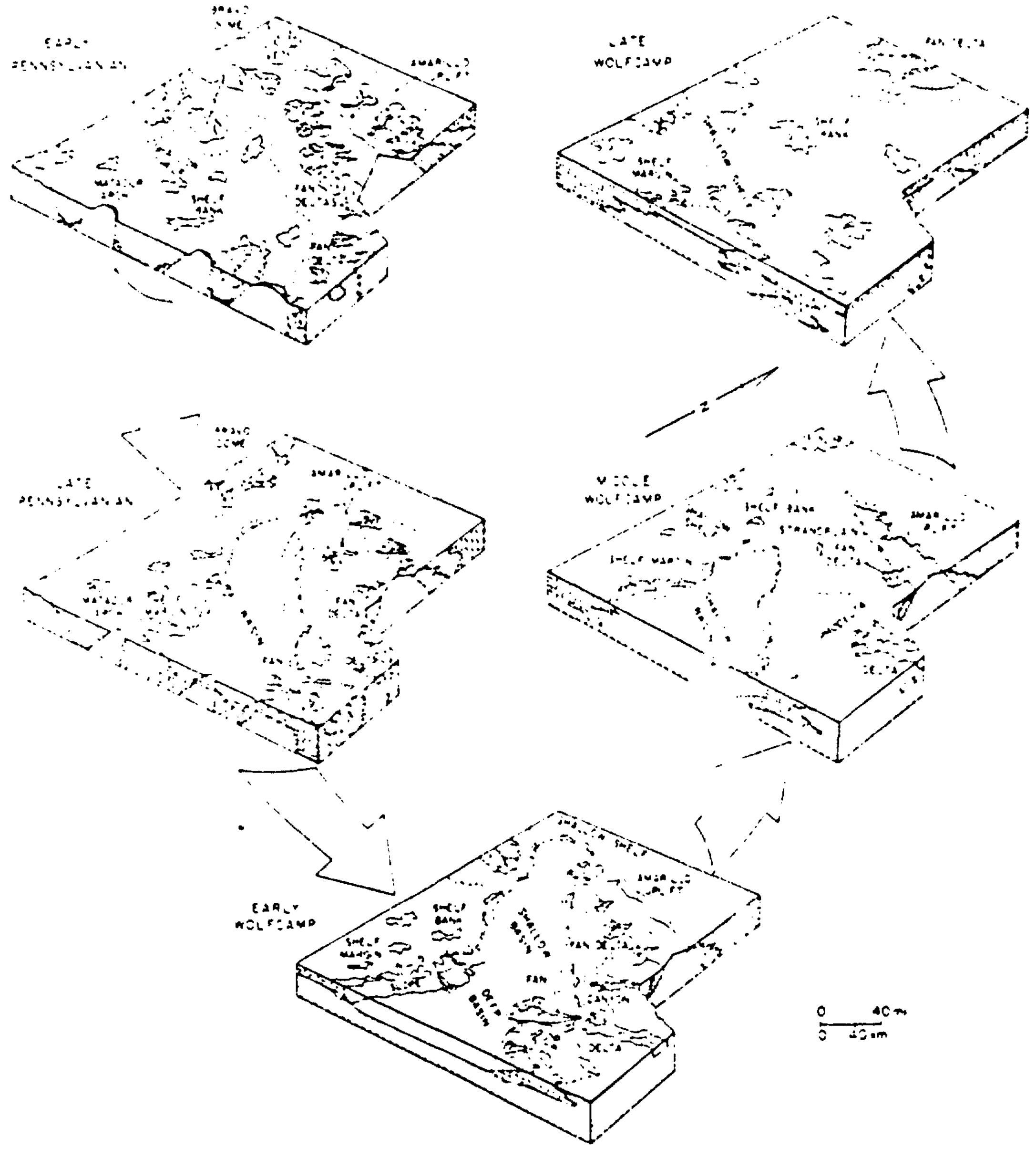


Figure 23. Block diagrams of paleogeographic evolution of Palo Duro Basin during Pennsylvanian and Wolfcampian time (from Handford and Dutton, 1980).

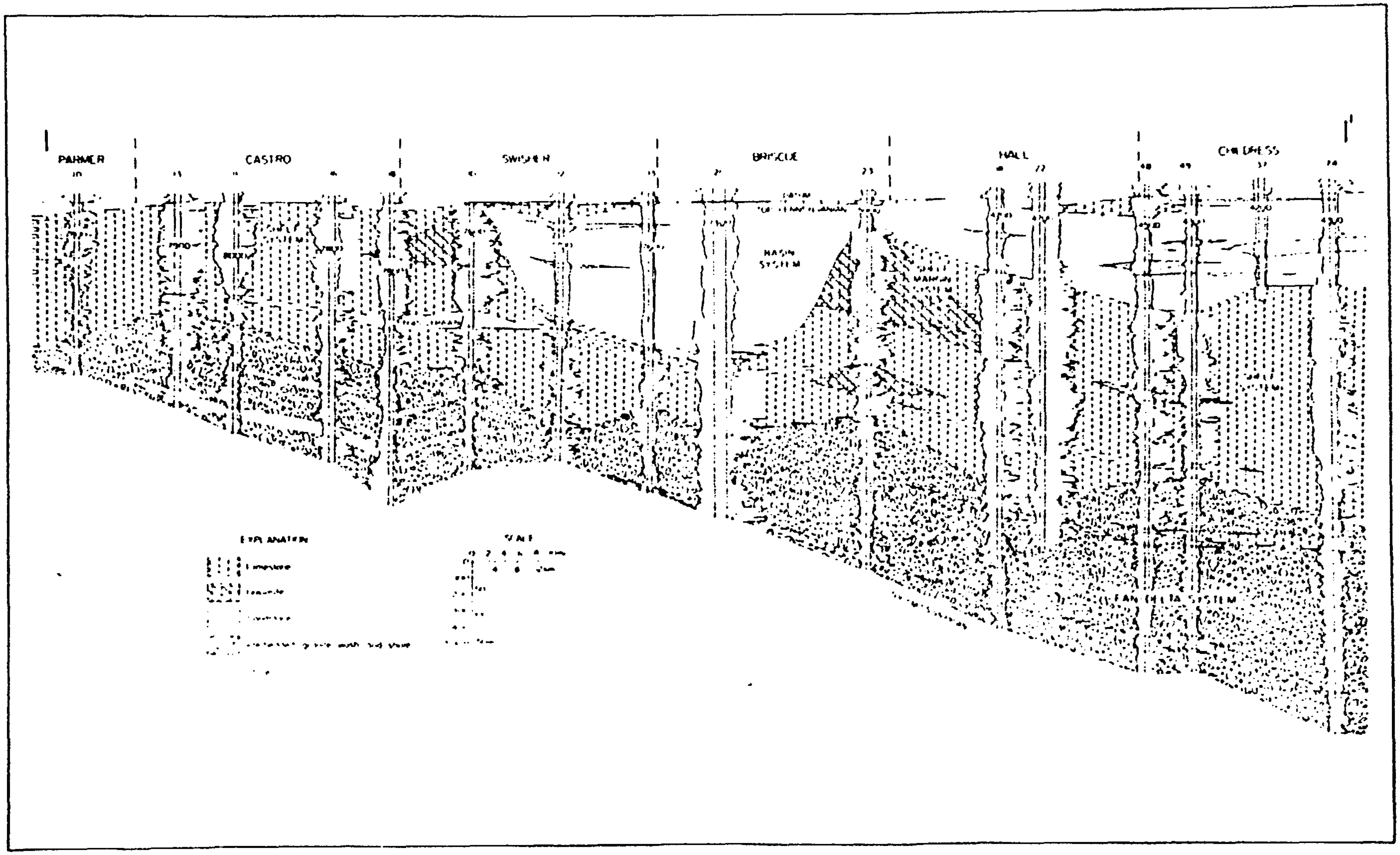


Figure 25. East-west cross section I-I' of Pennsylvanian strata, Parmer to Childress Counties (see fig. 3 for location).

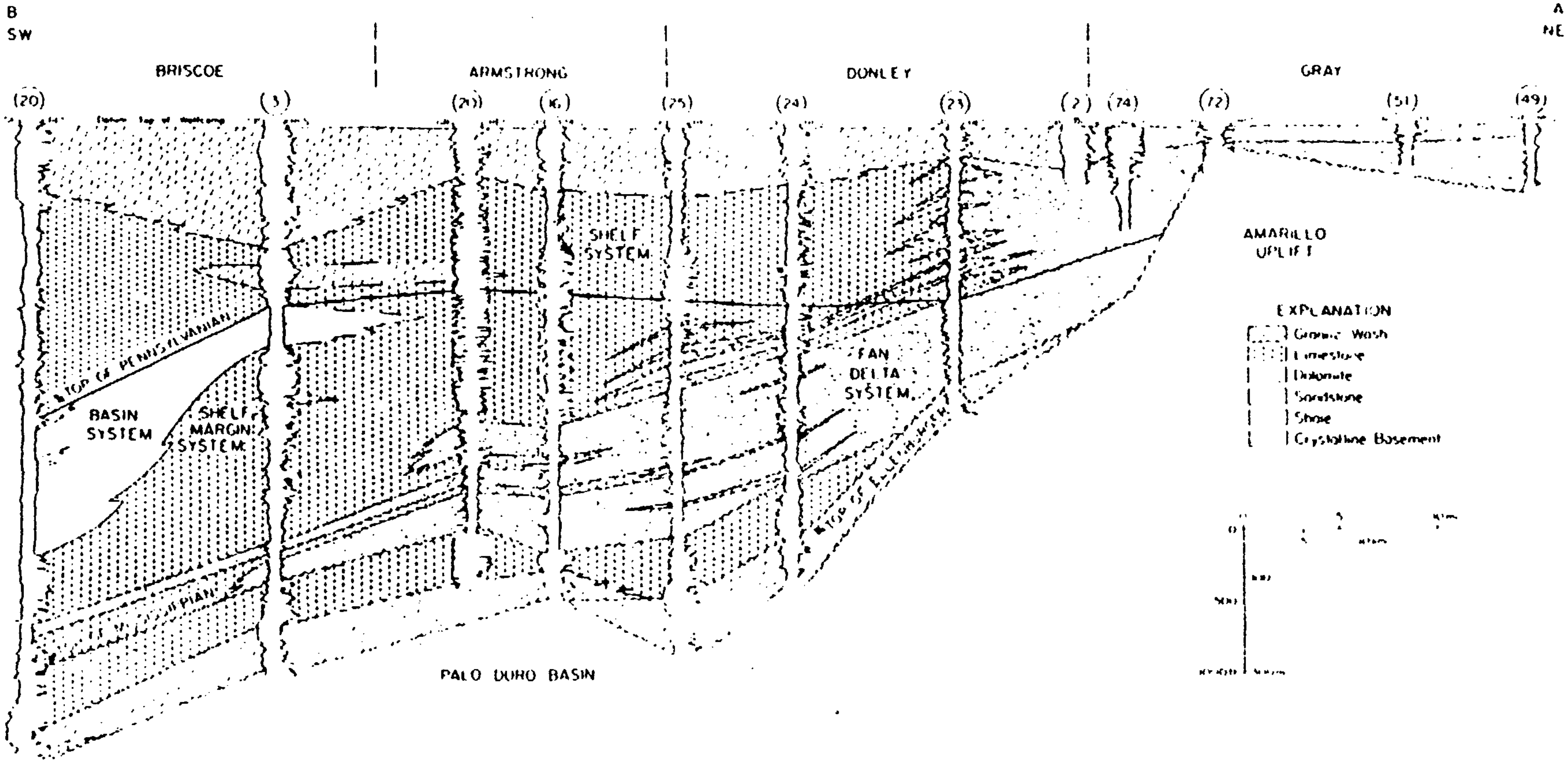


Figure 59. North-south regional cross section A-B from the central Palo Duro Basin to the Amarillo Uplift. Line of section shown in figure 57.

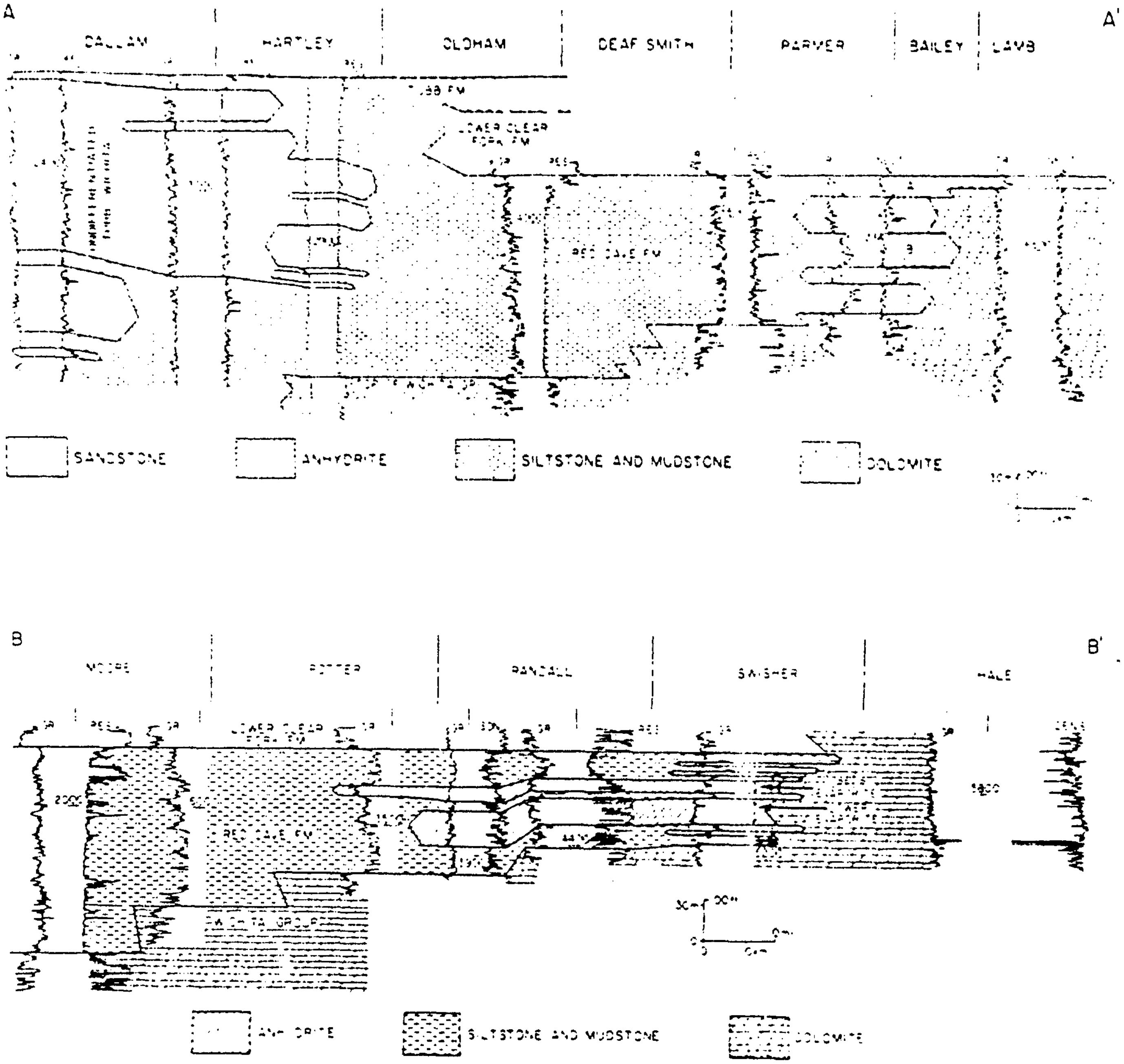


Figure 3. North-south cross sections A-A' and B-B' through the Red Cave Formation.

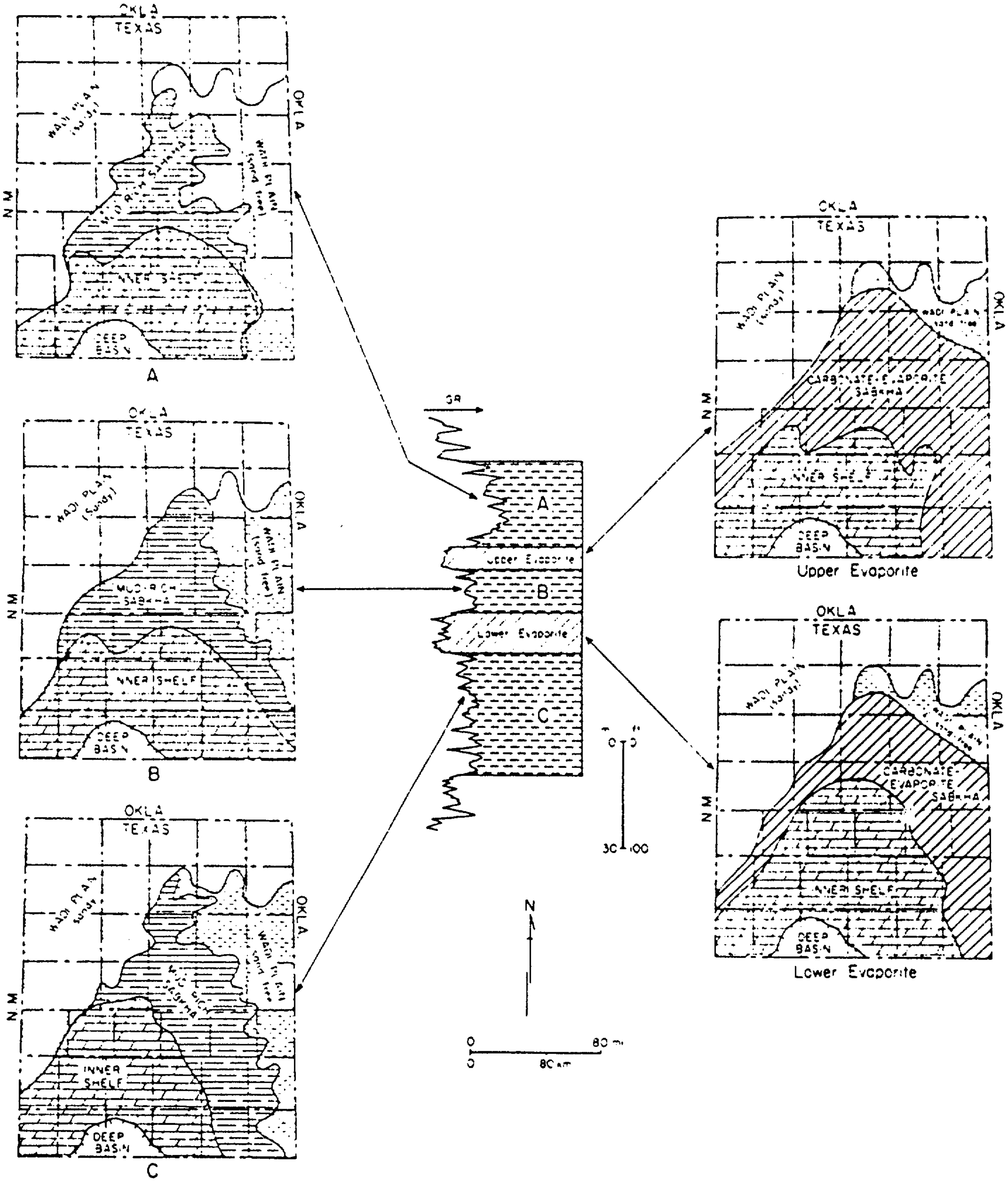


Figure 19. Paleogeography of the Red Cave Formation. Cyclic clastic and carbonate-evaporite facies reflect alternating styles of sabkha deposition that were brought on by the periodic availability and supply of clastics to sabkha environments.

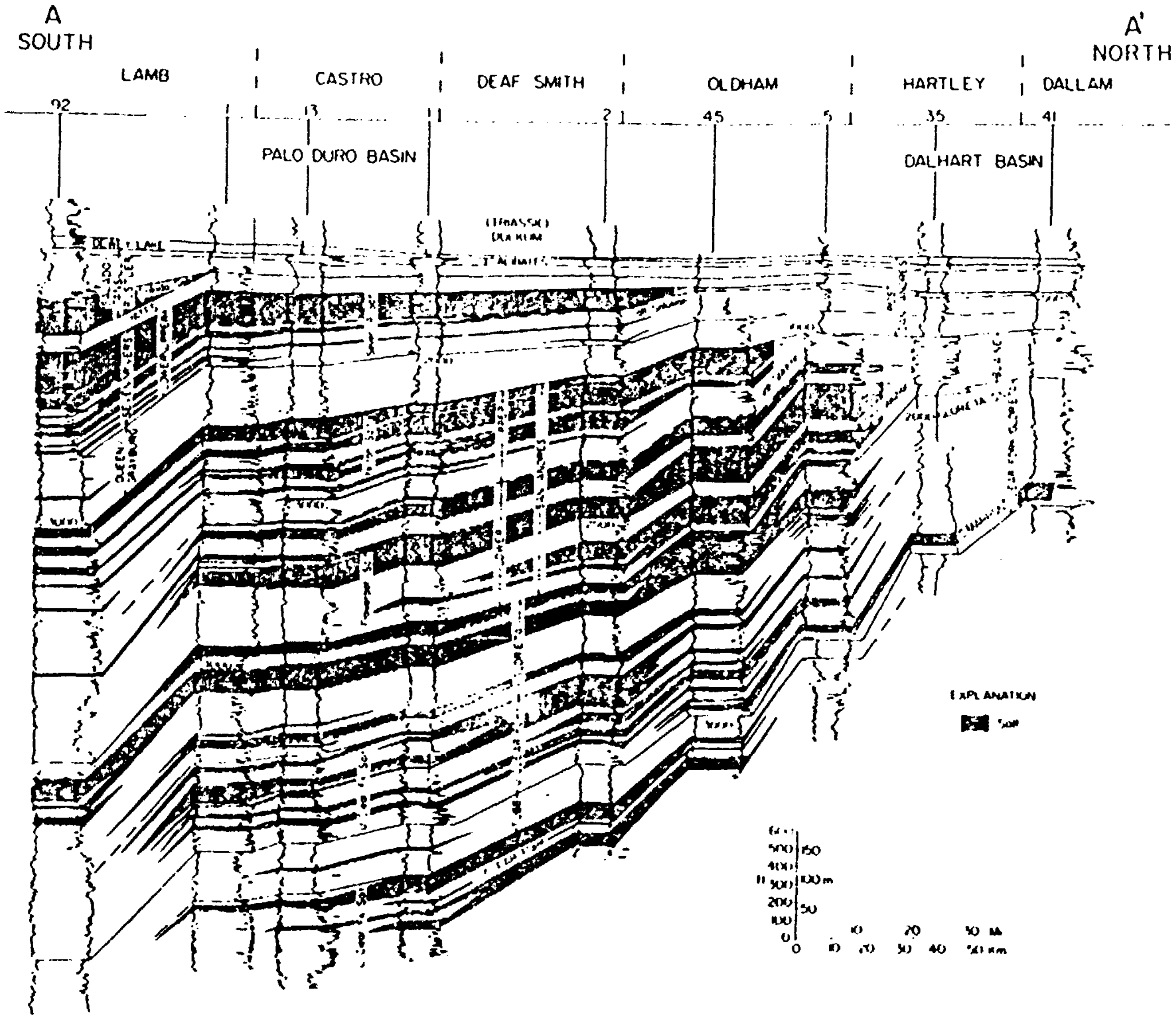


Figure 5. North-south cross section, Upper Permian salt-bearing strata, Texas Panhandle. Generalized salt units are correlated. Location of section in figure 4.

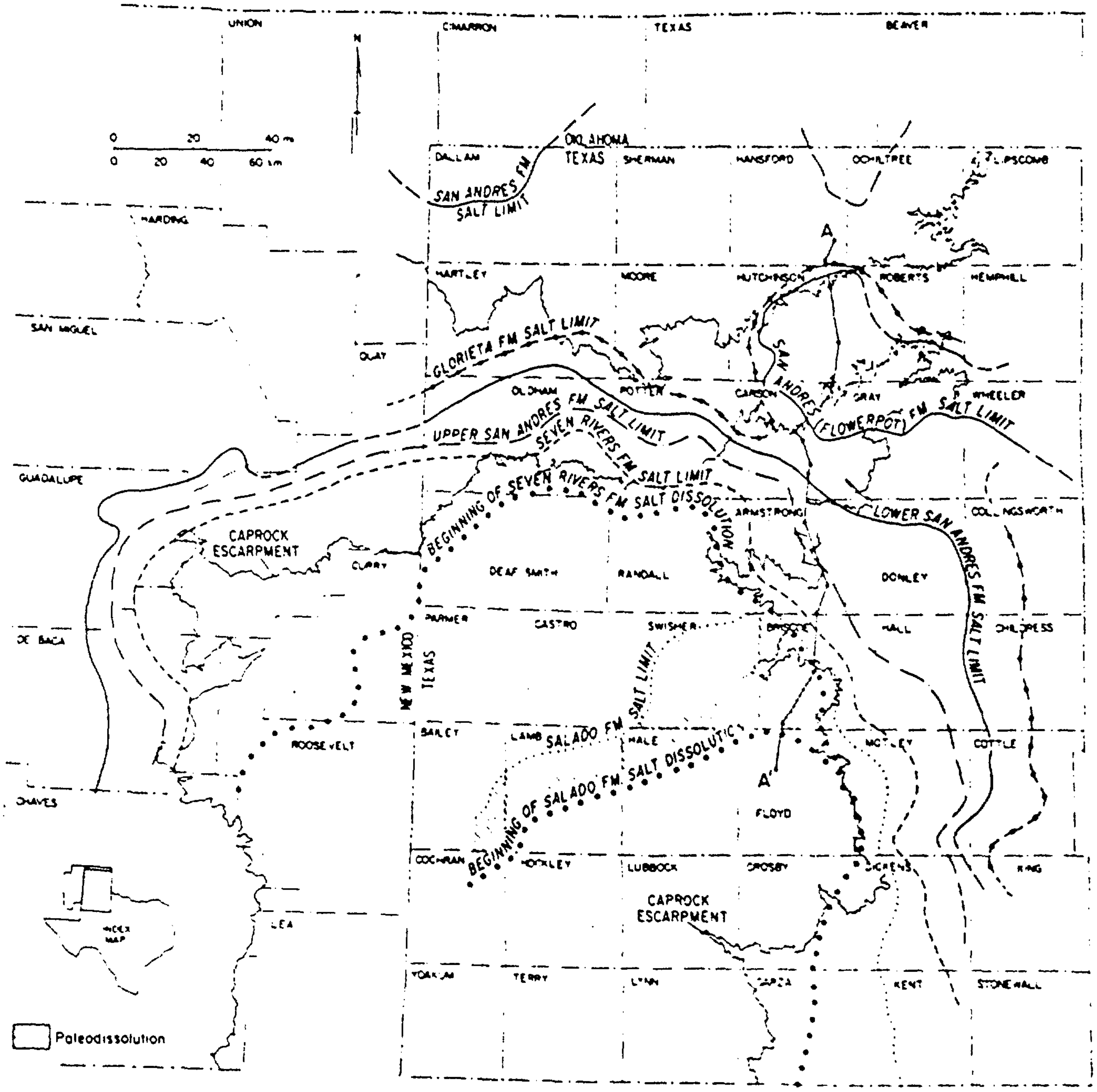


Figure 72. Salt dissolution zones, Texas Panhandle and eastern New Mexico. Except for the Seven Rivers and Salado Formations, where both the beginning of salt dissolution and the limit of salt are shown, the limit of salt for the younger formation marks the approximate beginning of salt dissolution for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

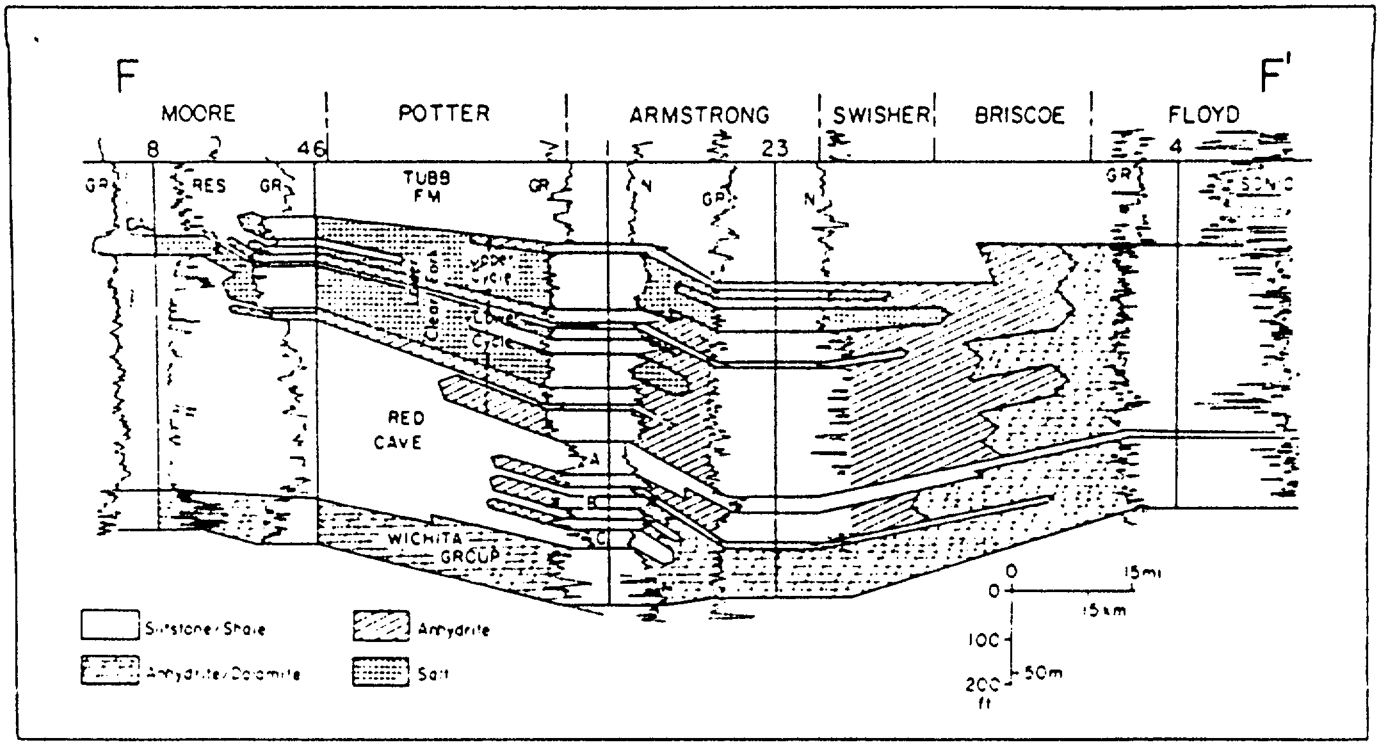


Figure 34. North-south cross section F-F' of lower Clear Fork Formation. See figure 3 for location (from Handford, 1981).

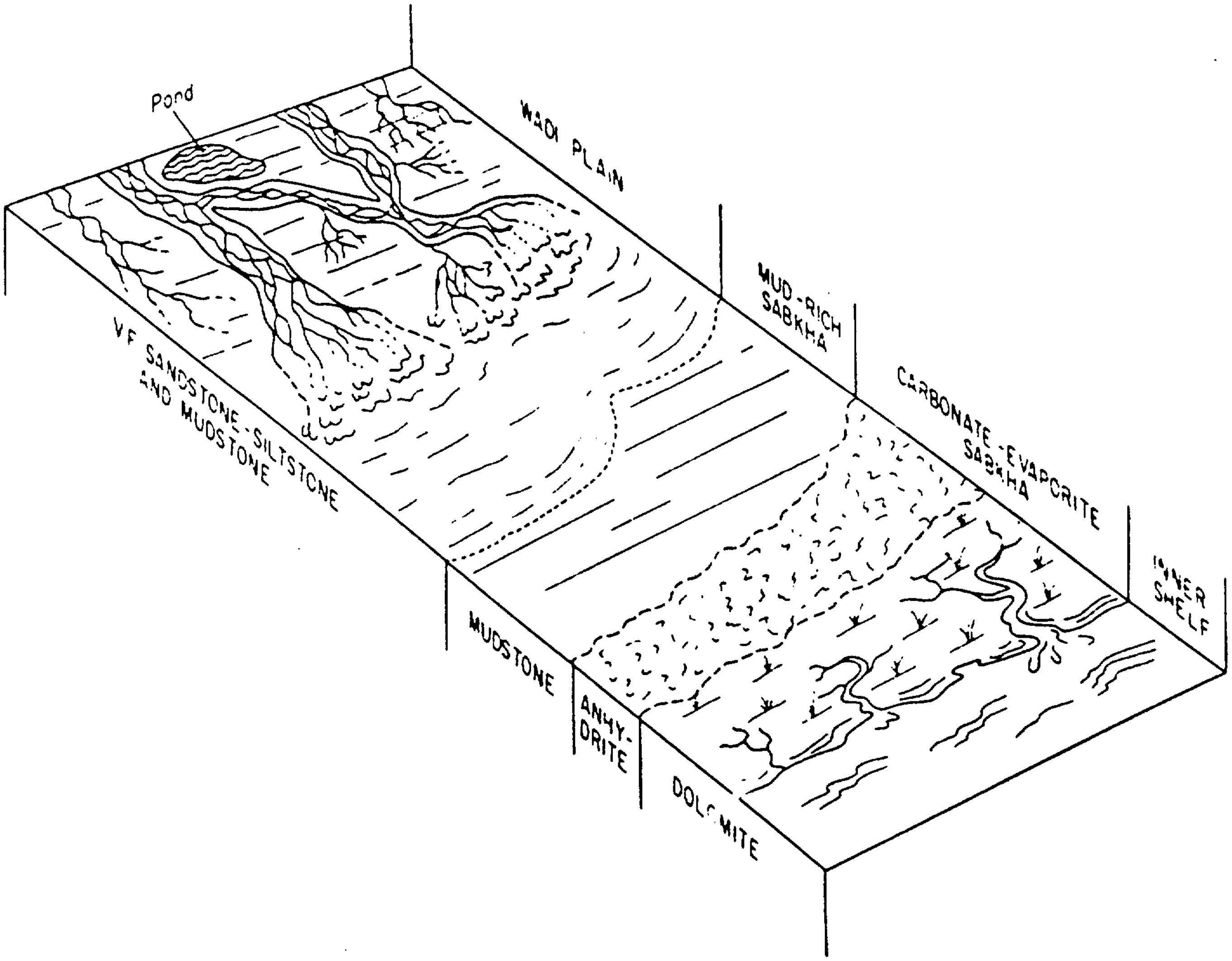


Figure 17. Composite depositional model for Red Cave carbonate, evaporite, and clastic facies.

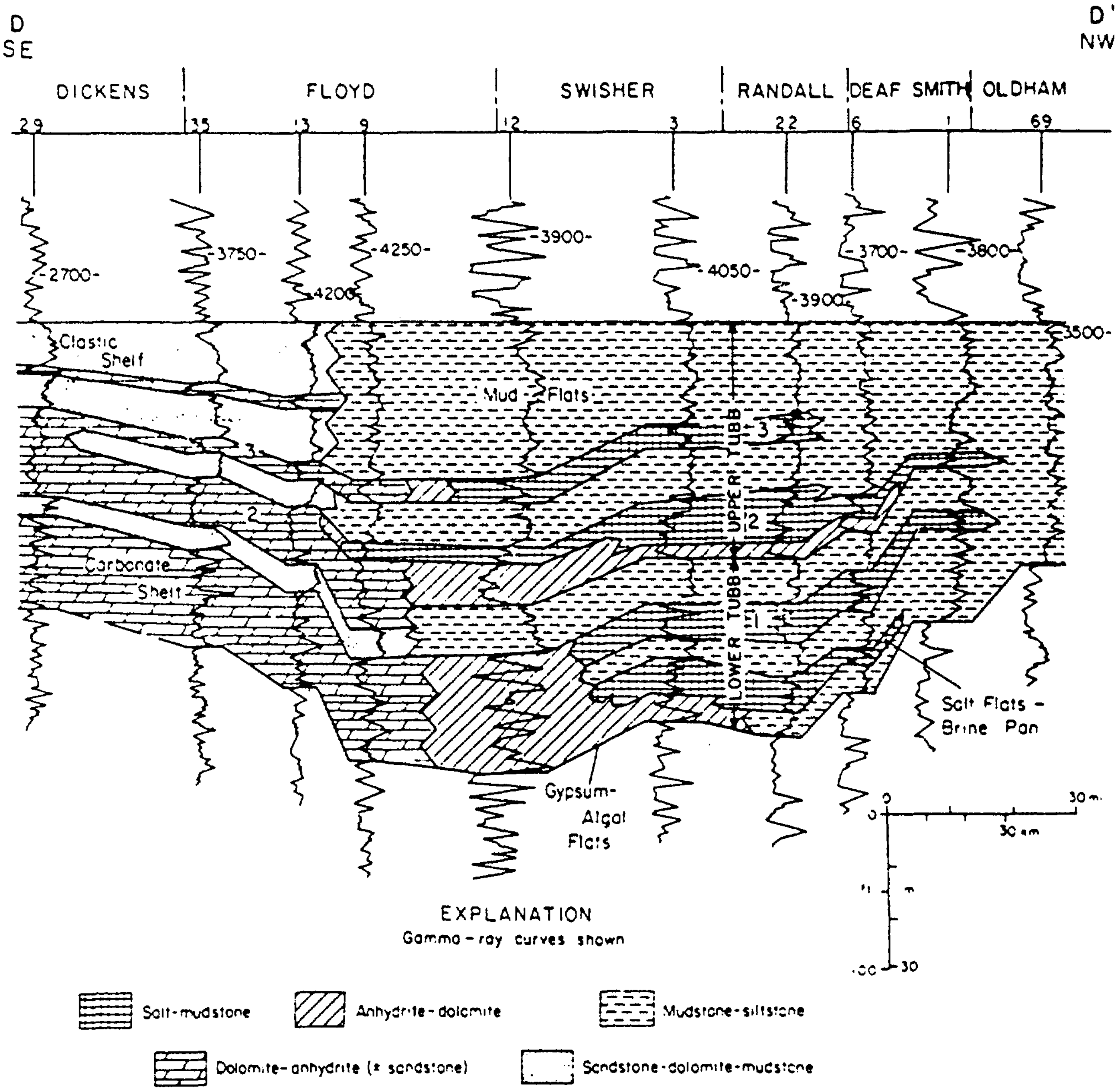


Figure 41. Northwest-southeast cross section, Tubb Formation, Palo Duro Basin. Line of cross section is indicated in figure 87. From Presley (1980b).

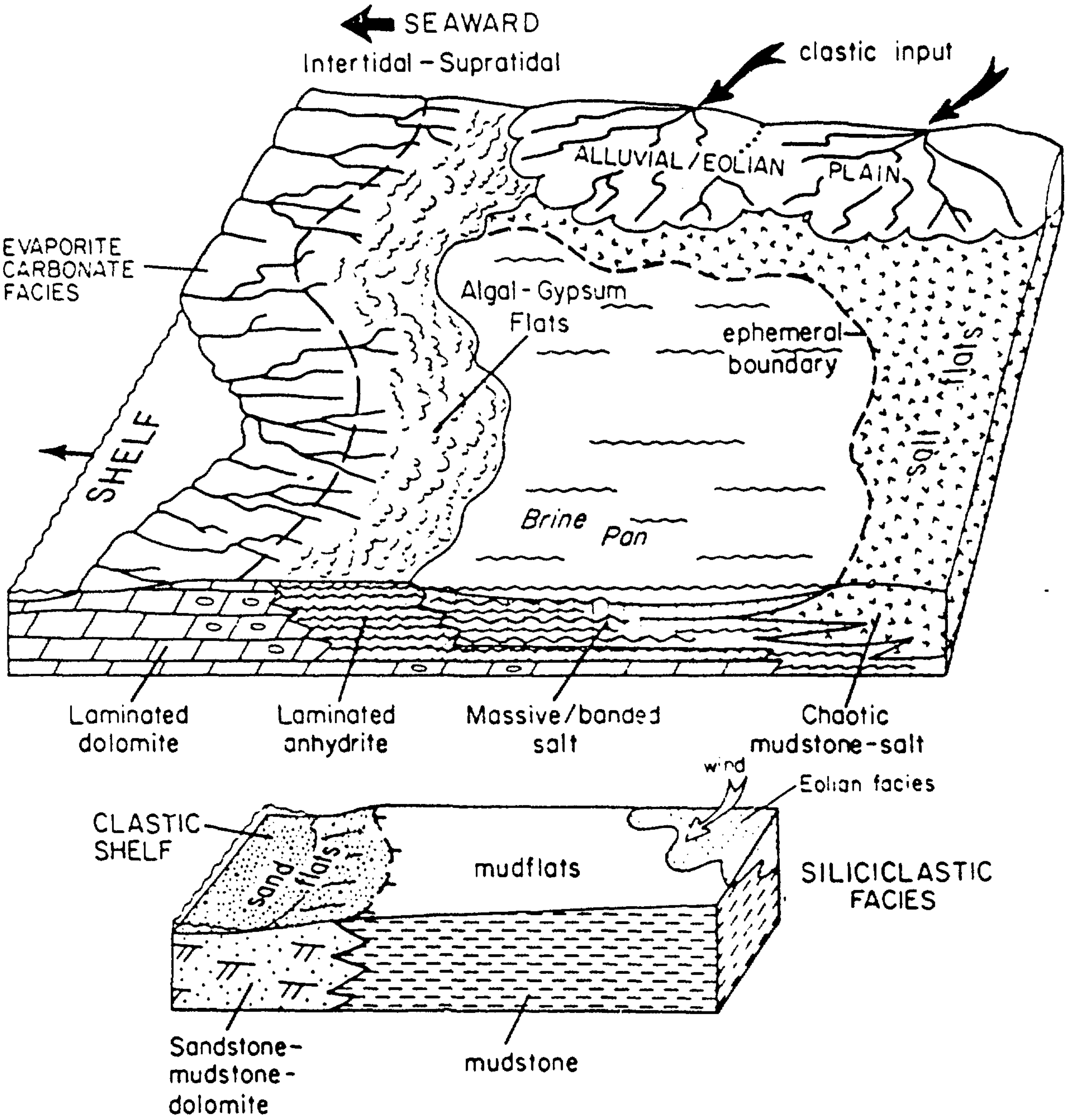


Figure 40. Facies and environments recorded in Tubb strata of the Palo Duro and Dalhart Basins. Evaporite-carbonate facies record a gradual basinward shift in environments. Siliciclastic (red-bed) facies dominate the Tubb sequence, and were deposited in tidal mud flats, which graded basinward into tidal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

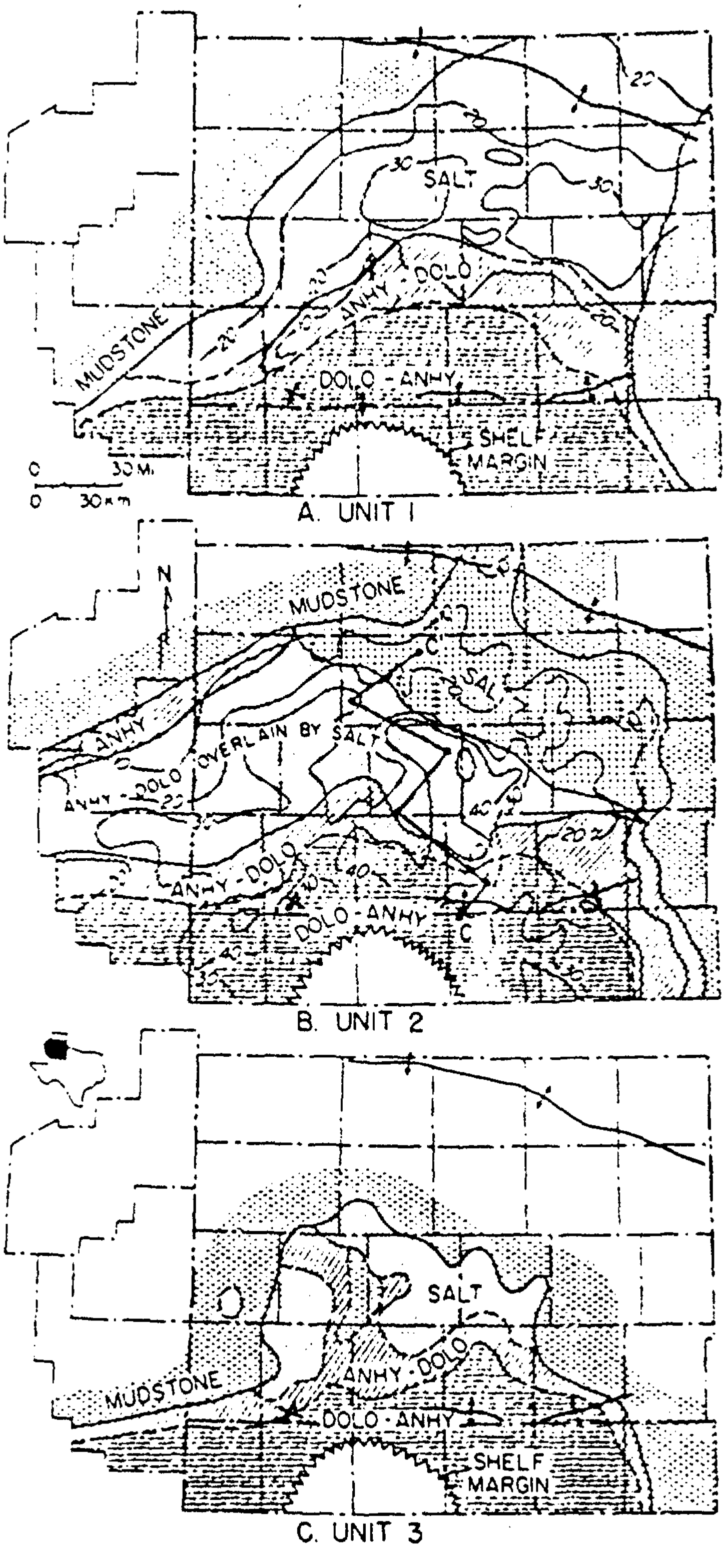


Figure 42. Facies maps of evaporite-carbonate units 1, 2, and 3 (oldest to youngest) of the Tubb Formation. Salt is dominant in updip regions to the north; carbonate is dominant to the south. These units show progressive southerly migration of evaporite-carbonate facies. From Presley (1980b).

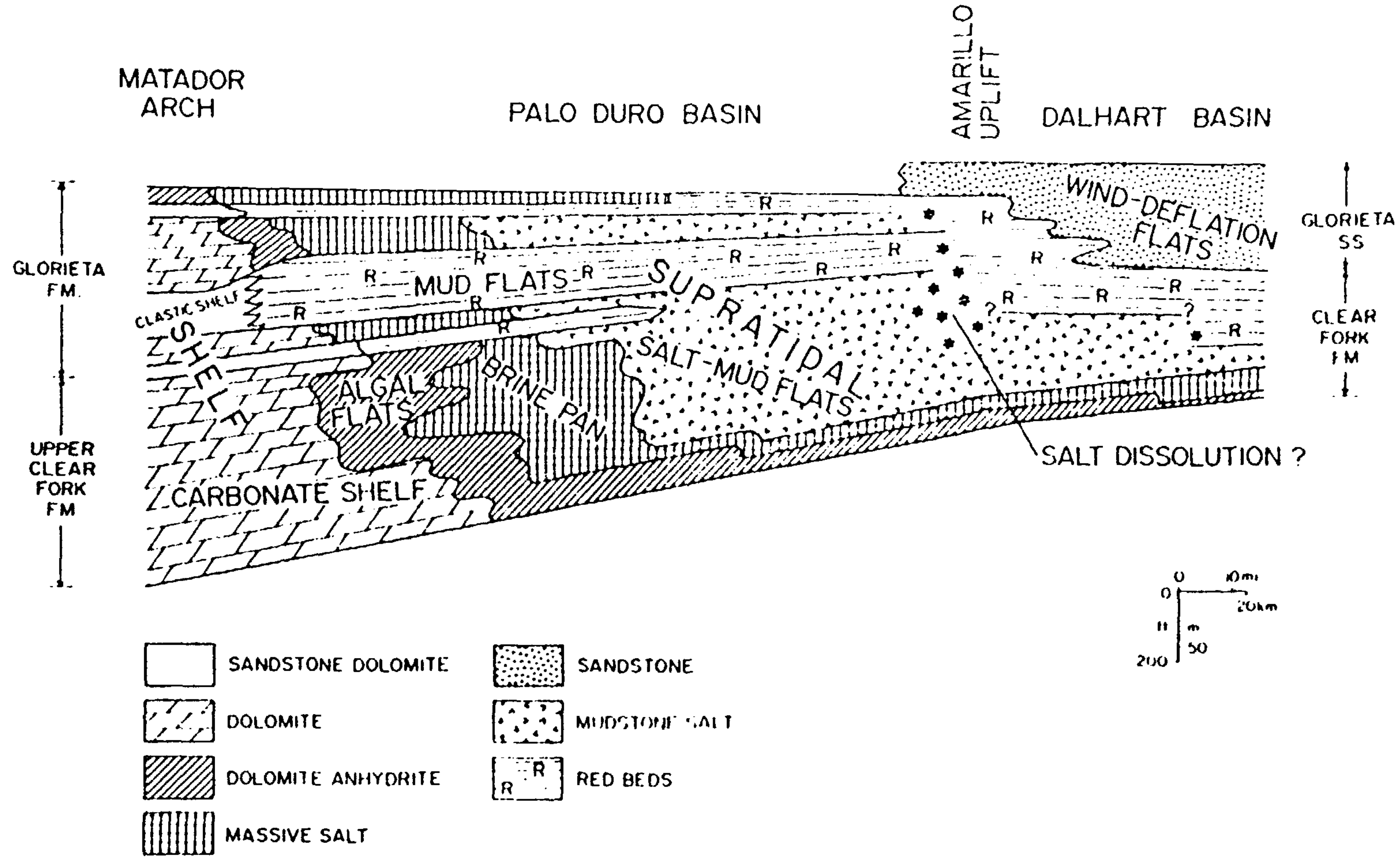


Figure 43. North-south facies cross section through Palo Duro and Dalhart Basins showing relation of environments for the upper Clear Fork and Glorieta Formations. From Presley (unpublished data).

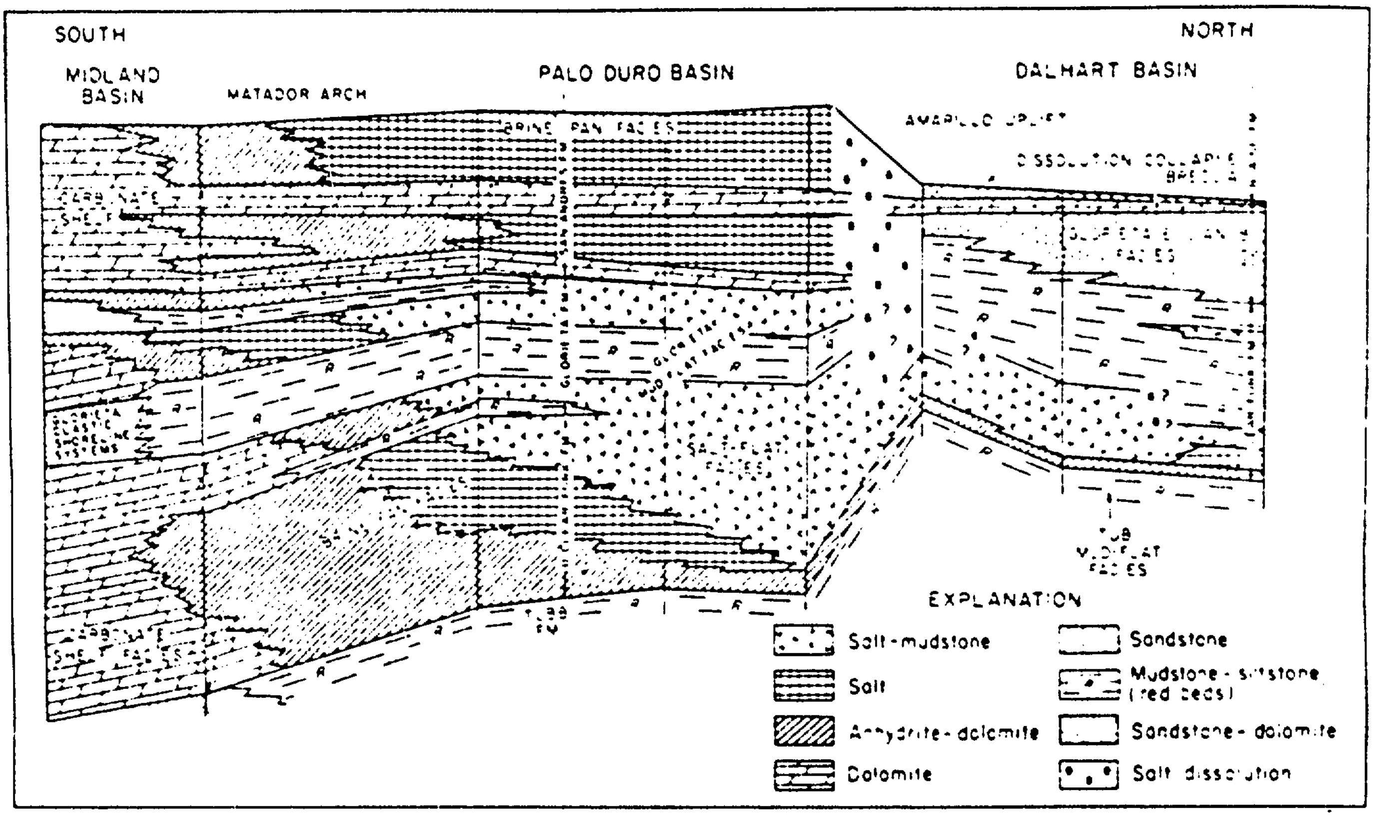


Figure 2. Diagrammatic north-south cross section of upper Clear Fork and Glorieta Formations and underlying and overlying units in Texas Panhandle. Generalized facies interpretations are shown. Location generally follows line of section A-A' in figure 1.

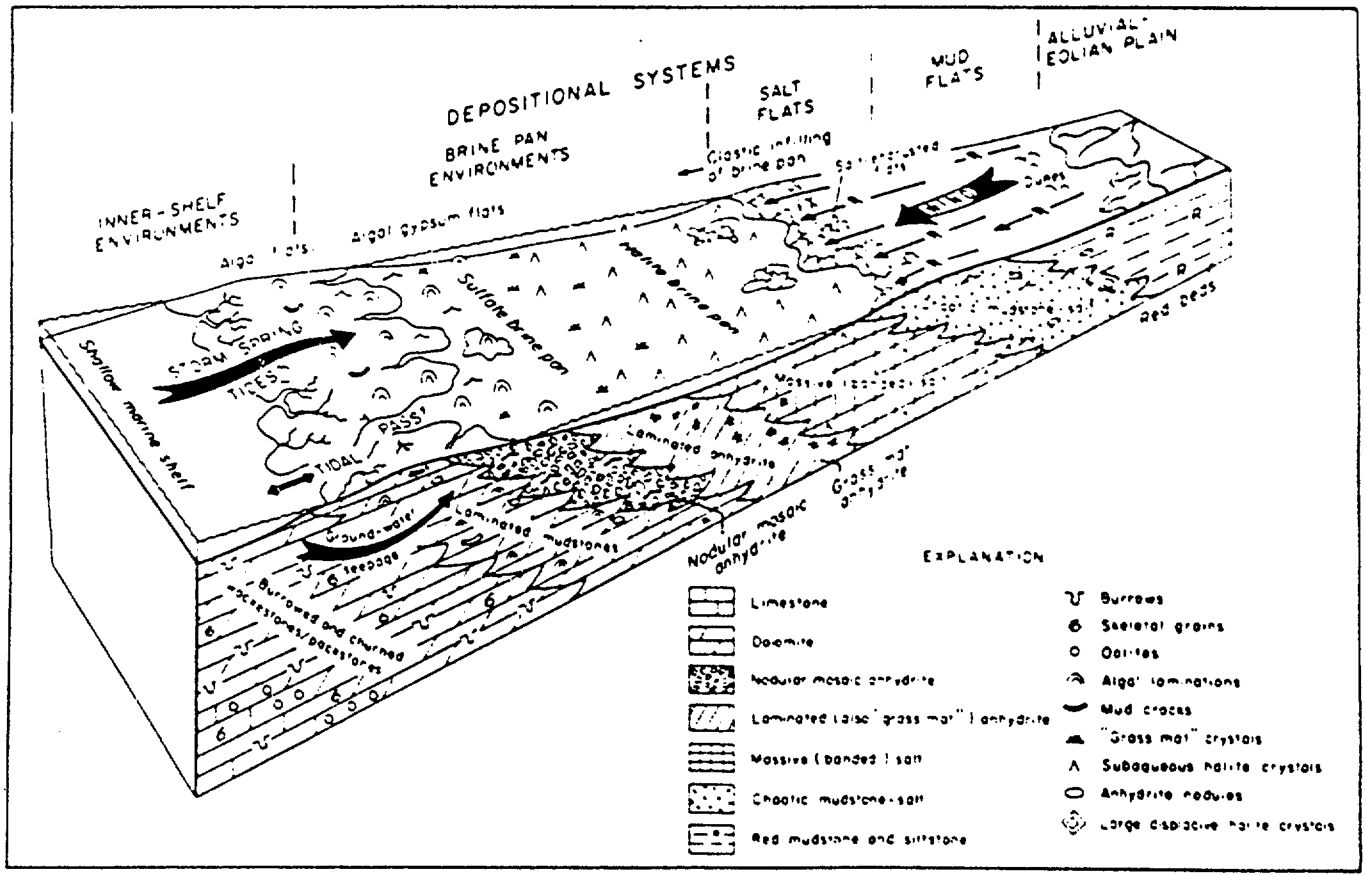


Figure 3. Evaporite and carbonate depositional facies and environments inferred for upper Clear Fork and Glorieta rocks.

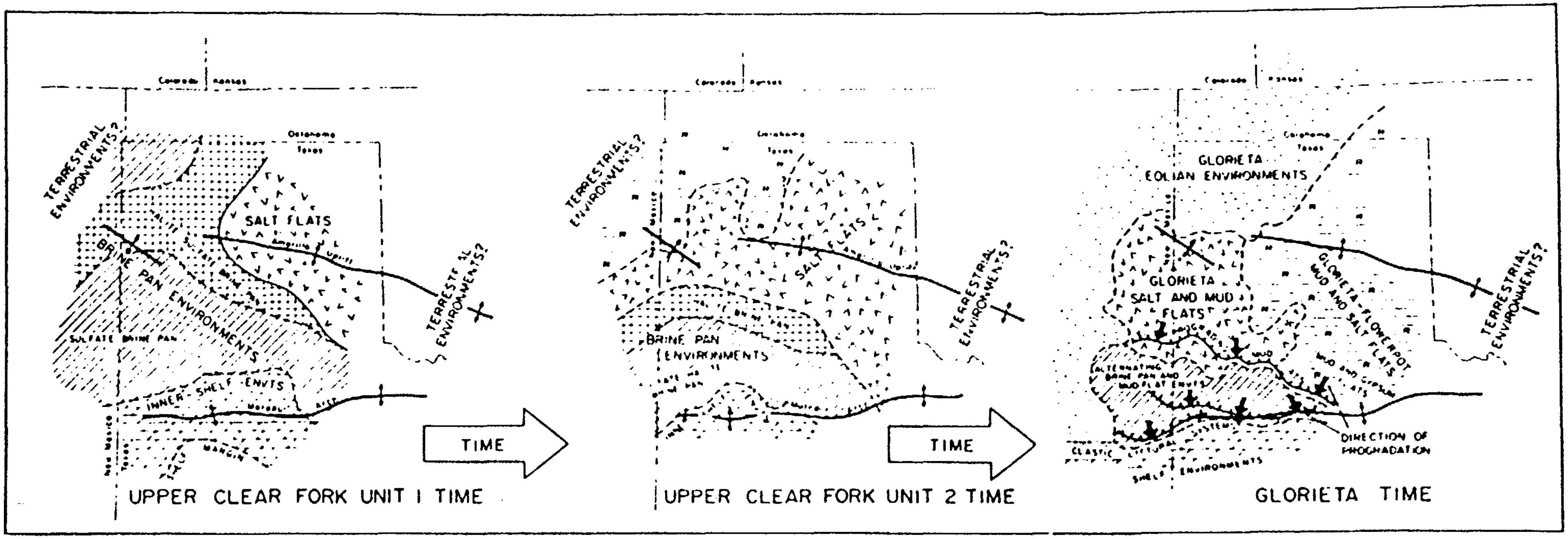


Figure 5. Paleogeography at the time of deposition of the upper Clear Fork and Glorieta Formations.

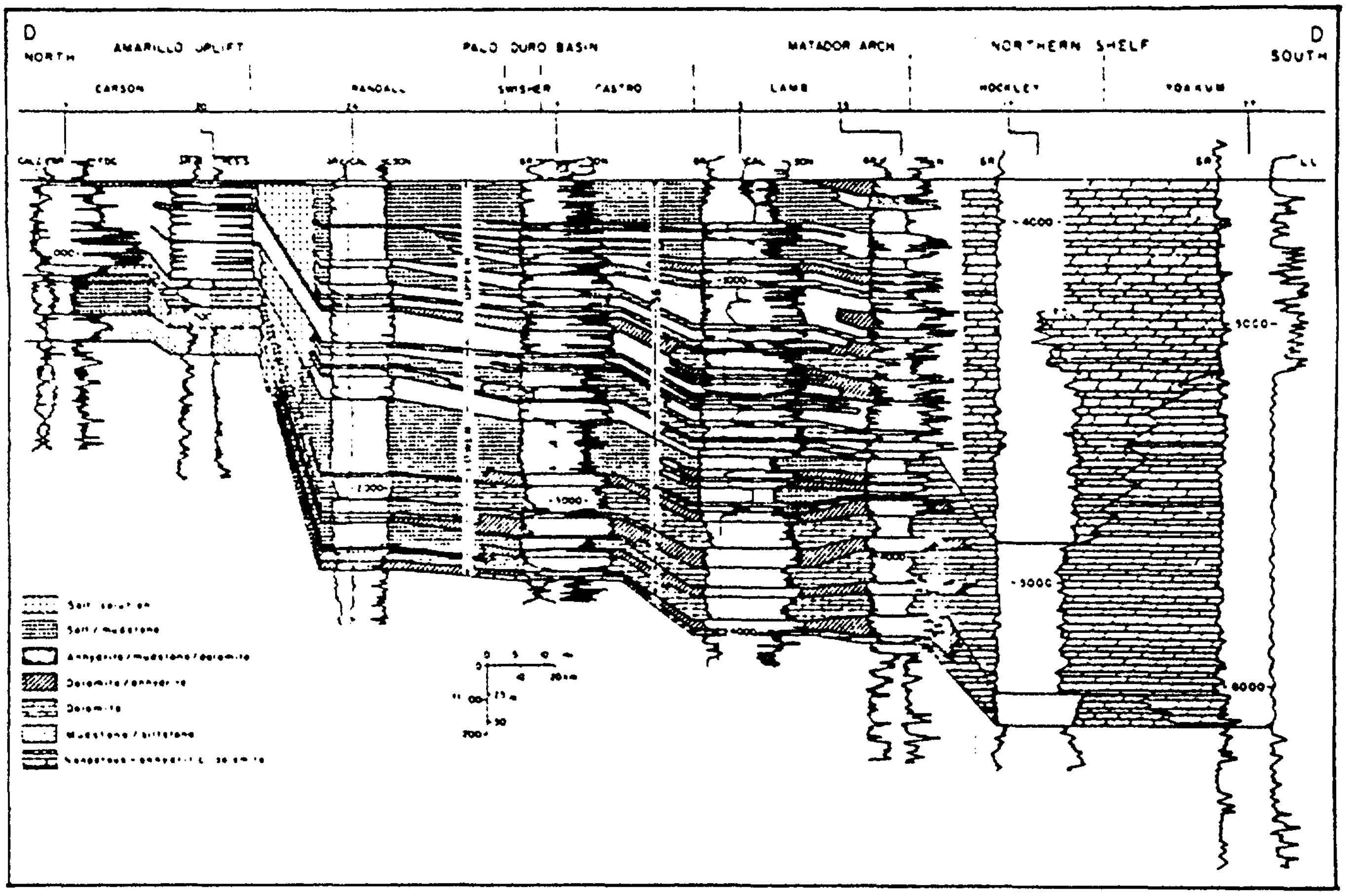
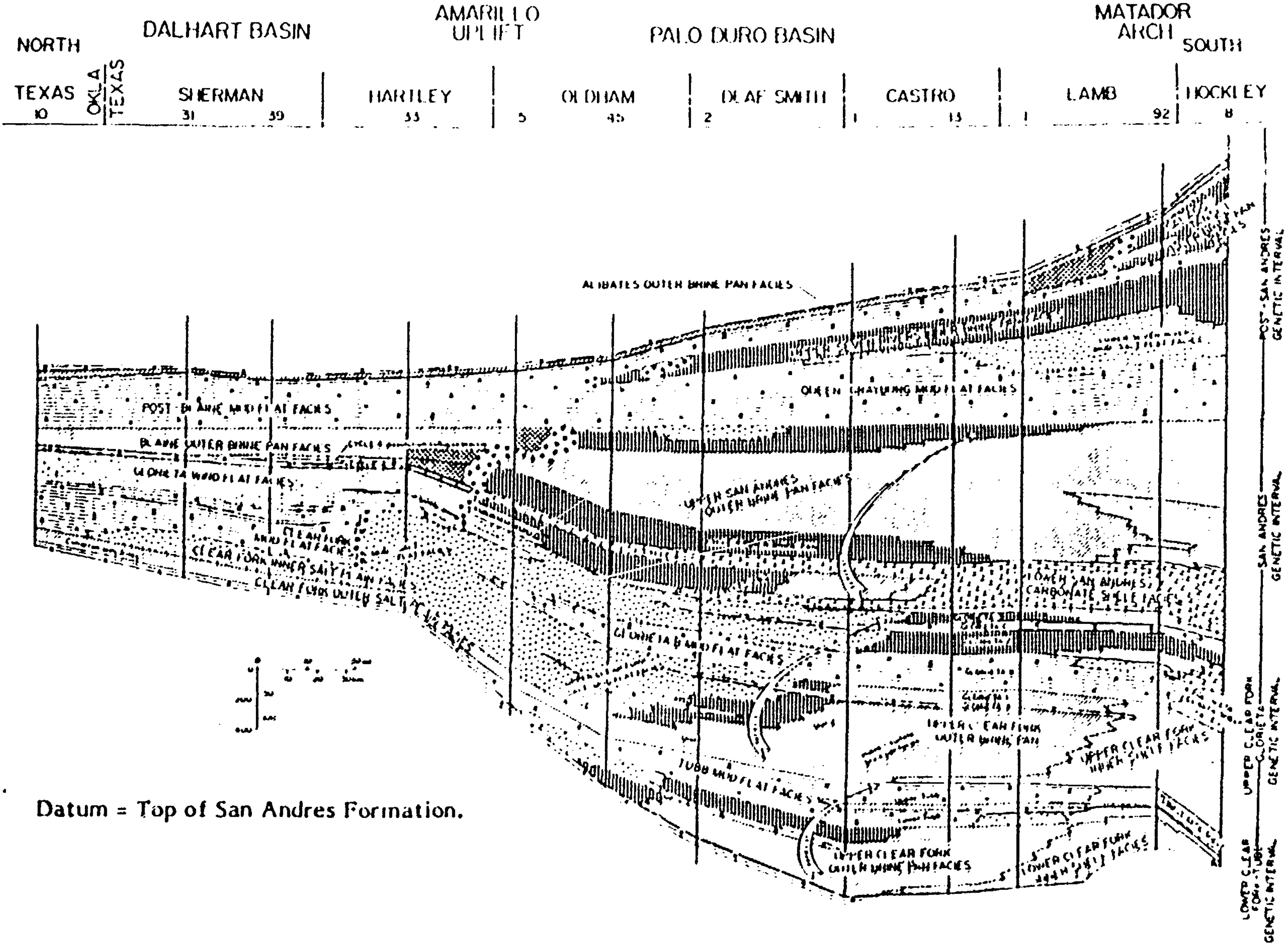


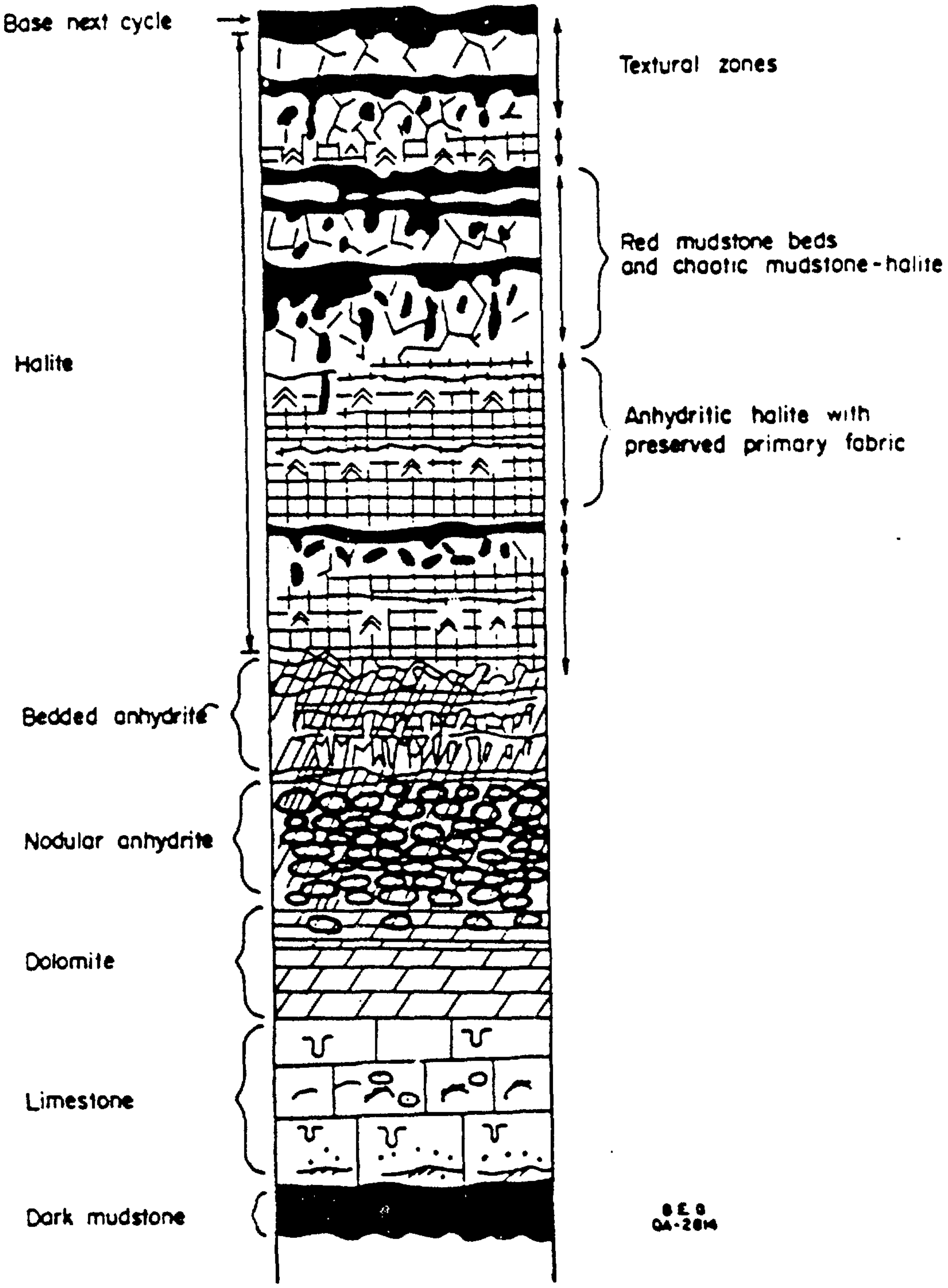
Figure 2. North-south cross section through the study area (after Presley, 1979, and P. Ramondetta, personal communication, 1981). Pinch-out of salt and anhydrite preclude detailed log correlation to the south. Datum: Top San Andres. See figure 1 for line of section.

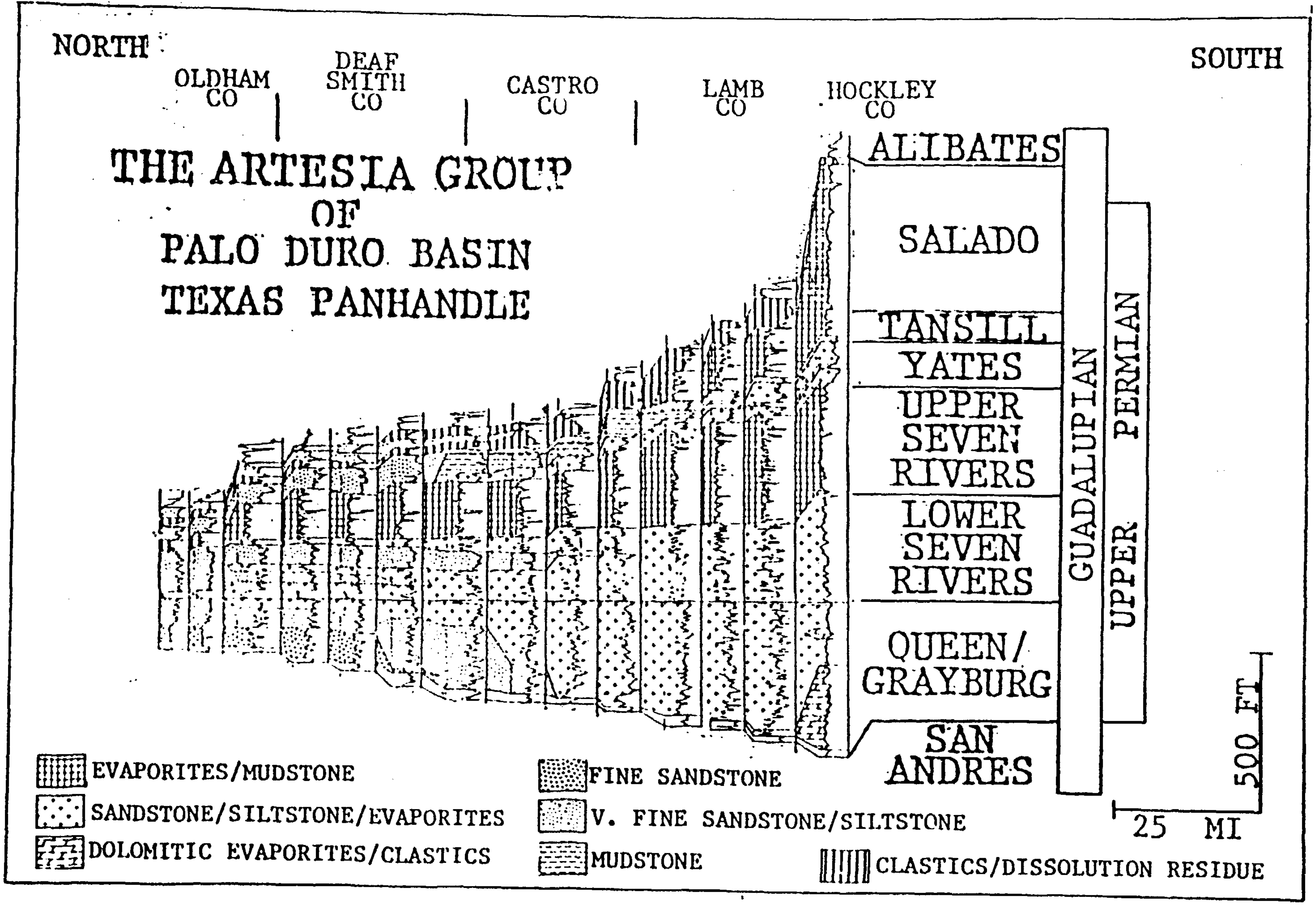
figure 2



Datum = Top of San Andres Formation.

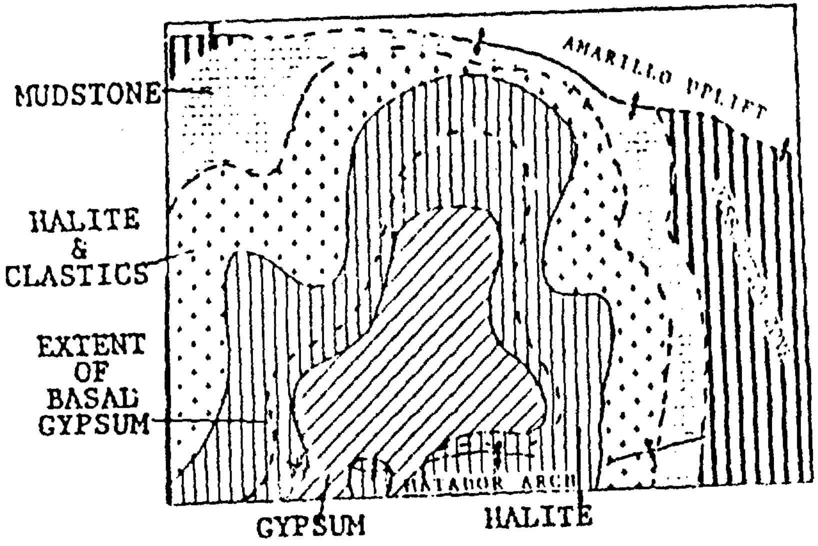
TYPICAL SAN ANDRES CYCLE



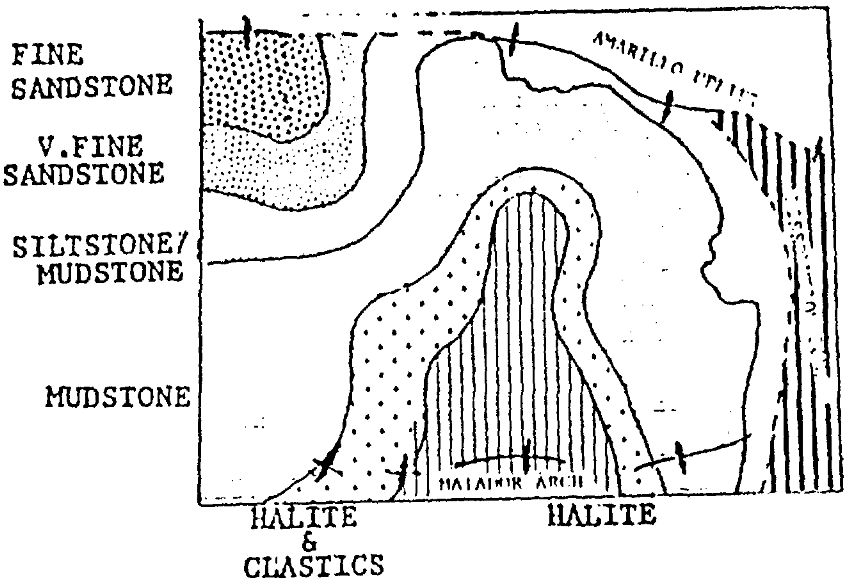


THE ARTESIA GROUP OF PALO DURO BASIN TEXAS PANHANDLE

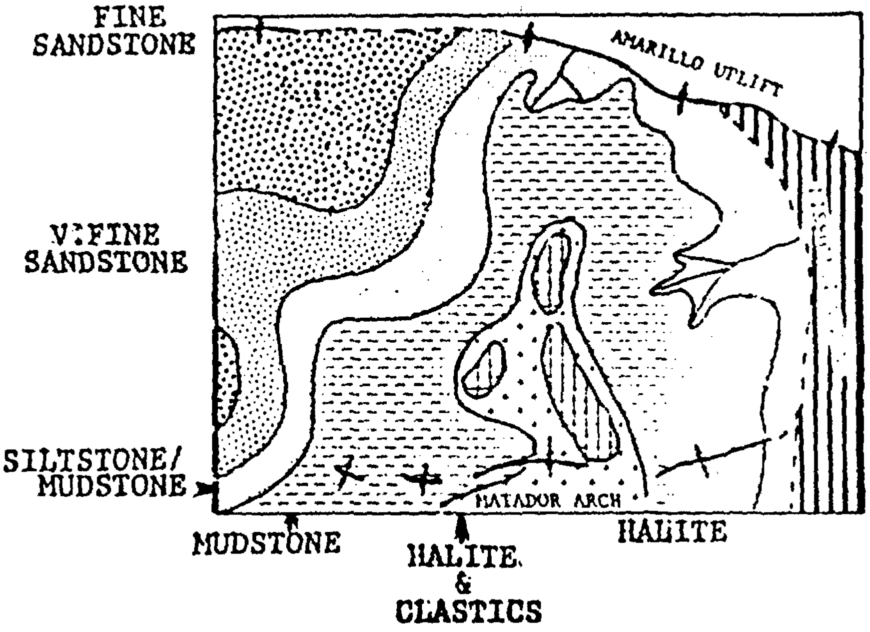
STAGE I



STAGE II



STAGE III



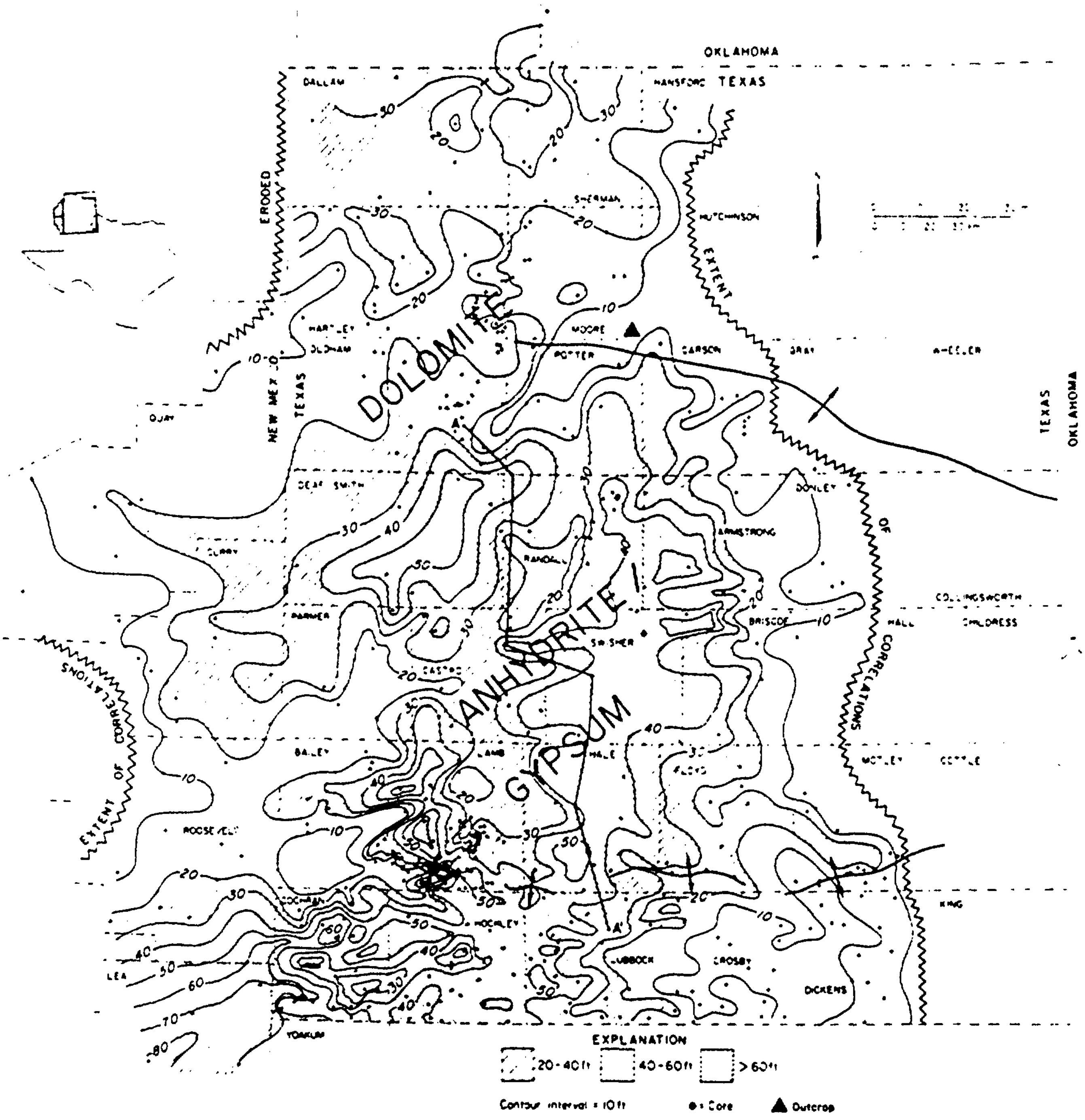


Figure 10. Isopach map, Alibates Formation. Serrate lines mark limit of correlation and erosional boundaries. Outcrop shown in Moore County. Maximum thickness in central and southern Palo Duro Basin.

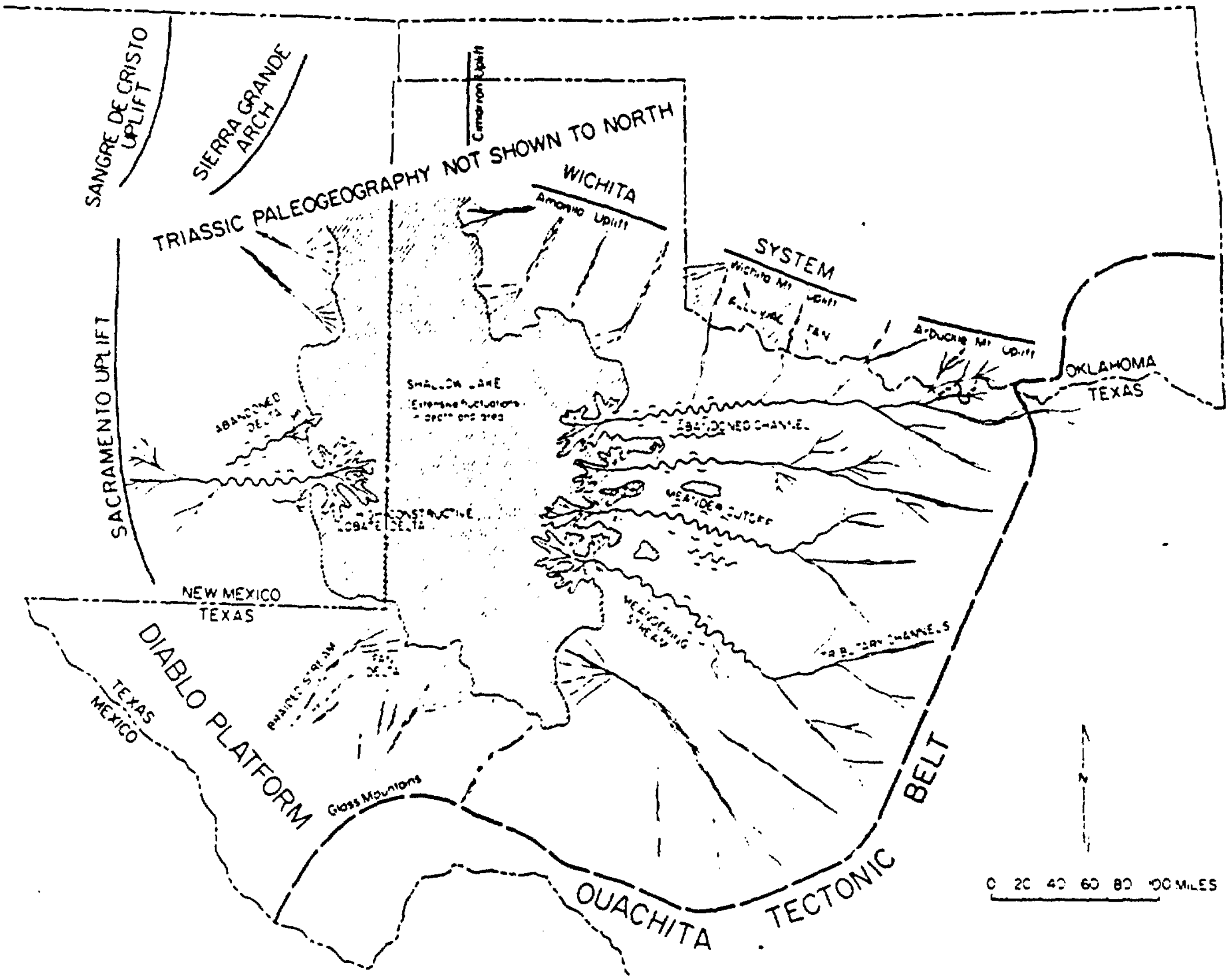


Figure 5. Inferred paleogeography during the initial stage of Dockum sedimentation in the area south of Amarillo Uplift - Bravo Dome. Depositional elements are braided streams, alluvial fans, fan deltas, meandering streams, distributary deltas, and shallow lakes.

Kreitler 8/6

DISSOLUTION CONSIDERATIONS

Process: Shallow ground water dissolving salt

Types: "Peripheral" and "Interior" ?

Controls: Hydraluic gradient, evaporite geology,
overlying geology

Extent: Geographic and stratigraphic

Rates: Rates of dissolution for different types

Timing: Ongoing or relict process

Implications to nuclear repository

TYPES OF DATA

Geologic data: Stratigraphic, structural,
geomorphic

Hydrologic-hydrochemical data: dissolution wells
saline springs

Core data: DOE stratigraphic and hydro wells

HYDROLOGIC-HYDROCHEMICAL DATA

Well locations

Mansfield and Sawyer well results ("peripheral")

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

Harmon and Detten wells ("interior")

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

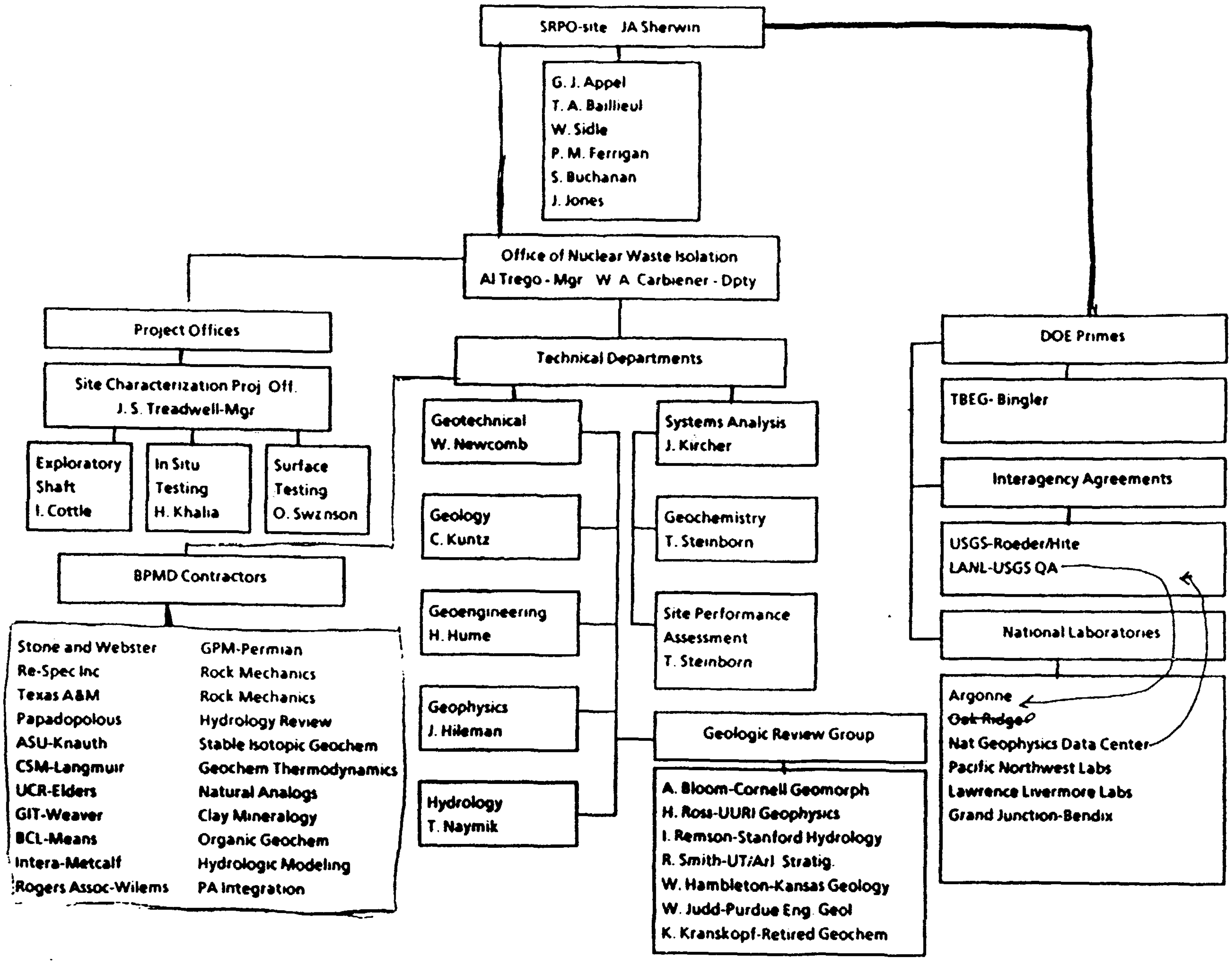
CORE DESCRIPTION

Well locations for core in dissolution zone

Diagnostic features of dissolution

Geographic distribution of dissolution features

DOE–SAIT Repository Project



Sherwin 1/8

GEOENGINEERING TASKS

TASK .13	LABORATORY TESTING
TASK .36	SUBCONTRACTED LABORATORY TESTING (F.Y. 1985)
TASK .62	GEOTECHNICAL STUDIES
TASK .63	ENGINEERING DESIGN SUPPORT (F.Y. 1983)
TASK .67	GEOTECHNICAL FIELD TESTS (F.Y. 1984)

THESE STUDIES SUPPORT THE FOLLOWING ACTIVITIES:

- EA PREPARATION
- SITE CHARACTERIZATION PLANNING
- PRELIMINARY DESIGN DEVELOPMENT

Lamb 8/6

FY 1985 ACTIVITIES – GEOENGINEERING

LABORATORY TESTING

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

GEOTECHNICAL STUDIES

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

LABORATORY TESTING - OBJECTIVES

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

  DEVELOP AVERAGE VALUES AND RANGES OF VALUES OF PHYSICAL AND MECHANICAL PROPERTIES PERTINENT TO:

  - EXCAVATION
  - SUPPORT AND LINING
  - SHAFT SEALING

LABORATORY TESTING - OBJECTIVES
(CONT.)

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

    PREDICTABILITY
    VARIABILITY
    ENGINEERING UNITS
  - ANALYSES

    AVERAGE VALUES
    RANGES OF PROPERTIES
    DATA BASE

LABORATORY TESTING - APPROACH

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

TESTING PRIOR TO SITE SELECTION

- [illegible] TESTS
- TEST EACH ROCK TYPE ENCOUNTERED
- EMPHASIS ON POSSIBLE TARGET HORIZONS AND ABOVE
- INVESTIGATE VARIABILITY OF PROPERTIES
- INVESTIGATE REPEATABILITY OF PROPERTIES
- INVESTIGATE EFFECTS OF [illegible], LITHOLOGIC CHANGES, STRATIGRAPHIC POSITION, ETC.
- PRELIMINARY AND [illegible] DATA FOR DESIGN [illegible]
- DEVELOP DATA BASE FOR PALO DURO ROCKS
- IDENTIFY PROPERTIES WHICH REQUIRE DETAILED TESTING AT THE SITE

TESTING FOR SITE CHARACTERIZATION AND LICENSING

- FEWER, MORE SOPHISTICATED TESTS
- CAREFUL SELECTION AND PRESERVATION OF SAMPLES
- DETERMINE PROPERTIES IMPORTANT FOR LOGGING, WELL DESIGN AND COMPLETION
- COMPLEMENT FIELD TESTS
- COMPARE WITH DATA FROM OTHER WELLS
- DEVELOP DESIGN PARAMETERS

TYPES OF TESTS

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

LABORATORY TESTING - ROCK CORE FROM PERMIAN BASIN

TEST	RESPONSIBILITY	PURPOSE
Physical/Index Properties Test		
Density	SWEC	Aid in interpretation of other tests. Develop data base. Correlate with stratigraphy and geophysical logs. Estimate construction behavior. Assess variability.
Porosity (effective)	SWEC	
Water Content	SWEC, SWEC Sub	
Hardness (Taber, Schmidt)	SWEc, SWEC Sub	
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/TBEG	

Rock Mechanics Data Summary - Permian Basin

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

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

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

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

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

SUMMARY OF ROCK MECHANICS LABORATORY TESTS
BY WELL

(xx) indicates number of additional scheduled tests.

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

SUMMARY OF ROCK MECHANICS LABORATORY TESTS
BY FORMATION

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

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

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

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

GEOPHYSICAL LOG INTERPRETATION

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

VELOCITY ANALYSIS - PURPOSE

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

VELOCITY ANALYSIS - APPROACH

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

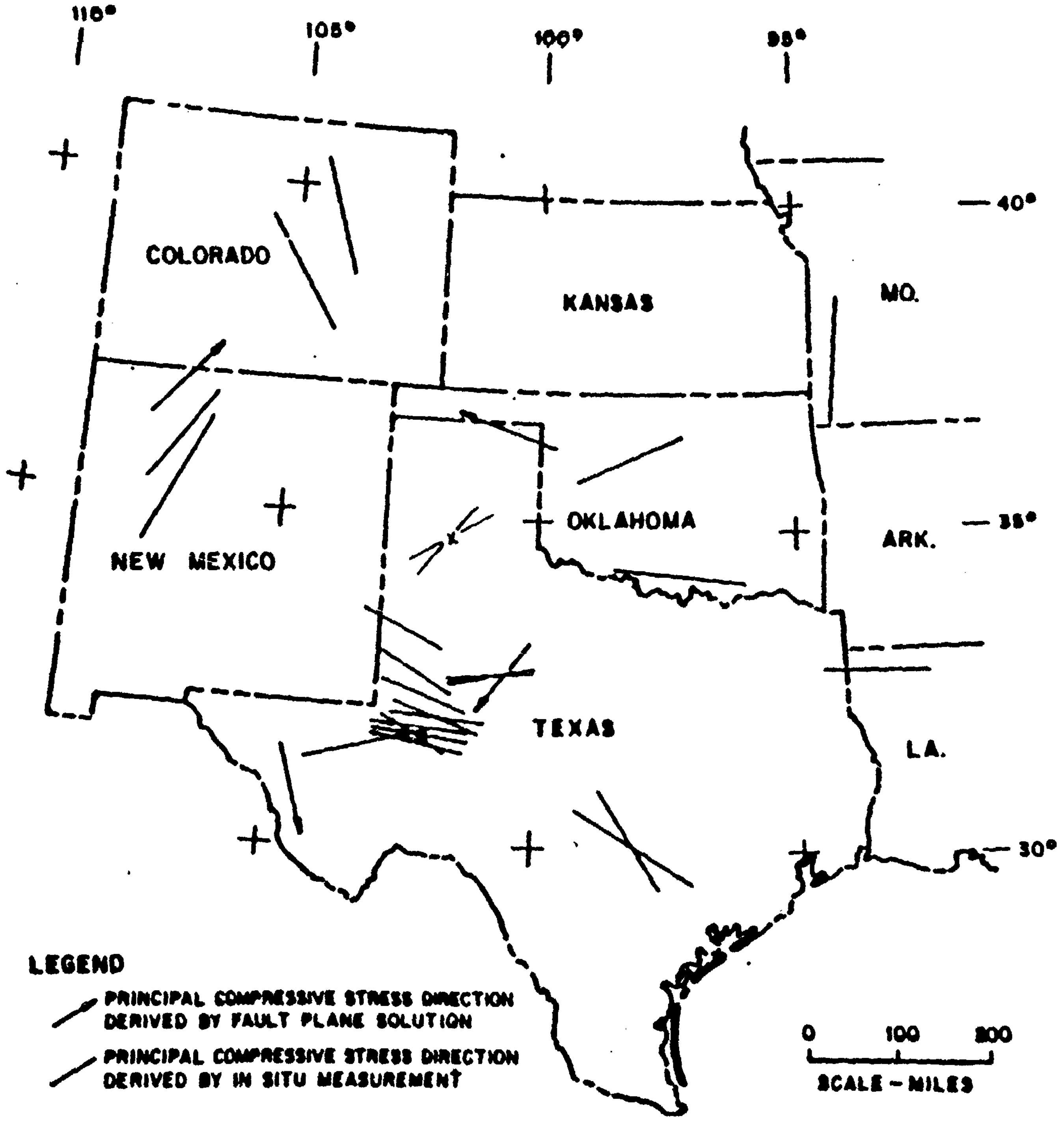
FIELD GEOTECHNICAL TESTING HOLTZCLAW NO. 1 WELL

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

Table 9-1. Summary of Calculated Stresses

Formation (Rock Type)	Depth (ft)	Vertical Stress (psi)	Horizontal Stress Min (psi)	Horizontal Stress Max (psi)	σ_v/Depth (psi/ft)	σ_{HMin}/Depth (psi/ft)	σ_{HMax}/Depth (psi/ft)	$\sigma_{HMax}/\sigma_{HMin}$
Queen/Grayburg (Siltstone)	1,850-1,858.5	1,835(a)	1,110	1,260	0.99	0.60	0.68	1.14
Upper San Andres (Anhydrite)	2,330-2,338.5	2,335(a)	(d)	(d)	1.00	-	-	-
Lower San Andres (Unit 5 Salt)	2,430-2,438.5	2,445(a)		(d)	1.00	-	-	-
		2,780(b)	2,915		1.14	1.20	-	-
Lower San Andres (Unit 4 Salt)	2,581-2,589.5	2,600(a)		(d)	1.01	-	-	-
		2,950(b)(c)	3,500(e)		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
Haimson, 1977

X Data from Holtzclaw No. 1

GEOTECHNICAL LOGS

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

GEOTECHNICAL PROFILES

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

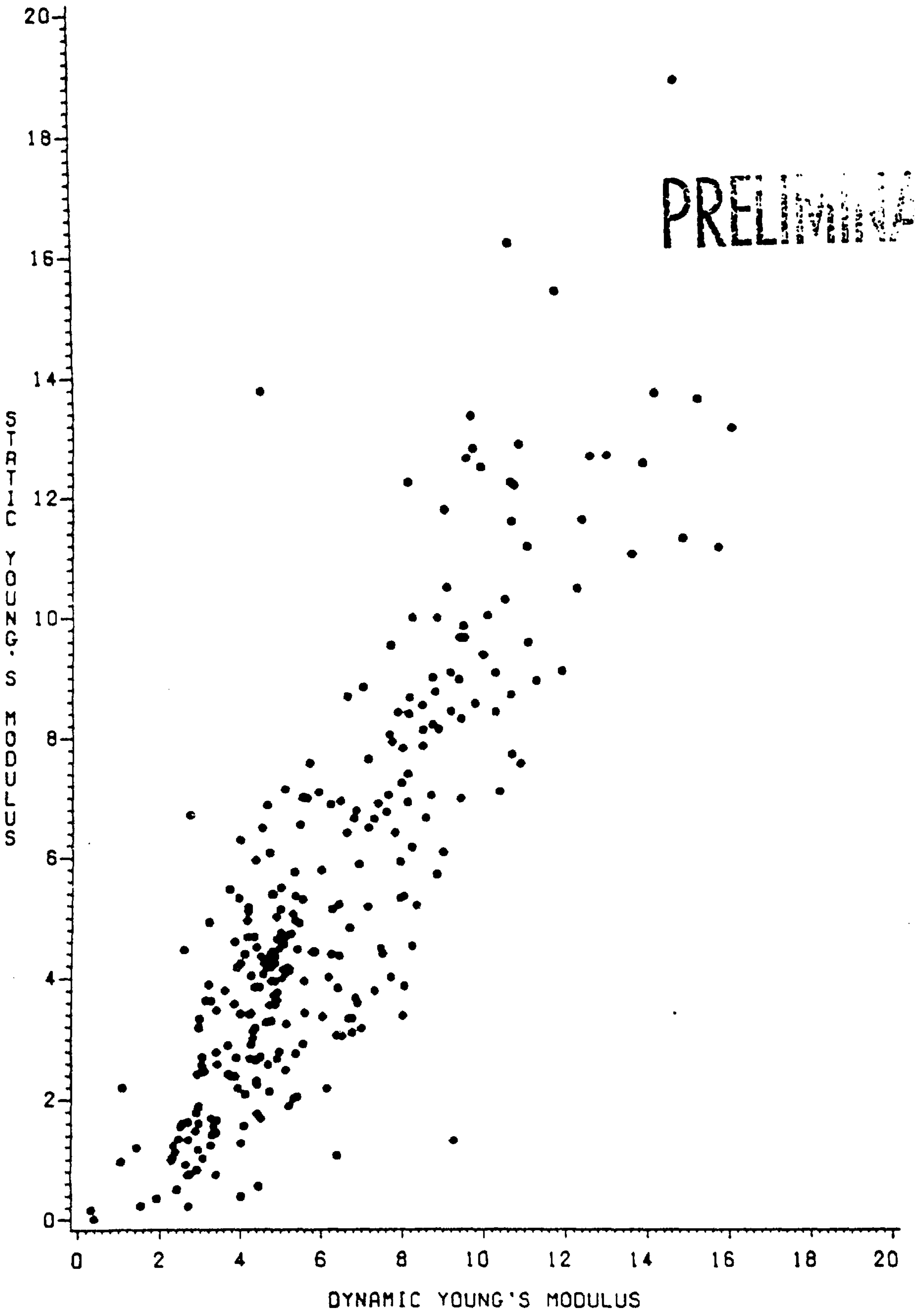
LAB TESTING DATA SUMMARY

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

LAB TESTING DATA SUMMARY

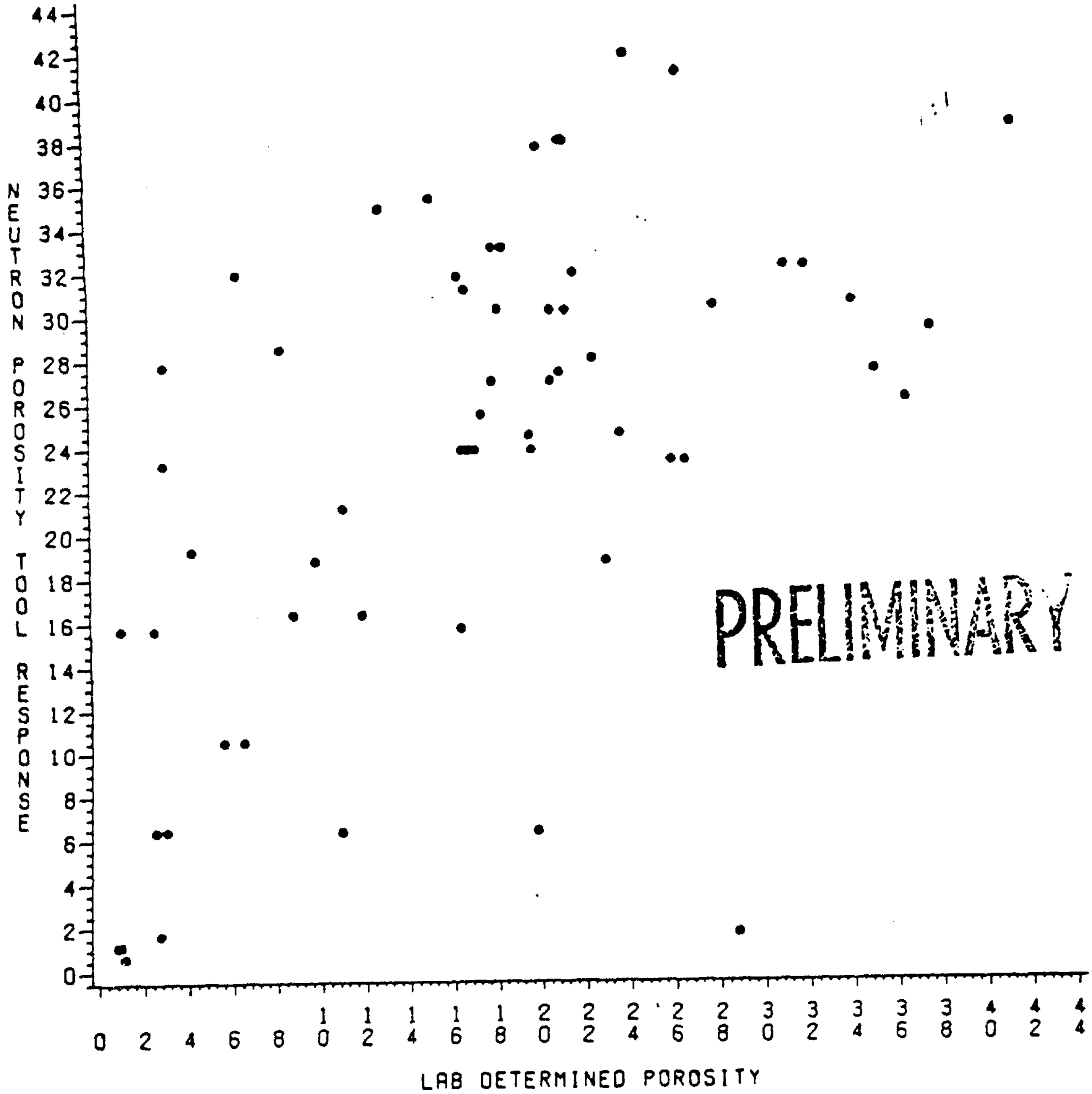
FORMATION (LITHOLOGY)	GRAIN DENSITY	POROSITY	STRENGTH	YOUNG'S MODULUS	P-WAVE VELOCITY
USA					
(SALTS)	*2.2	-	1855-9526#	3.71 (.38-5.38)	14568 (10075-16700)
(CLASTICS)	2.54 (2.34-2.69)	14 (1-28)	15932**	6.7**	19100**
(ANHYDRITES)	2.83 (2.68-2.94)	1.2 (0-5.7)	4740-28000	8.94 (3.62-18.94)	19100 (11500-24540)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

STATIC VS DYNAMIC MODULI CORRELATION



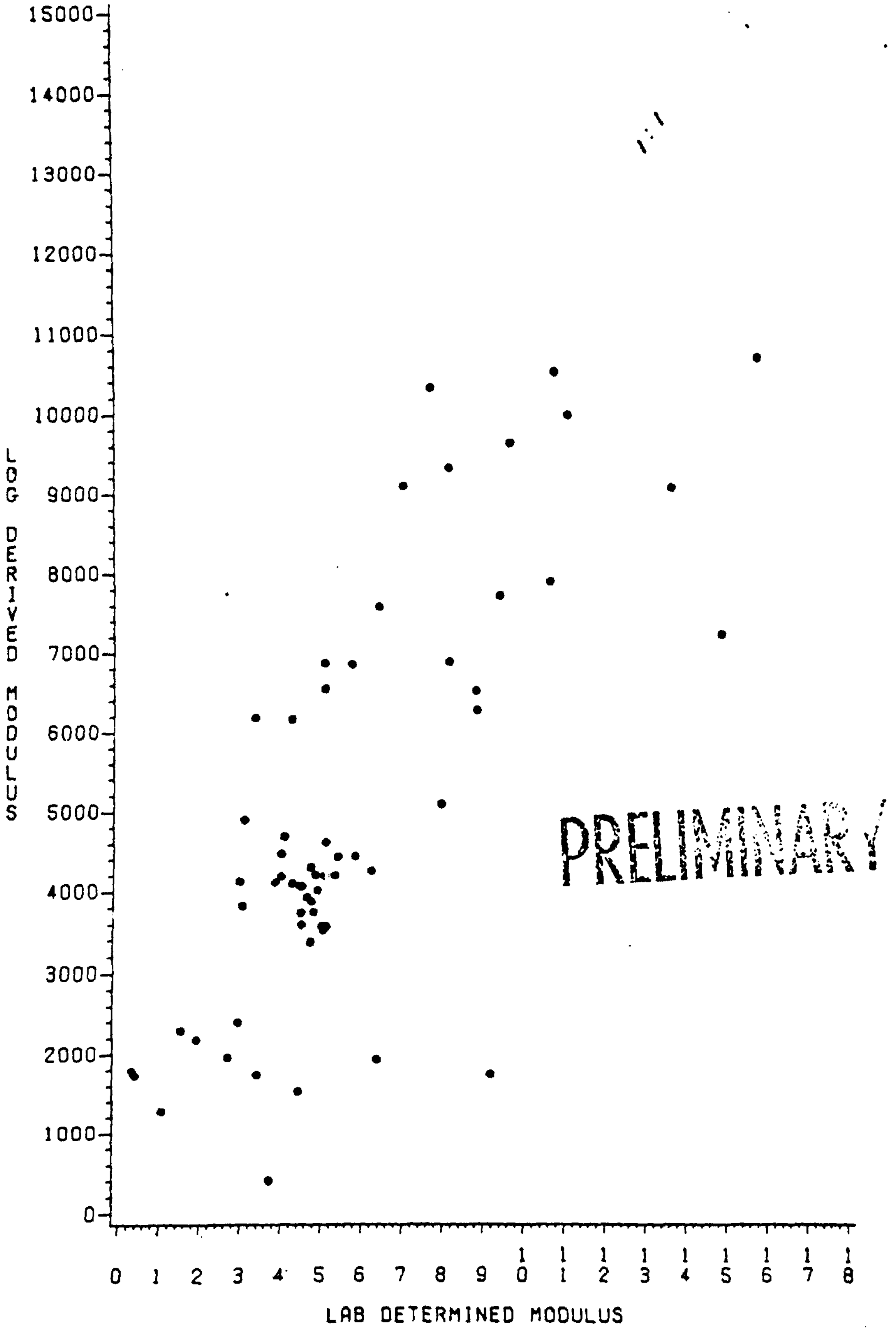
PRELIMINARY

LAB VS LOG CORRELATIONS



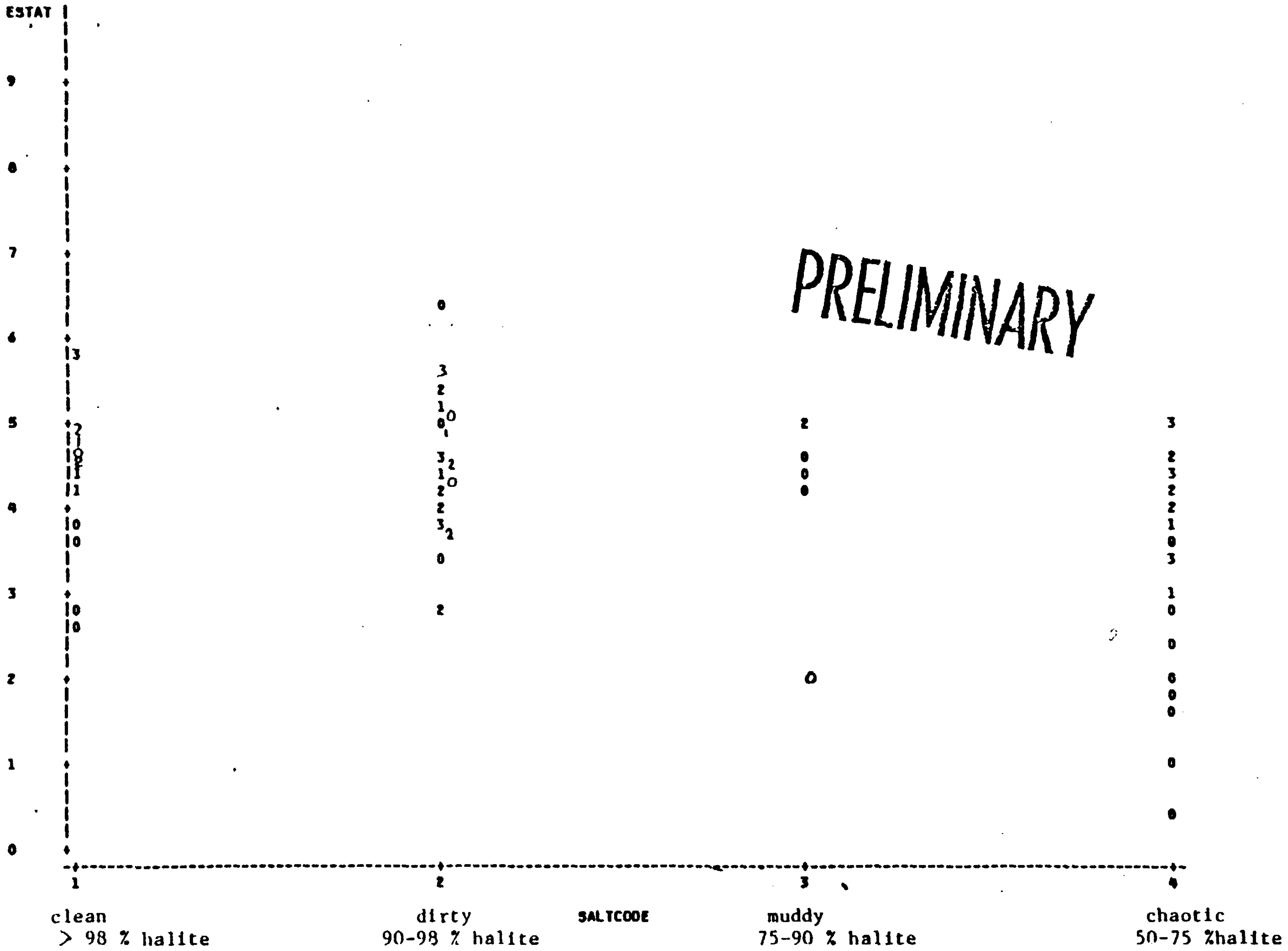
PRELIMINARY

LAB VS LOG CORRELATIONS



PRELIMINARY

PLOT OF ESTAT*SALTCODE   SYMBOL IS VALUE OF SIGMA3

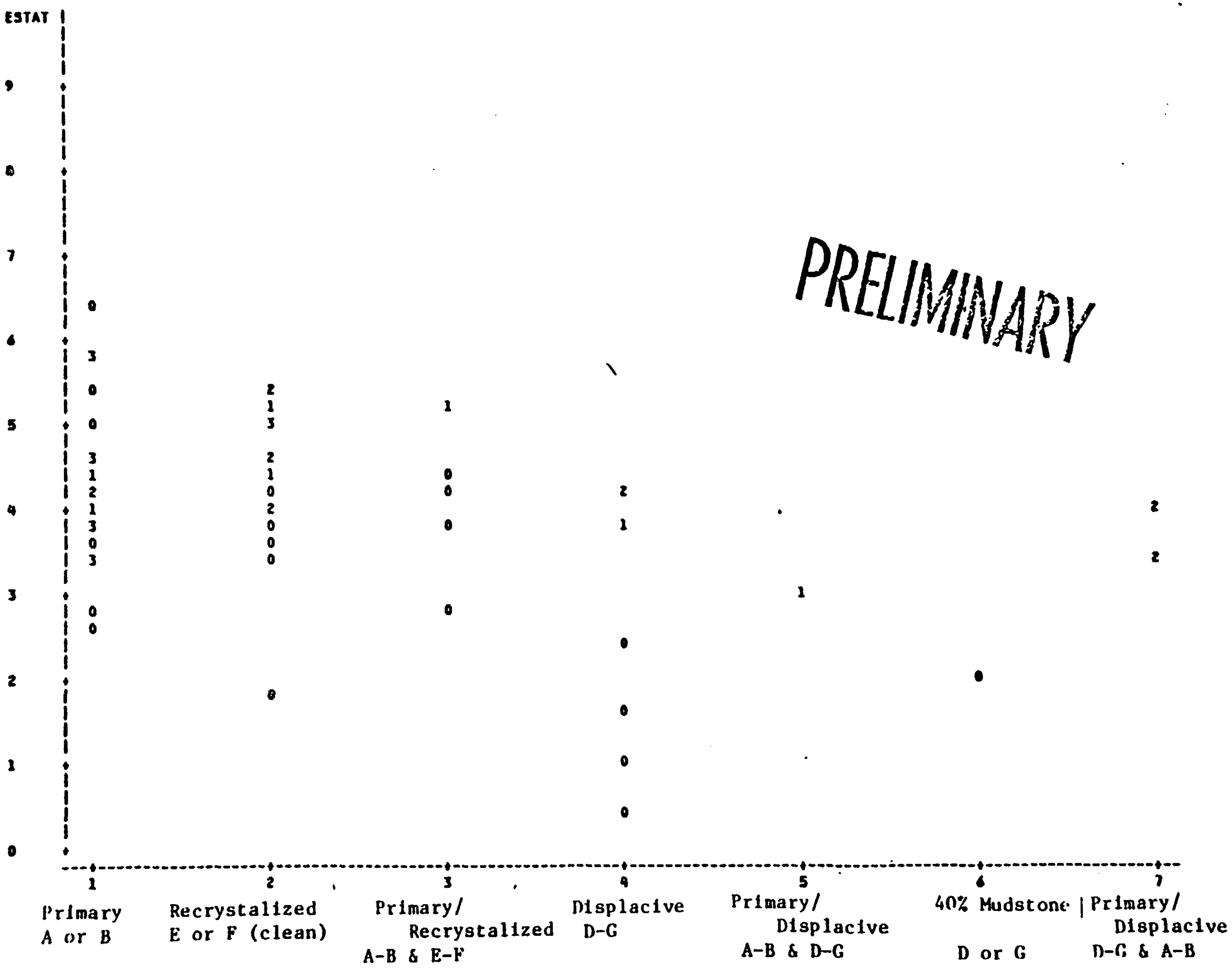


PRELIMINARY

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

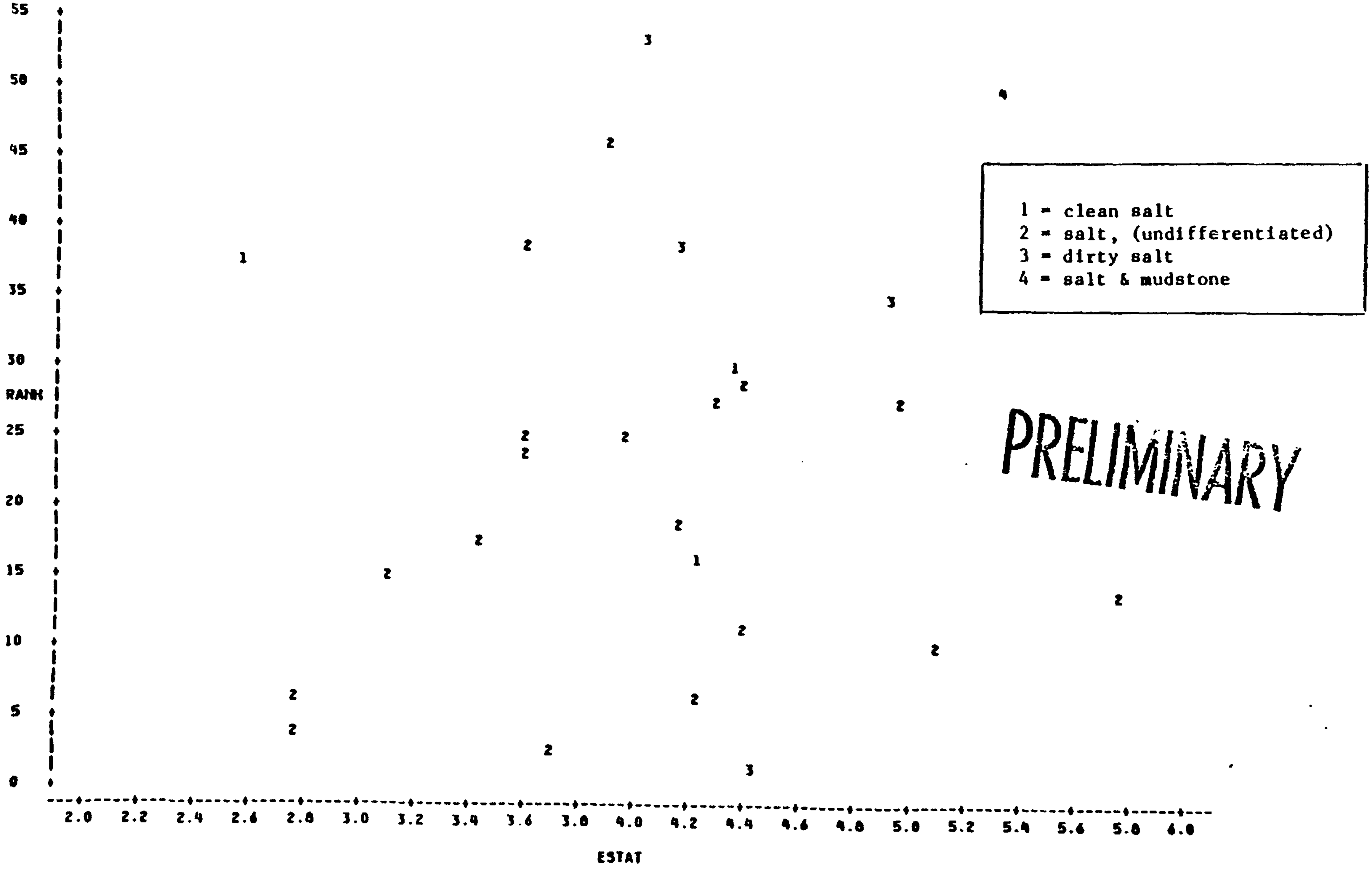
PLOT OF ESTAT*TYPE SYMBOL IS VALUE OF SIGMA3

PRELIMINARY



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

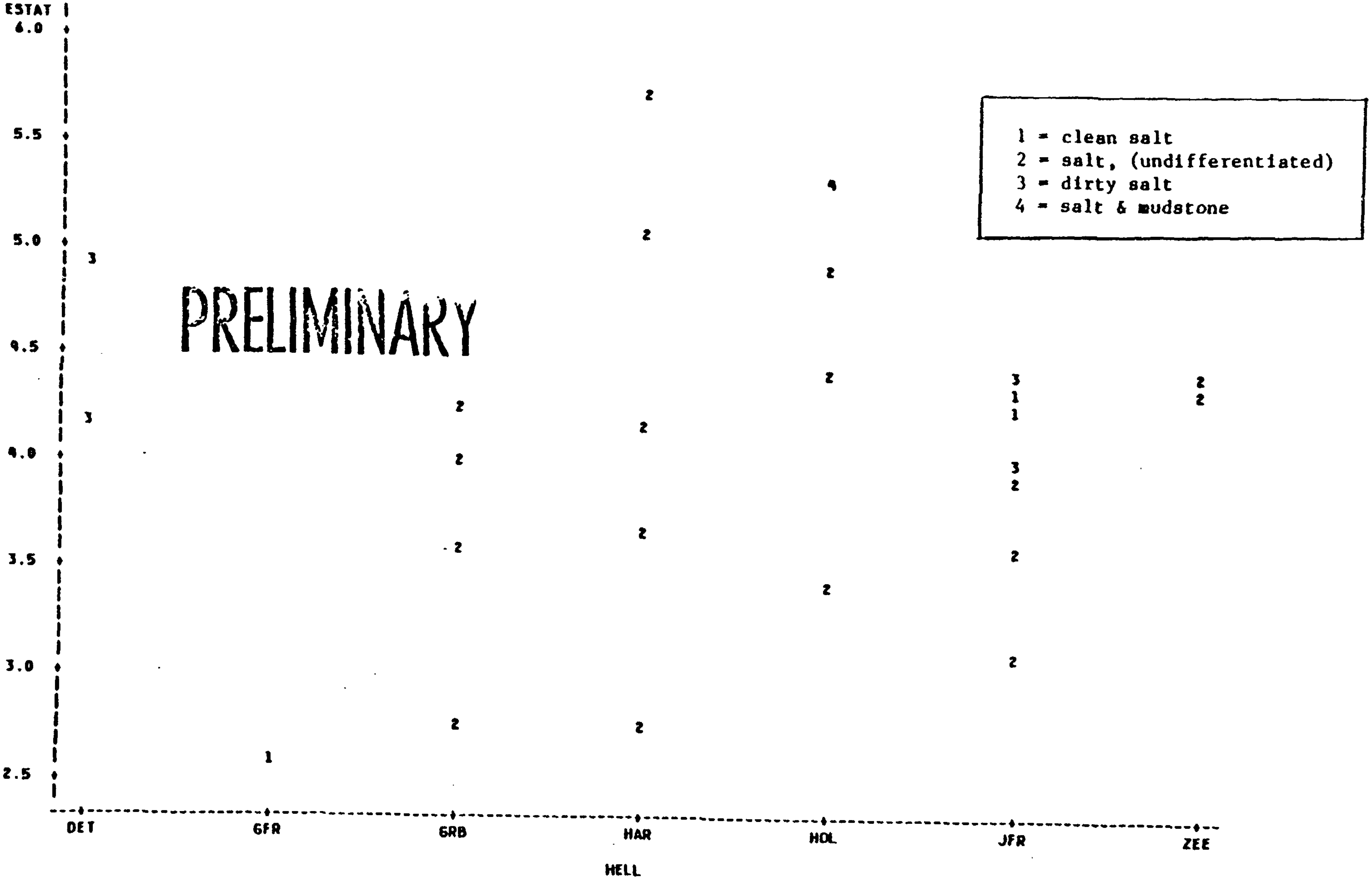
PLOT OF RANK*ESTAT SYMBOL IS VALUE OF RXCODE



PRELIMINARY

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

PLOT OF ESTAT*WELL   SYMBOL IS VALUE OF RXCODE



SAMPLE SELECTION

IMPORTANT HORIZONS

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

SAMPLING

- Somewhat Random
- Representative
- Testable

TESTING

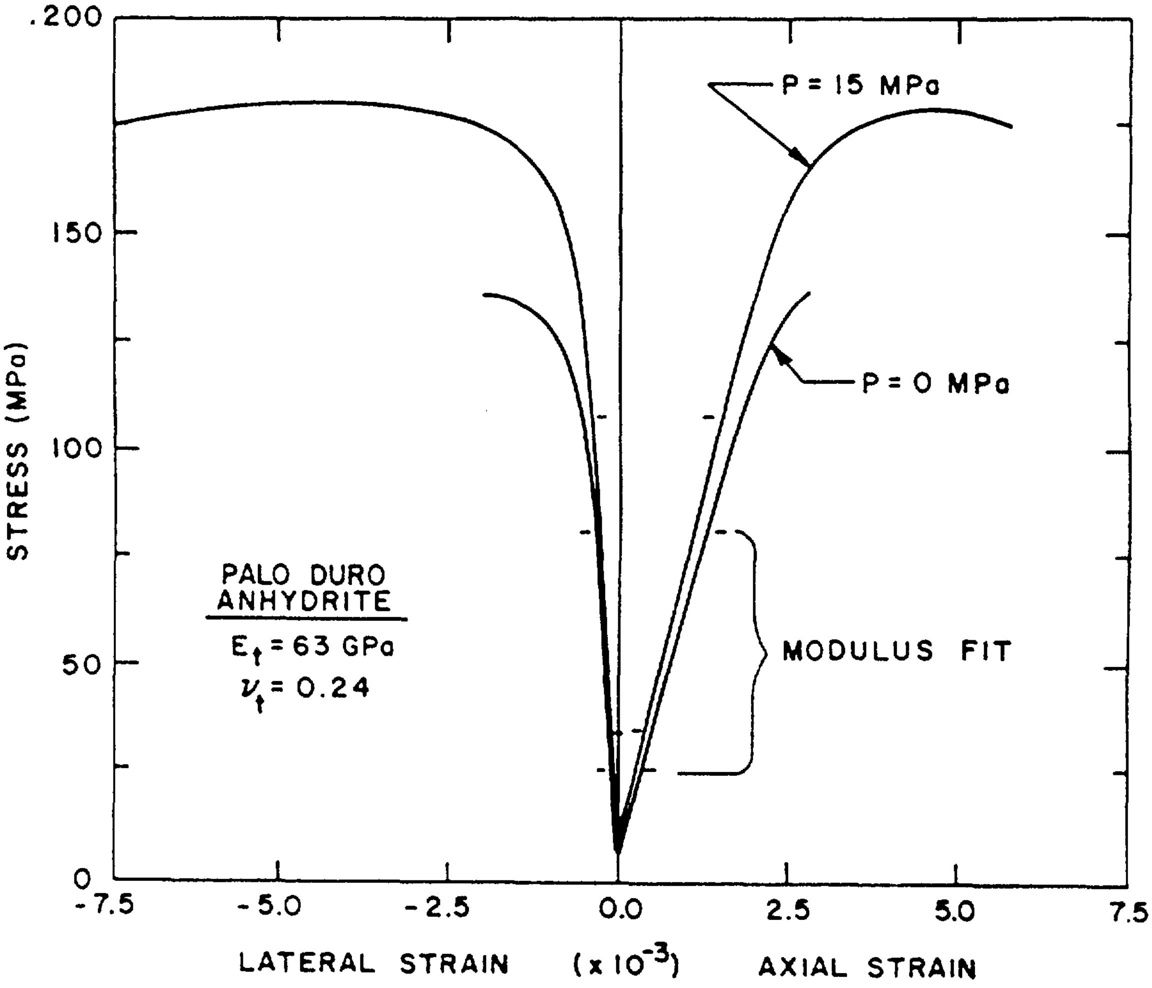
BRAZILIAN: Tensile Strength

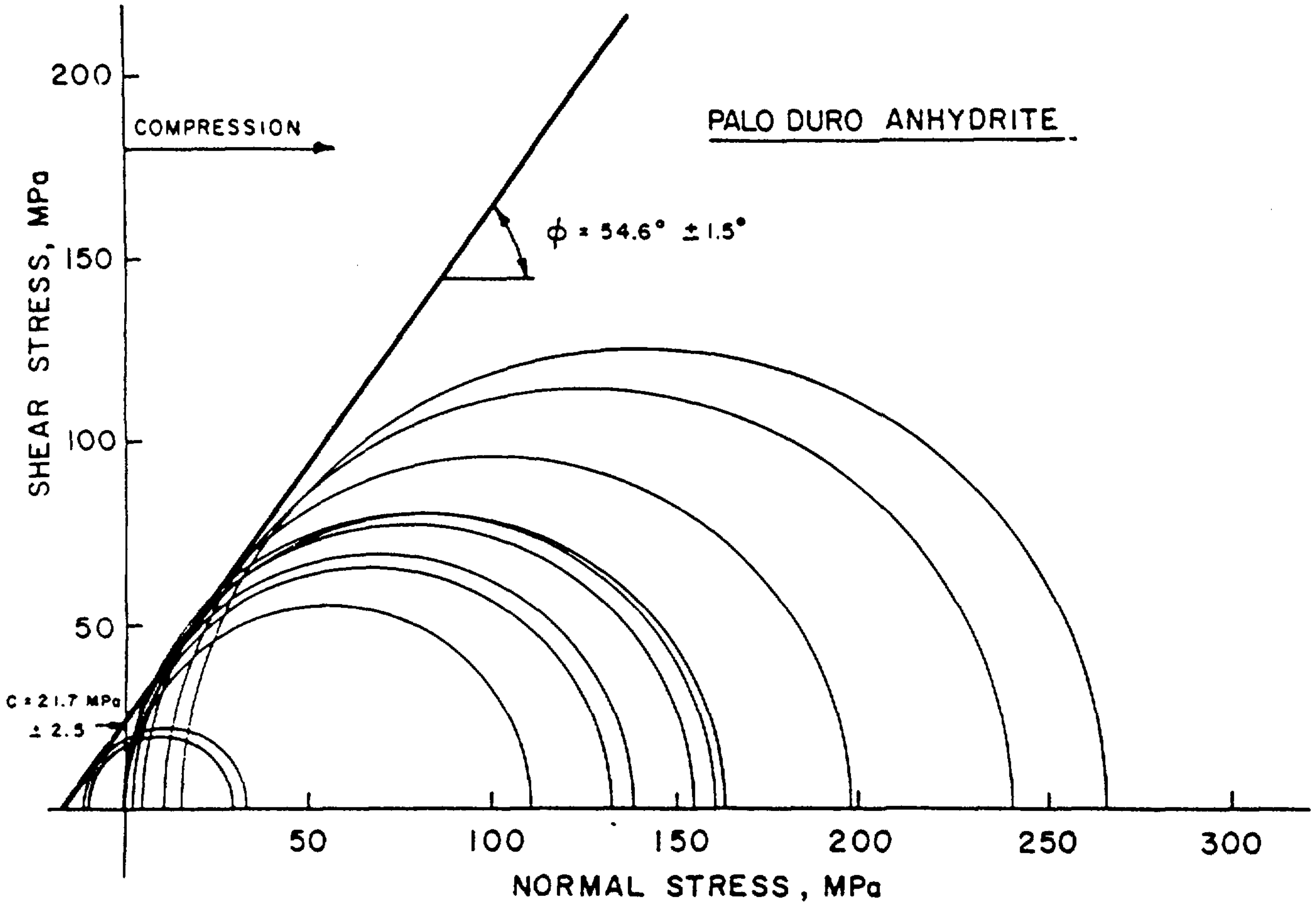
UNCONFINED COMPRESSION: Compressive Strength; Elastic Constants

TRIAXIAL COMPRESSION: Envelope of Compressive Strengths
Elastic Constants

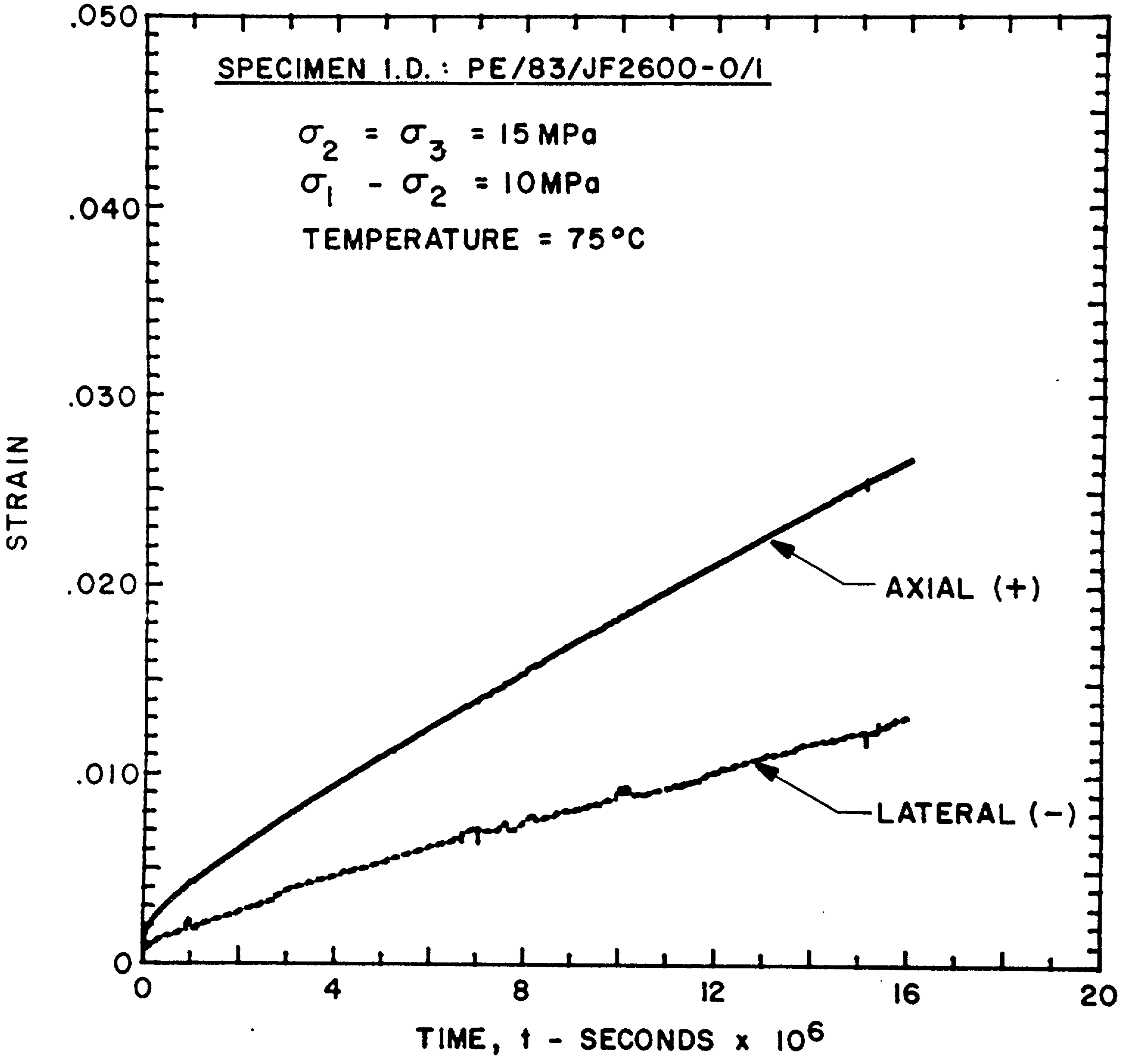
CREEP: Time-Dependent Deformation

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
AXIAL (+)
LATERAL (−)
STRAIN
.050
.040
.030
.020
.010
0
0
4
8
12
16
20
TIME, t - SECONDS x 10^6

GRABBE #1

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

MANSFIELD #1

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

REXWHITE #1

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

DETTEN #1

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

ZEECK #1

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

G. FRIEMEL #1

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

J. FRIEMEL #1

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

WOODS-HOLTZCLAW #1

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

REPORTS

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

Table 2-1. Nominal Impurity Content of Specimens

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

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

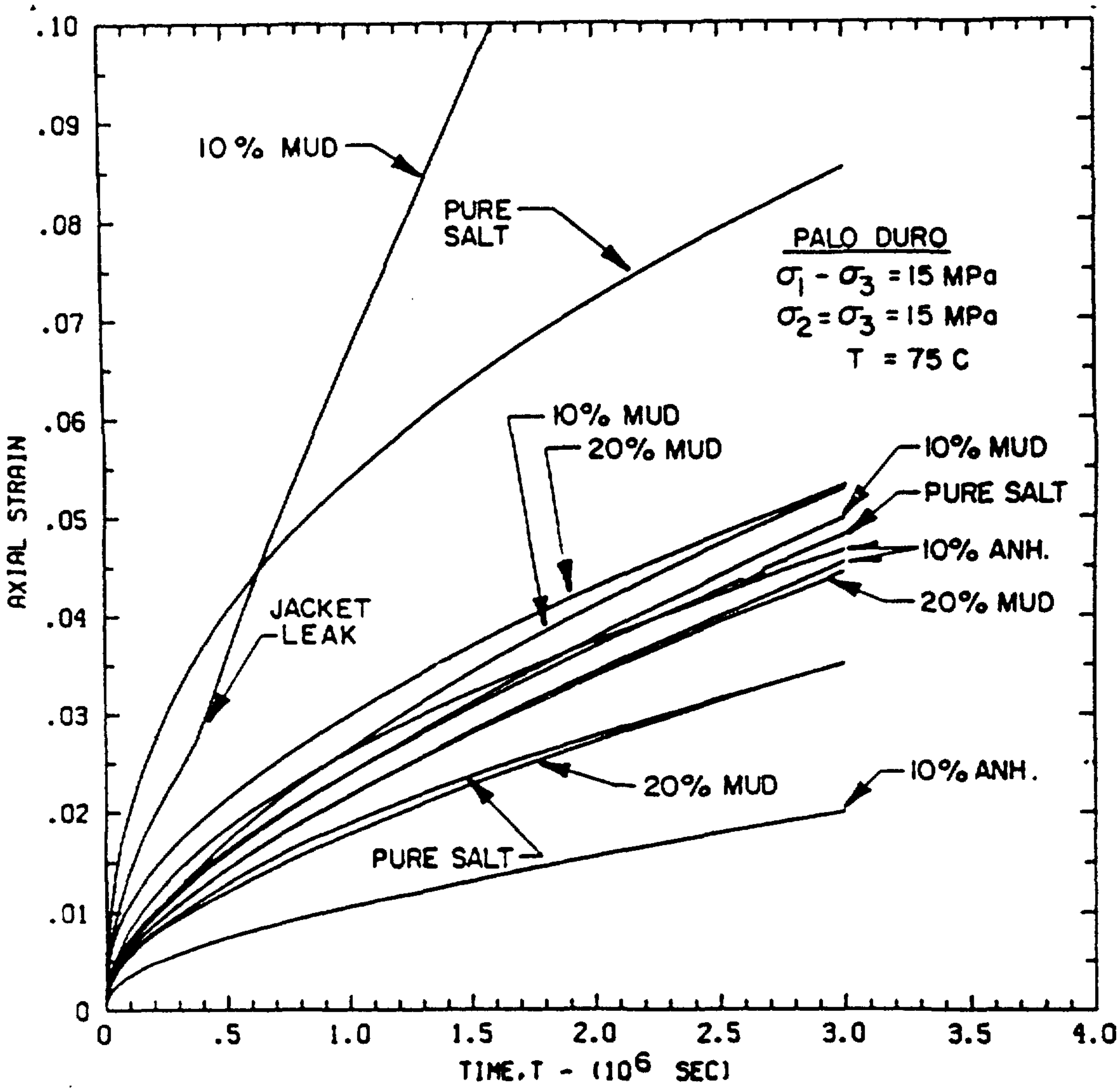

.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
AXIAL STRAIN
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TIME, T - (10⁶ SEC)
10 % MUD
PURE SALT
PALO DURO
σ1 - σ3 = 15 MPa
σ2 = σ3 = 15 MPa
T = 75 C
10% MUD
20% MUD
10% MUD
PURE SALT
10% ANH.
20% MUD
JACKET LEAK
20% MUD
10% ANH.
PURE SALT

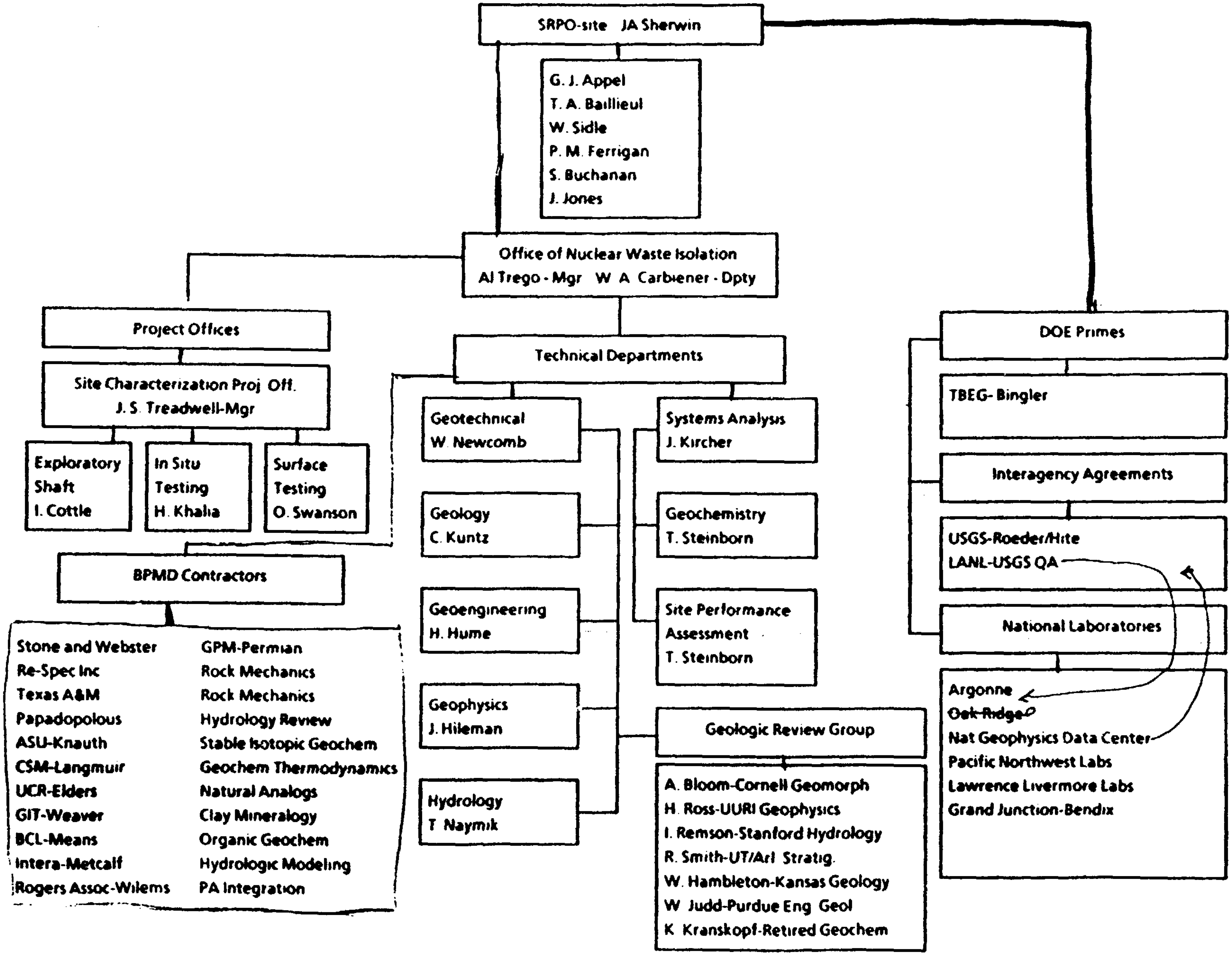
Table 4-2. Comparison of Current and Previous[a] Quasi-Static Parameter Values for Palo Duro Unit 5 Salt

Parameter	Currrent Value	Previous Value
Indirect Tensile[b] Strength, T_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



Sherwin 8/7

CONTRACT E512-05000
STONE & WEBSTER ENGINEERING CORPORATION

ONGOING TECHNICAL TASKS
FY1985 - FY1986

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

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

GEOPHYSICS
- MAINTAIN AND UPGRADE THE SEISMIC NETWORK

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

Washer 8/7

COMPUTER DATA BASES MAINTAINED BY STONE & WEBSTER

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

STONE & WEBSTER TECHNICAL REPORTS

REPORT NO.	DATE	REPORT TYPE	TITLE	
G82-16	11/23/82	Characterization Report	Area Geological Characterization Report (AGCR)	1.13
T-1	03/22/83	Topical Report	Ogallala Aquifer Mapping Report 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 Completion 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	Sept 85	Topical Report	A Report on Fracturing in the Deaf Smith Area	4.37 4.38
T-44	A.j [illegible]	Topical Report	Hydrogeologic Subdivision of the Wolfcamp Series and Pennsylvanian System of the Deaf Smith County Area, Texas	4.42 4.43 4.44 4.45

ROCK MECHANICS LABORATORY TESTING REPORTS

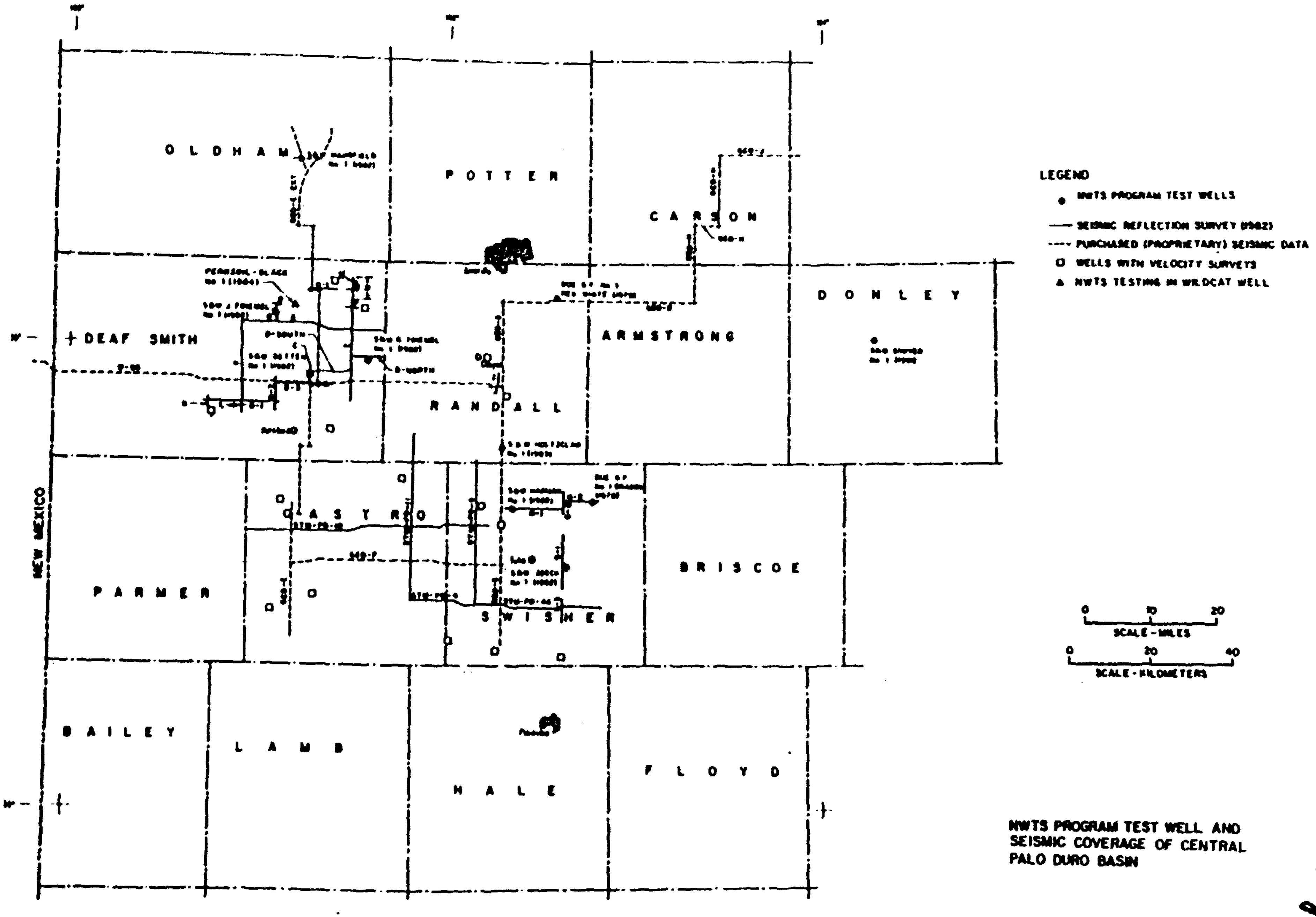
Report Title	Testing Lab	Report No. and Date	Presents Results of:
Laboratory Testing on Rock Core Samples from Mansfield No. 1 Well, Permian Basin Project	SWEC	13A-1 1-6-84	Density, Porosity, Water Content, Rebound Hardness, Tensile Strength, Slake Durability and Atterberg Limits Testing from the Mansfield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

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

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

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

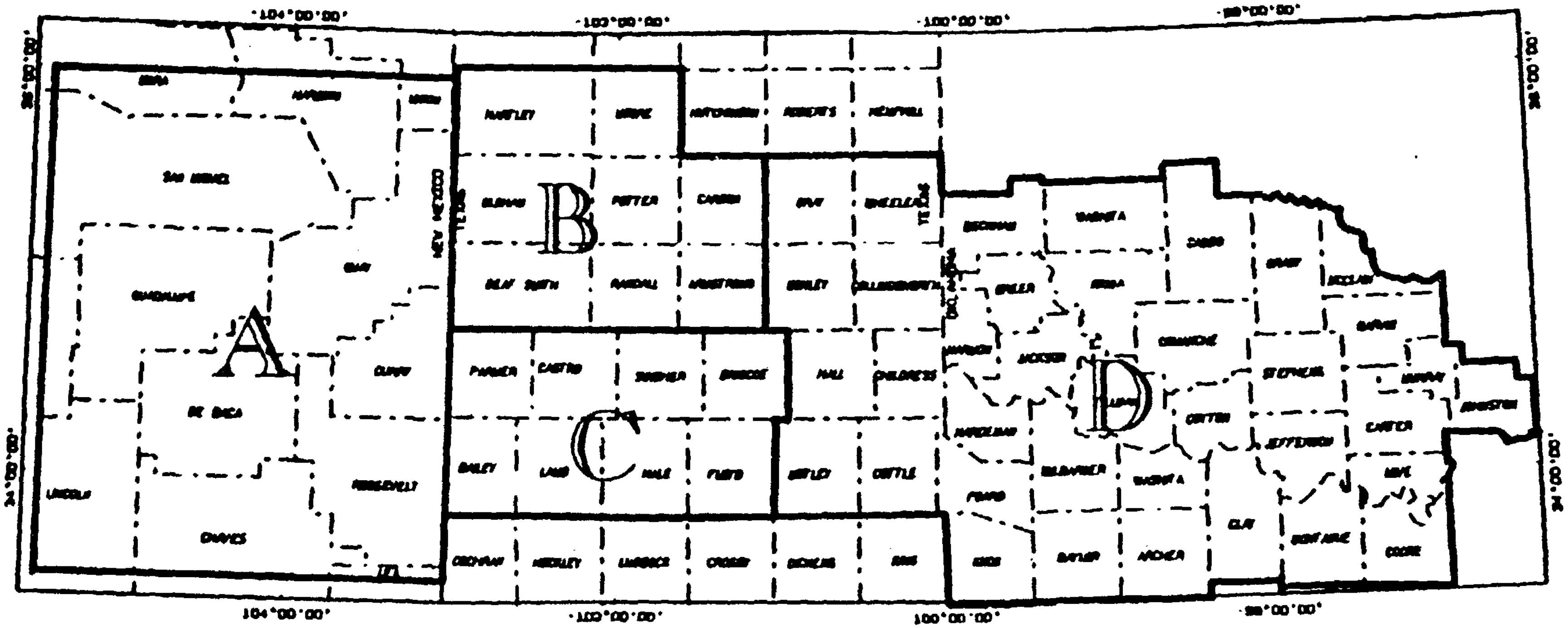
Report Title	Testing Lab	Report No. and Date	Presents Results of:
Suspected Presence of Solid Hydrocarbon in Bedded Salt Samples from the Permian Basin	RE1	4 (rev. 1) 11-28-84	Laboratory Efforts to Identify Material Previously Suspected to be Hydrocarbons



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

Murphy 3/7

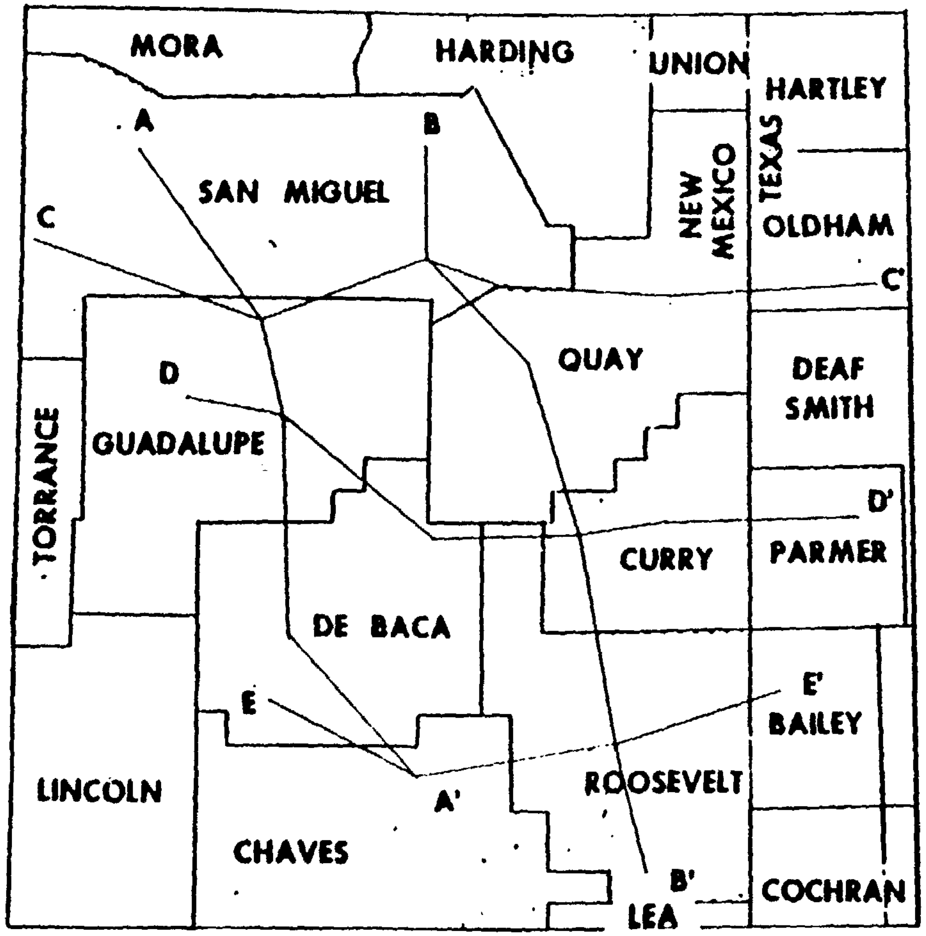
HYDROGEOLOGIC STUDY AREAS



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

-44,158

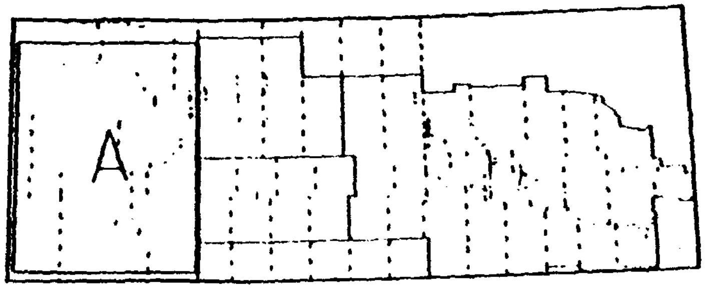
LOCATION OF STUDY AREA AND LINES OF CROSS SECTION



Legend.

ᵕ Well Control

— Cross Section Line



Hydrogeologic Study Areas

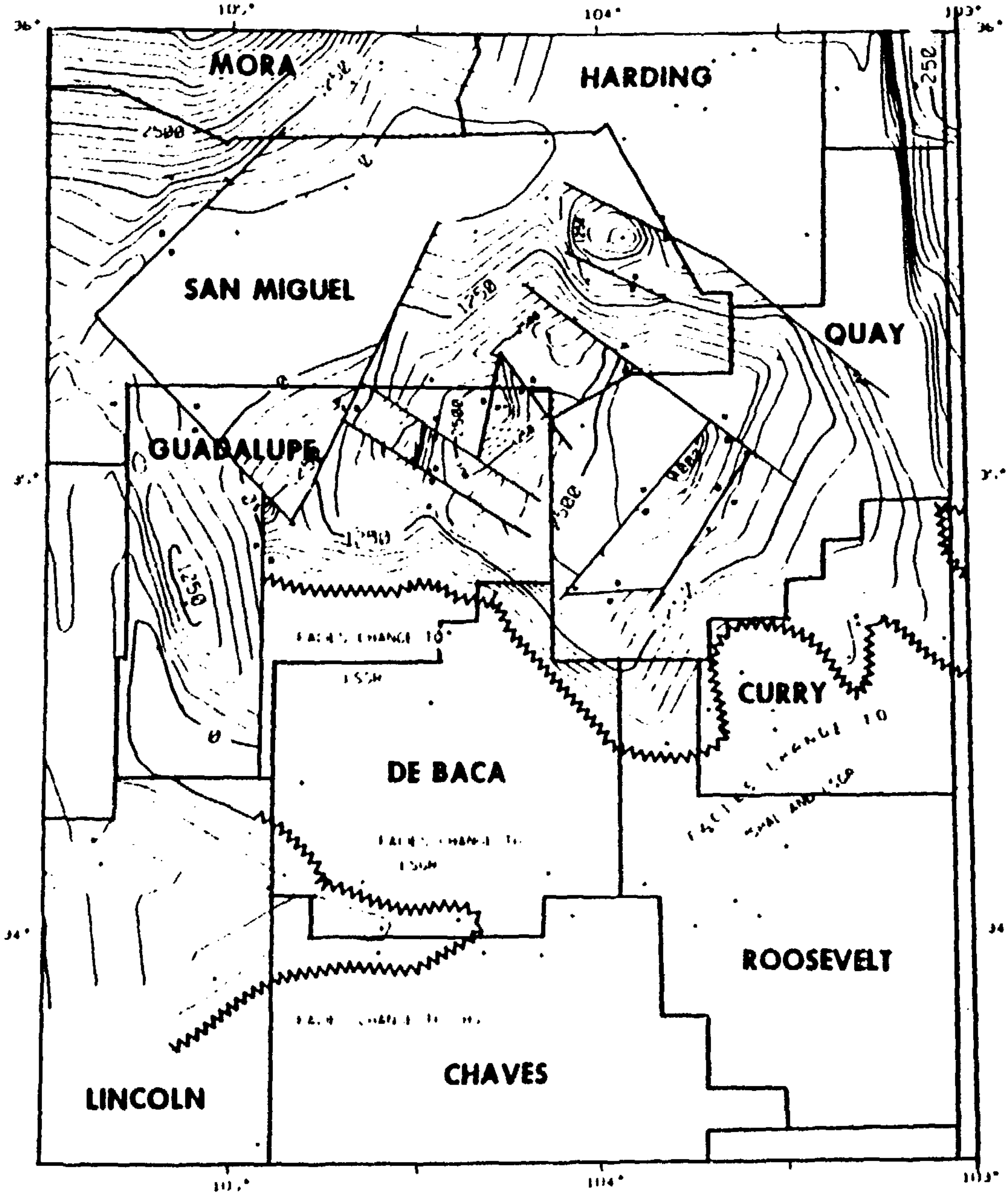
A Eastern New Mexico

B Deaf Smith

C Swisher

D Eastern Panhandle and Oklahoma

THICKNESS OF GRWA HYDROGEOLOGIC UNIT



LEGEND:

○ Well Control

Fault, U = Upthrown, D = Downthrown

/\/\ Facies Change

Datum: Mean Sea Level

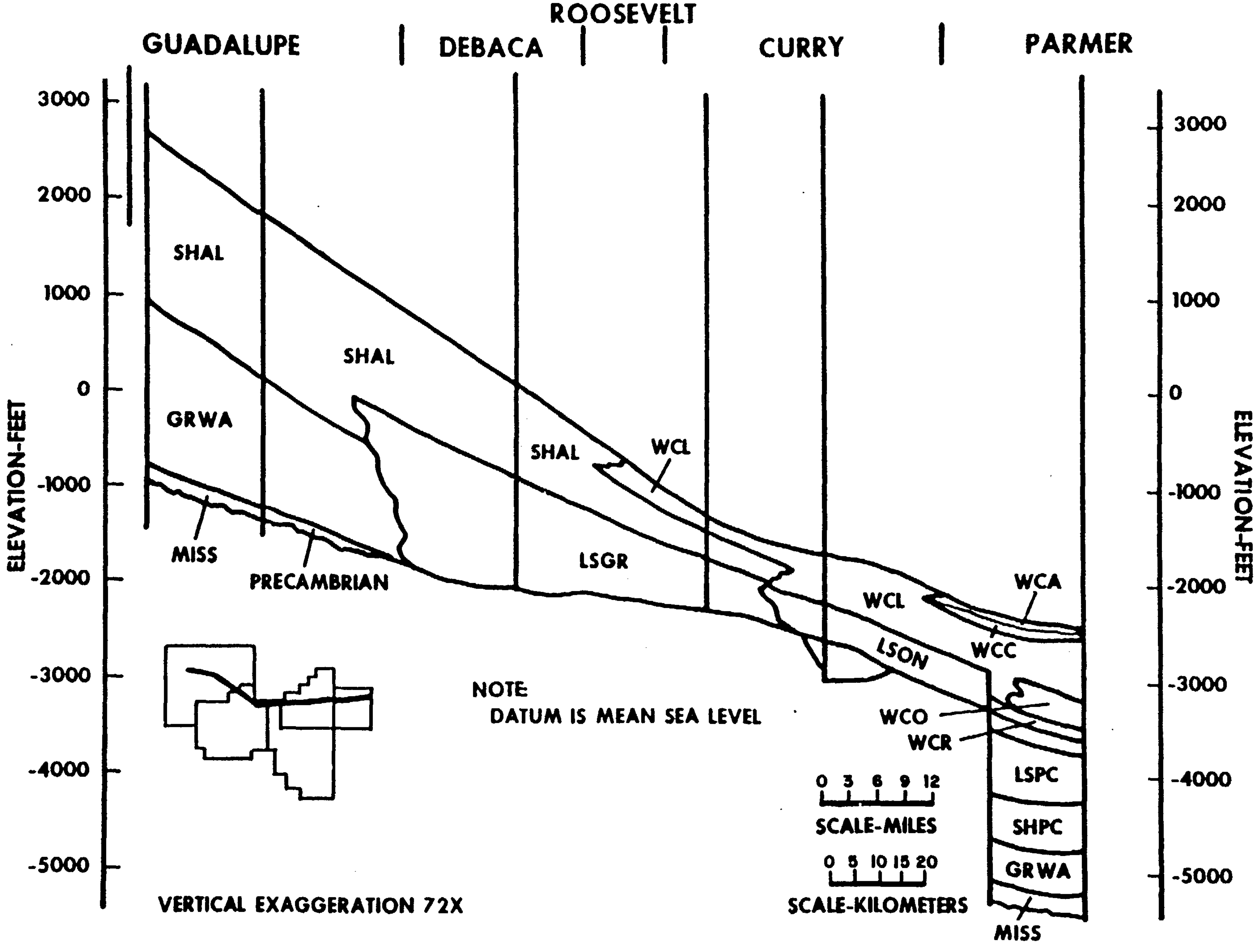
Contour Interval 250 Feet

SCALE-MILES

SCALE-KILOMETERS

85-44,167

CROSS SECTION D-D'



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PERMIAN BASIN CORE EXAMINATION MEETING

TEXAS BUREAU OF ECONOMIC GEOLOGY

Review of status of Palo Duro Basin Studies

<u>August 7, 1985</u>

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.

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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.

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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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Bassett, R. L., and Bentley, M. E., 1983, Deep brine aquifers in the Palo Duro Basin: regional flow and geochemical constraints: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 130, 59 p.

Gustavson, T. C., Kreitler, C. W., Bassett, R. L., Budnik, R. T., Ruppel, S. C., Baumgardner, R. W., Jr., Caran, S. C., Collins, E. W., Dutton, A. R., Dutton, S. P., Fisher, R. S., Fogg, G. E., Hovorka, S. D., Kolker, A., McGookey, D. A., Orr, E. D., Roberts, M. P., Senger, R. K., Smith, Dale A., and Smith, D. Anderson, 1983, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle: a report on the progress of nuclear waste isolation feasibility studies (1982): The University of Texas at Austin, Bureau of Economic Geology Geological Circular 83-4, 156 p.

1984

Collins, E. W., 1984, Styles of deformation in Permian strata, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 84-4, 32 p.

In press

Fisher, R. S., in press, Amount and nature of occluded water in bedded salt, Palo Duro Basin, Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular.

Gustavson, T. C., and Finley, R. J., in press, Late Cenozoic geomorphic evolution of the Texas Panhandle and northeastern New Mexico--case studies of structural control of regional drainage development: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations.

McGookey, D. A., Gustavson, T. C., and Hoadley, A. D., in press, Regional structural cross sections, mid-Permian to Quaternary strata, Texas Panhandle and eastern New Mexico, distribution of evaporites and areas of evaporite dissolution and collapse: The University of Texas at Austin, Bureau of Economic Geology Cross Sections.

Orr, E. D., Kreitler, C. W., and Senger, R. K., in press, Investigation of underpressuring in the deep-basin brine aquifer, Palo Duro Basin, Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 85-1.

Ruppel, S. C., in press, Stratigraphy and petroleum potential of Pre-Pennsylvanian Rocks, Palo Duro Basin, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations.

In preparation

Dutton, A. R., and Orr, E. D., in preparation, Hydrogeology and hydrochemical facies of the San Andres Formation in eastern New Mexico, West-Central Texas, and the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations.

Gustavson, T. C., and others, in preparation, Geomorphology and Quaternary stratigraphy of the Rolling Plains of the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Guidebook 22.

Gustavson, T. C., and others, in preparation, Geology and geohydrology of the Palo Duro Basin, Texas Panhandle, a report on the progress of nuclear waste isolation feasibility studies (1983): The University of Texas at Austin, Bureau of Economic Geology Geological Circular.

Hovorka, S. D., Luneau, B. A., and Thomas, S., in preparation, Stratigraphy of bedded halite in the Permian San Andres Formation, units 4 and 5, Palo Duro Basin, Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations.

Wirojanagud, P., Kreitler, C. W., and Smith, D. A., in preparation, Numerical modeling of regional ground-water flow in the deep-brine aquifers of the Palo Duro Basin, Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations.

PUBLICATIONS ASSOCIATED WITH RESEARCH IN THE PALO DURO AND DALHART BASINS

II. Outside Publications and Contract Reports

1978

Galloway, W. E., Gustavson, T. C., Dutton, S. P., Handford, R. J., and Presley, M. W., 1978, Locating field confirmation study areas for isolation of nuclear waste in the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Annual Report, 109 p.

Gustavson, T. C., Finley, R. J., and Woodruff, C. M., Jr., 1978, Geomorphic studies applied to the evaluation of nuclear waste isolation sites (abs.): Geological Society of America, Abstracts with Programs, v. 10, no. 1, p. 6.

Gustavson, T. C., Finley, R. J., Morabito, J. R., and Presley, M. W., 1978, Structural controls on drainage development on the Southern High Plains and Rolling Plains of the Texas Panhandle (abs): Geological Society of America, Abstracts with Programs, v. 10, no. 7, p. 413.

McGowen, J. H., Granata, G. E., and Seni, S. J., 1978, Depositional framework of the Lower Dockum Group (Triassic), Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Contract Report. 113 p. (U.S.G.S. Grant).

1979

Dutton, S. P., 1979, Alternating clastic-carbonate deposition in fan delta systems, Lower Pennsylvanian, Palo Duro Basin (abs.): Geological Society of America, Abstracts with Programs, v. 11, no. 2, p. 146-147.

Dutton, S. P., 1979, Depositional models and resource potential, Pennsylvanian System, Palo Duro Basin, Panhandle, Texas (abs.): American Association of Petroleum Geologists Bulletin, v. 63, no. 8, p. 1425.

Dutton, S. P., 1979, Facies patterns and depositional models, Pennsylvanian System, Palo Duro Basin, Panhandle, Texas (abs.): American Association of Petroleum Geologists Bulletin, v. 63, no. 3, p. 442-443.

Dutton, S. P., 1979, Pennsylvanian fan-delta sandstones of the Palo Duro Basin, Texas (abs.): American Association of Petroleum Geologists Bulletin, v. 63, no. 11, p. 2116.

Dutton, S. P., 1979, Pennsylvanian fan-delta sandstones of the Palo Duro Basin, Texas: in Pennsylvanian sandstones of the Mid-Continent: Tulsa Geological Society Special Publication, no. 1, p. 235-245.

Finley, R. J., and Gustavson, T. C., 1979, Geomorphic effects of a major storm on an instrumented drainage basin in the Texas Panhandle (abs.): Geological Society of America, Abstracts with Programs, v. 12, no. 1, p. 426.

Galloway, W. E., Gustavson, T. C., Dutton, S. P., Finley, R. J., Handford, C. R., and Presley, M. W., 1979, Locating field confirmation study areas for isolation of nuclear waste in the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Annual Report, 106 p.

Gustavson, T. C., and Finley, R. J., 1979, Timing and rates of regional salt dissolution in bedded Permian salts in the Texas Panhandle (abs.): Geological Society of America, Abstracts with Programs, v. 11, no. 7, p. 413.

Gustavson, T. C., Finley, R. J., Morabito, J. R., and Presley, M. W., 1979, Regional salt dissolution and subsidence, Texas Panhandle (abs.): Geological Society of America, Abstracts with Programs, v. 11, no. 2, p. 147-148.

Gustavson, T. C., Handford, C. R., Presley, M. W., Baumgardner, R. W., Jr., Dutton, S. P., Finley, R. J., McGillis, K. A., and Simpkins, W. W., 1979, Locating field confirmation study areas for isolation of nuclear waste in the Texas Panhandle: The University of Texas at Austin, Bureau of Economic Geology Annual Report, 99 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
OF-WTWI-1984-1	A Comparison of the Depositional Environment of the San Andres Formation in the Palo Duro Basin to Recent Evaporitic Environments (332 FJ) Geochemistry (6.0) and (332 FJ) Natural Analogs (6.4) Chapman	4-27-84	5-7-84	5-25-84
OF-WTWI-1984-2 32 p $3.20 + ship	Uplift, Tilting and Subsidence of the Palo Duro Basin Area (3.3.2.2 A,C,E,I) Tectonic History McGookey	5-15-84	5-15-84	5-25-84
OF-WTWI-1984-3 36 pages $3.60 + ship	Salt Dissolution: Examples from Beneath the Southern High Plains (3.3.2.2 G) Geomorphic Processes and (3.3.2.2 R) Salt Dissolution Gustavson & Budnik	5-15-84	5-15-84	5-25-84
OF-WTWI-1984-4 19 p $1.40 + ship	Active Stress Field in the Texas Panhandle (3.3.2.2 B) Tectonic History Budnik	5-21-84	5-21-84	5-28-84
OF-WTWI-1984-5	Status of Borehole Sealing Research and Its Application to the Palo Duro Basin (332 FI) Relationships Among Hydrogeologic Units (5.6.2) Simpkins	1-30-84	5-24-84	5-28-84
OF-WTWI-1984-6	Investigation of Underpressuring in the Deep-Basin Brine Aquifer, Palo Duro Basin, Using Pressure/Depth Profiles (332 FI) Relationships Among Hydrogeologic Units (5.6.2) Orr	1-30-84	5-23-84	5-28-84

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-7 13 p $1.30 + ship	Potentiometric Level of the Deep-Basin Brine Aquifer, Palo Duro Basin, Texas Panhandle (332 FI) Potentiometric Level (5.6.3) Smith	2-14-84	5-23-84	5-29-84
OF-WTWI-1984-8 183 pg × .10 64 pg × .20 $31.00 + shipping SUPERSEDED	Numerical Modeling of Regional Ground-Water Flow in the Deep-Basin Aquifers of the Palo Duro Basin, Texas Panhandle (332 FI) Regional Ground-Water Flow System (5.7) and (332 FI) Principal Ground-Water Flow Paths (5.7.2) Wirojanagud, Kreitler & Smith	2-24-84	6-1-84	6-1-84
OF-WTWI-1984-9	Structural Control of Physiography, Geomorphic Processes, and Lithofacies, Texas Panhandle (332 FH) Geomorphology (3.1) and (332 FH) Physiography and Topography (3.1.1) Gustavson & Budnik	3-12-84	5-23-84	5-29-84
OF-WTWI-1984-10	Late Quaternary Paleoclimatology of the Southern High Plains of Texas -- Implications for Disposal of Nuclear Waste (332 FJ) Long-Term Climate Assessment (7.2), (332 FJ) Paleoclimatology (7.2.1) and (332 FJ) Future Climatic Variation (7.2.2) Caran & Neck	3-12-84	5-23-84	5-29-84
OF-WTWI-1984-11 42 p $4.20 + ship	Host Rock Geochemistry of the Palo Duro Basin, Texas (332 FJ) Host Rock Geochemistry (6.1) Fisher	3-14-84	5-24-84	5-25-84

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-12 9 p. $0.90 + ship	Quaternary Faulting in Southeastern Briscoe County, Texas (332 FH) Geomorphic Units (3.1.2) Baumgardner & Caran	3-21-84	5-23-84	5-29-84
OF-WTWI-1984-13	Stratigraphy of a Significant Quaternary Alluvial Sequence, Briscoe, Floyd, Hall, and Motley Counties, Texas (332 FH) Geomorphic Units (3.1.2) Caran & Baumgardner	3-21-84	5-23-84	5-29-84
OF-WTWI-1984-14	Historic Seismicity In and Around the Texas Panhandle (332 FH) Long-Term Regional Stability with Respect to Tectonic and Geologic Processes (3.5) Pennington & Davis	3-28-84	5-23-84	5-31-84
OF-WTWI-1984-15	Long-Term Rates of Denudation Based on Hypsometric Analysis of Drainage Basins and Underlying Salt Beds in the Texas Panhandle and Northeast New Mexico (332 FH) Geomorphic Processes (3.1.3) Baumgardner	4-4-84	5-31-84	5-31-84
OF-WTWI-1984-16	Modern Eolian Processes on the Southern High Plains (332 FH) Geomorphic Processes (3.1.3) Machenberg & Caran	4-4-84	5-23-84	5-31-84
OF-WTWI-1984-17	Analysis of Dust Trap Sediments Collected on the Southern High Plains (332 FH) Geomorphic Processes (3.1.3) Machenberg	4-4-84	5-23-84	5-31-84

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

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-25	Status Report on Identification of Discharge Areas of Deep-Basin Brine Aquifers, Hardeman Basin, Texas (332GN D) Identification of Recharge-Discharge Areas Richter, Smith & Orr	6-25-84	6-25-84	N/A
OF-WTWI-1984-26 13 p \$1.30 + ship	Geochemical Environment of the Evaporite Aquitard and Deep-Basin Brine Aquifer, Palo Duro Basin, Texas (332GP A) Geochemical Stability Fisher	6-25-84	6-25-84	N/A
OF-WTWI-1983-4 30 p \$3^{00} + ship	Identification of Recharge-Discharge Areas of the Palo Duro Basin, Texas Panhandle (332 FI) Identification of Recharge-Discharge Areas (5.7.1) Senger & Richter	9-22-83	6-29-84	6-29-84
OF-WTWI-1983-5	Texas Panhandle Mineral Assessment: Summary Report (332 FH) Mineral and Hydrocarbon Resources (3.7) and (332 FH) Mineral Resources (3.7.1) Bureau of Business Research (for the Bureau of Economic Geology)	12-19-83	7-3-84	7-3-84
OF-WTWI-1983-6	Texas Panhandle Mineral Assessment: The Petroleum Industry (332 FH) Hydrocarbon Resources (3.7.2) Bureau of Business Research (for the Bureau of Economic Geology)	12-19-83	7-3-84	7-3-84

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1983-1	Tectonic History of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic History (3.3.2) Budnik	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-2	Tectonic Framework of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic Framework (3.3.1) Budnik	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-3	Fracture Studies of the Palo Duro Basin, Texas Panhandle (332 FH) Tectonic History (3.3.2) Collins	9-15-83	7-9-84	7-9-84
OF-WTWI-1983-9	Hydrocarbon Resources of the Palo Duro Basin, Texas Panhandle (3.7.2) Hydrocarbon Resources (3.9.3) Dutton	1-5-83	7-9-84	7-9-84
OF-WTWI-1983-14	Hydrocarbon Resources of the Palo Duro Basin, Texas Panhandle (332 FH) Hydrocarbon Resources (3.7.2) Ruppel and Dutton	12-21-83	7-9-84	7-9-84
OF-WTWI-1982-1 ~~70 pp x .10 = 7.00~~ 115 pp x .10 = 11.50 28 ft x 1.15/ft = 32.20 43.70 + ship	Hydrology of the Palo Duro Basin, Texas Panhandle (5.6.1) Hydrogeologic Units (5.1 & 5.1.1); (5.6.2) Relationship Among Hydrogeologic Units (5.1.2); (5.6.3) Potentiometric Level (5.1.3); (5.6.4) Hydraulic Characteristics of Principal Hydrogeologic Units (5.1.4); (5.7.1) Identification of Recharge and Discharge Areas (5.2.1); (5.7.2) Principal Ground-Water Flow Paths (5.2 & 5.2.2); and (5.7.3) Isotopic and Regional Hydrochemistry (5.2.3, 5.3.2, 6.2A, 6.2D) WTWI Staff, The Bureau of Economic Geology	10-26-82	7-18-84	7-18-84

OPEN-FILED CSRs AND TECHNICAL REPORTS

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

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-27 [illegible] [illegible]	Preliminary Results of Porosity and Permeability of Cores from DOE Wells in the Palo Duro Basin, Texas Panhandle (332GN C) Hydraulic Characteristics of Principal Hydrogeologic Units Senger, Smith & Conti	8-7-84	8-7-84	N/A
OF-WTWI-1984-28 [illegible] [illegible]	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 #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-29	Experimental Modeling of Diapirs: Initial Report (332HE C) Initial Report of Findings Jackson	8-17-84	8-17-84	N/A
OF-WTWI-1984-30	Stratigraphy of the Palo Duro Basin - A Status Report (332FH D1) Stratigraphy (3.2) Ruppel and others	8-21-84	8-17-84	N/A
OF-WTWI-1984-36 22 p. $2.20 + ship	Regional and Isotopic Hydrogeochemistry: Deep-Basin Brine Aquifer, Palo Duro Basin, Texas Panhandle (332GN B) Isotopic and Regional Hydrogeochemistry Fisher	8-23-84	8-22-84	N/A
OF-WTWI-1984-37	Regression Analysis of Erosion and Deposition at Six Stations in the Texas Panhandle (332GM G) Geomorphic Processes (332GM K) Erosion Rates Simpkins	8-24-84	8-24-84	N/A
OF-WTWI-1984-21 69 pg = 6.90 505 ft x 1.15 = 58.08 $64.98 + 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 54 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 [illegible]	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 [illegible]	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 figs 13.00 $15.00 + 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 1220 + 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 [illegible]	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

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OF #	Title, Deliverable & Author	Originally Submitted to DOE	Open-Filed	Re-submitted to DOE
OF-WTWI-1984-54 [illegible] 15 * [illegible] ship	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 11 p. * 1.60 + 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

BUREAU OF ECONOMIC GEOLOGY

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 pp 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

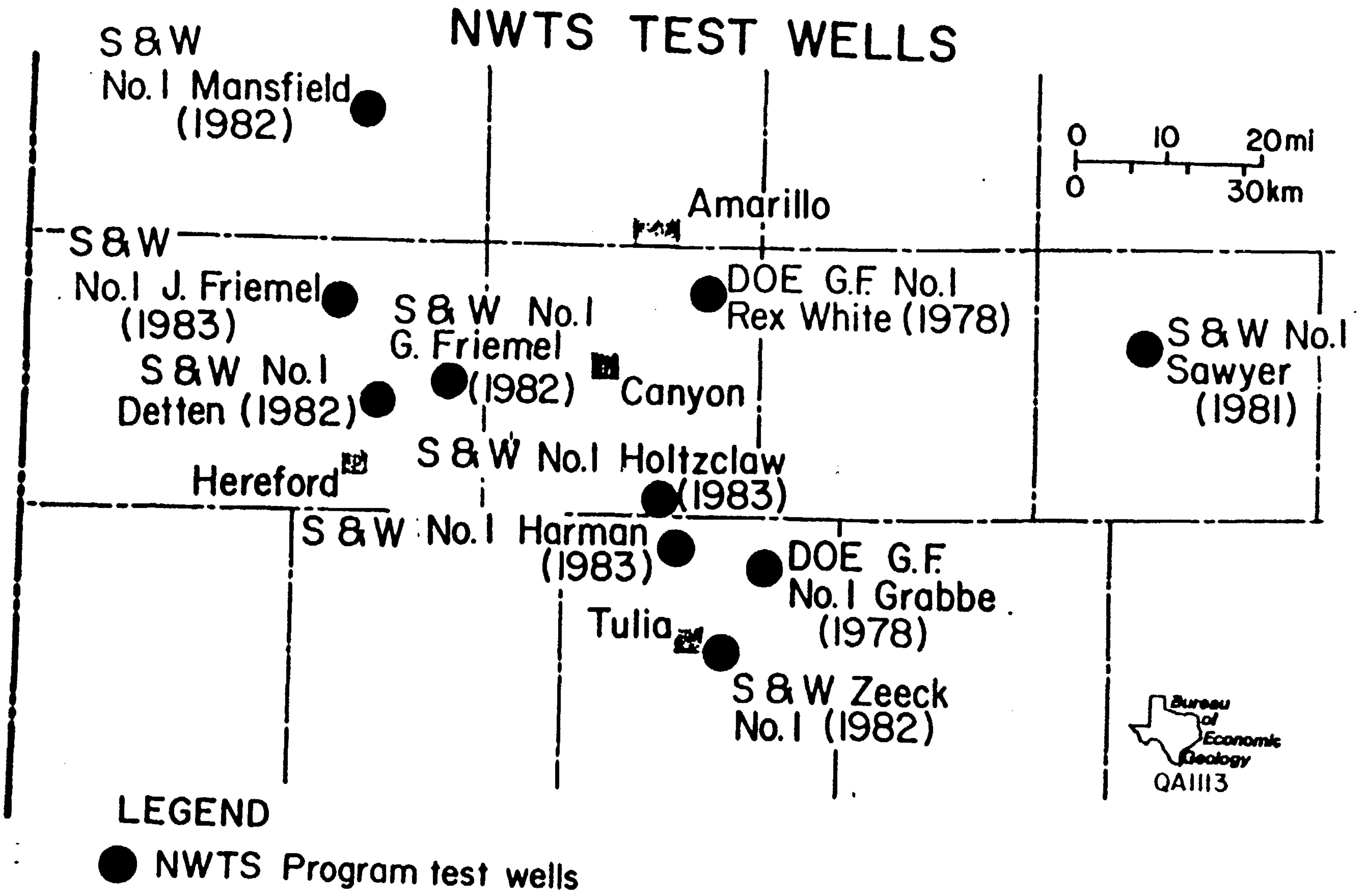
Kreitler 8/7

The Bureau of Economic Geology
The Univeristy of Texas at Austin

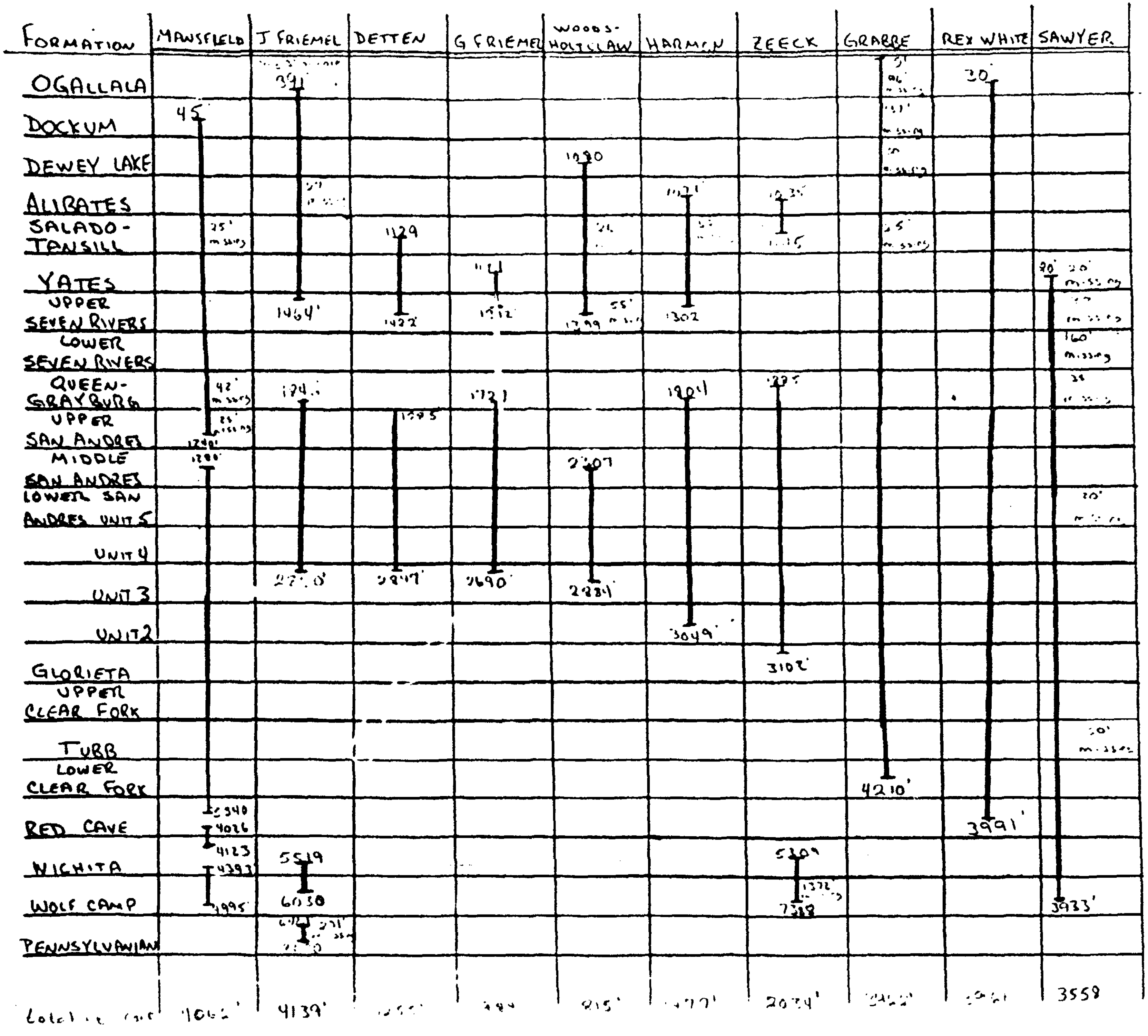
Status of Reports in Hydrology-Geochemistry,
West Texas Waste Isolation

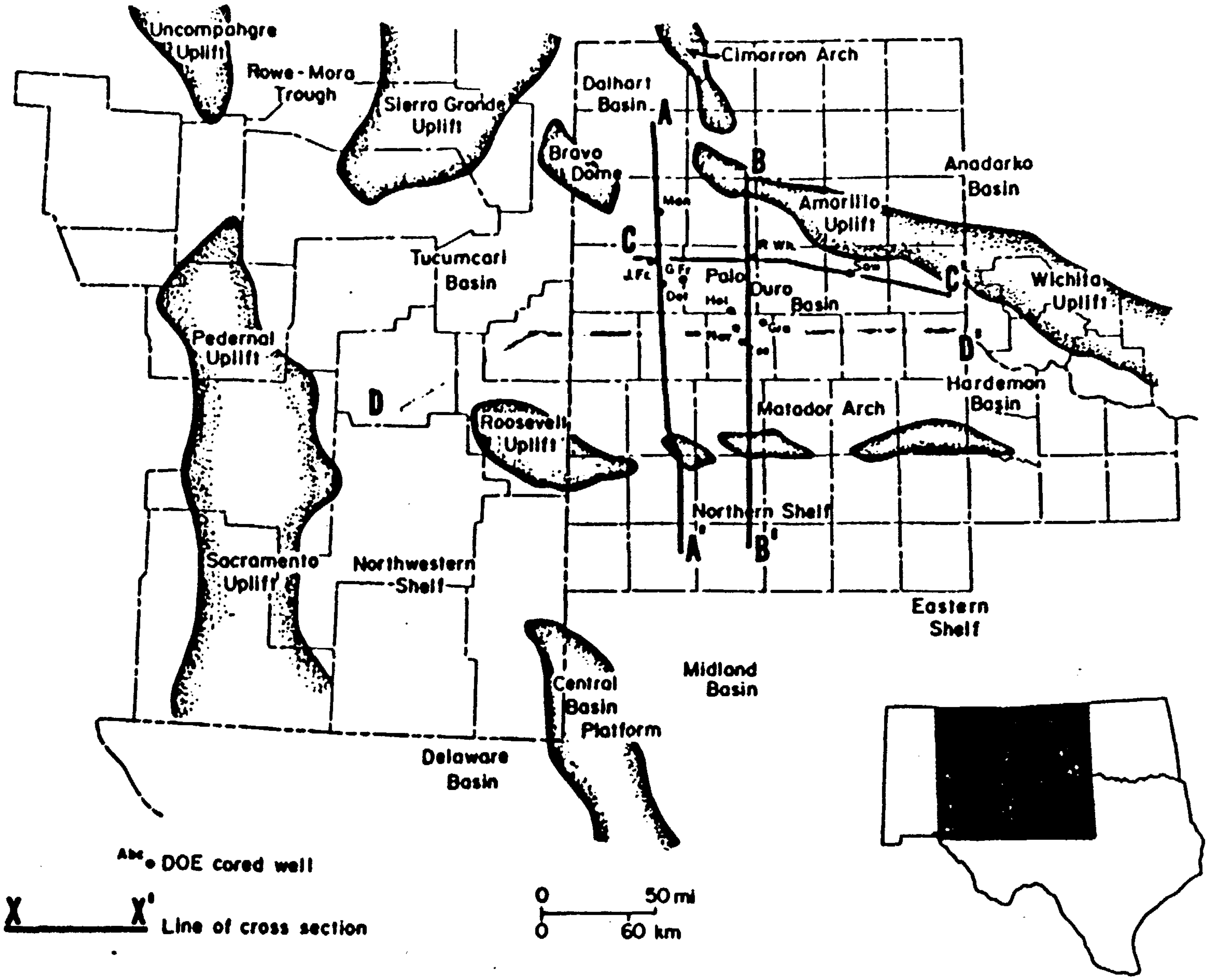
1. Modeling of hypothetical fracture flow, Palo Duro Basin, (Senger) in BEG review
2. Cross-sectional modeling of steady-state and transient ground water flow in the Palo Duro Basin, (Senger) In BEG review
3. Areal modeling of ground-water flow in the Deep-Basin Brine Aquifers, Palo Duro Basin, (Wirojanagud) In DOE review
4. Hydrology 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)
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)
0 10 20 mi
0 30 km
Bureau of Economic Geology
QA1113
LEGEND
● NWTS Program test wells

CORED INTERVALS





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

SYSTEM	SERIES	GROUP	Palo Duro Basin FORMATION	Dalhart Basin FORMATION	General Lithology and depositional setting
QUATERNARY	HOLOCENE		alluvium, dune sand Playa	alluvium, dune sand Playa	
	PLEISTOCENE		Tahoka "cover sands" Tule Blanco	"cover sands"	Lacustrine clastics and windblown deposits
TERTIARY	NEOGENE		Ogallala	Ogallala	Fluvial and lacustrine clastics
CRETACEOUS			undifferentiated	undifferentiated	Marine shales and limestone
TRIASSIC		DOCKUM			Fluvial-deltaic and lacustrine clastics
PERMIAN	OCHOA		Dewey Lake	Dewey Lake	Cyclic sequences: shallow-marine carbonates; hypersaline-shelf anhydrite, halite; continental red beds
			Alibates	Alibates	
		ARTESIA	Salado/Tansill	Artesia Group undifferentiated	
	GUADALUPE		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

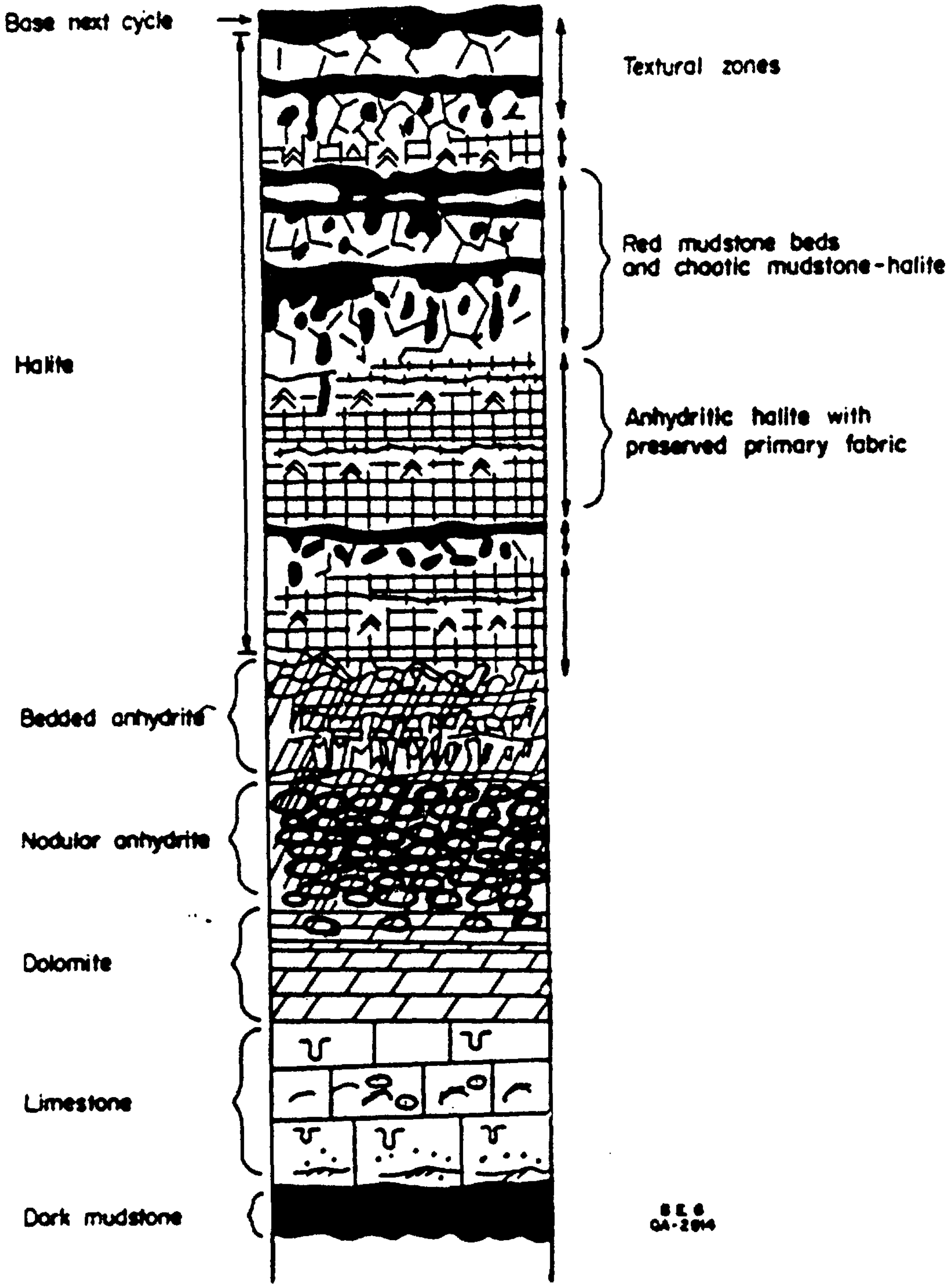
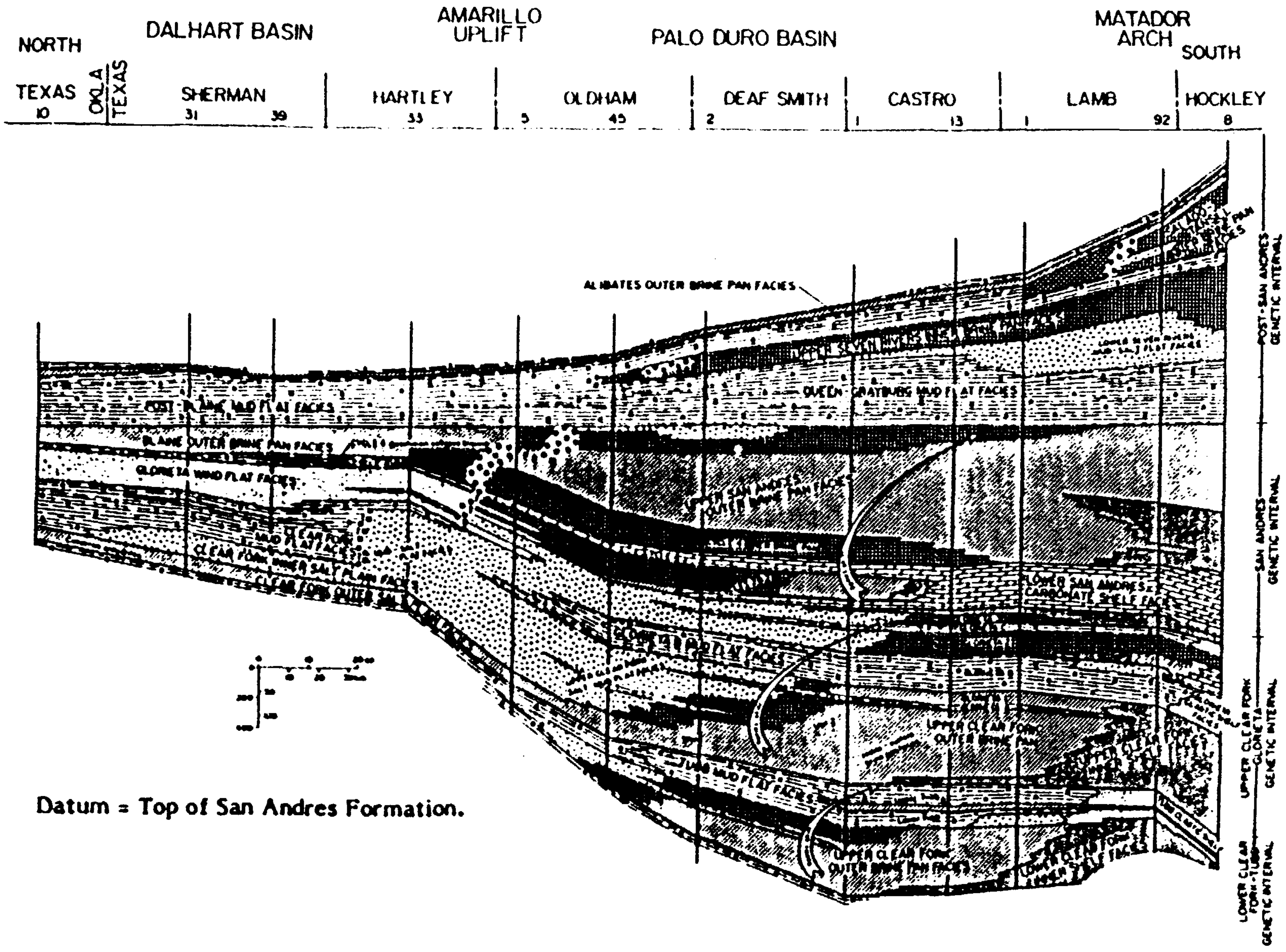


figure 2



Datum = Top of San Andres Formation.

Table 3 Textural classification of halite with genetic significance.

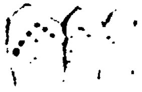
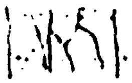
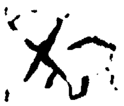
Symbol		A	B	C	D	E	F	G	H	I
halite type		chevron halite rock	color banded/ vertically oriented halite rock	C reserved for another primary fabric not yet recognized	chaotic mudstone-halite rock	[illegible] muddy halite rock	[illegible] anhydritic halite rock	displacive halite in other sediments	halite cavity-filling cement	fibrous fracture-filling halite cement
halite crystal size		0.5-5 cm tall	0.5-5cm tall		0.3 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 associated with mudstone and anhydrite insoluble residues	trace of hematite present as coloring agent, otherwise pure halite
	%	<1%-5%	1%-5%		10-50%	1-10%	1-25%	50-99%		
	location	anhydrite on grain boundaries, partings, mudstone only in pipe fills	within and between grains, along partings, in pipes		in masses between halite crystals, some also within grains	within grains, minor between grains	along partings, grain boundaries	matrix for halite		
fluid inclusions		abundant, small define relict growth faces	varied		few	varied	varied	few	large and abundant	?
associated with halite types		F along crystal boundaries and pipes, H and/or D in pipes	F & E, H and/ or D in pipes		mudstone beds typically includes remnant B halite	may contain remnant A,B, possible H	may contain remnant A,B possible H	non-halite rocks	all halite types	in non-halite rocks
identifying characteristics		minute fluid inclusions along relict halite growth faces	bedding and/ or vertical orientation of crystals		10-50% mudstone in intercrystalline masses, chaotic texture	halite colored red brown or black by 1-10% impurities, no bedding	halite with 1-25% anhydrite, ., no bedding	euhedral to subhedral halite crystals in sediments	exceptionally coarse clear crystals, fill cavity in other salt type	fibrous halite in fracture, many examples red colored
sketch										

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.

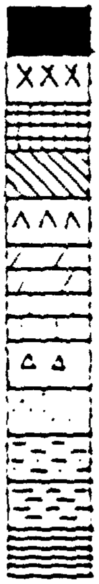
* indicates sample logged by BEG and a detailed description available in BEG files.

+ indicates sample logged, but no detailed description.

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

Column 2 Estimated percent lithology

<u>Mineral Composition</u>



Porosity
Potash Salt
Halite
Anhydrite
Gypsum
Dolostone
Limestone
Chert
Sandstone
Siltstone
Mudstone
Claystone

<u>Carbonate Components</u>

G	Grainstone
P	Packstone
W	Wackestone
M	Mudstone

Carbonate Components (continued)

o	oolites or coated grains
▭	intraclasts
6	fossiliferous (general)
⌒	molluscs
o	crinoids
⊖	forams
↶	brachiopods
A	phylloid algae
⊃	coral

Column 3 Structures

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

Halite

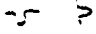
^ ^ ^	chevrons
ı ı ı ı	vertically oriented crystals
////	dark bands
// ¥	pipe, pits (show residue at bottom)
\ /	anhydrite
ˊ/ ˏ/ˎ-	chaotic mud salt
ˊ ˎ	recrystallized halite
⋌⋋	exceptionally coarse halite
―	mudstone interbed
∿∿∿	anhydrite interbed
— — —	discontinuous mudstone interbed
∼ ∼ ∼	discontinuous anhydrite interbed
\\	nonhorizontal bedding

Column 3 Structures (continued)

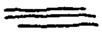
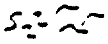
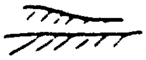
Anhydrite

	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)

<u>General</u>

o—o	boudinage
⌣	mudcracks
▭	clasts
⁄⁄	faulting
↗	fractures
ℬ	birdseye-fabric
≋	contorted alminae.
⊏	displacive halite hoppers
«‹ô›»	skeletal displacive halite
◊	filled fracture
o o o	nodules (note composition)
*	crystallotopic anhydrite in other lithologies

Column 4 Comments

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

<u>Halite Types</u>

A bedded halite with chevron fluid inclusions

B bedded halite with vertically oriented crystals

D chaotic mudsalt

E recrystallized muddy halite

F recrystallized halite with interstitial anhydrite

G displacive halite in sediment

H coarse recrystallized cavity fill halite

I fibrous fracture fill

See table and text for description of halite classification.

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

═══ mudstone

═〰 anhydrite

〰〰 irregular base, flat top

- - - discontinuous beds

C. Comments on interbeds

M indicates mudstone

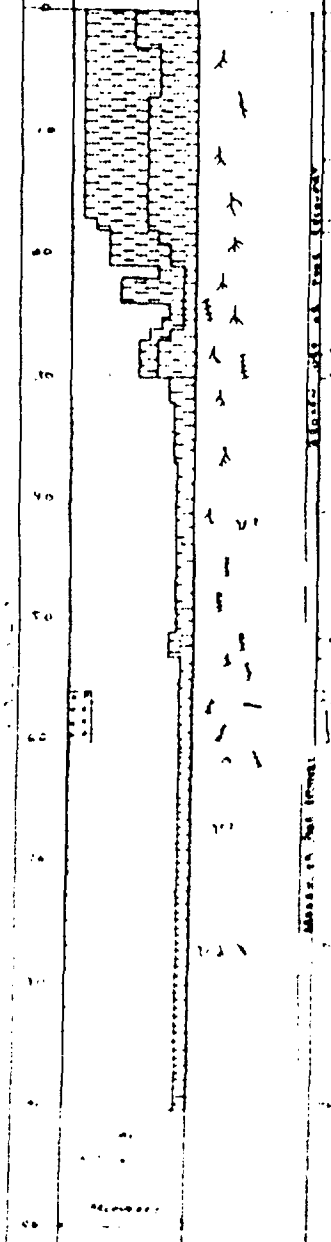
A indicates anhydrite Z indicates siltstone

bed thickness shown

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

WELL #1 GRABBE COUNTY SWISHER DATE 5/85
INTERVAL 0 100 [illegible] LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION



COMMENTS

- caliche nodules up to 2 cm
- sharp color change
- calcification intensifies
- calcification intensifies
- abundant root traces with MnO_2
- less calcite content in cement
- [illegible]
- slickensides + sharp color change
- root traces [illegible] fashion
- rare root traces
- [illegible] color change
- calc and [illegible]
- [illegible]
- [illegible]

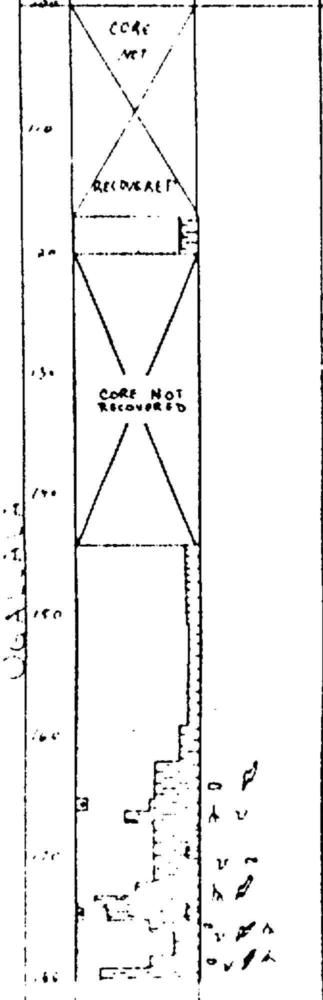
	LITHOLOGIC DESCRIPTION
30'	[illegible] (10YR 4/6), muddy and fine ss, no calc cement, rootlets with MnO_2 coating, calc nodules, calc [illegible] and trace [illegible] overlain by (from 30.1') and [illegible] (10YR 5/4) fine-med ss (no calc cement) with rootlets which fine upward into muddy siltstone with [illegible] low calc cement content; overlain by (from 1 to 0') mod R (5YR 3/4) calc cemented silty mudstone with calc nods.
69'	Lt B (5YR 5/6), calc cemented, fine-v fine ss with abdnt mud and sand grains + rootlets with Mn (manganese?) residue around some root traces
5	Lt B (5YR 5/4) fine-med ss (no calc cement) with [illegible] trace overlain by Pk-Gy (5YR 8/1) fine-med ss with [illegible] of root traces.
19'	
5 / 9'	Lt B (5YR 5/6) med ss (no calc cement) with [illegible] trace, [illegible] into a pale Orng (10YR 8/2) calc cemented fine-med ss
5 / 99	Gy Orng-Pk (10R 8/2) fine ss with abdnt mud grains, apparent [illegible] trace and abdnt calc nods or caliche nods with sand grains.
6 / 19'	Gy-Pk (5YR 8/2), poorly sorted, calc cemented, v fine ss [illegible] becomes [illegible] and [illegible] sand grains, [illegible] color changes to Lt B (5YR 6/4) at 81' [illegible] than anything else).

logged by DAJ date 5/85
date
checked date
transcribed by [illegible] date [illegible]
updated date
updated date

WELL #1 GRABBE　　COUNTY SWISHER　　DATE 5/85

INTERVAL 100 180　OGALLALA　　LOGGED BY DAJ

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



3.5 cm [illegible] fragment

3'

Gy-Orng Pk (5YR 7/2) calc cemented ss, large (3.5 cm) rounded [illegible] to [illegible] at top with some of calichification surrounding it.

24'

Base of caliche and [illegible] rich soil horizon overlain by Gy-Orng Pk (5YR 7/2) silty ss with opal-filled [illegible], abdnt calc nods (up to 8 cm), better sorted upward.

21

[illegible] nodules

abundant calcite nodules

[illegible]

opal [illegible] fracture

calc nodules

clay [illegible] [illegible]

[illegible]

[illegible]

calc nodules

[illegible]

[illegible] fracture

6

[illegible] (5YR 5/6) matrix with about 20% fine to [illegible] [illegible], [illegible] [illegible]; overlain by a [illegible] (5YR 8/4), [illegible], [illegible] [illegible] ss, a little bedding preserved, [illegible] [illegible] [illegible] [illegible], [illegible] clay clasts (possible [illegible] clasts, opal-filled [illegible] [illegible] with [illegible], better sorting upward, soil horizon at about [illegible]

19

168

logged by DAJ　　date

date

checked　　date

transcribed by [illegible]　　date

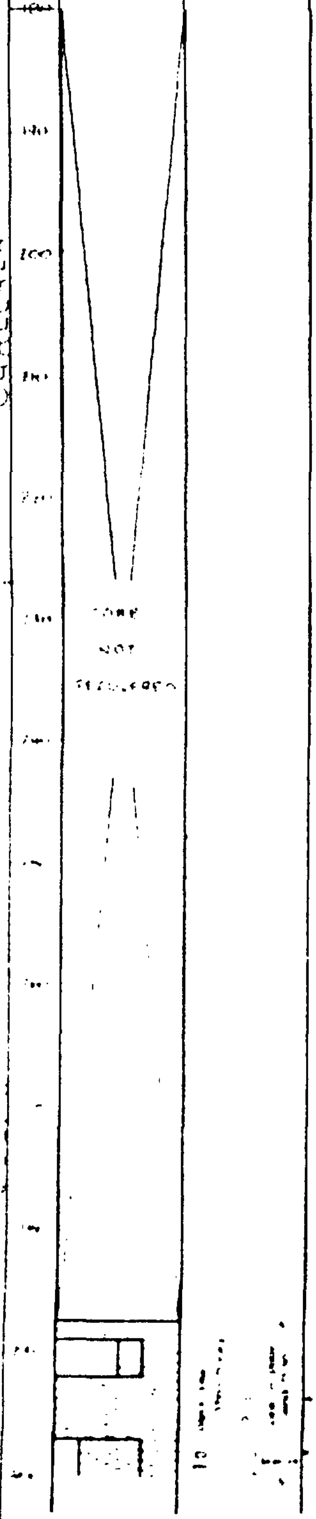
updated　　date

updated　　date

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 180-300' OGALLALA, DOCKUM LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION
CORE NOT RECOVERED				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



[illegible]

date

date

date

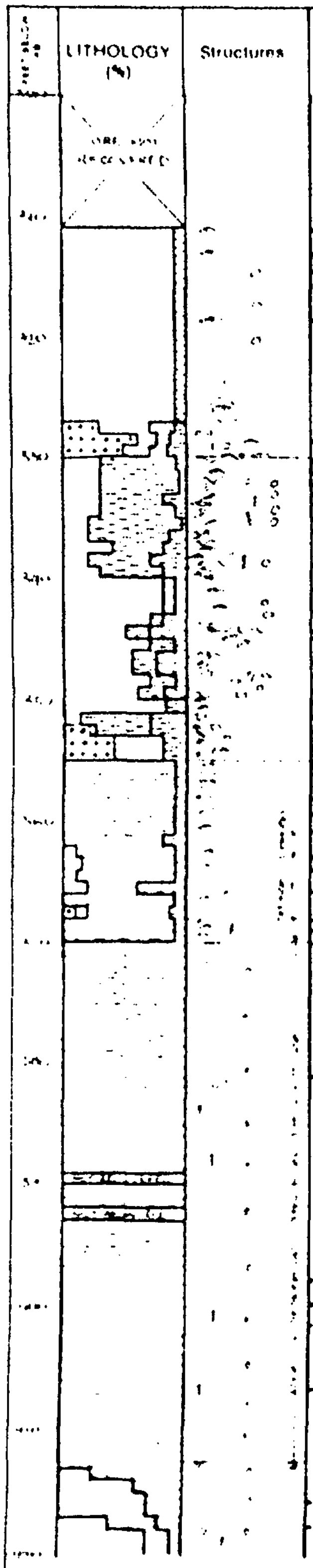
date

date

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 300-420' Dockum LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



climbing ripples & ripple drift lamination

Slightly climbing ripples

calcite nodules

low angle ripples

low angle ripples

wavy laminate

ripple cross-beds

parallel cross beds

[illegible]

low angle ripples

[illegible] angle ripples

[illegible]

mud-filled fractures

[illegible]

[illegible]

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 [illegible]. Scattered large (3cm) calcareous nodules in upper portion.

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 (1.5 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 scours, soft sediment deformation and reduced lenses in coarse or better sorted zones and calcite nodules (11.0 ft.).

Calcite cement concentrated in reduced zones.

At 332-334 feet having pronounced mud-filled fractures surrounded by calcite nodules.

Several purple-red zones, probably recent or incomplete reduction with greener (more reduced) cores.

Red brown cross laminated and ripple laminated siltstone with scattered reduction zones, coarse caliche lag in some ripples also having fractures [illegible] in section.

Basal dark red brown, generally massive [illegible]

Dark red brown burrowed and disrupted [illegible] increasing mud [illegible] upward. Numerous calcite nodules.

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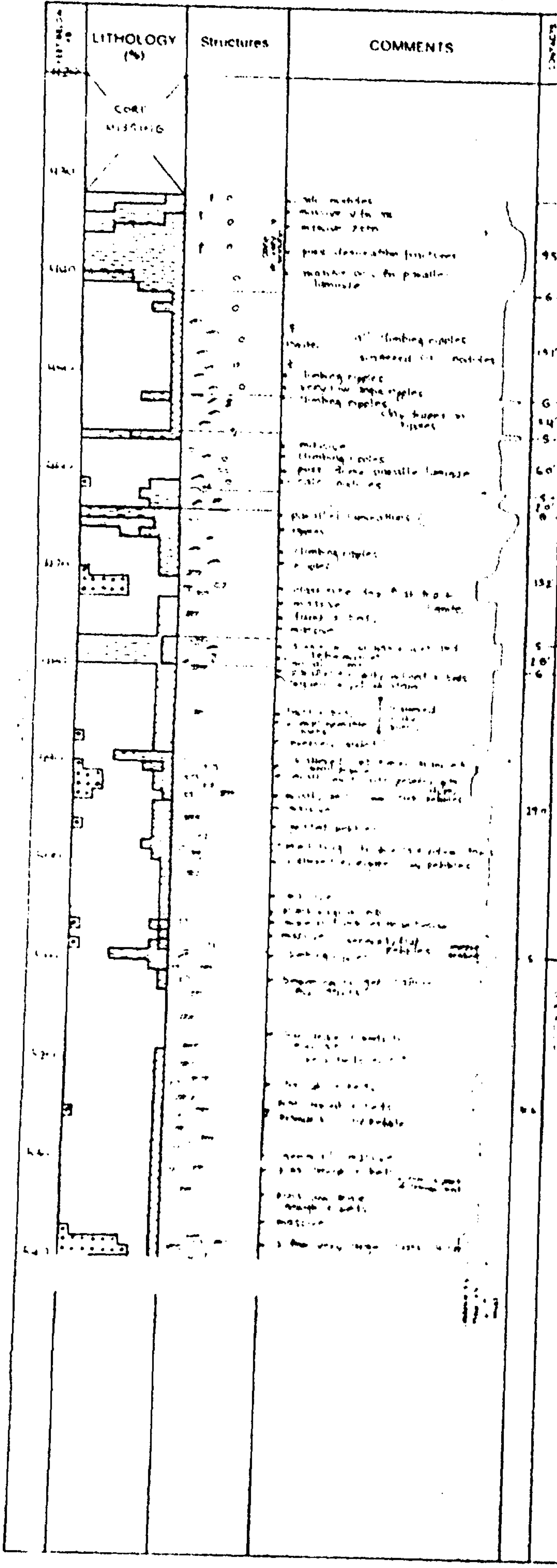
transcribed by date

updated date

updated date

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 420-540' Dockum LOGGED BY DAJ



LITHOLOGIC DESCRIPTION

9.5' Going upsection: (1) gray green silty mud, (2) [illegible] red brown [illegible] (very little silt) with scattered calcareous nodules, fractures, [illegible] cation or possibly mottles; and reduction spots, (3) dark red brown massive siltstone with fractures and reduction spots, (4) dark red brown massive fine sandstone with fractures, reduction spots and calcareous nodules

15.1' Gray green calcareous, micaceous, [illegible] ripples [illegible] ripple laminations fining upward into very fine sandstone. Scattered calcareous nodules and fine pyrite framboids.

3.4' Gray-green calcareous, micaceous ripple-laminated very fine sandstone grading upward into red brown parallel laminated mudstone.

6.0' Gray-green ripple laminated to parallel laminated very fine to fine sandstone capped by red-brown parallel laminated siltstone. [illegible] of calcareous nodules with ripples continuing through them. Micaceous

2.0' Gray-green ripple laminated fine sandstone beginning with interbedded mud and fine sandstone at the base which grades up into fine sandstone with mud drapes. Unit is capped by a siltstone.

13.2' Going upsection: (1) gray-green calcareous, micaceous, massive to parallel laminated fine sandstone, (2) flat mud clast pebble (up to 5cm) conglomerate, stratified, fining upward at top, with plant fragments, (3) a fining upward sequence of parallel to ripple and climbing ripple laminated siltstone and fine sandstone capped by massive to parallel laminated gray mudstone

1.0' Gray-green finely ripple laminated siltstone with small [illegible] and scour and collapse features with some deformation of [illegible] clasts in collapse. No calcite cement

27.0' Gray green calcareous, micaceous, massive to cross bedded medium fine sandstone with flat pebble conglomerate lenses. Matrix supported conglomerate consists of carbonate, silt, and mud pebbles. Some appear to be inversely graded (coarsening upward at [illegible]) and fining upward at [illegible]. These are mostly [illegible] and stratified sandstone. Sandstone is very micaceous with scattered mud [illegible]

[illegible]

Checked date

Transcribed by date

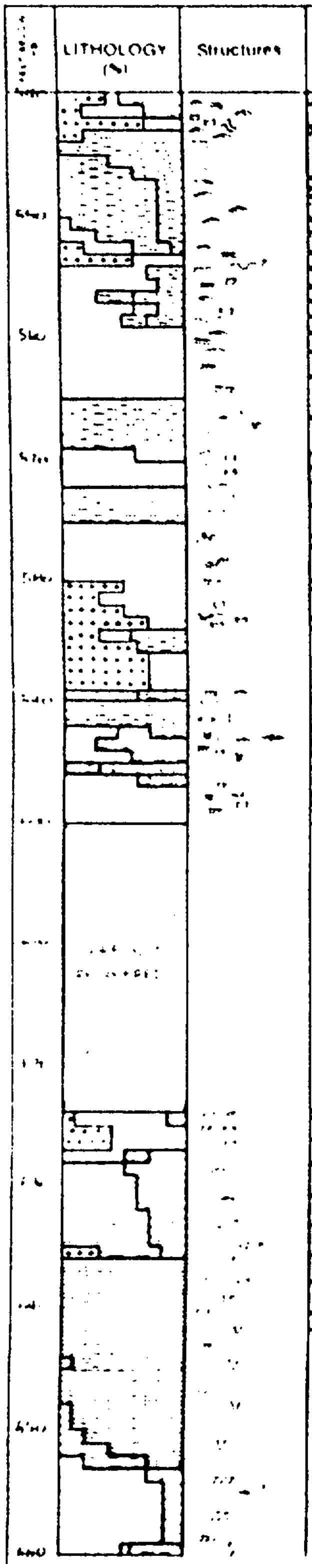
Updated date

Updated date

WELL Grabbe
INTERVAL 540-660'

COUNTY Swisher
LOGGED BY DAJ

DATE 3/84



COMMENTS

- climbing ripples
- clast supported
- high angle ripples
- low angle ripples
- parallel laminae
- large ripples
- v small scale ripples
- massive - no apparent struct
- climbing ripples
- prominent mud laminae
- matrix and clast supported
- poss. v low angle trough x-beds
- [illegible] caliche clasts
- climbing ripples
- silt drape
- climbing ripples
- low angle ripples
- low angle x-beds
- possible ripples and [illegible]
- climbing ripples
- [illegible] lams
- plant twigs
- fine horizontal lams
- [illegible] injection features also parallel horizontal lam [illegible]
- abundant plant debris
- x-beds
- [illegible] stratified
- matrix supported, stratified
- non stratified
- massive clast supported
- brecciated mud
- calcite streaks
- load casts of [illegible]
- clay clasts
- [illegible]
- [illegible]
- low angle x-beds
- clay clasts
- trough x-beds and high angle x-bed [illegible]

LITHOLOGIC DESCRIPTION

5

19.4'

Going upsection: (1) stratified calcareous granule and pebble [illegible] erate with laminae, (2) coarse to medium sandstone, (3) ripple laminated siltstone with abundant mica and mud laminae, (4) parallel laminated siltstone with mud and ochre colored material along bedding planes, (5) small ripple laminated siltstone, (6) large ripple laminated siltstone; (7) caliche and mud clast conglomerate (clast supported) [illegible] fine sandstone/siltstone with mud clasts, (9) climbing ripple laminated siltstone. All calcite cemented and micaceous. Color grades from white at base to tan and red brown at top

5

Gray-green to tan-brown medium sandstone with caliche clasts and drapes at base grades upward into parallel laminated (possible low angle trough cross-beds) sandstone at top. Sandstone is overlain by a thin mud bed (0.1')

5

8.7'

Going upsection: (1) parallel laminated and very low angle rippled fine sandstone, (2) climbing ripple laminated very fine sandstone with silt drape at depth 558, (3) low-angle ripple and climbing ripple laminae with scours and increasing silt content upsection, (4) ripple laminated mudstone and siltstone at top. Entire unit is very micaceous and lignitic. Color grades upwards from gray green at base to tan green at top

5

7.7'

A basal tan laminated, micaceous, lignitic, coarse sandstone with abundant plant fragments (at base) and scattered mud clasts grades upwards to 2.5' interbedded coarse sandstone and silt which grades upwards to 3.1' of green climbing rippled silt which grades upwards to a brown finely parallel laminated siltstone with possible ripples and burrows

5

18.0'

A gradational upwards fining sequence beginning with (1) a basal white to tan caliche pebble conglomerate with fine sandstone matrix (2) stratified granules and pebbles and fine sandstone (3) nonstratified conglomerate with fine sandstone lenses (4) matrix supported pebble conglomerate (5) parallel laminated, micaceous, lignitic fine sandstone with contorted beds and injection features (6) finely laminated siltstone
NOTE: Conglomerate pebbles are all calcareous, larger ones are flat, smaller ones are rounded to elongate. One round one has tension cracks with sparry calcite filling and more around it has sparry calcite cement.

5

8.7'

Whitish, red brown pebble conglomerate with a few cobble size material; pebbles are 1.2cm to 5.5cm in size, large ones are flattened and semi paralled, pebbles are calichified in mudstone and ripple laminated very fine sand and silt. Unit grades rapidly upsection to mudstone and calichified pebbles

4

11.0

Going upsection: (1) tan cross bedded medium sandstone with mud clasts and drapes, (2) rippled grayish-green siltstone, [illegible] feet thick, (3) dark brown mudstone, (4) grayish-green cross bedded coarse sandstone and silt with load features and clay clasts, (5) dark brown ripple laminated to structureless mudstone with calcite streaks (6) grayish green [illegible] sandstone with load casts into underlying mudstone, (7) dark brown brecciated to structureless mudstone with calcite streaks [illegible] and cross cutting apparent bedding with mica [illegible] (1) grayish green cross bedded medium sandstone

24.0

5.5

5

Going upsection [illegible] coarse [illegible] bedded sandstone with carbonate [illegible] carbonate granule conglomerate [illegible] medium sandstone

8.6

Gray green conglomerate [illegible] ripple laminated mudstone with [illegible] bedding [illegible] and increasing [illegible]

5

Dark brownish [illegible] siltstone. Many burrows [illegible] were found [illegible]

9.0

6

Brown to white, cross bedded coarse to medium sandstone [illegible] sorted with subangular to rounded grains [illegible] possible mudstone at base

9.0

logged by date

date

checked date

transcribed by date

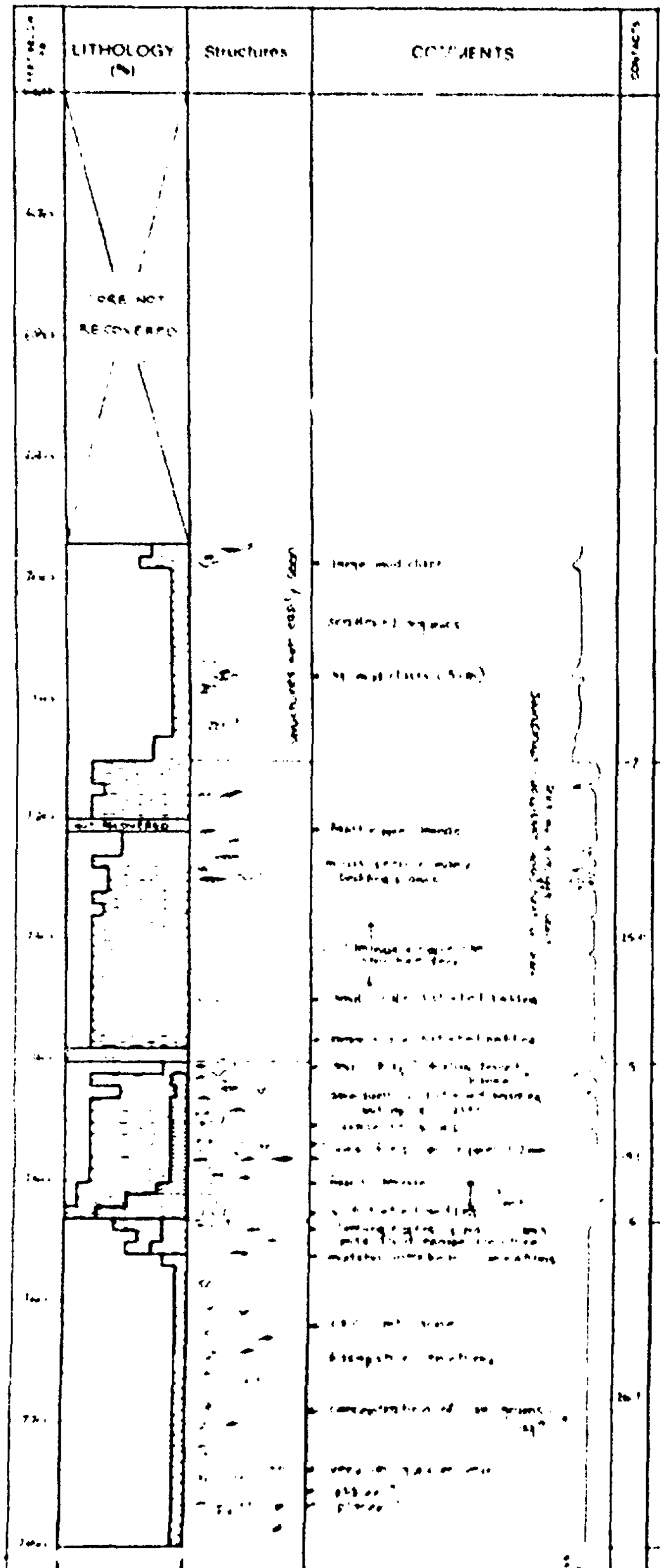
updated [illegible] date

updated date

WELL Grabbe COUNTY Swisher DATE 3/84

INTERVAL 660-780' DOCKUM LOGGED BY DAJ

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Brown silty coarse to medium sandstone with generally large scale structures. Contains probable cross bedding and parallel laminae, 2 zones of coarse sandstone with mud clasts, and scattered organic [illegible]. Sandstone is loosely packed [illegible], grains are subangular and base of unit is poorly sorted. Sorting improves upsection with no coarse grains present, but some chert fragments.

Red brown to gray green mudstone to siltstone with large and small scale disrupted bedding present at bottom where structures are visible. Large scale grades into small scale with some parallel laminae and ripple laminae seen in pieces from upper section. Several thin [illegible] are present increasing in number upwards. They generally have coarse well rounded sand at the base which fines upwards. Sorting is [illegible].

[illegible] to gray green coarse well rounded sandstone at base grades upwards to cross laminated very fine sandstone [illegible] which grades to ripple and parallel laminated very fine sandstone to siltstone which is capped by mudstone.

Red brown to gray green [illegible], fine sandstone, siltstone, and mudstone. Very disturbed bed at base [illegible] ripple laminated siltstone with abundant [illegible], numerous [illegible] escape structures. [illegible] contains reduction zones and zones [illegible] more permeable horizons and scattered [illegible] and burrows.

Red brown mottled, very fine sandstone with scattered [illegible] and [illegible] throughout [illegible] abundant [illegible] holes. [illegible] massive mudstone.

Logged by Date

Date

Revised Date

Transcribed by Date

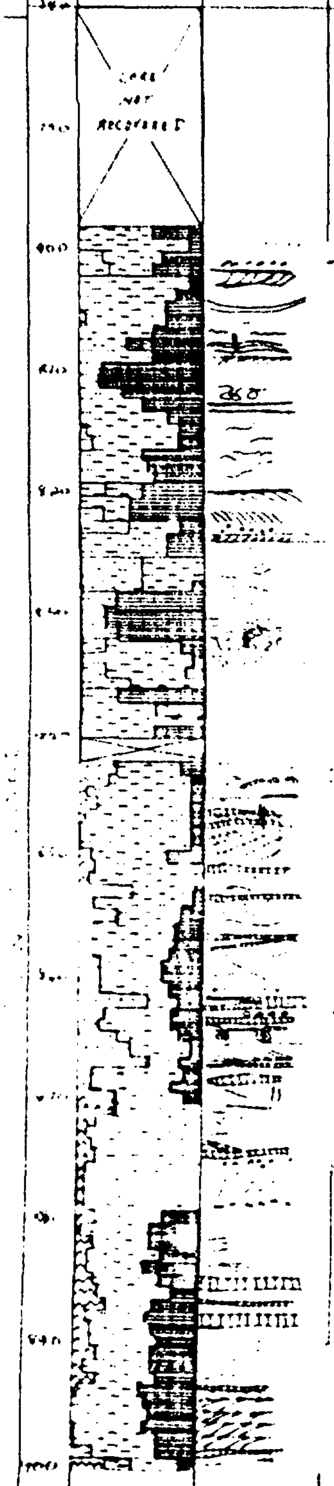
Entered file Date

Updated Date

WELL #1 GRABBE COUNTY SWISHER DATE 3/79

INTERVAL 780 - 900 DEWEY LAKE LOGGED BY WPJ, RAM, CS, SH

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



[illegible] siltstone

climbing ripples, contorted bedding

disrupted bedding

climbing ripples

load casts
clay drapes

stacked channel sequence

disrupted, initially laminated beds

clay chip conglomerate

burrowed ss

channels

disrupted

load casts

[illegible]

[illegible]

clay drapes

climbing ripples

small scale ripples, clay drapes, ss disrupted

[illegible]

load casts

disrupted

[illegible] drape

[illegible]

[illegible]

channels

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

date

checked date

transcribed by [illegible] date [illegible]

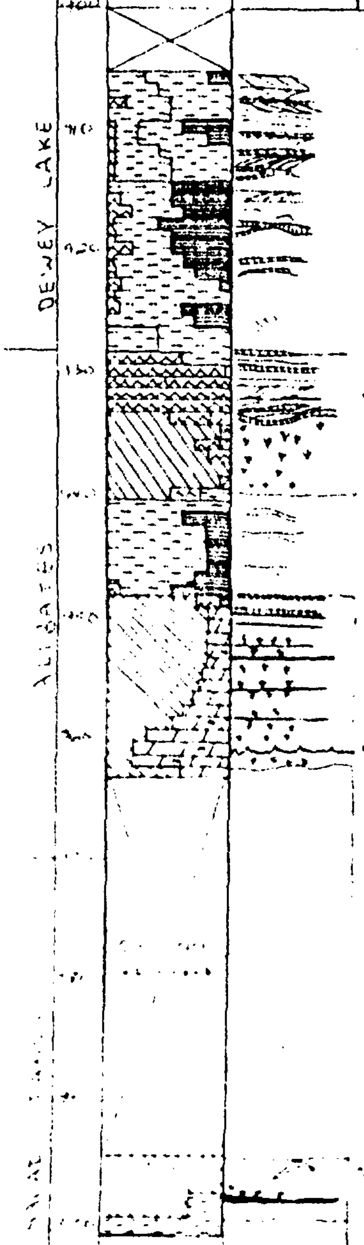
updated VG date 7/82

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 5-79

INTERVAL 900 · 1000 DEWEY LAKE, ALIBATES, SALADO · TANSILL LOGGED BY KAM, PK, SH

FT	LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION



climbing ripples

. Anh bed · chert

[illegible] [illegible] to Anh

Gyp/Anh crossbeds [illegible]
contorted laminae below · Anhydr,
soft sed deformation · not [illegible]
collapse

pseudomorphs are Anh filled

all [illegible] [illegible]
pseudomorphs [illegible]
[illegible] [illegible] Anhydrite

[illegible] [illegible]

DOLOMITE contains [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] found in [illegible] [illegible] [illegible]

[illegible] [illegible]

logged by K.A.M. S.H. date 5 79

date

checked date

transcribed by [illegible] date [illegible]

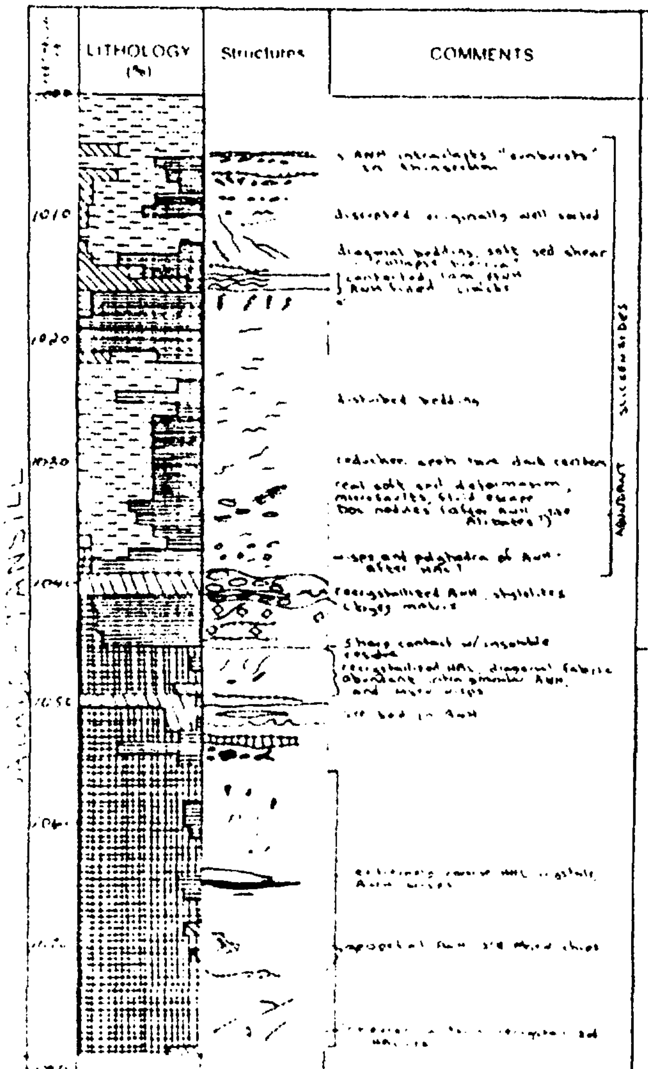
updated Ma date [illegible]

updated date

WELL #1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL 1000-1079 SALADO-TANSILL LOGGED BY PF, KAM, WFS, SH

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Anh intraclasts "sunbursts" in thinsection

dispersed originally well sorted

diagonal bedding, soft sed shear (collapse breccia?)

contorted lam. from Anh lined [illegible]

disturbed bedding

reduction spots two dark carbon

real soft sed deformation, microfaults, fluid escape Dol nodules (after Anh? like Alibates?)

wisps and polyhedra of Anh (after Hal?)

recrystallized Anh, stylolites clayey matrix

Sharp contact w/ insoluble residue

recrystallized HAL, diagonal fabric abundant intragranular Anh, and mud wisps

silt bed in Anh

extremely coarse HAL crystals, Anh wisps

[illegible] Anh and mud chips

[illegible]

logged by [illegible] date [illegible]

date

checked date

transcribed by [illegible] date [illegible]

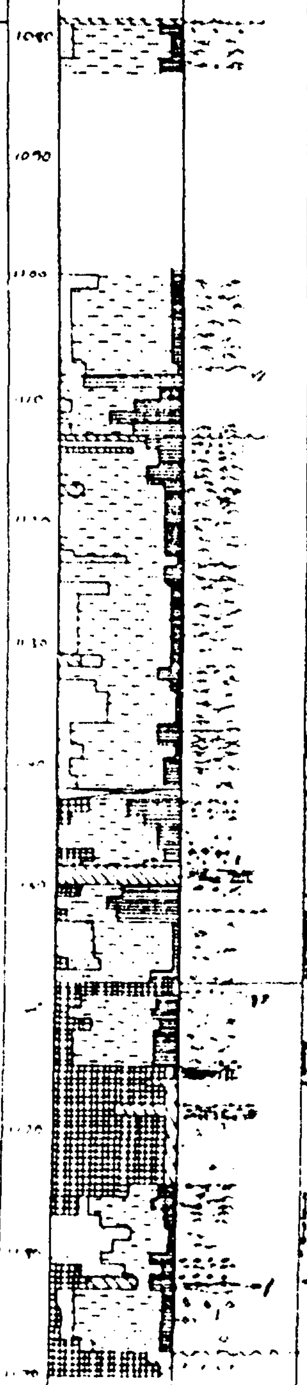
updated [illegible] date [illegible]

updated date

WELL # 1 GRABBE   COUNTY SWISHER   DATE

INTERVAL 1079 1190 YATES, UPPER SEVEN RIVERS   LOGGED BY SA

Depth	LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION



Brecciated, small eyes of hal
Dissolution structures

Brecciated, few dist. ripples

SEAN DIDN'T FINISH THIS DUE TO MOVING WSL - COULDN'T GET BOXES
CAC

Dissipation struct.
few poorly defined ripples

[illegible]

Slightly dist. ripples
in finer channels

Dissolution struct. & few
poorly defined ripples
Disseminated anhydrite
[illegible]

Small [illegible] disseminated
anhydrite
Some dist. ripples

Dissolution struct.

[illegible] ripples, few [illegible]
[illegible]
Poorly defined ripples

[illegible]
Small ripple train

[illegible]

Dissolution struct.

Brecciated, [illegible] ripples,
[illegible]

[illegible]

[illegible] ripples [illegible]

[illegible]

[illegible]

[illegible] ripples,
small [illegible] hal eyes

Dissolution [illegible]

Intraclasts [illegible]

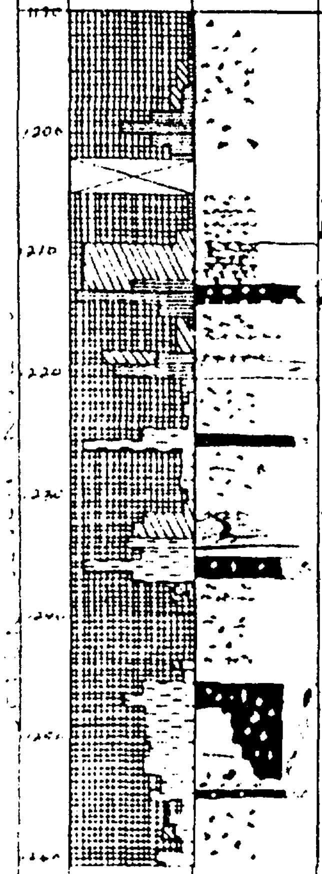
[illegible]

logged by SA' date
date
checked date
transcribed by CAC date 5.83
updated JY date 7/81
updated date

WELL #1 GRABBE COUNTY SWISHER DATE

INTERVAL 1170 - 1260 UPPER SEVEN RIVERS LOGGED BY

LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION



SMALL (1-2cm) IRREG MASSES OF ANH

BRECCIA

STRINGERS AND SMALL DISSEMINATED MASSES OF ANH

ABUNDANT HAL PSEUDOMORPHS AFTER GYPSUM

BRECCIA

SMALL INTERSTITIAL MASSES OF ANH

[illegible]

IRREG AND VERT BOUNDARY BETW HAL [illegible] AND [illegible] ANH [illegible]

SMALL IRREG MASSES OF ANH

SMALL IRREG MASSES OF ANH

[illegible] bedding

[illegible]

logged by ______ date ______

______ date ______

checked ______ date ______

transcribed by 4 [illegible] date [illegible] 15 [illegible]

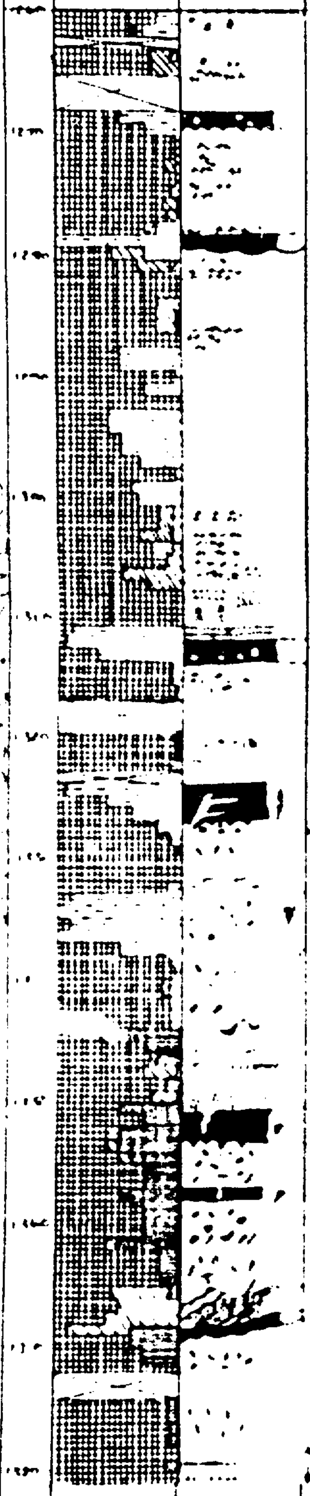
updated [illegible] date [illegible]

updated ______ date ______

WELL #1 GRABBE COUNTY SWISHER DATE 3/83

INTERVAL 1260 - 1381 UPPER SEVEN RIVERS LOGGED BY SN

Depth	LITHOLOGY (%)	Structures	COMMENTS		LITHOLOGIC DESCRIPTION



SMALL [illegible] IRREGULAR MASSES OF ANH

SMALL [illegible] & GREEN MASSES OF ANH

[illegible]

logged by [illegible] date [illegible]

date

checked date

transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL #1 GRABBE COUNTY SWISHER

INTERVAL 1377-1469 LOWER SEVEN RIVERS VDN

LITHOLOGY (%)	Structures	COMMENTS	[illegible]

several 1-2 mm laminae of ANH
large irregular ANH nodules in ...
3-5 cm ANH w/ HAL lenses
... ANH w/ grassoid ...

vertical ... channel w/ clear xln HAL fill
(... ... content)
SILTSTN INTERVALS W/ ... APPEARANCE
5 CM ANH
11 cm DISPLACIVE HAL ... AREAS ... ...
... found in flattened ANH ... distributed in ... zones

5 cm ANH

5 cm ANH ...
coarse ... HAL ...
extremely skeletal HAL
concentration of ANH nodules

ANHYDRITIC PATCHES

... vertical HAL
tiny ANH nodules

... 1453 ... ...
HORIZONTAL HAL FILLED ...

... ANH w/ HAL
... laminar character
... HAL ... ... larger HAL ... xls

Clear, coarsely xln hal with abundant instl anh as both thin laminae and irregular, flattened masses plus minor instl RB mud, sparse relict chevrons abundant in lowest 7 cm of hal.

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

White, and xln hal with minor instl anh, rare remnant chevrons

Dk RB, coarse siltstn with displacive hal in patches, uppermost 17 cm "clotted" hal and siltstn, grading down into less abundant fine, displacive hal; at 1393.5', a vertical channel with clear, xln hal fill appears, also patches of coarse, displacive hal filled fractures, small hal xls and tiny anh nodules, irregularly scattered in section, small Gy Gn reduction spots scattered throughout

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

RB, mud to coarse siltstn and very fine ss with abundant disturbed texture of clay dissipation features; 1398.8-1397.2' has thin stringers of hal with some vertically oriented, single xls associated, also thin vertical hal-filled fractures; small hal xls and tiny anh nodules irregularly scattered in section; small Gy Gn reduction spots scattered throughout.

Upper .9', a large, chaotic mudsalt-filled pit in muddy hal, thin (1 mm) anh laminae at 1408.9'; lower 1.2' clear coarse xln hal with minor instl anh and mdstn

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

Dk RB, mud to coarse siltstn, coarse silt in flattened patches, disturbed ripples(?) in upper .5', large displacive hal xls grading down into extremely skeletal hal hoppers then tiny hal xls, lowermost .5' with increasing hal, disturbed texture and grading into chaotic mudsalt topping next unit.

Upper .4' of chaotic mudsalt overlying clear, coarsely xln hal with instl mud increasing in abundance toward the bottom, 5 cm of contorted anh at base.

Upper 1.6' of unit has large irregular hal xls, stringers and masses grading down into extremely skeletal hal hopper xls, rest of unit RB coarse siltstn 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 1421.0', lowermost .6' with intraclastic texture.

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

Dk RB mud to coarse siltstn and very fine ss, basically structureless, fine to large anh nodules (less than 1 mm to 1 cm) widely scattered throughout; extremely skeletal hal from 1428.8 to 1429.1', small Gy Gn reduction spots common.

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

Clear, coarse hal xls with abundant instl RB mdstn and minor hal

Dk RB mud to coarse siltstn and very fine ss with abundant small hal xls, few larger hal masses, rare tiny anh nodules, slightly coarser-grained at top.

Upper .4' of coarse displacive hal in a silty, RB mdstn, minor anh, underlain by .1' of clear, coarsely xln hal in a solution pit, the remaining .9' of rusty hal with interstitial RB mdstn and minor hal

Dk RB, coarse siltstone with extremely coarse, skeletal hal xls, disturbed texture and tiny anh nodules.

Chaotic mudsalt of RB silty matrix, flattened anh mass at 1441.1'.

Dk RB, coarse siltstn with extremely fine, skeletal hal hoppers and small hal xls, 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, curdled patchy area at 1452.4', 1451.1-1451.5', and coarser patch at 1454.0-1454.2', abundant clay dissipation features

Chaotic mudsalt with minor associated anh grading downward into cleaner, more coarsely xln hal with instl RB mdstn and minor anh, grading into unit below.

Lt Gy anh, 5 cm thick with hal xls entrained

Fine to coarsely grained hal with fine blebs or thin stringers of RB mdstn and minor anh, grading into unit below.

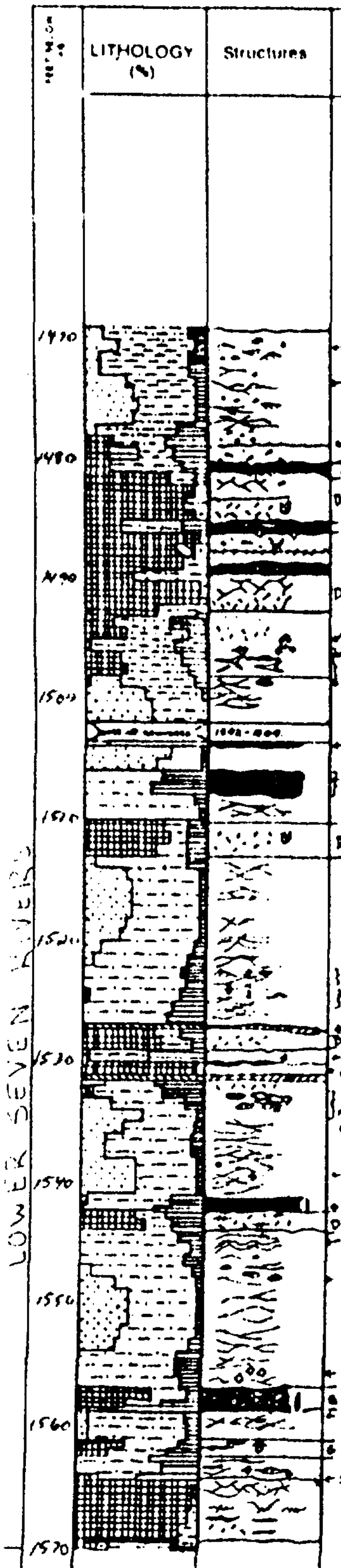
RB siltstn to very fine ss with displacive hal, xls finer and more abundant at top of unit, becoming larger and more widely spaced down into unit; skeletal hal xls throughout, clay dissipation features common

logged by VDN date 11/84
date
checked SH date 11/84
transcribed by CAC date 5/85
updated DG date 7/85
updated date

WELL #1 GRABBE COUNTY SWISHER DATE 10/84

INTERVAL 1469 - 1570 LOWER SEVEN RIVERS LOGGED BY SN, VN

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



COMMENTS

← 1m ANH nodules 1-4mm

← sm ANH nodules 1-4mm

← "clotted" mud w/ many HAL xmc

G

D + C

G

D + E, F

Anhydrite nodule at 1495 + lg HAL hopper

Anhydrite irregular flattened masses @ 1495.9'

extremely deformed HAL hoppers and flattened ANH nodule

← @ clay-rich interval (12 cm)

@ narrow vertical HAL - filled fractures

clay rich interval (6 cm)

D

} sm HAL xtals + masses, silty lenses

} sm HAL xtals + masses, silty lenses

← 9 cm ANH layer

D + G

← more clay-rich @ bottom

17 cm ANH layer, w/ HAL + red clay stains

} sm poorly developed ANH nodules good chicken wire appearance of HAL + MDSTN

← @ sm ANH + HAL xls - found rarely

@ sm vert HAL filled fractures

D + F interstitial MDSTN + ANH blebs

← anhydrite (?) cmt'd, soft sed. deformation

← 9 cm horizontal layer, reduced 94.9'

← lg displacive HAL xtals 1555.3-5'

G

F 9 cm slightly silty clay intvl

G

← 5 in pit of chaotic mudsalt + interstitial ANH

LITHOLOGIC DESCRIPTION

Dk RB cse silt to v fine ss, basically structureless with few dark spls (preferentially hal cemented(?)) and abdnt brighter & clay dissipation features, also abdt fine Gy-Gn reduction spots scattered throughout, few v small anh nods and hal xls scattered within, entire section hal cemented, lowermost 6" of mdstn with clotted appearance due to lar hal, grades into unit below.

Chaotic mudsalt with RB silty mdstn lentils.

Dk RB silty mdstn with med-large disp hal xls and skeletal hal hoppers, sm anh blebs.

Cse xline clear hal with abdnt (matrix?) RB mdstn and lt Gy anh, largely dissolution pit fill with chaotic mudsalt.

Dk RB mdstn with large disp hal xls and small vert hal filled fracs, small flattened and reduced siltstn clasts at top, scattered reduction spots.

Cse xline clear hal with small (matrix) RB mdstn and anh, largely dissolution pit fill(?), 6 cm layer of anh at 1487.6', upper part lt Gy, lower 3-4 cm very RB mud-rich, sharply bounded both contacts.

Dk RB silty mdstn with disp hal hoppers, small reduction spots.

Clear, cse xline hal with abdnt (matrix) RB mdstn and sm anh, largely dissolution pit fill with chaotic mudsalt(?)

Dk RB silty mdstn with slightly (upper part) to extremely (lower part) skeletal hal hoppers, sm anh in irr to nod masses, intermittent small reduction spots, occasional (or) silt-rich lenses, dark spls?, clay dissipation features throughout.

Dk RB cse silt to v fine ss, basically structureless with abdnt clay dissipation features and occasional silt rich lenses (dark spls(?)), scattered Gy-Gn reduction spots.

Brighter RB clayey, fine silt mdstn at 1501.6-1501.9' and 1506.1-1508', lower interval with vert hal-filled fracs (< 2 cm wide), few silty (preferentially hal cemented) lenses, dark spls(?) and clay dissipation features.

Chaotic mudsalt of large clear hal xls with abdnt (matrix) dk RB mdstn.

Dk RB med to cse siltstn to v fine ss, basically structureless, especially in (cse?) intervals, some silt rich lenses (dark spls?) in finer intervals; scattered tiny to large coalesced Gy-Gn reduction spots, locally abdnt in cse, replacement hal as small to med xls or masses preferentially in masses at 1522-1523' and 1524.3-1525', section generally contains spots.

Red Gy anh layer from 1527-1527.8', silted contact top and bottom.

Chaotic mudsalt with abdnt RB silty mdstn lentils, hal xls 1 cm to 4 cm.

Dk RB silty mdstn with few large hal xls + sm hal frac fill.

Clear + cmly xline hal with minor RB mdstn lentils.

Red Gy anh from 1531-1531.7', small amount intergrown hal + RB mdstn, faintly lam with pale Gy lam.

Dk RB v fine ss to brighter RB med to cse siltstn, structureless with minor clay dissipation features, upper 2.5' with small hal xls + blebs and several poorly defined anh nods, hal displacive in mud giving good chicken wire structure here, otherwise rare small anh and hal xls, scattered Gy-Gn reduction spots, locally more abdnt in cse intervals, rather abrupt grain size change (including cessation of hal cement) at 1541.2', patchy cse hal cement.

Chaotic mudsalt with abundant squeezed + disr anh nods and (matrix) dk RB silty mdstn.

Dk RB med & cse siltstn to v fine ss, more clay rich at top and bottom, sm + dark anhydrite(?) and at 1544.6-1545.2', flattened anh nods (2 cm to 5 cm) in uppermost finer section, clay dissipation features throughout, also small Gy-Gn reduction spots, few large hal xls in lower fine interval (as noted at left).

Dk RB silty mdstn with large disp hal xls and narrow vert hal filled fracs.

Dk RB cse siltstn with abdnt clay dissipation features and small Gy-Gn reduction spots scattered within.

Dk RB silty mdstn with large disp hal hoppers, silty lenses with reduction spots.

Brighter RB cse siltstn with abdnt clay dissipation features, few large disp hal xls + small reduction spots.

Clear cmly xline hal with small amount of (matrix) RB mdstn grading downward into cse hal with (matrix) anh as residue in brown cmly xls, at 1567.1' hal becomes less cmly xline with abdnt dk RB mdstn lentils, + minor anh.

logged by SU, VDN date 10/84

date

checked date

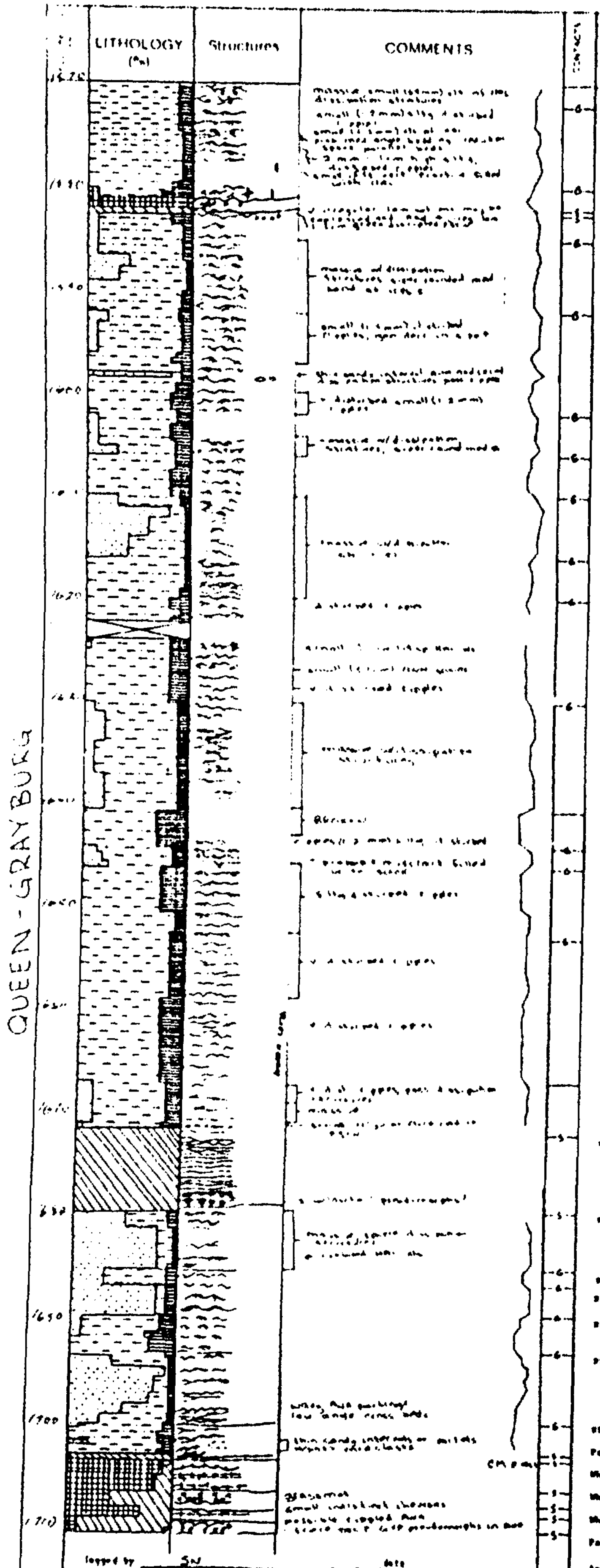
transcribed by CAC date 5/85

updated PG date 7/85

updated date

WELL #1 GRABBE COUNTY SWISHER

INTERVAL 1570 – 1710 QUEEN GRAYBURG LOGGED BY SN



LITHOLOGIC DESCRIPTION

RB massive cse siltstn with dissipation structures and scattered small xls of displacive hal.

RB silty clayey cse-md siltstn with silty dark poorly defined rpls (… 3 cm) to sandy cse siltstn with poorly defined rpls and low angle bedding, small (2-3 mm) hal xls scattered at about 1576.5', 0.5' vert frac filled with hal at 1578'.

RB chaotic hal mdstn with scarce chevrons near base, grading into RB mdstn to clayey siltstn with disp hal (cubes less than 2.5 cm)

Gy, RB ftr anh lam.

RB sandy cse siltstn with poorly defined rpls (2.5 cm), silty dark.

RB, generally massive, sandy to v sandy cse siltstn, sand fraction is v fine sand at about 1586.5', upper round frosted md sand grains, dissipation structures may incompletely define some indistinct rpls.

RB sandy cse siltstn to clayey cse-md siltstn with poorly defined rpls, between 1592-1593' rpls (1-3 cm) dec in size upward, rpls 1594.5-1597' about 1-2 cm, v dark, generally massive with dissipation structures from 1597-1599' and small (less than 2 cm) anh nods at about 1598-1599'.

RB massive sandy cse siltstn with dissipation structures, upper round md sand at about 1605.5'.

RB clayey cse-fine siltstn with silty dark rpls (about 1-3 cm), rpls inc in size upward.

RB v sandy cse siltstn grading upward to slightly silty v fine ss with generally massive appearance and dissipation structures, sand percent inc upward to about 1611' where it grades into overlying siltstn.

RB cse siltstn with massive appearance and dissipation structures

RB cse-fine clayey siltstn with small v dark rpls in lower 3' and poorly defined silty dark rpls in upper 5' (2' core missing 1622-1624'), small (greater than 1 cm) disp hal xls at about 1626.5' and small (less than 1 cm) anh grains at about 1626.5'.

RB massive sandy cse siltstn with dissipation structures, sand is [illegible] percent maximum 1631-1636' and 1637-1640.5'.

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

RB sandy cse siltstn with poorly defined rpls, probable mudcrack filled with v fine sand at 1645.5'.

RB v clayey cse-md siltstn with silty dark rpls.

RB clayey mdstn-fine siltstn with v dark rpls visible in places, rpl wavelength about 1 cm.

RB sandy cse siltstn with poorly defined rpl to massive appearance, rpls dark with possible dissipation structures.

Wht to Gy to RB anh with irr hz lam about 1 mm to 1 cm thick, Wht nod anh at 1672.9', possible primary structures (anh after gyp swallowtails) at about 1679'.

RB silty clayey fine v fine ss with massive texture and sparse dissipation structures, becomes finer grained immediately beneath overlying anh.

RB clayey sandy siltstn with v dark rpl texture.

RB slightly muddy v fine ss with probable poorly defined rpls incompletely outlined by dissipation structures.

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

RB silty sandy siltstn to silty clayey fine to v fine sandstone with dissipation structures at 1693', 1696' and 1698'; interval coarsens upward to 1686.5', then fines upward, lower part is gradational from underlying siltstn interval and upper part is gradational to overlying clayey siltstn, dissipation structures probably incompletely outline poorly defined rpls, rest of interval massive.

RB clayey siltstn with v dark rpl texture.

Pale Gn to Purple wavy lam anh.

Wht to pale RB recrystallized hal with rare and disc irr lam of anh.

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

Wht to pale RB hal with possible chevrons and cont/disc lam of anh.

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

logged by SN date ______

______ date ______

checked ______ date ______

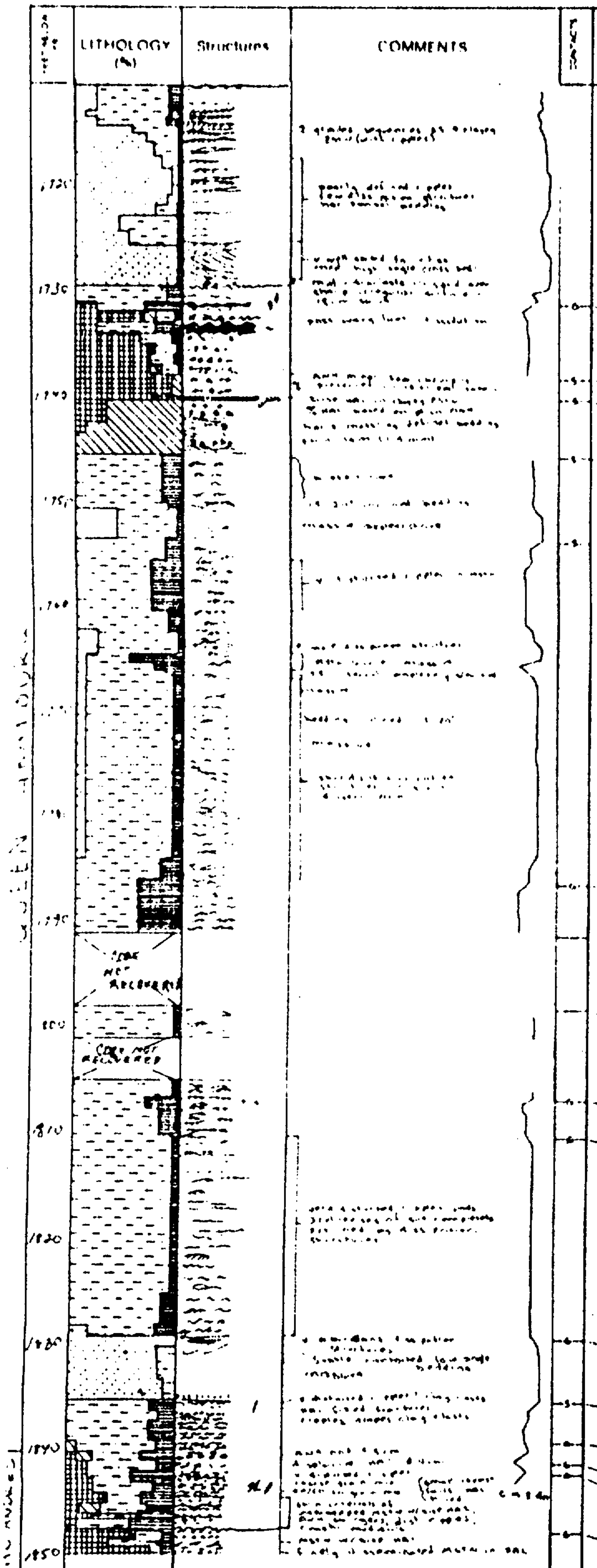
transcribed by EAC date 5/85

updated PO date 7/85

updated ______ date ______

WELL #1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL 1710 – 1850 Queen Grayburg, upper San Andres LOGGED BY SN



LITHOLOGIC DESCRIPTION

BR chaotic bxl mdsto to mdsto with diap bxl, minor anh as irr masses and stringers at 1732.5' and 1738', thin interval of mdsto with a dark rpls at 1733.5'.

Clean, Wht, recrystallized anh-bxl rock with few preserved chevrons, anh occurs as blebs and stringers.

Buff, Gy to BR lam to massive anh, ? bxl (or upward from 1743.0'; to upper 1' bxl occurs as poorly diffused small grains or in a few irr lam in upper 1', dom anh interval separated from overlying anhydritic bxl interval by thin mdsto with diap bxl at 1740-1740.2'.

BR, silty, clayey, sandy, crs siltsto to mdsto with dark rpls, rpls in coarser are more dark than coarser grained intervals, bedding generally hz except for 15-20 degree bedding at about 1750-1751' and 1770-1771', reduction spots throughout, particularly abdnt in coar intervals, rpls are incompletely outlined by dissipation structures, abdnt dissem pyrite grains 1762-1763', although ? gyp is probably trace, in general, sandy intervals are dominantly crs silt, clay rich intervals tend to be dominated by med-fine silt, intermediate textures comprise mixtures of crs-fine silt with mixtures of med silt.

BR mdsto with ? dark rpl texture.

BR silt/clayey crs to med siltsto, clay approximately 5%, massive appearance, faint rpl lam incomplete, defined by dissipation structures.

BR clayey and fine siltsto to mdsto with dim silty rpls, probable mud drapes and a fine lam, some are soft sed deformation.

BR crs-med siltsto (upper 15') with 5% clay to crs-fine siltsto (lower 4') with 15-20% clay, lower 1' had 20% v fine sand, very dark rpl texture.

BR silty v fine ss with massive appearance.

BR clayey med-fine siltsto with 15-25% clay, v dark rpls (silty ends, lenses) and possible clay drapes and drape interclasts.

BR v clayey med-fine siltsto with a dark rpls.

BR mdsto with flattened small anh nods, para to coar bedding, diap irr anh stringers and diap bxl.

BR mdsto with diap bxl.

BR mdsto with diap anh stringers, diap bxl and v dark rpls, intbd with crs and fine grained chaotic bxl mdsto rock, very lam anh and brecciated mdsto residue textures.

BR chaotic bxl mdsto rock intbd with mdsto with diap bxl.

Logged by SN date 10/84

date

Edited date

Described by CAC date 5/85

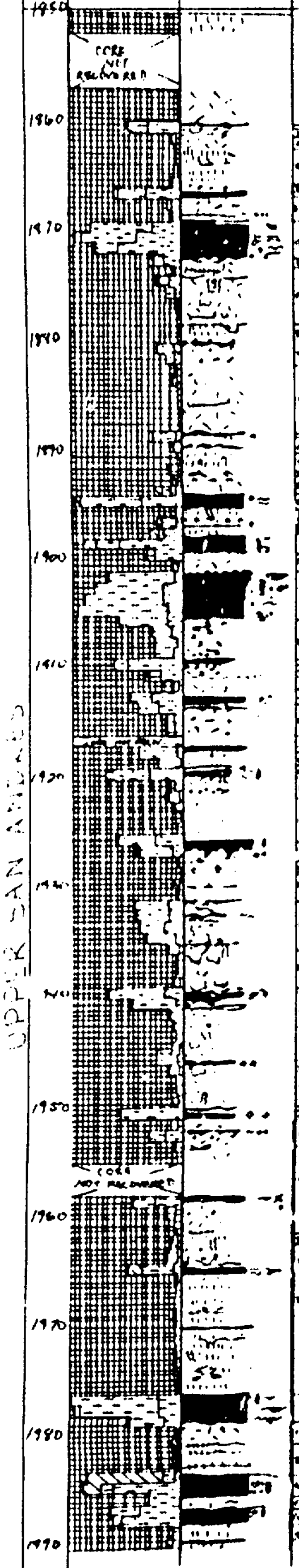
edited PG date 7/85

edited date

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

INTERVAL 1950-1990 UPPER SAN ANDRES LOGGED BY JV

LITHOLOGY (%) | Structures | COMMENTS | LITHOLOGIC DESCRIPTION



COMMENTS

MISSING FOOTAGE 1852-1857'

interbed apparent from back side of core.

curved slickenside surface

1 cm SLTN, interbed caps banded ANH

coarse xyls

1.3' long vertical fr. .5" 2 cm wide in interbed filled W fibrous HAL

mm scale spalling near top of interbed [illegible], [illegible] rotation w/in sediment)

1-2% ANH

1% ANH

core missing 1916.0-1916.9'

large vertical fx w/HAL cont cuts through interbed

1% ANH

1% ANH

slickensides in MDSTN

pipe outlined by sinuous track of small clasts of Gr ZSTN & ANH

0.5' thick interlam ANH & [illegible] interbed W/ [illegible] & displacive HAL, ANH at base

pink irregular interbed of MDSTN & ANH clasts

8 cm salt xyls

irregular interbed of ANH & md

slickensides fx.

1.5 cm thick SLTN interbed

LITHOLOGIC DESCRIPTION

Banded hal with trace insol mud & anh, missing footage from 1852-1857'.

Anhed hal with trace insol mud.

Anhed hal with insol silt & anh → a silty mdstn intbd (0.5') with small anh clasts → anhed hal with abdnt patches of siltstn → banded hal with insol mdstn within pipes → anhed hal with minor insol mud → anhed hal with patches of silty mdstn → silty mdstn intbd (0.4') with insol hal.

Anhed hal with insol mud & silt and with an area of very cracked large patches of BB silty mdstn presumably associated with a large pipe → a thin clastic interval with patches of anh & mdstn → a mdstn & siltstn intbd with abdnt disp hal and minor hal frac fill, intbd changes from massive silty mdstn at base up into a chaotic siltstn & mdstn fabric with abdnt small anh clasts, then up into a dark rpl lam muddy siltstn.

Anhed hal with minor insol mud & silt inc upward → anhed hal with abdnt small patches of muddy siltstn → banded hal with subvert xls and minor insol mud & anh; unit capped by a thin (1 cm) siltstn intbd, large xls with little mud residue occurs in lower portion of unit.

Anhed hal with min insol mud & anh → thin clastic mdstn-hal interval → banded hal with occasional chevron structures → anhed hal with patches of anhydritic mdstn along disp. intbd and with min insol mud and anh → muddy siltstn intbd (0.1') with abdnt disp hal.

Anhed hal with insol anh & mdstn → BB silty mdstn intbd (1.6') with a long vert frac filled with fibrous hal, upper part of intbd is anhydritic, overlying this is banded hal with minor insol anh & mud and interrupted by a thin mdstn intbd and a chaotic mdstn/hal interval → a muddy siltstn intbd (1.5') with dark structures and disp hal in upper part.

Anhed hal with abdnt patches of muddy siltstn and clastics content inc upward → muddy siltstn intbd (about 6.0') with disp skeletal hal hoppers and small clasts of anh & mdstn; intbd lams are usually broken with little preservation of original sed structures, especially at top of intbd where siltstn has well-developed rpl lam.

Anhed hal with abdnt clasts of BB silty mud & containing a 1 cm thick silty mdstn intbd → a silty mdstn intbd (0.5') with minor disp hal & frac fill → anhed hal with minor insol mud and silt → anhed hal with abdnt silty mdstn patches → silty mdstn intbd with disp hal

Anhed hal with insol silt & trace mud & anh → anhed hal with abdnt small patches of muddy siltstn & minor anh → a muddy siltstn intbd with a vert frac filled with fibrous hal → another siltstn intbd with rpl lams & a small cont anh clast → anhed hal with abdnt patches of muddy siltstn inc upward → siltstn intbd interrupted by missing footage

Anhed hal with insol silt and anh with a thin interval containing abdnt well developed chevron structures → a BB muddy siltstn intbd (1.6') with several anh clasts and a long, vert hal filled frac cutting across; thin anh lam caps intbd, intbd has dark rpl lam structures, dissolution features occur in lower part of section.

Anhed hal with insol silt and trace anh → anhed hal with abdnt patches of dark lam muddy siltstn and anhydritic siltstn, clastics content inc upward throughout unit, several dissolution features, especially pits, occur in lower part of section.

Anhed hal with minor insol silt & trace mud → in area of anhed hal with abdnt patches of BB muddy siltstn → anhed hal with insol silt → anhed hal with abdnt patches of siltstn which quickly grade upward into a chaotic siltstn intbd with abdnt disp hal & com small clasts of mud & anh, dissolution features are com, especially in lower part, upper contact is gradational with overlying B hal, beginning of cyclic nature of clastics

Anhed hal with min insol mud, silt and trace anh → anhed hal with abdnt small patches of muddy siltstn & containing a thin (0.2') dk rpl lam to dark silty mdstn intbd → BB silty mdstn intbd (0.1') with disp hal, core missing from 1955-1958'.

Anhed hal with insol mud → anhed hal with abdnt small patches of muddy siltstn → rpl lam muddy siltstn intbd.

Intbd of interlam siltstn & anh with minor disp hal → anhed hal with abdnt patches of muddy siltstn & anhydritic mdstn.

Banded hal with minor insol hal & mdstn, unit has several pipes and pits resulting in areas of anhed hal with insol mud (B hal), hal morphology is usually gradational between subvert and anhed.

Anhed hal with minor insol mud & anh and occasionally patches of siltstn in upper portion → dark to rpl lam muddy siltstn intbd with disp skeletal hal hoppers, a frac filled with fibrous hal near the top, and occasional small clasts of mdstn scattered throughout.

Banded hal with minor insol anh, large pit cuts across upper part.

Mdstn intbd with large hal filled fracs and skeletal hal hoppers, intbd grades upward into siltstn → anhed hal with min insol mud → lt colored silty anh intbd (2.1') with frac in lower part & disp hal in upper part, anh consists mostly of very small nods, upper part is rpl lam, sharp dissolution upper contact.

Banded hal with minor insol mud, lower part containing a thin siltstn intbd and occasional patches of muddy siltstn.

[illegible] by JV date 10/84

date

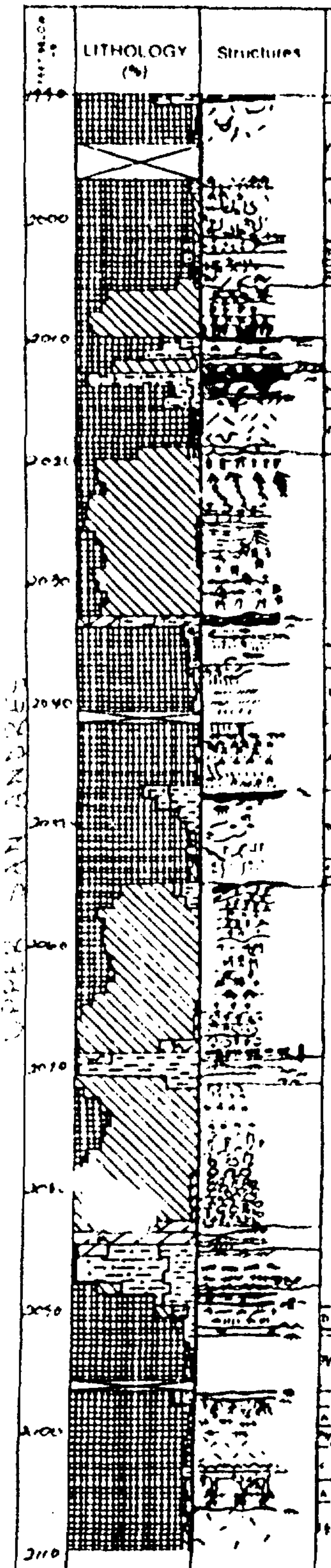
[illegible] SH date 10/84

Transcribed by CAC date 3/85

typed PG date 7/85

edited date

WELL #1 GRABBE COUNTY SWISHER DATE 10/84
INTERVAL 1990'-2110' UPPER SAN ANDRES LOGGED BY JV



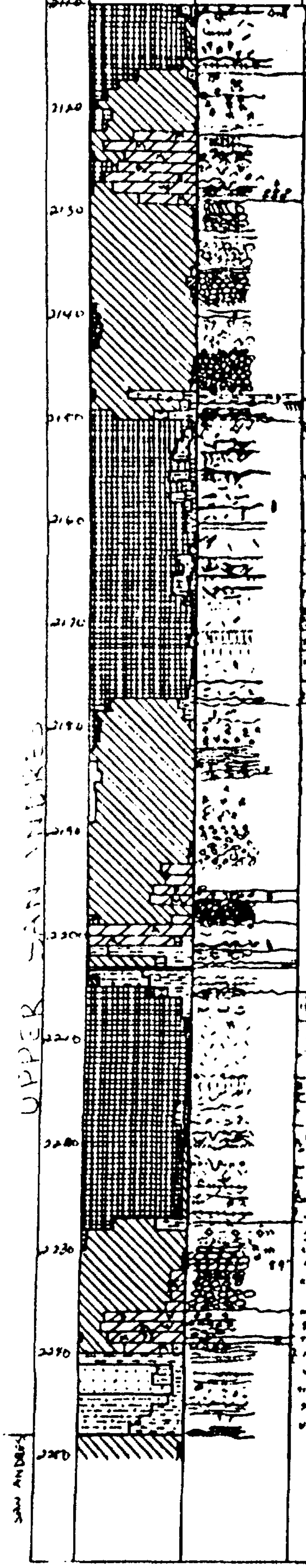
COMMENTS		LITHOLOGIC DESCRIPTION
1 cm thick [illegible] ripple lam [illegible] 1% ANH interesting [illegible]	3	Anhed hal with minor (most) mud + silt and trace anh, several dissolution features present, unit capped by rpl lam siltstn lnthd, missing footage from 1994-1997'.
3% mud 1% mud Dissolution boundary	4	Anhed hal with minor (most) anh + trace of RB mud, chevron structures occur locally near the base and top of the unit, unit capped by a 1 cm thick folted anh lnthd.
Dissolution contact	5	Anhed anhydritic hal with occasional chevron structures → thin chaotic mdstn/hal rock → thin zone (about 0.4') of banded hal with subvert xls and a chevron structure → anhed hal with abdnt small patches of muddy siltstn.
	5	Bedded hal with abdnt small vert gyp pseudomorphs with hal cement which originate from bedding plane (about 2.5') → mixture of anh + hal that becomes chaotic near the top of the unit, upper contact is a dissolution surface with anh residue.
RR [illegible] / truncation surface	4	Chaotic anh + hal mixture (0.7') → anhed hal with occasional patches of RB muddy siltstn and several lnthds of rpl lam RB muddy siltstn lnthds, 0.2' thick lnterlam mdstn + siltstn lnthd caps unit.
[illegible]	5	Anhed hal with several large patches of muddy siltstn and thin anhydritic mdstn and anh lnthds in lower part, an 18.75 cm thick dark muddy siltstn lnthd with some disp (?) hal occurs at top of unit
[illegible]	6	Anhed hal with minor (most) mud and silt and occasionally anh, small [illegible] occurs in lower part.
5 mm thick [illegible]	5	Silty RB mdstn lnthd (0.5') → rpl lam silty anh (0.5') with well developed rpl foresets → anh with large vertically oriented gyp pseudomorphs with red stained rims and filled with hal (about 4') → mixture of crinkly lam anh and gyp pseudomorphs (about 1.5') → crinkly lam anh with occasional gyp pseudomorphs (about 1.5') → wavy lam anh with small gyp pseudomorphs, originating from bedding planes (about 1.5') → anh with large, generally vert gyp pseudomorphs (about 1') → massive anh (0.25') that caps the unit with a sharp, irr upper contact with overlying hal
[illegible]		
[illegible]		
1 3% anh 1 3% anh	5	Anhed hal with abdnt, usually hz oriented, patches of RB silty mdstn, (most) mud + occasionally anh in clay abdnt, unit appears to have originated from bedded hal, sharp contact with overlying (part) lnthd
Vaguely [illegible] white hal (cumulate structures) [illegible] 2043' [illegible]	6	Banded, clear hal with minor (most) anh and abdnt chevron structures → RB banded hal with (most) RB muddy silt and minor anh, vert oriented hal xls, though not well developed, are present throughout the section, occasional pipes also occur in unit, banding within hal occurs on a 2.5-1.0 cm scale
0.5' thick [illegible] in lower part + massive [illegible] in upper part	3	Anhed hal with abdnt patches of RB mdstn and muddy siltstn, amount of (most) clastics [illegible] steadily upward, number of rpl lam clasts also [illegible] upward, upper contact marked by lnthd of mdstn with disp hal → siltstn.
	6	Anhed hal with (most) anh + minor mud, basal portion above contact is a clear
[illegible] vertical dissolution boundary	5	RI Gy anh with occasional nods and blebs of wavy bedding where [illegible] matrix is mostly replaced by anh → anh with abdnt gyp pseudomorphs filled with hal cement, pseudomorphs grade from rather large vertically oriented xls at base into smaller xls that originate from wavy (?) bedding planes, upper 1.6' contains a vert dissolution boundary between anh with pseudomorphs and anhed hal with abdnt patches and [illegible] muddy anh + anhydritic mud, upper contact is an irr, hz dissolution boundary between anh with pseudomorphs and anhed hal with abdnt patches and (most) muddy anh + anhydritic mud, upper contact is an irr, hz dissolution boundary which [illegible] across the earlier dissolution event
Red stain [illegible]	4	RB RB claystn/mdstn (1.2') with few ? patches anh → 1.0' [illegible] rpl lnterlam siltstn/mdstn upward → a 0.15' dolo mdstn with large [illegible] filled frac, upper contact marked by a horizon of desiccated(?) dolo mdstn intraclasts.
[illegible]	5	RI Gy mud and anh with dolo mdstn matrix, at 2079' the mud texture begins to disappear as hal becomes the (most) component, hal inc upward up to [illegible] (?) ; 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 [illegible] nods, the upper contact is sharp with the overlying RB claystn.
Thousands of v small hal cube molds along bedding planes	5	Rpl lam dolo mdstn with abdnt v small hal cube molds along bedding planes
Fine clastics similar to RI marker	3	Dark to rust tan RB siltstn with abdnt clasts of RB mud + some anh → similar Gy siltstn → 0.3' thick Gy fissile muddy siltstn with several small flattened anh nods.
Residue 6 cm RB silty mdstn	5	Anhed hal with abdnt patches of rust tan muddy siltstn and anh, several silty mdstn lnthds occur in the interval.
Lam mdstn interbed	6	Anhed hal with (most) and occasional patches of anh + minor mud, mud content inc upward, portions of section appear banded as in 8 hal, but hal, though similar in xl size, is anhed; missing footage from 2096-2097'
2096-2097' missing A 3 cm thick RB, rippled to contorted lam anh silty mdstn interbed, 20 [illegible] 1 cm thick similar interbed 1-2% silt	5	Anhed, silty Wht hal with minor (most) anh + mud with abdnt vert oriented chevrons, mud inc upward to where it outlines 2 cm thick beds of hal.
<1% anh	6	Anhed hal with RB mud and silt and minor anh.
2 cm thick anh mdstn interbed	4	Anhed, silty Wht hal with (most) anh + vert chevron structures, upper contact is gradational with overlying mdstn lnthd.
1-2% mud	5	Anhed hal with (most) anh and RB mud and silt, relative proportions vary upward

logged by JV date 10/84
date
checked SH date 10/84
transcribed by CAC date 5/85
updated [illegible] date 11/85
updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 10/84

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

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



THIN (1 cm) ANHYDRITE AND INTERBED

LARGE ANH-LINED PIT <5% MUD

IRREGULAR 2-4 cm THICK ANH INTERBED

SKELETAL HAL HOPPERS

HAL-FILLED FRAC

MUCH REMOBILIZATION (CONTORTIONS, [illegible]) [illegible] BOTTOMS

EROSION OR DISSOLUTION CONTACT

5% HAL

[illegible] [illegible] MARKS ANH NODULES

INTERESTING AREA OF LARGE BROWN [illegible] [illegible] ANH [illegible] ANH

NODULES COALESCE TO FORM A MASSIVE TEXTURE

FORMER ANH/HAL CONTACT

10 cm [illegible] ANH

4 cm THICK SILTY MDSTN INTERBED [illegible] HAL [illegible] AND [illegible] MOTTLED [illegible]

1% [illegible] ANH

LARGE MUDDY SILTSTN PATCH W/ CONTORTED LAM

1% ANH

1% MUD / SILT

3 cm THICK MUDDY SILTSTN INTERBED

5 cm THICK RIPPLE DISTURBED LAM MUDDY [illegible]

1.5 cm [illegible] SILTSTN INTERBED

(1-2%) INCL MUD

SMALL MUD CLASTS

TRACE OF DOL

ABOUT 1% INCL [illegible]

MINOR ANH BODIES REPLACING DOL

20 cm

ABOUT 1% INCL DOL

40 cm DOL w/ 1 cm HAL REPLACED

SHARP CONTACT [illegible] DOL & MDSTN

31 cm GY MDSTN, MINOR ANH

15 cm ANH 0.5 ft MISSING SECTION

30 cm RB SILTSTN

3.5 cm MASSIVE [illegible] ANH [illegible]

25 cm RB MDSTN

14 cm RESIDUE

OCC [illegible] PATCHES & DISTURBED [illegible] PATCHES OF SILTY MUD

RB MUD PRESENT, ANH IS MUDDY

WELL-FORMED CARST PITS

TRACE OF BLACK INSOL MAT [illegible] THICK ANH INTERBEDS — VERY FINE HAL XLS

THIN, TILTED LAM ANH AT TOP OF ANH [illegible] NODULAR TEXTURE IN ANH

<1% DOL

<1% HAL

REMAINING INSOL DOL [illegible]

8 cm THICK IRREGULAR [illegible] [illegible] ACROSS [illegible] FABRIC

40 % PORE FILLING ANH

MOLDIC POROSITY-FILLING HAL

8 cm ZONE OF [illegible] DENSE DOL MDSTN

THIN ZONE OF [illegible] MOLDS W/ HAL [illegible] FILL

[illegible] DOL MDSTN [illegible] OF ABOUT ANH NODULES

V. FISSILE, [illegible] UPWARDS

[illegible] [illegible] [illegible] SOFT SEDIMENT [illegible]

V. FISSILE

3 — Anhed hal with abdnt patches of muddy silt overlying thin clastic [illegible].

Anhed hal with incl anh, RB mud and silt, from the base incl components change from clastics to anh to a mixture of clastics + anh, occasional pits and pipes occur in the interval.

5 — Thin (1') vaguely lam mud and anh → 1' [illegible] of anh/hal mixture exhibiting a diagenetic fabric, hal appears to be replacing anh by filling abdnt small vugs(?) and sometimes leaving only a [illegible] network of anh, overlying this is a 3' interval of disp and skeletal hal within anh.

6 — Lam dolo mdstn with scattered anh nods → thin dolo mdstn → 2' [illegible] forams, molds, pelecypod grains with moldic porosity usually filled with hal → finely rpl lam dolo mdstn with anh nods dec upward [illegible] hal-filled frac at 2127.1'.

5 — Bl-Gy and mosaic anh at base, small anh nods with minor incl dol → massive anh with faint remnants of nod texture and a little [illegible] matrix, at 2132' is a thin (0.2') wavy lam interval → 0.6' thick dark interval → nod anh, upper 3' differs from rest of unit by having slightly dolo, muddy silicic matrix, upper contact is a dissolution contact with overlying dolo.

6 — Bl Gy anh with poorly defined, randomly oriented gyp pseudomorphs filled with hal cement → wavy rpl lam anh with fewer but slightly better developed gyp pseudomorphs filled with hal cement

6 — Bl-Gy and mosaic anh with incl dolo, dolo matrix dec upward from about 5% to less than 0.5%.

5 — Bl-Gy wavy rpl lam anh → 0.8' thick, slightly muddy siltstn [illegible], siltstn grades from RB upward to Gy, this horizon of small anh nods and also [illegible] fibrous hal filled frac in Gy siltstn, siltstn to rpl lam

5 — Anhed hal with abdnt patches of RB muddy siltstn + minor incl mud, [illegible] patches have cont in dark lam, several dissolution features present, relative mud content appears to inc upward, [illegible] silty [illegible] caps hal unit.

6 — Anhed hal with minor incl anh, silt and mud, anh content dec upward while silt and mud content inc upward.

6 — Cse anhed hal with abdnt patches of RB muddy silt and minor incl RB mud, large patches are usually associated with [illegible] and dissolution features (pits and pipes), several siltstn [illegible] in interval.

6 — Anhed hal alternating with poorly developed vert oriented banded hal, minor incl RB and Gy mud, anh and mud/anh throughout and not usually exceeding 5%, small chevrons in anhed hal at 2173.2'.

5 — Anhed hal with incl RB silty mud, thin mdstn [illegible] marks sharp upper contact.

5 — Bl-Gy and R stained (slightly mottled) anh with chicken-wire texture, some wavy [illegible] bedding + incl hal cement, sharp wavy upper contact

5 — Wavy lam anh with occasional + small bedding plane gyp pseudomorphs, lam [illegible] consists of alternating [illegible] lam of Bl Gy and Gy anh, lam anh → anh with chaotic or non-oriented poorly developed gyp pseudomorphs filled with hal cement.

6 — Nod-looking anh with indistinct "nods" of anh and radiating masses of [illegible] blades, hal is minor cement between the spherules.

6 — Bl Gy anh nods with incl dolo, dolo is wavy bedded at 2191-2196', dol [illegible] dec upward and is replaced by a Bl B anh which is an aggregate of blades in contrast to the massive texture of the nods.

5 — Bl-Gy and mosaic anh → 0.3' thick dolo mdstn to wkstn contains minor anh nods, fossils include pelecypods, ostracods(?), dolo has sharp upper contact and lower contact, erosional or dissolution?

5 — Bl Gy silty mdstn (1.0') → 2.2' lt B dolo mdstn → 0.3' of which replaced by anh + hal, dolo mdstn is fairly structureless except near top where there is possible cross bedding, dolo is somewhat silty near base.

6 — Cont, interlam RB silty mdstn + anh along basal contact → 0.6' of [illegible] lam RB muddy siltstn → 0.15' anh laths → 0.9' dark lam RB silty muddy siltstn with + small elongated anh blades near base, missing footage from 2203-2203.5', 0.5' wavy to dark lam anh with some R stain → 0.6' of Gy anhydritic silty mdstn which make gradational contact with overlying unit

6 — Anhed hal with abdnt patches of RB silty mud and occasional anhydritic mud, mud content inc upward, especially near gradational contact with overlying mdstn unit.

Anhed hal with minor incl mud and anh, mud + anh vary in relative abundance with some sections mostly anh and some mostly incl mud, both are usually present, occasional small pipes are present as well as a partial chevron in an anh zone, incl material generally inc upward.

6 — Anhed hal with minor incl mud + occasional [illegible] of muddy siltstn → anhed hal with rare patches of RB muddy siltstn + minor incl mud.

6 — Cse anhed hal with minor incl anh, anh content inc upward; in lower part thin anh laths are com and hal shows occasional bands with traces of incl RB mud, middle unit contains occasional partial chevrons, it also contains some subvert hal xls, 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 incl muddy anh.

5 — Bl-Gy nod anh with varying amounts of dolo mdstn matrix, nods inc slightly in size upward until 2232' where nods are suddenly small and again inc in size upward, dolo matrix then dec quickly and anh nods coalesce to form somewhat massive texture, in upper 2' anh has nod texture (Bl patches in Bl Gy anh) with hal beginning to appear, hal inc upward, yielding a chaotic fabric, sharp upper contact.

6 — B, rpl lam to massive dolo mdstn with Bl-Gy, slightly flattened anh nods, nods are commonly rare in zones, minor hal cement in occasional fossil molds.

6

logged by JV, LE date 10/84

date

checked SA date 10/84

transcribed by CAC date 3/85

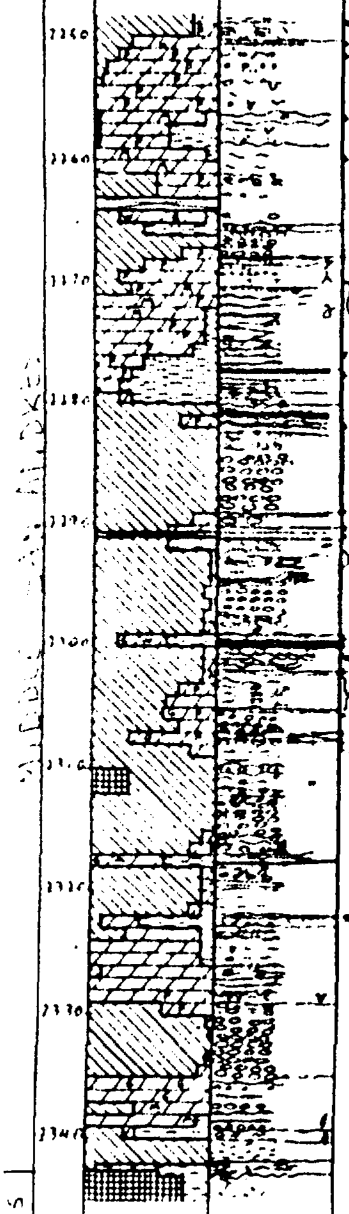
updated TG date 7/8?

updated date

WELL #1 Grabbe   COUNTY Swisher   DATE 9-84

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

LITHOLOGY (%) | Structures | COMMENTS | Cycles | LITHOLOGIC DESCRIPTION



COMMENTS

- dolomite interbeds
- tan intraclast grainstone
- dolomicrite breccia with anhydrite cement
- silt partings
- silt partings
- anhydrite after skeletal halite ?
- rippled fabric modified by wispy lamination, or microstylolitization micro drapes
- packstone grainstone layer
- fissil claystone
- bedded dolomitic anhydrite
- anhydrite - cemented dolograinstone
- dolomitic mudstone
- 22909 - 22910 missing
- gradational anhydrite/mudstone transition, compressed nodules
- light brown dolomite
- black gray [illegible] mudstone
- anhydrite with disrupted texture
- dolomitic anhydrite
- laminated anhydrite + dolomite truncated by anhydrite nodules pseudomorphs
- dolomite bed
- burrowed gradational top
- dolomite bed rippled grainstone/pack
- subhedral nodules may be pseudomorphs after gypsum
- * see detail below

LITHOLOGIC DESCRIPTION

5 – [illegible] anhedritic siltstone, dark bedding grades upward into silty dolo pkstn

Dolo is shelly with anh filled moldic porosity and anh replacement of dolo, anh nods present below missing core are large - [illegible] cm - and common

Above missing core bedded mud anh with [illegible] lentil dolo and lathd dolo, from 2261-2250' dolo with scattered rare anh nods and occasional silt partings

Dolo mdstn with wispy organic rich lam, tight with pores with anh filled moldic porosity, massive Gy-B anh with dolo laths and wispy lam within anh.

5 – [illegible] siltstone, wisps of dolo + anh, disrupted texture grading to lathd anh + siltstone, fissile from 2270-2276', becoming more indurated as dolo inc.

Dolo is lt B with dk B lam, rpl and burrowed (mtmrl).

Anh-filled skeletal hal molds in upper dolo section.

Bl-Gy anh, mod, bedded, grading to massive anh at top.

5 – [illegible] Gy anh with wisps of siltstone, grades to [illegible] siltstone with anh nods and stringers, dark, [illegible] bedding to 2291'.

Anh nods with lentil dolo and dolo laths, dk Gy bedded nods with [illegible] lentil mottles; nods grade to massive anh with indistinct bedding.

Dolo beds have extensive anh replacement of allochems

6 – [illegible], fissile anh mdstn grading to dolo in basal 1', dolo pkstn has hal + anh-filled moldic porosity similar to below, anh nods with lentil dol., dk Bl-Gy, becomes lighter upward with dec dolo, and dec in size and grade to bedded, massive anh.

5 – [illegible], fissile mdstn with small anh nods at base - becoming dolo toward top, grading to dolo at 2312', rpl lam pkstn, anh-replaced allochems in dolo, dolo grades into mod bedded anh - Bl Gy anh with lentil lt B dolo

2315.5-2311.5' Gy-B-Bk anh, mdstn with relict B bedding, grades up to hal anh laths, displacive anh in hal, grades to B Gy bedded hal, becoming more [illegible] with lentil dolo.

Dolo beds have hal + anh filled moldic porosity.

2305-2300', bedded massive anh with dolo laths

5 – Gradation of dolo into clastics, inc clastics and dec dolo upsection with anh cement + beds, grades to dolo anh, massive bedded with dolo stringers, becomes mod at top with lentil dolo.

6 – Lt B dolo, wispy to well lam, cross bedding and burrows at 2323 [illegible]', [illegible] anh nods at 2326, top 1' is interlam anh and dolo in [illegible] 10 mm lam, hal filled moldic porosity.

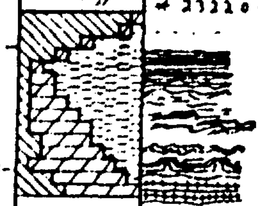
6 – Bl Gy bedded mod anh with lentil lt B dolo, [illegible] mod contacts

6 – Lt B dolo pkstn, cross bedded + planar lam, hal filled moldic porosity, [illegible] throughout dolo, lam and anh beds, silty rpl dolomicrite at base,

5 – Plat lam to massive siltstone, [illegible] with wisps of lam(?), grades to massive bedded anh, top 1' [illegible] siltstone with anh nods, hal-filled pores

6 – Bal, cycle 5.

Lithology at 23220 - 23232



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

Inc in clastics vert, anh cement and rare nods at beds, dolo throughout, lathd siltstn + claystn.

logged by PG   date 9/84

date

checked SR   date 1/84

transcribed by CAC   date 5/85

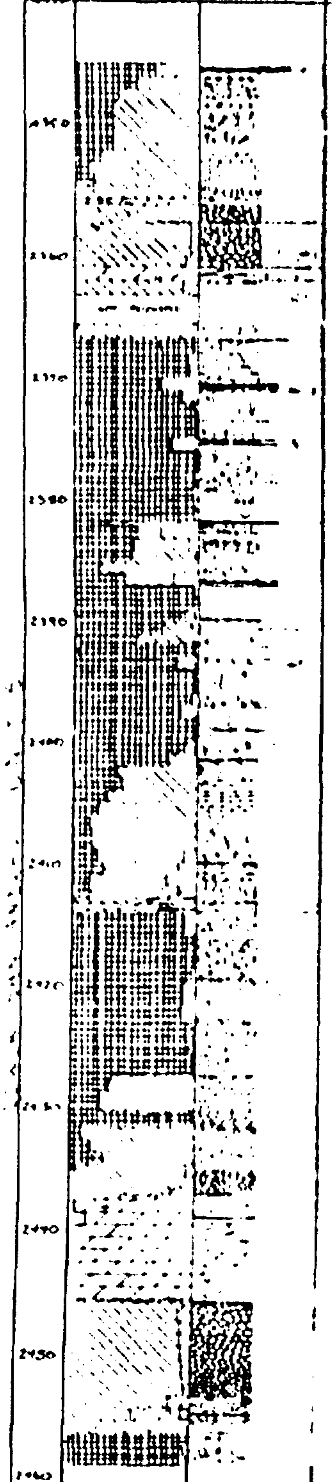
updated [illegible]   date [illegible]

updated   date

WELL # 1 GRABBE COUNTY SWISHER DATE 8/83

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

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Primarily bedded B type hal with numerous [illegible] [illegible], [illegible] and [illegible] become more numerous and [illegible] upward. [illegible] hal above [illegible] grades upward to B type hal

A gradational sequence of [illegible] anh hal with [illegible] chevrons to chevron hal to [illegible] muddy hal with [illegible] primary bedding features present, and [illegible] throughout [illegible] upward.

Chaotic mixture of hal, anh and [illegible], [illegible] [illegible] [illegible] cm, anh and [illegible] as large [illegible] [illegible] bodies

Hal replacing gyp pseudomorphs, [illegible] becoming [illegible] grading upward to finely disseminated hal anh mixture

Typical [illegible] muddy hal becoming [illegible] muddy upward, [illegible] [illegible], see [illegible].

0.7' [illegible] muddy hal with some [illegible] [illegible], [illegible] sharply overlies.

Both mixture of hal and anh with hal replaced gyp pseudomorphs, anh [illegible] upward

[illegible] anh hal, [illegible]. hal replaced gyp [illegible] [illegible] basal 0.1'.

Chevron hal, grades to bedded B type hal, [illegible] [illegible] pitted and [illegible] upward

[illegible], [illegible] cavity fill sharply [illegible] [illegible] [illegible] from and both B-type, chaotic [illegible] type [illegible]

[illegible] anhedritic hal and [illegible] cavity fill, [illegible] contact with anh below, grades upward to bedded B [illegible]

Hal pseudomorphs after gyp, [illegible] [illegible], [illegible] from less than 1 mm to 1 cm [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] and [illegible], [illegible] [illegible] [illegible] upward from [illegible] mm [illegible]

Both, [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible]

Two [illegible] of B type chevron hal [illegible] [illegible] [illegible] type bedded hal, grading upward to chaotic [illegible] [illegible] anh and [illegible] [illegible] [illegible] [illegible] [illegible] bedded [illegible] [illegible] [illegible] [illegible], B type hal and [illegible] and [illegible] to B type.

Hal replacing [illegible], pseudomorphs [illegible], [illegible] less than [illegible] mm, [illegible] hal [illegible] [illegible] with anh [illegible]

Typical [illegible] [illegible] cavity fill hal, [illegible] disseminated anh

Hal replacing gyp pseudomorphs to finely disseminated [illegible] and anh grading upward to [illegible] anh with hal [illegible]

Mud to mud-mosaic anh.

Anh [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible], [illegible] [illegible], hal [illegible] [illegible].

Bedded and anh grading upward to mud mosaic anh with [illegible] [illegible] throughout, [illegible] [illegible] upward [illegible] [illegible] to [illegible] cm

[illegible], both [illegible], anh and [illegible] [illegible].

[illegible] [illegible] bedded hal.

logged by SJ date 8,83

date

checked SH date 8/83

transcribed by CAC date 5,85

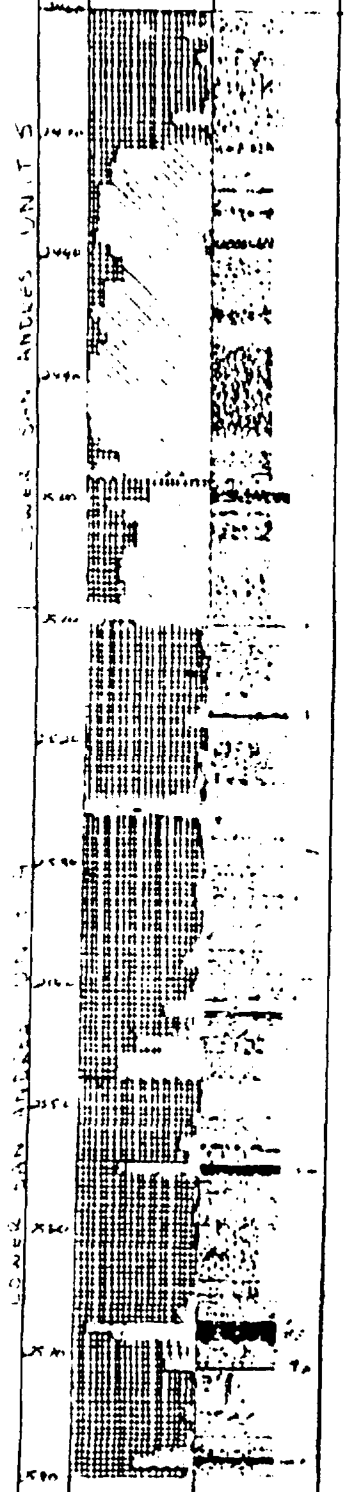
updated [illegible] date 1/83

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 8, [illegible]

INTERVAL 2460 2590 LOWER SAN ANDRES UNIT 5 - UNIT 4 LOGGED BY S. THOMAS

LITHOLOGY (%)	Structures	COMMENTS	Contacts	LITHOLOGIC DESCRIPTION



Chevron hal in varying degrees of disturbance and [illegible]

[illegible] B, Fe, Ding and Bl contorted anh with hal stringers, [illegible] structures resemble carbonate fabric.

Red anh with fossil Bk clay and mdst grading upward to [illegible] Bk and B cont anh with dissem hal.

Anh with large fossil voids filled with hal

Hal replacing gypsum after gyp, pseudomorphs 1 cm [illegible] (?) cont), grades to bedded mosaic anh [illegible] grading back to gypsum texture, replaced with hal

Finely lam anh and Bk claystone/mdst, becoming [illegible] upward.

Chevron hal, no vert oriented xls above mdst breaks

Alternating B mdst and flap hal beds capped by [illegible] type hal.

Hal replacing gypsum after gyp, grades upward [illegible] (5 cm) to small (1 cm) pseudomorphs in mosaic [illegible] anh/hal mixture

C/D-type hal with large BB mdst fossil bodies, xls cubic to 7 cm, ave less than 1 cm, capped by B type hal, xls cubed, greater than 4 cm.

Typical B-type hal, [illegible] and dark upward, grading to C/D hal, 4% anh plus hal 40 color, minor B mdst [illegible] from above through pipes.

Gradational sequence of hal types, fossil anh and mdst in roughly equal proportions throughout except top [illegible] capped by four mdst [illegible], entire unit appears highly dark, can xls at base.

Typical B type hal, xls cubed to 1 cm

Slightly banded bedded hal with zones of [illegible] recrystallized zones consist of polygonal hal xls [illegible] size, fossil mud and anh highly dissem and [illegible] of growth.

Generally typical chaotic mudsalt with zones and pockets of primary bedding, coarsest xls below [illegible], xls [illegible] 3 cm, fossil mud is highly dissem and occurs as fossil bodies and stringers.

Felted anh with fossil hal bodies and zones

Gy anh with hal pseudomorphs after gyp

Cum B-type hal with B-type top 5 cm, fossil mud less than 1% [illegible] xls cubed 1 1.5 cm.

A and B type hal with high % of finely dissem material, chaotic zones associated with mdst lathes.

Predominantly F-type hal with zones and pockets containing primary bedding features, xls cubed, range from 2-10 cm, finest xls top 1', capped by [illegible] lam [illegible]

Classic B-type hal cut by thin organic partings, becoming [illegible] pitted and dark upward, beds range from 1 5 cm

Bedded hal cut by numerous paper-like anh partings with minor clastic component, hal to 4% [illegible]

Bedded B-type hal with high % of finely dissem fossil BB mdst, capped by BB dark, interstitial mdst/siltstone lathe.

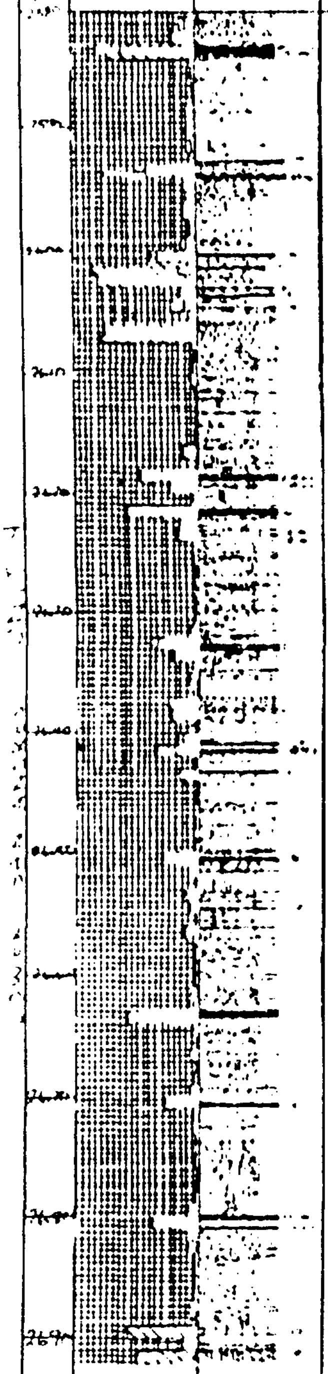
Highly recrystallized zone with some primary bedding features in upper 1', hal crystals in A type interval hal are [illegible] cm and polygonal in shape, smallest xls in upper 1', ave 5x5 mm.

logged by S. T. date 9, 83
_______________ date ____
checked SH date 9/83
transcribed by LAC date 5, 85
updated PSa date 7/85
updated ______ date ____

WELL #1 GRABBE COUNTY SWISHER DATE 5,84

INTERVAL 2590 - 2692 LOWER SAN ANDRES-UNIT 4 LOGGED BY S. THOMAS

Depth (ft)	LITHOLOGY (%)	Structures	COMMENTS	Code	LITHOLOGIC DESCRIPTION



Code	LITHOLOGIC DESCRIPTION
5	Slightly banded B type hal, becoming [illegible] upward, capped by an interval of typical B type hal associated with the mdstn laths, and is reduced at [illegible] laths.
	Two successive hal units grading from [illegible] partially [illegible] A type hal, [illegible], each unit capped by dark mdstn [illegible] the upper [illegible] is reduced
4	Cy anh, bottom 8 cm is massive, becomes bedded hal pseudomorphed and [illegible] upward.
4	[illegible], recrystallized hal capped by A type [illegible], and [illegible] sharply [illegible] upward above [illegible]
5	Cy anh with bedded hal pseudomorphs [illegible] 17 cm to [illegible] anh to hal
5	Recrystallized B and C-type hal, grades to bedded hal with [illegible] scattered and scattered chevron cases, bedded hal [illegible] from mud to heavily recrystallized.
5	B type hal in varying degrees of disturbance, cut by mdstn [illegible], [illegible] to anh upward.
6	A and B type hal with well developed banding, bands grade from [illegible] to [illegible], hal becomes [illegible] dark upward, capped by [illegible]/mdstn laths.
5	Bedded hal becoming [illegible] dark upward, grading to B type hal
5	Chevron hal cut by mud filled pipes, [illegible] and dark upward.
5	Typical B-type hal, becoming free of mud and cut by [illegible] 2636.1-2635.7'
4	[illegible] shape like anh [illegible] in [illegible] hal
6	Recrystallized B type hal grades to B type with [illegible] mud [illegible] greater than 1 cm
5	Gray B banded hal with well [illegible] by [illegible] mdstn laths
5	Recrystallized [illegible]/polygonal, about [illegible] cm [illegible] hal [illegible] upward to chevron hal, sharply capped by a [illegible] laths
3	Well [illegible] A and B type hal, anh [illegible] debris [illegible] the hal.
3	Alternating units of B and A type hal, [illegible] with mdstn laths, and [illegible] upward
6	Dark B type hal, common pits and [illegible] anh stringers
5	[illegible] and pitted B and A type hal, scattered [illegible] of A, B, and C-type hal associated with mdstn laths
4	Generally a highly dark B type hal capped by a [illegible] cm mdstn drape, [illegible] hal bedding [illegible] at [illegible] B-type hal associated with mdstn laths.
5	Chaotic [illegible] cut by thick mdstn [illegible], [illegible] small (up to 2x1 cm) but numerous
5	Banded hal with anh laths becoming [illegible] dark upward
6	B-type hal showing varying degrees of recrystallization

logged by ST ____ date 5.84

____ date ____

checked SH ____ date [illegible]

transcribed by CAC ____ date 5.84

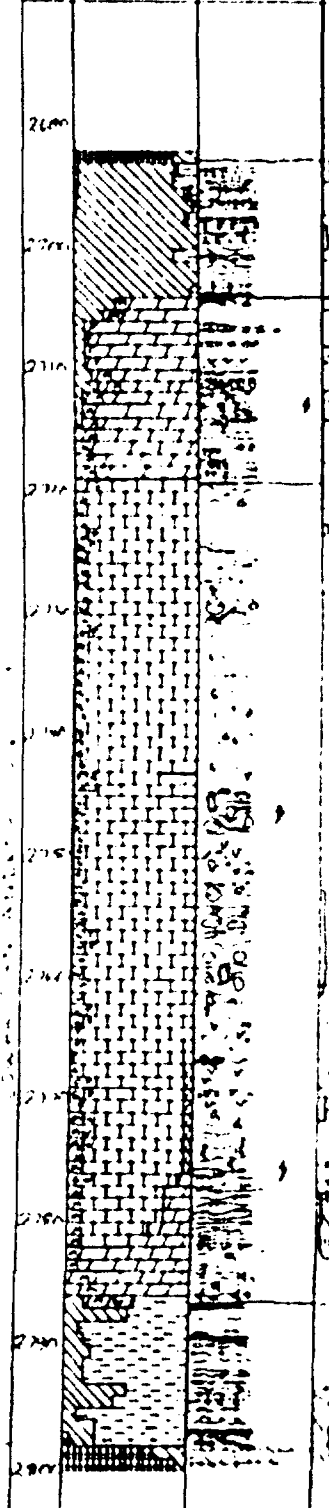
updated [illegible] ____ date 7.84

updated ____ date ____

WELL # 1 GRABBE　　COUNTY SWISHER　　DATE [illegible] '8[illegible]

INTERVAL 2692 - 2900 LOWER SAN ANDRES UNIT 4 / UNIT 3　　LOGGED BY Luneau, Elliott

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION



[illegible] horizontal [illegible] band [illegible] 1cm

[illegible] not truncated by laminated [illegible] & ANH

[illegible] texture in ANH [illegible]

[illegible] in [illegible] matrix

[illegible] salt and deformation

[illegible] texture produced by partial ANH replacement of [illegible]

[illegible] mudcrack [illegible] filled by [illegible] & anh nodules

[illegible] (5cm) [illegible] mudcrack

[illegible] replacement of ANH nodules

[illegible] filled [illegible] by [illegible] & ANH (6cm)

[illegible]

[illegible] HAL [illegible]

[illegible] irregular [illegible] of HAL replacement, [illegible]

HAL filled vertical fx

allochems are [illegible] replaced by ANH some grains show [illegible] partial replacement

small [illegible] of ANH in [illegible]

high spired gastropod (1cm)

[illegible]? Much algal [illegible] replaced by HAL [illegible] phylloid algae

[illegible] filled w/ clear HAL

[illegible] ANH (<1mm) [illegible] nodule (1cm) [illegible] ANH [illegible]

[illegible] ANH (<1mm) [illegible] radiating [illegible] of calcite [illegible] anhedral anh [illegible] (2mm)

fossil dark shale (9cm)

[illegible] ANH [illegible] (4cm) [illegible] ANH clasts or nodules [illegible] filled [illegible] by HAL [illegible] and [illegible] clasts abundant 1cm [illegible] clasts (1-10 [illegible])

[illegible]

logged by [illegible] date [illegible]

date

checked [illegible] date [illegible]

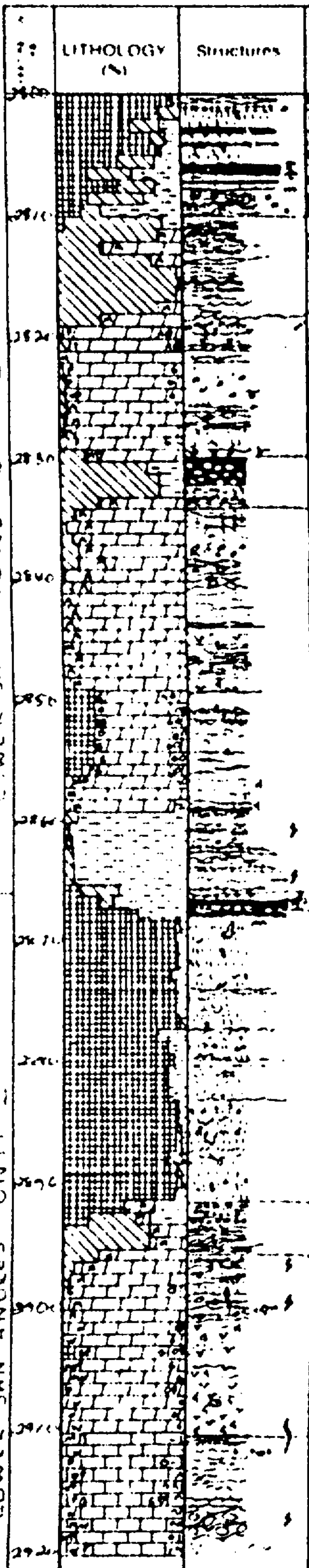
transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE Nov 1984

INTERVAL 2800 - 2920 LOWER SAN ANDRES UNIT 3 UNIT 2 LOGGED BY Luneau, Elliott



COMMENTS

Hal [illegible] 2mm
A 8cm [illegible]
A, 6cm ANH [illegible]
A 9cm ANH [illegible]
A, 60mm, ANH [illegible]
A, 7cm, 9cm ANH [illegible]
HAL IS [illegible] IN [illegible]
[illegible] FOLDS OF THE [illegible]
SMALL IRREGULAR HAL FILLED [illegible] VERTICALLY
[illegible] UPFILLED [illegible]

HIGH ANGLE FRACTURE
ANH [illegible] 2.0'

[illegible] UPWARD
ABOUT [illegible], [illegible]

[illegible] LAMINATED [illegible] SEAMS, [illegible]
[illegible] MARKS [illegible]

ZONES OF HAL CEMENTATION ARE [illegible] RELATIVE TO SURROUNDING [illegible], LAMINATIONS [illegible] & [illegible] ZONES
— DARK SHALE PARTING

DARK SHALE PARTING
THIN [illegible] CONTAINS [illegible] POSSIBLE [illegible] DEPOSITS [illegible] OOLITES

[illegible]
[illegible]
[illegible] ANH [illegible]
RED FIBROUS HAL FILLED FRAC
[illegible] BRECCIA
THIN FRACTURES INFILLED [illegible] HALITE
[illegible] BRECCIA [illegible] FRAGMENTS & [illegible]
— POSSIBLE [illegible] IN SALT, ANH [illegible]
[illegible] 1mm
B [illegible] 4mm DISSEMINATED

[illegible] 2mm
1 large [illegible]
[illegible] 2mm

clear, fibrous hal filled frac
[illegible] zones of hal cementation and [illegible] fractures [illegible]
of clear fibrous HAL filled frac

several small hal-filled cavities w/ banded chert rims;
irregular zones of hal cementation
← GYPSUM RIM ON ANH NODULE & NODULE (UNKNOWN origin)
clear fibrous HAL filled fracture 8" long
ABOUT HAL FRACT CONFINED TO LIGHTER ZONE

POSSIBLE [illegible] CRINOIDS & OTHER UNKNOWN ALLOCHEMS, POSS. [illegible] ALGAE OR CORAL;
RED FIBROUS HAL FILLED FRAC CONFINED TO LIGHTER ZONES
BRACHIOPODS, [illegible] SHELLS

LITHOLOGIC DESCRIPTION

Primarily B type hal with mdst interbeds - B and C hal associated with interbeds, small amounts of A type hal mixed with B

B-type hal interbd with dk gy mdst beds with anhyd cement

Interlam anh & dk terrig mdst with disc hal interbeds & poorly formed hal hoppers, lam is para to cont, hal is [illegible] to color

Dl gy anh with interlam dk terrig mdst & dolo, lower 1' is predominantly dolo, unit below with interbeds of nod anh, [illegible] lam, 0.9' thick interbd of lam, wispy lam and [illegible] dolo mdst at [illegible], small [illegible] of hal in mdst are aligned vert in upper half of interbed, [illegible] in lower half, mdst appears deformed around hal [illegible] in this section, hal cemented zones are [illegible] deeply etched in relation to the surrounding dolo, lam in upper [illegible] highly folded and contorted with tight similar folds at [illegible] at 2811.5'.

Tle-B anhedritic, intbd dolo mdst/pkst, mdst is wispy lam, pkst contains coated grains, algae, mollusca and other fossils which are difficult to identify, most are dissolved and infilled with hal, these beds are burrowed to bioturbated.

Dl-Gy nod to lam anh, dk terr mdst is interlam with anh and is found [illegible] between nods, trace amounts of dolo mdst are also present, nods in lower 1' are small and are 1 cm in diameter, nods in upper 1' are large, terrig mdst in upper 1' is fissile and splits easily along [illegible] planes, sharp but cont or soft and deformed contacts both above and below

Tle-B anhedritic dolo mdst, wispy lam, gradational to unit below but [illegible] an inc in nod anh, upper 1' contains [illegible] anh & dolo [illegible] nod [illegible] resistant beds, where hal cemented zones are etched relative to surrounding mdst, mdst matrix is [illegible] and may represent differences in the amount of anh cement

Lt Gy dolo mdst, upper 1' is wispy lam with large [illegible] & hal cementation which are etched relative to surrounding dolo, lam is [illegible] through these zones, lower section is lam with a small burrow, disrupting [illegible] lam, burrows are commonly cemented by hal and are etched relative to surrounding rock, local zone of org-rich terrig mdst produces fissility in rock.

Tle-B dolo oolite pkst, & well sorted ooids are the most abund allochems, other allochems include mollusca, echinoderms, green algae, pellets are rare in lags at first in the finer grained oolitic matrix, ooliths are dissolved and infilled with hal, lower 1' is cross bedded.

Tle-B lam to rpl lam silty dolo mdst, lower 2' is bioturbated, lam is produced by variability in silt content & organics, contains interbeds of [illegible] mollusc pkst/wkst in upper 1', green algae may also be present in [illegible] poorly-formed hal hoppers occur along some lam.

Dk Gy-Bk terrig mdst with alternating zones of well preserved rpl lam [illegible] intraclastic fabric, cont and disc anh lam & small [illegible] of anh & [illegible] float in matrix, [illegible] at 2862.0 is soft and deformed with clasts of mdst & mdst breccia, upper 1' is highly fissile, 0.1' bed of nod anh at top.

Intbd [illegible] mdst with [illegible] fabric and B type hal.

Primarily B type hal, bedded with [illegible], [illegible], few chevron inclusions, intbd B and C hal [illegible] and associated with the few interbeds.

Interlam anh, dolo & terrig mdst, lam is para to wavy and cont, [illegible] in upper 1.5', upper zone is characterized by nod anh textures, disc hal pods & an inc in terrig mdst content, lower boundary is gradational & dolo mdst below, upper boundary with hal is sharp.

Tle B dolo sparsely foss wkst with grain/pkst interbeds, fossils are small and difficult to identify, most are molds or infilled with hal, the upper and lower boundaries are gradational, lower 0.5' contains [illegible] small burrows and vague wispy or lam, lam [illegible] upward and is [illegible] disrupted by burrowing, rpl lam in upper 2', this upper zone contains [illegible] of hal cementation which end abruptly near [illegible], unit is slightly [illegible] with large and small nods scattered throughout, [illegible] fibrous hal filled [illegible] are up to 1' long, hal hoppers are present at 2899-2901', these grain to pkst interbeds less than 1' thick have sharp to gradational contacts and are composed primarily of mollusca, coated grains, [illegible] & [illegible] clasts - all molds or infilled with hal, diagenesis in these grainy interbeds appears complicated with small hal filled cavities and [illegible] zones of hal cementation, cavities have banded chert rims.

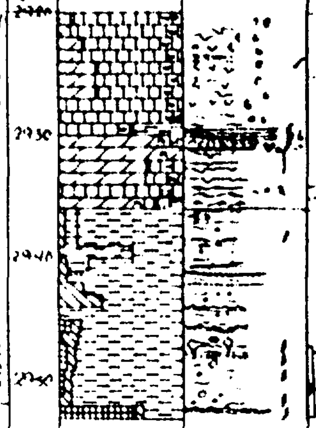
Tle-B-Gy limestone wkst/pkst, this unit is gradational to unit below but is distinguished by an inc in grain content and more pronounced [illegible] (nod) fabric, two pkst interbeds have gradational boundaries, upper 1' consists of faint wispy lam and local zone of bivalves and/or green algae, fossils include bivalves, algae, brachiopods, bryozoa, crinoids, fossils are [illegible] small and difficult to identify.

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 2920-3040 LOWER SAN ANDRES - UNIT 2, GLORIETA LOGGED BY [illegible]

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



COMMENTS

diagonal open fracture

large gray calcite cemented nodule

Red fibrous anhy filled fracture
[illegible] of [illegible] intraclast matrix

[illegible] fracture [illegible] cement
[illegible] cementation or replacement
[illegible] change [illegible] of mineralogy [illegible]
sharp irregular contact with clasts of [illegible] matrix

Red fibrous anhy filled fracture

[illegible], more [illegible]

Red fibrous anhy filled fractures [illegible]
[illegible] vertically oriented

Reduction zones

LITHOLOGIC DESCRIPTION

Yle-B limestone wkstn, [illegible] tan to olive tan, small burrows, [illegible] fossils are small and difficult to identify, unit has a diagonal fabric caused by differential cementation, this cementation appears to be controlled by burrowing in the same location

Ylo-B olive tan dolo mdstn, a small burrows [illegible] tan, [illegible] fracture cuts unit.

YR Gy-Gn to Gy [illegible] tan carbonate mdstn/pkstn, upper 1" [illegible] and paleospodic [illegible], some of anhydrite [illegible] replacement at 2936 2936.5'.

RR Gy RR [illegible] mdstn with dark intraclastic fabric, lower contact is gradational to unit below but is characterized by [illegible] unit upward, mud [illegible], blebs & disc. and [illegible] clasts in a mdstn matrix, [illegible] at 2940' and [illegible] and deformed, red fibrous hal filled fracs at 2940', [illegible] fissile, splits easily along [illegible] partings

RR [illegible] mdstn with dark intraclastic fabric, small [illegible] to disc. contorted and intraclasts, large [illegible] formed [illegible], & fibrous hal fracs sometimes appear to [illegible], unit is poorly cemented and splits easily along [illegible] parting, trace amounts of calcite [illegible] along edges of [illegible] filled cavities.

Uppermost bedded unit of Glorieta.

2960
2970
2980
2990
3000
3010
3020
3030
3040

logged by LE date 1-91

date

checked [illegible] date [illegible]

transcribed by [illegible] date [illegible]5

updated [illegible] date [illegible]

updated date

WELL N 1 Grabbe
COUNTY Swisher
DATE
INTERVAL 3040 3160 GLORIETA
LOGGED BY

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

WELL #1 GRABBE COUNTY SWISHER DATE

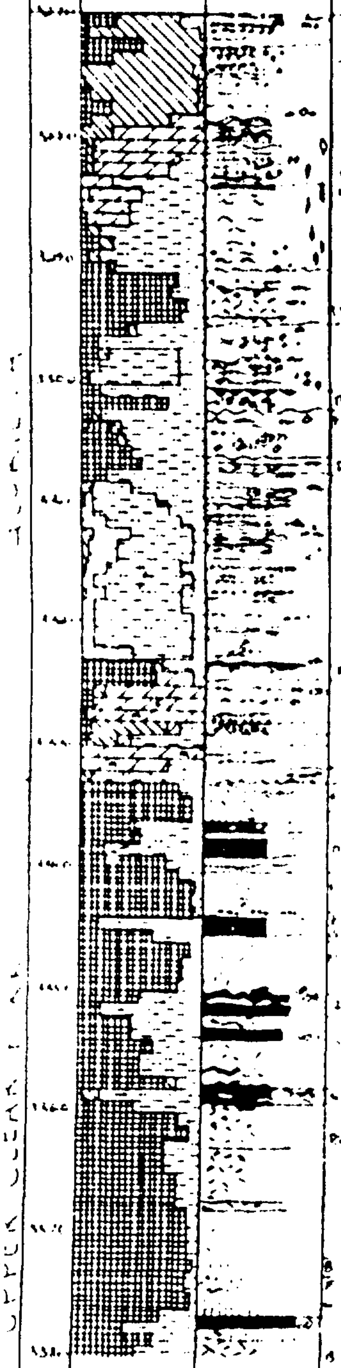
INTERVAL 3160 - 3270 GLORIETA LOGGED BY

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

WELL GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL [illegible] - 5510 GLORIETA, UPPER CLEAR FORK LOGGED BY RG

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



[illegible] and [illegible] bed
[illegible] bed

[illegible] AND [illegible]

[illegible] with dolomite
[illegible] grains
[illegible] migration
[illegible] not clear
[illegible] mudstone

[illegible] mudstone

[illegible] ANH bed

[illegible] ANH bed
[illegible] ANH bed

[illegible] appears to be [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

logged by RG date [illegible]

date

checked SH date [illegible]

transcribed by CAS date 5, 85

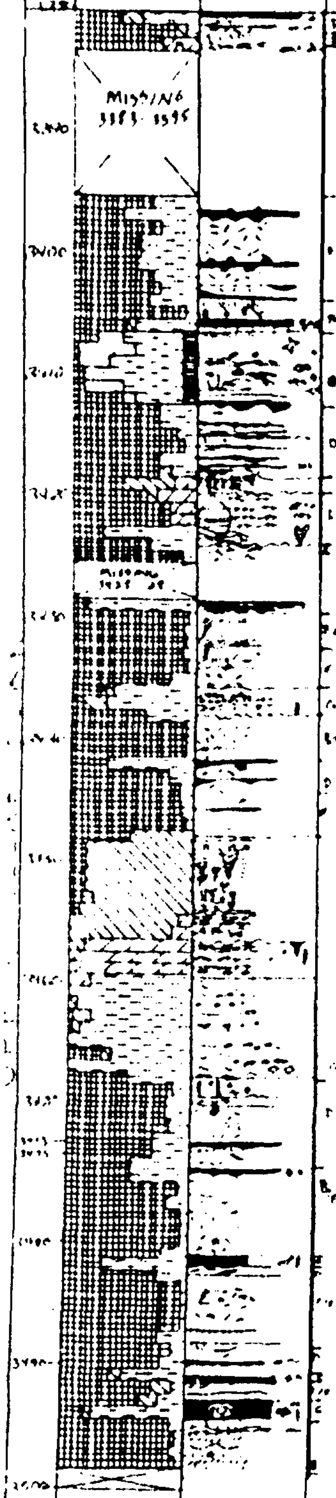
updated RG date [illegible]

updated date

WELL # 1 GRABBE COUNTY SWISHER DATE 2/85

INTERVAL 3380 3500 UPPER CLEAR FORK LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	LITHOLOGIC DESCRIPTION



DOL cement

very little ?? laminae sedimentary disruption structures

fracture fill [illegible] anhydrite

fibrous red HAL fracture fill ... majority of core, [illegible]

some laminated [illegible] of [illegible]

possible dissolution of [illegible] bedding

thin clay parting HAL replacement of DOL.

trace HAL

vertical HAL mudcracks, [illegible]

3473 [illegible]

Rock [illegible] HAL.

3497.2-3500 missing

Interlam dolo mdst & hal with disp hal to dol, overlain by bedded hal and chaotic mdst.

? large & fibrous hal filled frac running length of dolo and [illegible] at 3418.5', dolo to B.G. with cpt lam and hal replacement of dolo.

Interlam anh, dolo & hal mdst lam, mound shaped unit with poorly preserved gyp pseudomorphs.

Chaotic mdst with relict bedded texture, underlies ?? siltst with fine sand lam and clasts breccia, lam to dark with [illegible], fluid escape and syndep microfaulting.

Siltst to chaotic mdst.

Chaotic mdst with thin sections of bedded hal, ?? siltst [illegible] hal, anh mdst, [illegible], ?? at top of unit, becomes dolo and has large frac filled with & fibrous hal

[illegible] & cpl dolo mdst, hal replacing dolo along bedding planes, clay parting every few cms.

Anh mud with dolo lamel at 3456.1', losing dolo upward, anh [illegible] lam [illegible] dark texture, hal replacement

Hal defines large swallowtail gyp pseudomorphs

Top of anh is lam to contact with overlying hal

Dominantly chaotic mdst with recrystallized hal, ?? mdst, [illegible] with dark bedding, anh mud, disp hal, some units of & type hal, dark bands are mud-rich - vert aligned anhed ole.

Occasional pits and pipes.

?? mdst at top with relict hal in rounded, elongate masses, anh nods, dark and brecciated bedding, flexible - swelling [illegible].

Grade from ?? to ?? Dp lam, flexible at top.

logged by [illegible] date [illegible]

date

checked [illegible] date [illegible]

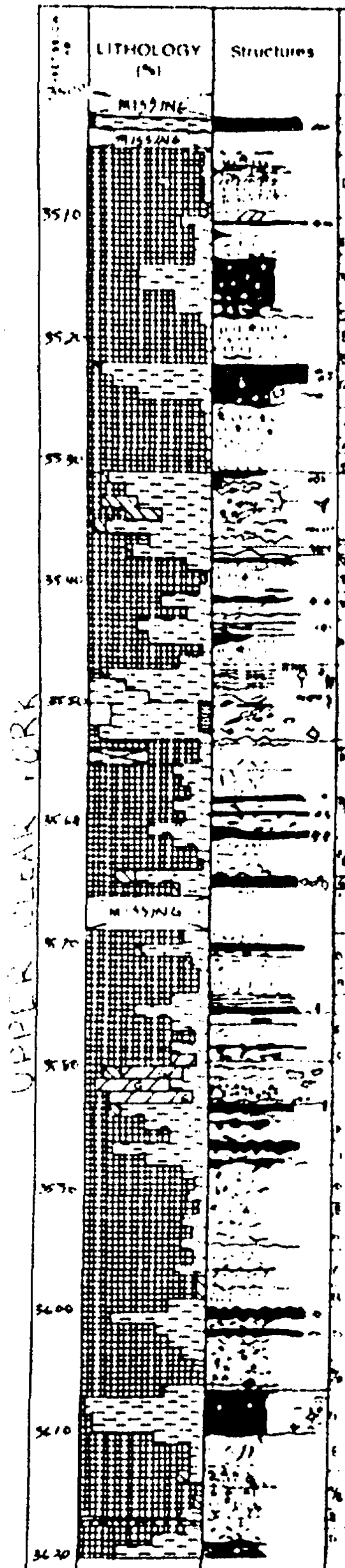
transcribed by [illegible] date [illegible]

updated [illegible] date [illegible]

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 2/95

INTERVAL 3500 - 3620 UPPER CLEAR FORK LOGGED BY RG



COMMENTS

3499.5 - 3502.5 MISSING

3503.0 - 3504.6 MISSING

Residue HAL hoppers, ANH and

trace MSTN

interbedded HAL thin skeletal beds and thick coarse xl beds

trace ANH as nodules

highly contorted bedding, possible collapse

~3556' ANH as nodules or clasts/breccia

wavy lamination possible dissolution

3566.2 - 3567.9 MISSING

ANH + HAL

3 MSTN interbeds

ooid grainstone with fenestral fabric

trace ANH

vertical contorted MDSTN/ANH stringers

trace RB MDSTN

3617.0 - 3617.5 MISSING

LITHOLOGIC DESCRIPTION

Interlam RB mdstn, hal, anh, thin steep lam with zones of brecciated [illegible].

Hal is dominantly bedded with some [illegible] and chaotic textures near mdstn beds.

Boudin-like mdstn at 3510.5' to 8 Cg, cut with disp hal and steep to vert clastic(?) anh, immediately overlain by a contorted slice hal, then by bedded B-type hal.

RB mdstn with disp skeletal hal at 3502-3503'.

RB siltstn with clayey clasts, a fine sand lam and pockets, lam is v flat with flame structures and fluid escape, top is Gy mdstn with slightly flat lam, both by disp hal growth, hal-filled fracs.

Hal has frequent mdstn intbds, some chaotic mosaic near intbds, short units of bedded hal.

Lt B dolo mdstn + grnstn, oolite, allochems are oolites, [illegible] is ooid grnstn with hal-filled lam, fenestral fabric, above [illegible] is [illegible] lam dolo mdstn + grnstn with skeletal hal hoppers and anh intbds, [illegible] is sharply overlain by chaotic mosaic, hal is dominantly [illegible] and chaotic within some of vert aligned [illegible] bedded B-type hal

Mdstns are RB with anh and + hal hoppers, anh and [illegible] hal at [illegible] have [illegible] stringers at contact with hal.

Thick brecciated [illegible] steep lam RB mdstn with disp hal to 3606.5', overlain by bedded hal, then chaotic mosaic.

Mdstn intbds typically overlain by 2-1' of B-type hal, then 1-8' of chaotic mosaic.

Anh sharply overlies mdstn, lam with poorly preserved grassmat texture and selenite xls in hal, gives fine lacy texture, RB mdstn with large hal cubes overlies anh - intbd chaotic mosaic and mdstns.

Hal is bedded with minor anh above 3616', recrystallized hal with mdstn + anh from 3616' to top.

logged by RG date 2/95

date

checked SH date 2/95

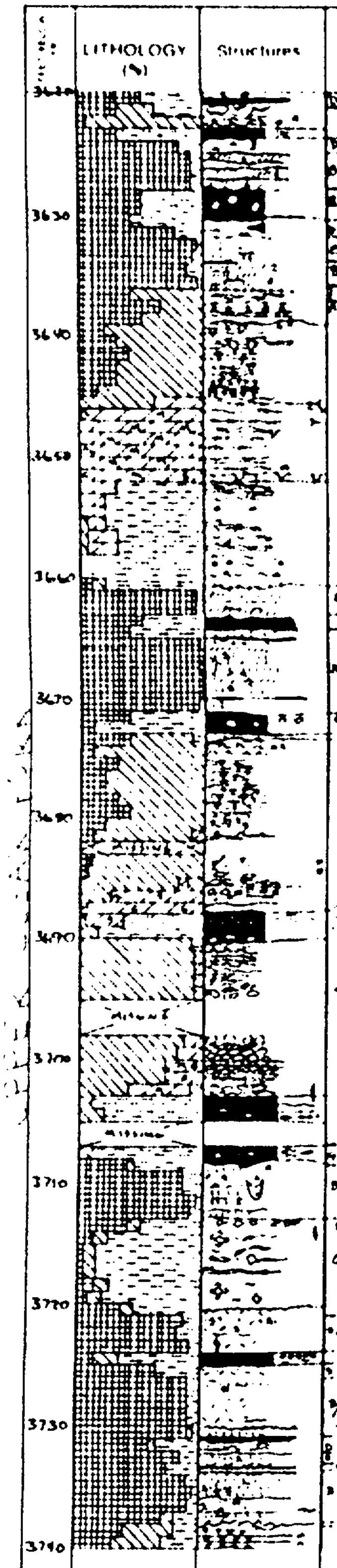
transcribed by CRC date 4/95

updated RG date 7/95

updated date

WELL #1 GRABBE | COUNTY SWISHER | DATE 1/95

INTERVAL 3620-3740 | UPPER CLEAR FORK | LOGGED BY PG



COMMENTS

INTERBEDDED ANH, HAL

DOLOMITIC PARTING

DOL MDSTN RIPPLES [illegible] REPLACED BY HAL

SEEN AS ANH NODULES [illegible] AND HAL [illegible]

NODULES W/ WISPY ANH & DOL BRWN CORES DISTURBED

RED FIBROUS HAL FILLED FRAC

THIN HAL & ANH INTERBEDS

INTERB. OF MDSTN & ANH

MDSTN HAS HAL HOPPERS DISP ANH

LITHOLOGIC DESCRIPTION

Exceptionally long, well developed cycle for MB, base [illegible] with wispy dist bedding, Cy mdsto contacts sharply with BB mdsto, massive to brecciated, dstb lam, A to above 3630', isolated anh nod, [illegible] Cy above 3630' with Cy and BB mud, grade to clastic dolo.

Dolo is rpl lam with burrows, dstb bedding, is B [illegible] and mdsto with hal [illegible] molds after grains, Cy mdst is B dolo, skeletal hal [illegible], sharp contact with anh.

Anh is lam at base with well developed gyp pseudomorphs preserved in hal, some single xls as large as [illegible] cm, lam runs through some xls, top 2' is dolo with mdst anh, hal interlam.

Anh inclds with hal at [illegible].

Hal is BB banded with the vert elongated xls, black mud [illegible] for B type, some chevrons.

Mdsto bed at 3633', has large hal hoppers, disp hal capped by banded hal at series of thin mdsto beds.

BB mdsto bed at 3624.6' sharply overlies hal.

BB mdsto with disp hal, massive, sharply overlain by banded hal with muddy intervals at 3668' and 3665'.

BB mdsto inclsd at 3662.6' grades to AB Cy dist anh (minor), minor disp hal

Banded hal, vert oriented xls, thin mdsto at anh partings, grades to anh at top.

Cy mdsto with anh nod, friable, grades to BB mdsto then back to AB Cy with anh nod, sharply overlain by rpl dolo grnsto with isolated hal molds, [illegible] inclds with nod anh.

Nod anh becomes poorly bedded with dstb lam hal after gyp pseudomorphs poorly preserved - little or no primary texture preserved.

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

Top 1' is lam anh with small gyp pseudomorphs.

Muddy and hal rich at top.

Lt BB mdsto with wispy anh, breccia, lam clasts, isolated nod, [illegible] at top of mdsto.

Dolo overlies mdsto, gradational contact(?), dolo grades to nod anh with fossil dolo and dolo inclds, nods poorly defined above 3698.5'

Both anh dolo between 3696-3693', lam anh with dolo defining lam to top of unit.

BB mdsto with Cy reduced areas, wispy, dist bedding, rip up clasts, brecciated, small anh nod, large skeletal hal hoppers, Cy AB lam mdsto at top with [illegible] filled with hal, overlain by chaotic mudsalt, long section of B type banded hal with zones of mdsto pods, mosaic hal, thin mdsto inclds.

Lt BB mdsto with wispy lam breccia, skeletal hal overlying anh has well preserved gyp pseudomorphs and grassmat texture.

Anh grades to hal with thin mdsto bed at 3730', hal is dominantly B type bedded with cubed vert aligned xls with mdsto lam and incls, mud with D type zones within B.

B-type hal with select B below mdsto at 3725', mdsto overlain by muddy bedded hal and chaotic mudsalt.

logged by PG date 1/95

date

checked PG date 1/95

transcribed by CPK date 2/95

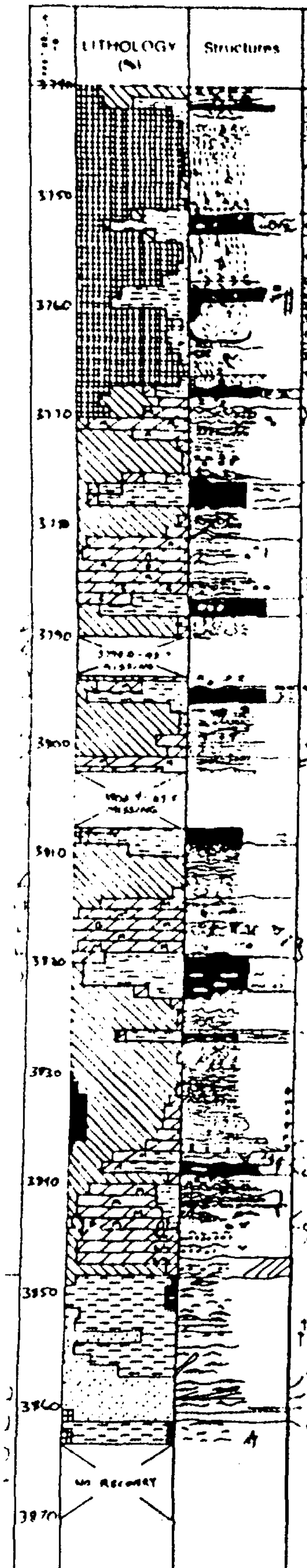
updated PG date 1/95

updated date

WELL #1 GRABBE COUNTY SWISHER DATE 1/85

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

DEPTH | LITHOLOGY (%) | Structures | COMMENTS | CONTACTS | LITHOLOGIC DESCRIPTION



ANH LAMINATED BED W/ CONTORTED ANH INTRABEDS

DIFFERENTIAL CEMENTATION OF DOL. [illegible] MASSIVE [illegible] MIDDLE

[illegible] RIPPLED, SANDY DOL.

TRACE ANH AS SMALL NODULES

? CU, INTRACLAST AT TOP

CLAY RICH, FRIABLE

BURROWING [illegible]

DOL INTRABED

THIN MUDDY PARTINGS

TRACE ANH AS SMALL NODULE

MASSIVE, STRUCTURE LESS

SMALL NODS & STRINGERS OF DOL

DOL [illegible]

DOL INTRABED

WISPS & SWIRLED THIN [illegible] DOL.

CLEAR, FIBROUS HAL

ANH REPLACING DOL, FILLING POROSITY

COATED GRAINS, MOLDIC POROSITY [illegible] SHELLS - BIVALVE GRN ALGAE

FU

CU

Current climbing ripples

Erosion surface

Horizontal [illegible] burrows [illegible] diagonal [illegible]

Sharp contact

BB mdstn with anh nods and hal hoppers - dark [illegible] becomes [illegible] toward top of mdstn with hal cubes, thin anh bed between mdstn and well-developed B type hal, thin section of [illegible] hal at 3744.5', hal is [illegible] and chaotic below contact with overlying [illegible]

Basal BB mdstn with wisps of dolo, diat anh, becomes [illegible] lating cement [illegible], base of anh has well preserved [illegible] texture in [illegible] grading to finely lam anh; sharp contact between anh and lt B spl dolo, dolo has [illegible] differentially cemented areas - probably hal cement, anh forms [illegible] in center of these [illegible], corroded areas; dolo intclts with anh, hal grading to poorly-defined anh lam; mdstn [illegible] between [illegible] and first hal unit, hal is dominantly B type with large [illegible] and mdstn intclts, dominantly vert aligned, cubed hal with mdstn + anh, as mdstn + anh form fine beds in bedded hal.

B Gy clayey mdstn with anh nods, grades to dolo at 3786 [illegible], thin bioturbated zone at 3783.5', scattered small anh nods, [illegible] with anh, some gyp pseudomorph preservation, becomes [illegible] finely lam [illegible] sharp uneven contact at top.

Spl lt B dolo pkstn with 2 thin mdstn partings, anh has poorly developed nods with dolo intclts [illegible], becomes lam, sharp [illegible] contact with mdstn, Mh + BB dark mdstn with patchy anh, thin dolo at 3791.6' grades to lam anh with gyp pseudomorphs in dolo; anh above 3790' has patchy dolo with and gyp pseudomorphs.

Mh BB mdstn with wisps + nod anh, wisps dark lam to structureless, [illegible] structureless above 3821'; dolo above 3816' is [illegible] mdstn with small anh nods, shell and coated grain pkstn above 3811.4' is a dark bioturbated, becomes spl lam with diap anh nods above 3817'.

Sharp contact with bedded anh, poorly developed nods become [illegible] lam, [illegible] Gy anh with lt B dolo (?) defining lam, top of anh has a small [illegible] with small Mh mdstn, becomes muddier with diat wispy bedding and rare nods of wispy anh; top of mdstn to dolo.

? mdstn [illegible] with basal residue of dolstn, [illegible] coated grains and shells, [illegible] mdstn with anh replacing and diap dolo, [illegible] differential cement, all dolo is muddy; anh is all [illegible] with dolo, showing [illegible] preservation of gyp pseudomorphs, grainst and intclts within dolo beds, residue-like mdstn at [illegible] and [illegible], [illegible] mdstn, diat bedding, wispy anh stringers, [illegible] dolo upward, [illegible] shaped structure [illegible] at [illegible] dolo with different cement, porous anh with dolo intclts from [illegible], nods of dolo [illegible] topmost part of bedded anh.

Laminated DOL.

Gray laminated ANH.

Mixed rippled and disturbed laminated siltstone and sandstone.

PB ripple and cross-laminated med grained sandstone.

See next sheet.

logged by PG BL date 12/84 - 1/85

date

checked SH date 1/85

transcribed by CAC date 2/85

updated PG date 7/85

updated date

WELL # GRABBE

COUNTY SWISHER

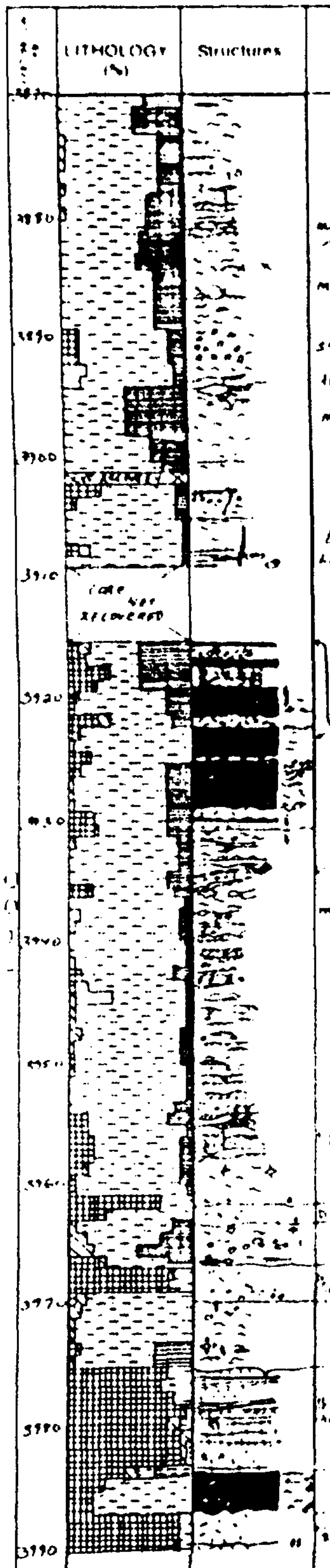
DATE 12/84

INTERVAL 3870 - 3990

TUBB

LOGGED BY B. LUNEAU

LITHOLOGY (%) | Structures | COMMENTS | LITHOLOGIC DESCRIPTION



mud cracks / halite casts on finning upward sequence with clay drapes

molds of hoppers

small, isolated euhedral halite

truncation surface

mudcrack ?

bimodal Liesegang banding

dolomite rims displacive halite

breccia

molds of halite xyls

"Pockets" of HALITE

nice hopper and molds of hoppers

Mixed dark and rpl tan RB siltstone.

Zones of transitional B to C type hal mixed with dark tan and intraclastic siltstone.

Rpl tan RB siltstone mixed with dark and intraclastic texture, [illegible] dark upward, contains pockets of hal and a zone of breccia near top.

Dark and intraclastic siltstone mixed with A-type hal

Hal, primarily bedded B type with some [illegible] of bone, associated with molds of [illegible], mixed with tan siltstone and anh.

logged by BL date 12/84

date

checked SH date 12/84

transcribed by CAC date 7/88

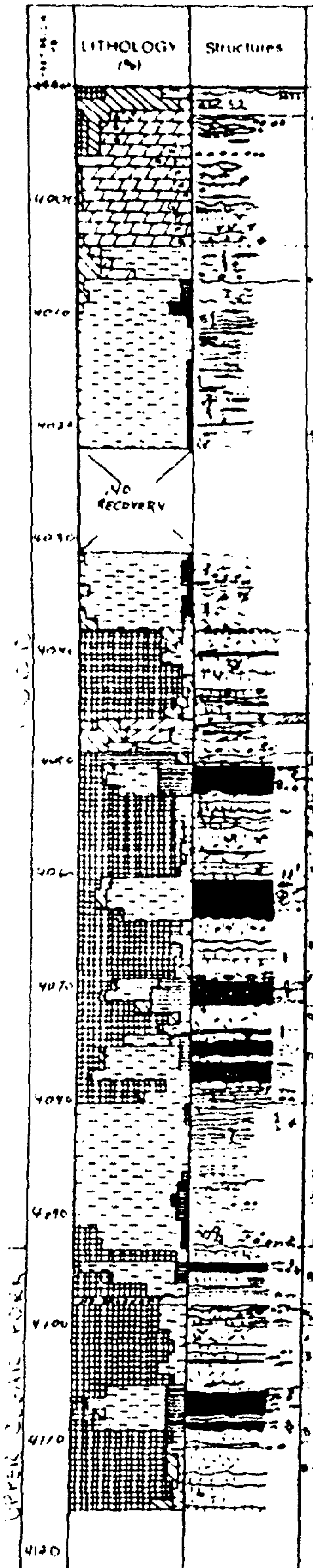
updated TV date

updated date

WELL #1 GRABBE COUNTY SWISHER DATE Dec 1984

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

LITHOLOGY (%) | Structures | COMMENTS | LITHOLOGIC DESCRIPTION



Massive Gy anh.

grainstone with abundant fenestrae

Tie B dolo gnstn, bioturbated and spl lam, fenestral porosity at top filled with hal cement

Lt Tie-B to Gy dark dolo mdstn with anh nods and B hal veins

core does not match up

Pale Gn with OB mot, finely lam siltstn, contains rare [illegible], clay films, [illegible] features and liesegang banding, dark at top with [illegible]

Liesegang banding

intraclasts of clay drapes

Lt OB lam siltstn with clay drapes, texture is dark and contains intraclasts of clay drapes.

Gy intraclastic and dark mdstn at the base, grades upward to lam dolo gnstn overlain by mdstn — a massive Gy anh — bedded hal [illegible] with mdstn and anh with [illegible] texture at top

Base of small cycle

Hal B mixed with C, D and A in lower portion and mixed with [illegible] half, [illegible] with dark and red lam siltstn, B hal associated with [illegible]

abundant anhydrite nodules extensively replaced by halite

intraclastic

Pale Gn to Tie-B siltstn, dark, intraclastic texture at base, graded upward to finely lam pale Gn and OB mot siltstn.

very finely laminated clean salt

clay drapes

contaminated salt

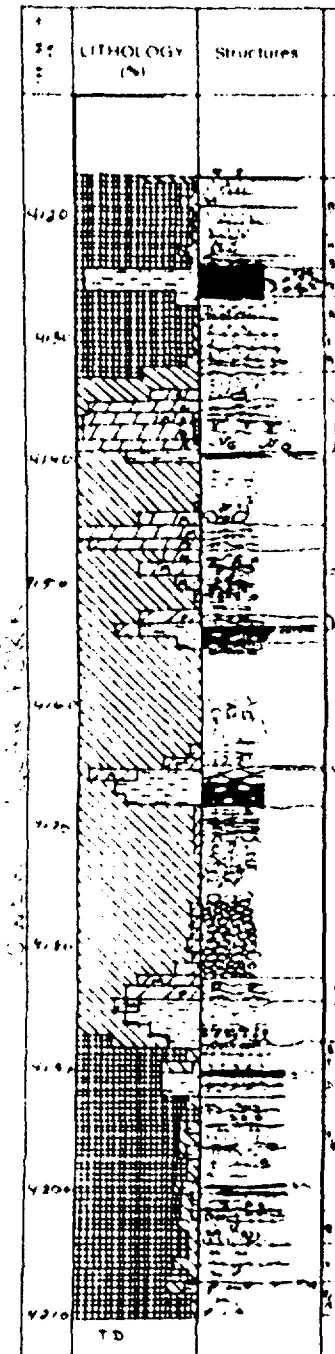
Hal [illegible] with lam siltstn, hal consists of B [illegible] to C and A type hal, C and B type hal are associated with the bases of [illegible], [illegible] have dark texture at base and are spl lam at top, also contain skeletal hal [illegible] and hoppers.

large displacive skeletal halite [illegible] in clasts
bedded siltstone at top

logged by BL date 12, 84
date
checked SH date 6, 85
transcribed by CK date 5, 85
updated PG date 7/85
updated date

WELL # 1 GRABBE COUNTY SWISHER DATE [illegible]

INTERVAL 4116 4210 LOWER CLEAR FORK LOGGED BY FG

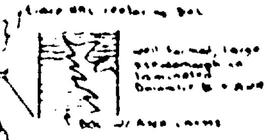


COMMENTS

} red and gray mudstone with intraclasts of mudstone, skeletal HAL

} 1.5 ft dolomicrite, rippled coarse crystal grains, intraclasts, grainstone at top, dissolved, skeletal grainstone at base
CALCITE CEMENT

[illegible] by hal



30 cm [illegible] dolomite grainstone and anhydrite with pseudomorphs after gypsum

4 cm silty dolomicrite

} 32 cm ripple laminated coated grain [illegible] layers, brecciated at base

Red to gray HAL [illegible] mudstone

ANH filled pipe.

} trace [illegible] mudstone

LITHOLOGIC DESCRIPTION

Fissile Dol-B mdstn, calcite cement, sharp contact with [illegible], lam to massive, bivalve shell molds filled with hal, and [illegible] dolo in upper section

Anh to massive to poorly nod

Hal to anhedritic with anh partings and muds

DR & Cp mdstn with disp hal, breccia, poorly lam at [illegible], [illegible] late by hal.

[illegible] olive hal above mdstn & anh bed at 4118', anh [illegible]

Sharp contact with Cp mdstn, then massive anh with hal [illegible] pseudomorphs.

Cp fissile mdstn with anh nod at base, becomes dolo at [illegible] mdstn, anh to poorly lam with some pseudomorphs preserved in [illegible] and dolo at anh and dolo & anh lathe, dolo at [illegible] to rpl lam with hal replacing dolo along lam and in patches.

Anh at top to massive to poorly lam.

Cp fissile mdstn with anh nod and lam [illegible] algal, dolo, [illegible] and dolomitic at top.

Poorly developed lam and nod textures, appears almost [illegible], perhaps hal-filled originally, [illegible] clast material [illegible]

Cp mdstn with anh beds and nods, algal dolo texture, [illegible] contact with rpl dolo mdstn, pelite at base [illegible] replacive and disp anh nods within dolo

Anh is [illegible] Cp, and with [illegible] dolo, lower nod and [illegible], [illegible] lam above 4171' with dolo defining algal, then lam texture.

Brecciated hal with mud and anh partings, thin interstitial stringers [illegible] of anh as anh & mdstn, mdstn is [illegible] Cp as beds or patches

Thin bedded units are clean with anh stringers between some beds and [illegible] anh-filled pipe at 4203' [illegible].

logged by FG date [illegible]
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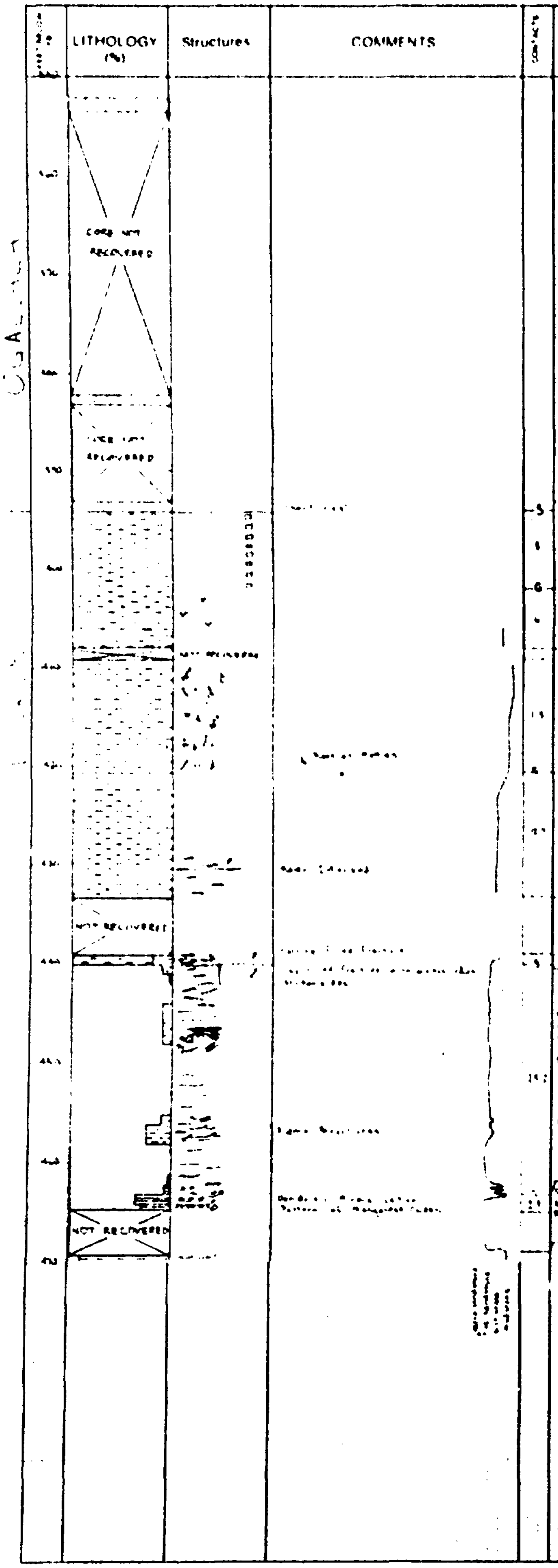
checked SH date [illegible]
transcribed by CA date [illegible]
updated FG date [illegible]
updated date

WELL J. [illegible]   COUNTY [illegible]   DATE [illegible]
INTERVAL [illegible]   OGALLALA, DOCKUM   LOGGED BY [illegible]

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Light red brown fine ss, poorly sorted, well rounded grains

Red brown ss overlain by light gray fine ss poorly sorted, [illegible] rounded grains

Red brown fine ss, slightly muddy, poorly sorted well rounded grains [illegible] 1.5cm diameter chert clast

Calcareous, light red brown siltite, [illegible] mud rich dark red brown stringers surrounding clast.

Light to medium red brown siltite, burrowed w/ a "blocky" texture, [illegible] red clay rich stringers. Highly calcareous becomes more [illegible] upwards & contains calcareous fragments upwards

Pale reddish black to dark yellowish orange silty mdst, moderately burrowed (5 or rootlets) small (less than 1mm) circular calcareous clasts [illegible] in & near burrows, mud in burrows pale olive color

Blocky texture, broken [illegible] of clasts in burrows

Carbonate cement

Pale reddish brown fine siltite, small scale cross sets [illegible] becoming structureless up section [illegible]

Carbonate cement

Alternating cross bedded coarse siltite & horizontally laminated mdst w/ [illegible] lenses. Top [illegible] 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 mm calcareous nodules

Climbing ripples

Sequences of rounded elongate clastic clasts (up to 3 x 1.5cm) overlain by fine ss. Clasts imbricated, scattered large (1.5 x 2cm) calcareous (caliche) nodules. Bottom 1.0' reduced

15' of reduced sandy mdst w/ calcareous nodules up to 1 x 1 cm

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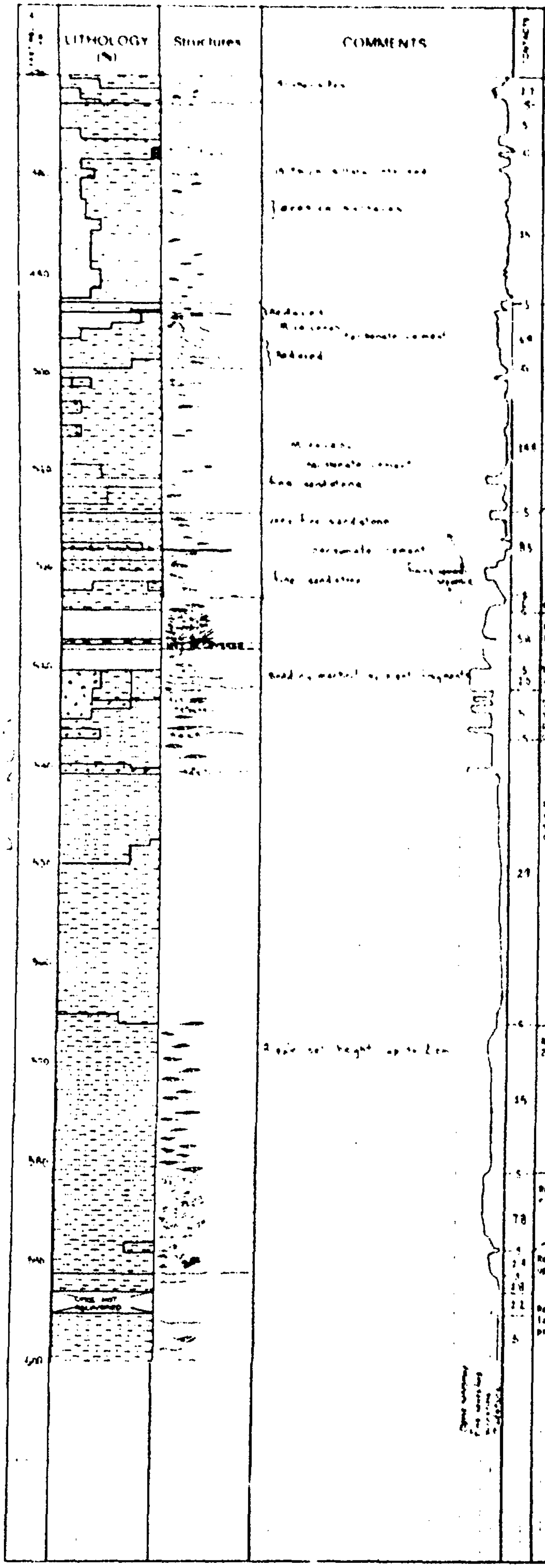
WELL [illegible] COUNTY Deaf Smith DATE [illegible]

INTERVAL [illegible] DOCKUM LOGGED BY [illegible]



LITHOLOGIC DESCRIPTION

Reduced cycles of scour surfaces, ss & siltstn w/ well developed [illegible] cycle grades upwards to gray red mdstn w/ slickensides

Micaceous gray red siltstn w/ scattered 2 x 2 cm cal [illegible] grading up section to gray red mdstn

Gray red mdstn full of lense shaped siltstn laminations, low angle [illegible] tions

Ripple laminated coarse sandy siltstn & silty very [illegible] carbonate cement. Beds dip steeply from [illegible] to [illegible]. Beds [illegible] and below these footages. Thin [illegible] mdstn [illegible]

Gray red mdstn w/ very fine ss, siltstn interbeds marked by scoured [illegible] grading upwards back to mdstn. Scattered siltstn lenticular [illegible] ripple laminations.

Lower half is very micaceous but contains mica throughout

Alternating units of claystn, mdstn, siltstn & ss, [illegible] & st, low angle siltstn lenticular bedding in mdstn. [illegible] Carbonate cement throughout

SS very well cemented
Siltstn/claystn poorly cemented

Colors gray red & light olive gray not unique to any rock type or grain size

Black ripple laminated siltstn

Pale green to red brown fine grained ss [illegible] laminated w/ superimposed [illegible] laminations. Grades upwards to overlying unit. [illegible] grains

Pale green coarse sand to granule size congl, siltstn mdstn matrix, [illegible] bedding planes marked by lignite, organic debris

Stacked sequence-repetitive cycle of pale green basal coarse sand to granule size congl, grain supported w/ siltstn matrix, about 20 [illegible] pale green ripple laminated siltstn, [illegible] to less than 10cm thick [illegible] contain lignite grade organic fragments

Red brown mdstn which grades upwards to very fine siltstn. [illegible] reduction spots & green mottling. Also contains scattered [illegible] sand to granule size grains throughout, some are calcareous. Texture is [illegible] contains dendritic stringers of dark brown clay or mud

Red brown & pale green ripple laminated micaceous siltstn, ripple set height up to 2 cm, fines upward to overlying mdstn. A & B type ripples

Red brown cross stratified coarse grained siltstn w/ thin (less than 5 mm) [illegible] rip up clast basal lags. Stratification sets up to 5 cm thick

Red brown & pale green rippled & burrowed siltstn w/ contorted bedding which grades upward to mdstn

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]

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checked SB date [illegible]

transcribed by [illegible] date [illegible]

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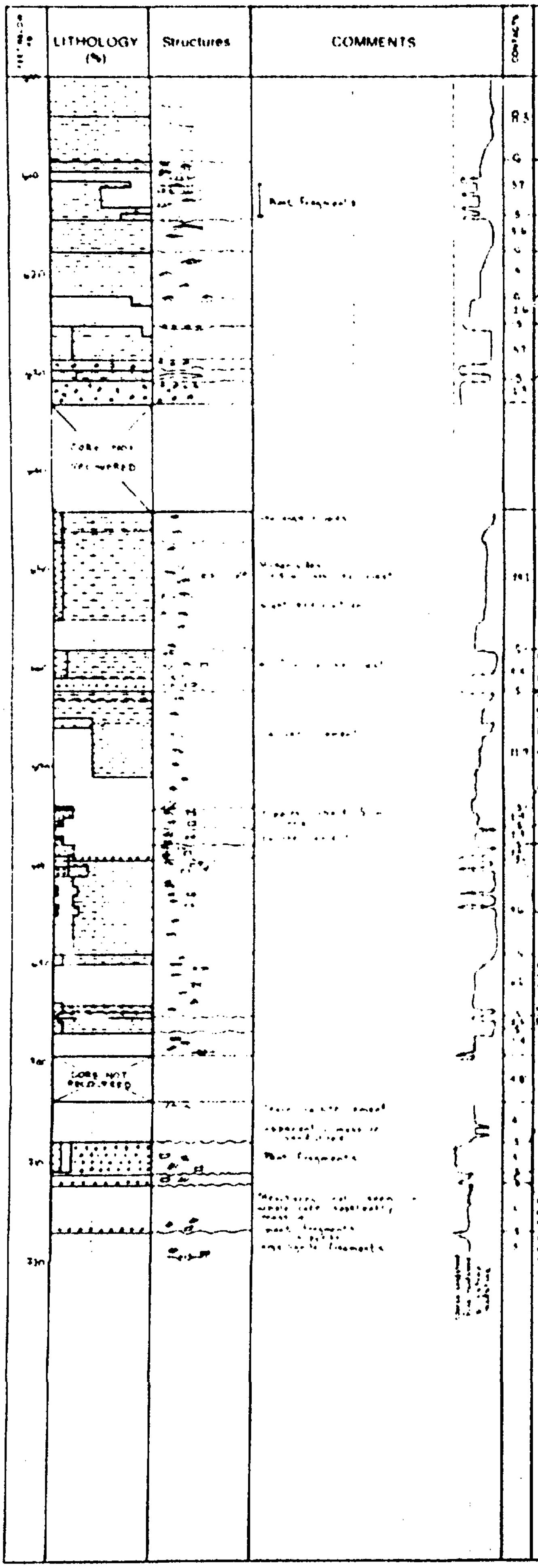
WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

INTERVAL [illegible] 120 DOCKUM LOGGED BY [illegible]



LITHOLOGIC DESCRIPTION

Red brown & pale green mdstn to very fine siltstn w/ few horizontal [illegible] laminae. Grain size changes are gradational. Internal structure is [illegible] preserved

Pale green stacked sequences of a basal caliche grained sand w/ [illegible] fragments (10-40cm thick) overlain by cross laminated & ripple laminated [illegible] (15-30cm thick). The basal contact of sand beds is a scour surface & the [illegible] contact is sharp to gradational

Pale green & red brown mdstn contains cross laminated silt laminae [illegible]

Red brown ripple laminated siltstn, calcareous, fines upward [illegible]

Red brown medium ss w/ a mud rich matrix, granule rich at the base [illegible] grains well rounded, poorly sorted

Red brown w/ a caliche grain congl (see below) intercalated, no apparent structure in unslabbed core

Mixed pale green & red brown mdstn w/ rounded & subangular granules of [illegible] & minor sand. grains are matrix supported. caliche granule [illegible]

Gray green ripple laminated fine ss, calcite cement, abundant mica & [illegible] organic material mixed w/ sand. low relief ripple sets at base about [illegible] to much [illegible] of top (about 2 mm). Grades upward to red brown ripple laminated siltstn w/ calcite cement, tends to be evenly laminated in middle w/ ripples increasing at top. Burrowing & abundant soft sediment deformation w/ some brecciation & faulting grading into gray green ripple laminated siltstn sharply overlain by black low angle ripple laminated mdstn

White cross bedded caliche congl about 1' thick grading rapidly to [illegible] w/ soft sediment deformation grading to brown red ripple laminated [illegible] mdstn w/ possible burrows

Two fining upward sequences, lower set is gray green cross bedded [illegible] medium ss, large scale clay [illegible] grades rapidly into finely laminated ripple laminated fine ss which grades to finely laminated siltstn w/ fine [illegible] (old ripples) w/ small climbing ripple sets 1.5 cm thick. Grades to finely laminated silty mdstn. Top set is gray green ripple laminated siltstn grading to ripple laminated mdstn

Gray green ripple laminated fine ss w/ ss load casts containing [illegible] in thin clay bed.

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

[illegible] caliche pebble congl about 1' thick sharply overlies a poorly sorted subangular-subrounded ss w/ silt coarsening upward sequence about 1.5 cm thick. This is overlain by a parallel laminated mdstn, [illegible] in section a clay dike is truncated by a ripple laminated fine ss & [illegible] ripple fine ss w/ soft sediment deformation [illegible] w/ [illegible] angular [illegible] & fine ss matrix [illegible]

Gray green to red brown to brown sequences of calcite granular congl from [illegible] to 12cm thick grading to ripple laminated silty mdstn to parallel laminated silty mdstn from 1-4 feet [illegible] 5 feet thick, calcite cement, soft sediment deformation

Gray green ripple laminated fine sand grading to gray orange pink ripple laminated sandy siltstn grading to brown mdstn grading to gray orange pink cross bedded [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 siltstn.

Brown mdstn w/ trace of silt.

Gray green apparently medium fine ss, moderate sorting subround to round grains w/ mdstn intraclasts at base, interbeds organic and or opaque minerals. Soft sediment deformation just below unrecovered interval, above beds [illegible] bedded ripple laminations & parallel lamination sequences. Abundant mica flakes.

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

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

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

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

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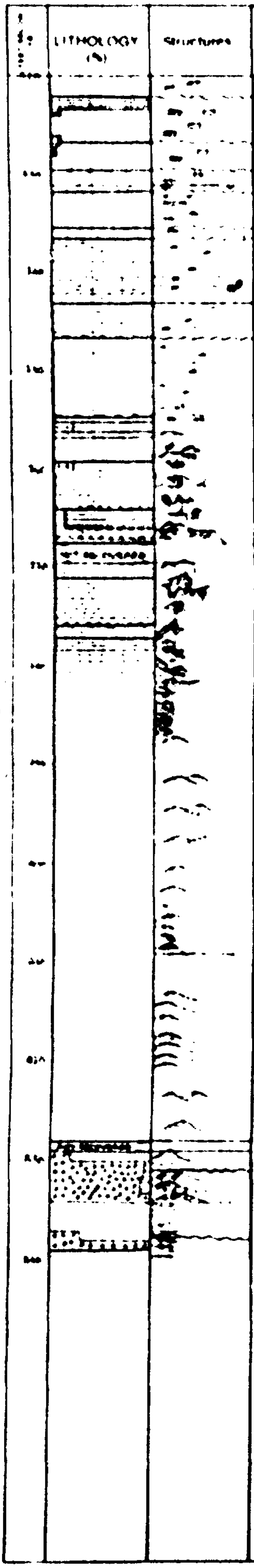
COUNTY [illegible]

WELL [illegible] DATE [illegible]

INTERVAL [illegible] [illegible] LOGGED BY [illegible]



COMMENTS		LITHOLOGIC DESCRIPTION
[illegible]	[illegible]	[illegible]

Logged by [illegible] Date [illegible]

Date

Revised Date

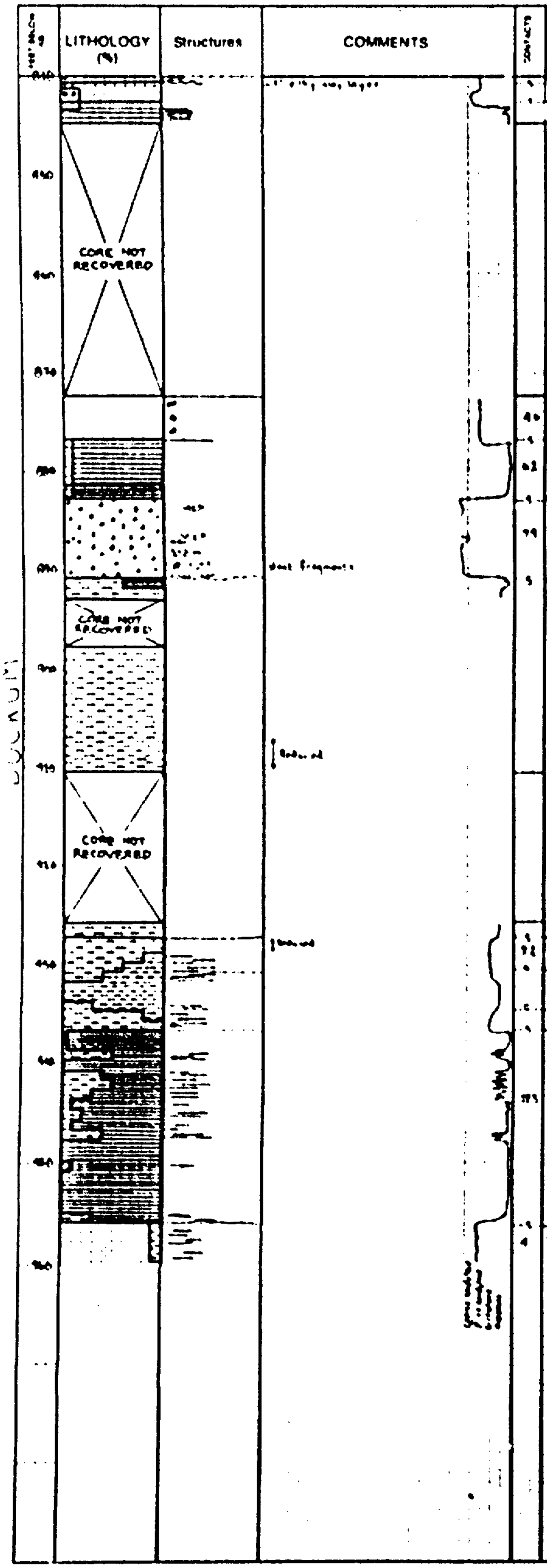
Transcribed by [illegible] Date [illegible]

Updated Date

Updated Date

WELL J. Friemel COUNTY Deaf Smith DATE August 198?

INTERVAL 840-960 DOCKUM LOGGED BY ST, DJ, BL, SN, CW, WC, PM



LITHOLOGIC DESCRIPTION

Red tan fine ss w/ pebbles (1-3cm), silty calcareous.

Green grey claystn, thinly laminated, becomes silty in top 0.1 feet

Red tan fine ss w/ a few small (about 1cm) mud clasts. No obvious structures; a few very thin (less than 1mm) black lines oriented horizontally (possible organics). Friable calcareous cement.

Black, silty claystn. 3cm of green clay at the top

Calcite cemented pebblized congl, grain size very coarse, sand to cobble w/ granule to pebble size predominate. Clasts, rounded to subrounded w/ scattered angular clasts, about 85% chert pebbles, orange, purple, red, grey & pink, about 15% carbonate clasts, pebble to cobble and less than 1% plant fragments. Clasts often enclosed w/ yellow rims (uranium?)

Vertical sequence, scour surface, chaotic fabric, slight imbrication, graded beds of very coarse ss, repeated sequence

Unconsolidated massive dark red brown mdstn. Basal 2.5' reduced w/ brecciated, random texture w/ small rounded caliche(?) clasts, calcareous to about 904'.

(Soil texture?)

Dark red brown massive mdstn.

Finely laminated muddy micaceous dark red brown siltstn

Dark red brown massive mdstn w/ gradational upper & lower contact

Ripple laminated dark red brown siltstn.

Moderate reddish orange massive claystn grades up to moderate dark red brown claystn w/ numerous fine interlaminae of pale yellowish orange micaceous siltstn. Laminations are 3mm-1cm

Low angle & horizontal laminated dark red brown/moderate red brown slightly muddy fine ss. Grains well rounded & poorly cemented

logged by ST, BL, SN date 8/83

date

checked date

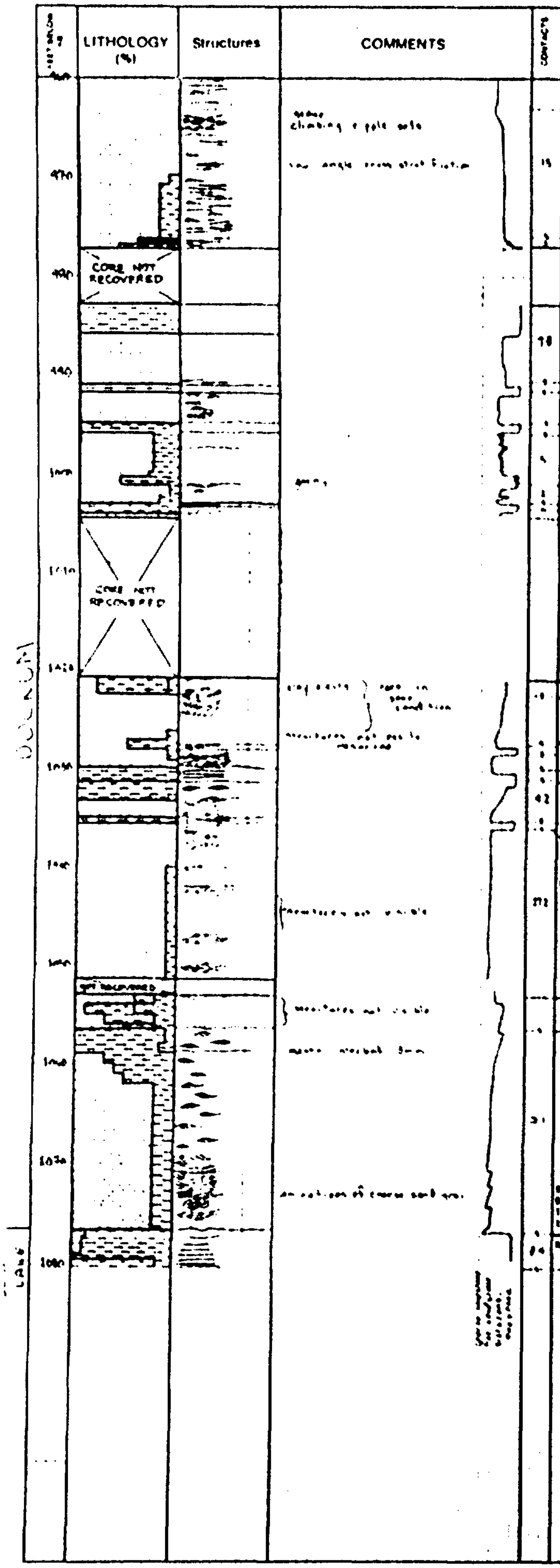
transcribed by PA YN date 1/84

updated date

updated date

WELL J. Friemel COUNTY Deaf Smith DATE August 1983

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



LITHOLOGIC DESCRIPTION

See Previous Page

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 rouned & sorted, poor to moderate cementation

Interlaminated yellowish ss & gray black claystn.

Massive micaceous, very fine ss. Grains well rounded. Bottom foot reduced grading to non-reduced (reddish) sediments. Carbonate cement.

Dark red brown mdstn.

Cross bedded carbonate cemented ss. Grains rounded, well sorted. Degree of cementation decreases up section capped by ? dark red brown mdst.

Poorly consolidated muddy fine ss, grains well rounded & sorted. Patchy carbonate cement found in 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

Dark red brown sandy siltstn containing clay clasts, laminated at top

Light red brown laminated ss, medium grained, poorly sorted which fines upwards

Red brown laminated mdstn

Red brown, cross laminated, poorly sorted medium grain ss

Red brown laminated mdstn

Red brown cross laminated, poorly sorted medium grained ss grading to ripple laminated siltstn.

Red brown mdstn, poorly lithified, possibly laminated

Red brown & pale green medium grained ss, poorly sorted, low angle cross laminated

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.

Red brown ss that fines upward from coarse ss to siltstn, struct set also fine upward. Base contains coarse sand grains scattered in a fine sand matrix becomes cross laminated upwards w/ thin, single grain laminae of well rounded coarse sand at the base of cross sets. Ripple laminations upwards in silty portions

Red brown mdstn w/ no apparent structures becomes silty upwards

logged by Bu, ST date 8-83

date

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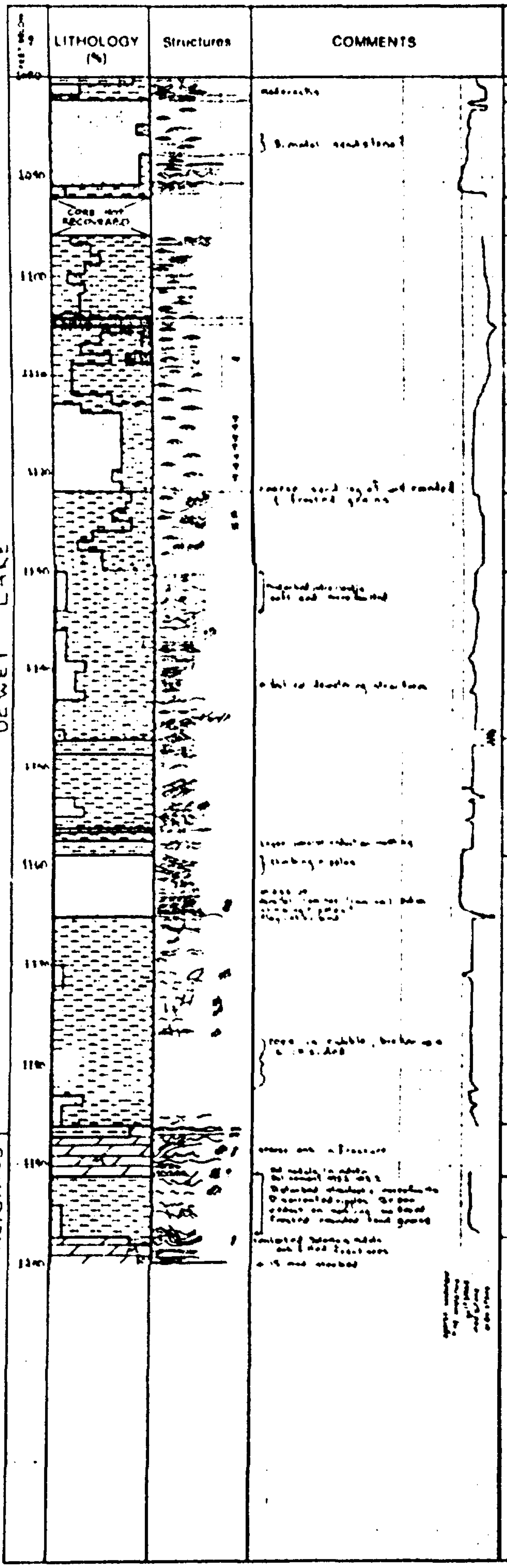
WELL J. Friemel COUNTY Deaf Smith DATE August 1983

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



CONTACTS	LITHOLOGIC DESCRIPTION
6	.5' red brown mdstn sharply overlain by .3' red brown & green ripple laminated fine grained ss sharply overlain by red brown mdstn w/ ss filled mud cracks, mdstn grades to siltstn up section.
	Red brown & pale green fine ss w/ climbing ripples. Some small lenticular coarse ss lags of bimodal grain size near the base, contains mdstn drapes. Higher up, generally fines upward
	Red brown & pale green coarse ss w/ very well rounded & nearly spherical grains (bimodal grain size?) contains laminations of mdstn 1-5mm or ss lenses, mdstn laminations are contorted in places, ss very friable fines upward
	Red brown laminated mdstn w/ thin less than 1mm siltstn laminations & discontinuous lenticular siltstn bodies. Has ss rim around core which may be coring process induced.
80	Red brown & pale green mdstn w/ thin, low angle, siltstn laminations & interbeds .3 to 8 cm of ripple laminated siltstn some of which have a pale yellowish color. Abundance of siltstn increases upwards as does thickness of beds. Siltstn at the top of the unit is soft sediment deformed
	Gray purple to dusky red & green gray, laminated claystn, rippled at the top. Color is distinctively different from over & underlying red brown ripple laminated siltstn & mdstn.
	Pale green & red brown ripple laminated siltstn w/ mud & clay drapes
81	Red brown mdstn w/ thin less than 1mm ripple laminations of siltstn
90	Red brown & pale green ss & siltstn ripple laminations. Basal contact is marked by a lag of coarse sand sized well rounded & frosted (?) grains which also appear scattered throughout the overlying rock. Ripples discontinuous & deformed in basal 0.5'. Ripple laminations continuous upwards w/ small zones of soft sediment deformation. Lithology gradations upwards to ripple laminated siltstn & mdstn described above.
80	Red brown & pale green mdstn & siltstn, consists of alternating beds of ripple laminated siltstn (1.5cm to 15cm thick) & mdstn containing thin (less than 1mm) ripple laminations of siltstn, mdstn beds from 4-10cm thick. Both lithologies marked by abundant soft sediment deformation, loading & contortion of laminae. Ripple laminated siltstn beds have mdstn drapes.
27	Red brown very fine ss, silty sandy coarse siltstn to medium siltstn/mdstn. Climbing ripples, through ripples & ripple drift abundant grouped in packs w/ horizontal. Generally finer grained of disturbed laminae between packs. Abundant layer parallel light green reduction mottling 1142.0-1136.8. Sparse dark minerals (biotite?) in cross-laminae & bedding surfaces. Globular calcite cement at 1150, 1151.7(?), 1152.3. Vertical dewatering structures (from sand, through mud) at 1101.6. 1.5' mdstn at 1148.5-1147 w/ horizontal bedding. Microfaults present throughout but not abundant. Top 5.5' very laminated, soft sediment deformation, microfaulted.
11	
27	Red brown medium to coarse siltstn. Disturbed intraclastic, 1.5mm-5cm intraclasts of coarse siltstn medium siltstn matrix (possible collapse?). Large fine to very fine ss intraclasts (about .5') at 1172-1177. Little clay except as matrix at 1175-1176. Silt grains angular-subrounded. Sand grains (in silt matrix) at 1166-1165 well rounded, frosted(?). Possible biotite in disturbed ripple cross-beds at 1170.5.
	Very pale yellow, green, purple dolstn w/ contorted laminations (1-5cm, 1.5-2cm). Sects of laminations have high porosity (fragment gypsum?) adjacent parts have less possible pale olive microstylolites. Brown red porous chert nodules in porous laminations. Subvertical subhorizontal fractures are filled 1189.1, 1187.4. Contorted green mdstn bed, 1187.5.
52	Pale red brown contorted dol pkstn(?) 1190.6-1191.2 to ripple laminated dol pkstn to thinly laminated (about 1mm) mdstn, 1190.6 to top. Microfaults throughout
	Contorted interval resembles dol nodule in top of underlying unit.
55	Red brown coarse siltstn, remnant bedding & sedimentary structures contorted & discontinuous. Microfaulting present. Zone of dol cement w/ isolated ripples at 1193.2-1192.2. Sharp, contorted contacts at top & bottom of mdstn interval. Lower boundary erosional or collapse(?). Pale olive reduction mottling 1196.?-1196.0. Dol nodule at top. Coarse rounded, frosted sand grains.

logged by SL [illegible] date 8.83

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transcribed by [illegible] date .84

updated date

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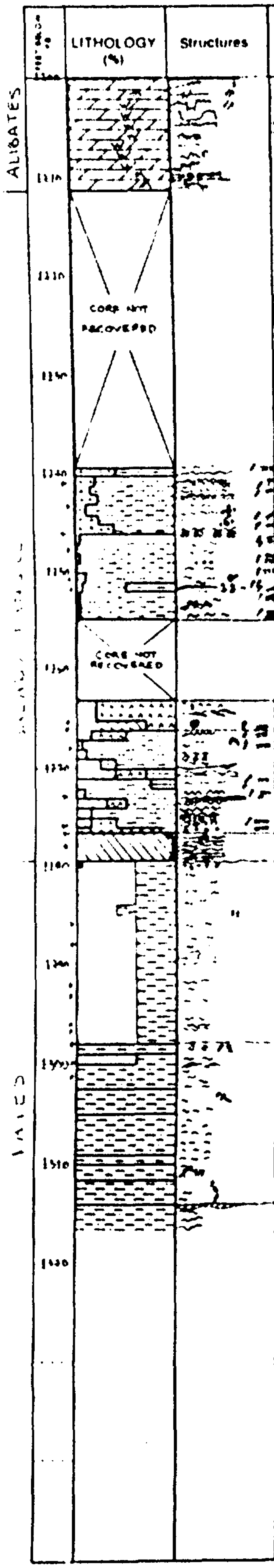
WELL J. Friemel COUNTY Deaf Smith DATE October 1983

INTERVAL 1200'–1317' ALIBATES, SALADO TANSILL, YATES LOGGED BY SI, BJ, BG, SN, [illegible]



COMMENTS

[illegible]
high porosity along stylolites
truncated intraclasts
abundant microstylolites (gray olive)
contorted fabric well developed
porosity in [illegible]
microstylolites (gray [illegible]) [illegible]

[illegible] contorted gyp [illegible]
[illegible] fractures gyp filled
[illegible]
[illegible] crystals?
[illegible]
[illegible] gyp [illegible]
[illegible] fractures gyp filled
[illegible]
reduction spots [illegible]

[illegible] fractures [illegible]
[illegible]
[illegible] gyp crystals
[illegible] fractures gyp filled
[illegible]
[illegible]
[illegible]

zones of preferential hal crust
[illegible]
reduction [illegible]
[illegible] microfaults
[illegible] reduction zones & spots
zones of preferential hal cement
[illegible] reduction
[illegible]
reduced zone [illegible] banding
[illegible] zone
reduction zone [illegible]
iron banding & reduction [illegible]
reduction zone
[illegible]
reduction [illegible] banding

CONTACTS

LITHOLOGIC DESCRIPTION

Pale red brown to gray yellow green ripple laminated dol mdstn w/ thin mud drapes at 1200.9 -1200.4. Mud interbed at 1200. Mud [illegible] decreases up from interbed. Top is contorted, collapse of mud interbed into dolstn. Discontinuous parallel fractures (anh ? filled) in dol. Subvertical to collapsed mdstn. Upper 1' pale gray red purple.

White dolomitic mdstn to intraclastic mdstn. Mud cracks? at 1200.8 1204.4 & 1205.? separated by contorted & microfaulted intraclastic mdstn. Porosity well developed in intraclasts. Gray olive microstylolites & abundant discontinuous well developed along microstylolites, could be truncated intraclasts. Primary textures obscured by diagenetic alteration.

Moderately dark reddish brown mdstn w/ numerous fractures infilled w/ gyp, small gyp blebs & discontinuous contorted gyp laminations. Sand sized euhedral gyp crystals scattered evenly throughout mdstn, 1' vein (1242') shows evidence of brittle deformation

Light medium reddish brown siltstn w/ numerous fractures infilled w/ gyp & small gyp nodules; 1' mdstn interbed at 1251.5, lower 3' has dist. and intraclastic fabric w/ contorted laminations.

Light medium red bedded anh w/ gyp fractures parallel to bedding & gyp nodules throughout.

Light dark reddish brown mdstn w/ gyp infilled horizontal fractures & bedded nodular mosaic anh interbeds, disturbed intraclastic fabric & disrupted gyp laminations at 1271-1272, sand & silt size euhedral gyp crystals scattered through mdstn at top & bottom of unit; hal cement. Mdstn/gyp/anh insoluble residue.

Light bluish gray bedded anh w/ parallel wavy laminations, gyp nodules scattered throughout. Euhedral vertical gyp at base

Medium dark reddish brown siltstn w/ disturbed intraclastic fabric. Fabric is accentuated by zones of preferential hal crust from 1280 & 1281.5, zone from 1280.5-1286.8 is composed of very fine siltstn transitional to mdstn & is fractured, some porosity

Medium dark reddish brown very fine ss w/ wavy laminations, near vertical upper contact w/ unit above; hal cement

Medium dark reddish brown very fine ss w/ disturbed intraclastic fabric, fabric is accentuated by zones of preferential hal cementation

Light dark reddish brown siltstn w/ mdstn interbeds; wavy laminations & disturbed intraclastic fabric are common in siltstn; mdstns have disturbed intraclastic fabric & numerous hairline fractures, reduction zones & iron banding are common. Hal crust

Light medium reddish brown siltstn w/ vague wispy lens-shaped pods of darker siltstn; vague wavy laminations, hal crust

logged by SN [illegible] date [illegible]
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transcribed by [illegible] date [illegible]
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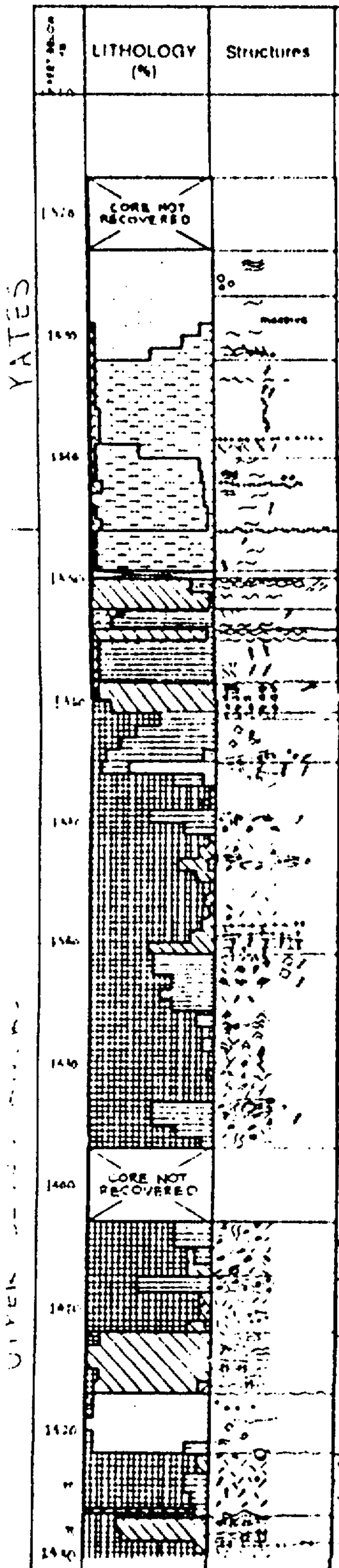
WELL 3 [illegible] COUNTY Deaf Smith DATE [illegible]

INTERVAL 1319'–1430' YATES, UPPER SEVEN RIVERS LOGGED BY [illegible]



COMMENTS

} reduction zone

microfaulting along mdstn lam; small gypsum nodules (average diameter [illegible])

numerous reduction spots

mdstn gyp [illegible]

[illegible] fractures throughout infilled [illegible] gyp surface

gyp filled fractures [illegible] anh bed

gradually increasing [illegible] upward

gyp pseudomorphs [illegible] anh interbed

gyp filled fracture [illegible]

gyp filled fracture

numerous reduction spots

[illegible] horizontal mdstn lam

} gyp filled fractures slickensides

reduction rings

gyp filled fractures slickensides [illegible] filled gyp

hal pseudomorphs after gyp [illegible] crystals [illegible]

[illegible] fracture [illegible]

small [illegible] fractures [illegible] filled w/ hal

[illegible] anh interbeds

first appearance of [illegible] pseudomorphs [illegible]

[illegible] fractures [illegible] hal

[illegible]

< 5% [illegible]

uniformly [illegible] nodes

[illegible] & irregular [illegible] stringers

} irregular [illegible] filled w/ hal

tiny [illegible] nodules ([illegible]) in [illegible]

hal filled [illegible] in anh

LITHOLOGIC DESCRIPTION

Light dark reddish brown wavy laminated very fine ss/mdstn, isolated lens-shaped pods of mdstn & microfaulting along mdstn laminations in mid portion of unit; isolated lens-shaped pods of ss in upper portions; 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 [illegible] content to top of unit, core is highly fractured, broken & crumbly w/ slickensides, fractures filled w/ gyp; hal crust

Light dark reddish brown siltstn w/ wavy to contorted lamination; thin [illegible] lens-shaped pods of dark reddish brown mdstn & disturbed intraclast. fabric; [illegible] infilling small fractures, one anh interbed, hal crust, gradual [illegible] contact into mdstn

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

Light medium bluish gray bedded anh w/ 2-20% claystn present as wavy [illegible] contorted laminae; collapsed & disturbed intraclastic fabrics at [illegible]

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 [illegible] hal, clastic content greatest at top & bottom of bed, claystn intraclasts (2-4mm) in sandy matrix at base of unit; 10cm of recrystallized hal at 126[illegible]

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

Colorless, cloudy, recrystallized anh/hal rock ([illegible] lower [illegible]) [illegible] anh interbeds grading to pinkish recrystallized anh/hal rock (upper [illegible]). Except for interbeds anh tends to occur as thin subhorizontal, radially undulating surfaces & as [illegible] bodies w/ this hal, giving cloudy appearance & becoming pinkish in upper [illegible]. Chevrons & hal pseudo/gyp abundant in lower [illegible] small ([illegible]cm) hal crystals have jig saw like appearance becoming clear & larger [illegible] than [illegible] in upper [illegible]

Red brown chaotic mdstn-hal rock (D), 30-50% interstitial clay. Percent clay increases upward

Very light red brown coarsely crystalline hal rock [illegible] interstitial clay [illegible] & 1386' [illegible] interstitial anh at 1391'; lesser amount of interstitial anh & [illegible] throughout. Probably not cavity fill (no well defined walls or floors). Hal crystal size increases upwards (2-4cm)

Red brown chaotic mdstn-hal rock (D, 50% hal) small claystn bodies uniformly distributed.

Red brown recrystallized anh hal rock (F lower [illegible]) to chaotic mdstn hal rock ([illegible] upper 10.9') 15-50% interstitial clay. Generally hal crystal size, claystn interstitial bodies, size & clay abundance increase upwards. Type F has irregular anh bodies w/ offshoot stringers defining grain boundaries 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 [illegible]) & red brown clay (less than 3%). Hal is equant

Yellow red orange, gray anh, thinly laminated to nodular [illegible] 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 1-5mm)

see next page

logged by CW, WB date 5 85

date

checked SH date 1 85

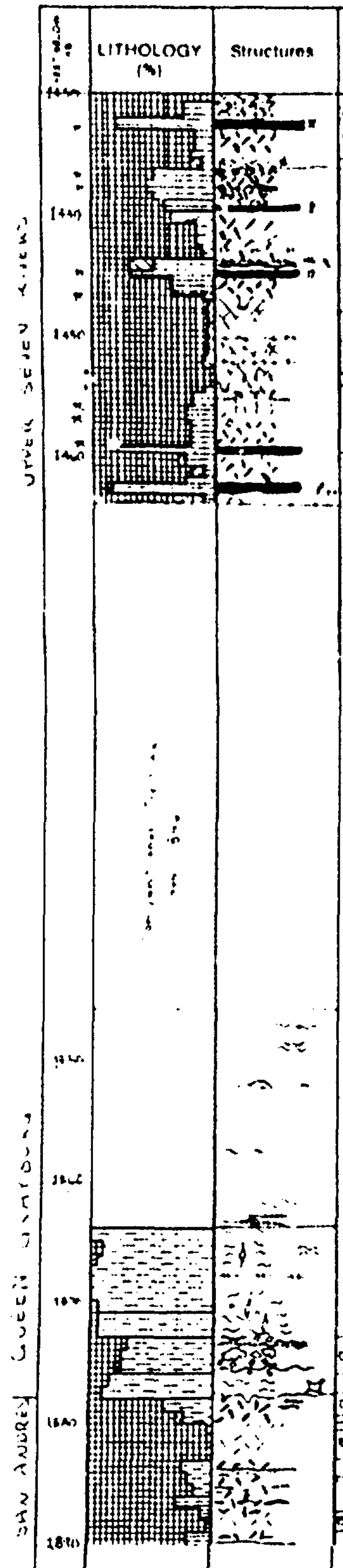
transcribed by SH [illegible] date 2 85

updated date

updated date

WELL J. Friemel COUNTY Deaf Smith DATE Nov 85

INTERVAL 1430 1830 UPPER SEVEN RIVERS, QUEEN-GRAYBURG, UPPER SAN ANDRES LOGGED BY ST, SJ, RG, [illegible], [illegible], SL, FA



COMMENTS

anh blades replace anh masses

white fibrous hal filled fracture (4mm wide, 50cm long)

pink & white wavy laminated anh bed (1-2 inch), polygonal pressure? hal filled fractures, polygonal in plan view at 1445

1% anh [illegible] vertical [illegible]

Polygonal fracture filling hal

[illegible] cement of greater concentration [illegible] dissolution structure?

1% Anh some rounded [illegible]

1% Anh

[illegible] laminae

[illegible] [illegible]

Fibrous [illegible] fills are white.

2% Anh

many Anh laminae, probable insoluble residue [illegible] clasts

Anh wavy laminae

4% [illegible]

2% mud

CONTACTS	LITHOLOGIC DESCRIPTION
	Cavity filling pure hal grading up to recrystallized anh hal
.5 .5 .6	Reddish brown chaotic mdstn-hal. Top 30cm fine (5mm) mdstn clasts, hal middle [illegible] mdstn w/ displacive hoppers. Lower 22cm coarse (2.5cm) hal-mdstn
.3	Mostly anhydritic hal w/ about 2% mud within crystals. Anh is in [illegible] bodies (.5-6cm) between hal crystals & is being replaced by [illegible] large crystals of gyp (.1-2mm) long.
.05	Reddish brown chaotic mdstn-hal. Mud & clay content increases up section [illegible] interbeds. Mudsalt at top 1 inch is composed of densely packed mdstn masses functions as cement
.6 11 .8	Clear coarse crystalline anhydritic hal (1-6cm) w/ several [illegible] of recrystallized reddish muddy hal. H typ hal fills pits. Chevrons are abundant at the base of the unit.
.5 .6	Reddish brown chaotic mdstn hal. Somewhat coarse, recrystalli[illegible] between & within crystals. Contains few displacive hal cubes. [illegible] masses
.4	Reddish brown chaotic mdstn-hal, white & gray anh occurs in the same form as the angular & rounded bodies (2-4cm) of clay which are within & between crystals
18	Reddish brown mostly massive hal cement fine & very fine [illegible] very [illegible] evidence of cross laminae in a few zones. Contains a homogeneous distribution of greenish gray reduction spots (.1-1.5cm in diameter) covering 1% of the core
.5 .41 .6	Reddish brown massive to disturbed intraclastic mdstn & siltstn w/ numerous greenish gray reduction spots (.1-.5cm in diameter). Clear fibrous hal filled vertical fractures occur throughout the unit.
.5 .6	Reddish brown chaotic mdstn hal & anhydritic hal w/ a zone of [illegible]. Anh occurs as laminae & tiny nodules (.1-.3cm) throughout the unit
	Reddish brown, brown and dark gray recrystallized hal. Alternating between [illegible] mdstn hal & muddy hal once. Faint dark banding occurs near the top of the unit along w/ some vertically oriented crystals

logged by PN date 4 85

date

checked SH date 85

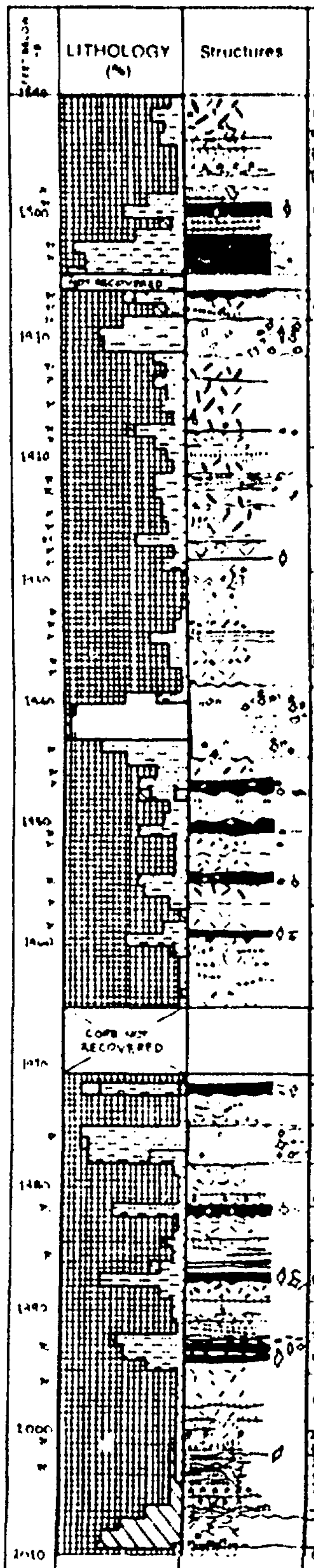
transcribed by PR [illegible] date 2 86

updated date

updated date

WELL 3 Friemel
COUNTY Deaf Smith
DATE October 1984
INTERVAL 1840'–2010' UPPER SAN ANDRES
LOGGED BY SI, BT, BL, SH, CW, LF, PH

UPPER SAN ANDRES



COMMENTS

5% anh
1% anh [illegible]
Fracture filled w/ C type hal
1% anh possible hal dissolution
Dipping anh beds
1-2 mm anh nodules
Dipping 45° 1% anh
mdstn filled fractures? [illegible]
1% anh
[illegible] colored
5% mud
1% anh
1% hal numerous tiny
[illegible] spots
pseudomorphs of [illegible] hal
3% [illegible]
2% anh colored mud nodules
hal filled fracture 2cm wide
2% anh
2–[illegible]% anh
1 cm mud [illegible] masses
1% mud [illegible] hal
[illegible] clay stringers
1% anh
1% anh
C type hal within interbed
orange [illegible] hal in fracture
5% anh
abundant orange hal filled polygonal fractures
irregular fractures
1% anh
Thin fracture in interbed
35 cm deep pit
orange [illegible]
1% anh [illegible] interbed

CONTACTS / LITHOLOGIC DESCRIPTION

-8- 9
Brown & yellowish brown [illegible] banded hal w/ vertically oriented crystals & [illegible] by numerous recrystallized pits. 0.1' of chevron hal occurs at 1845'. [illegible] orange hal filled fracture [illegible] up about 10% of a mdstn siltstn interbed near the base of the unit.

-5- 5
Reddish brown massive to contorted mdstn contains several tiny anh nodules (less than 1cm), numerous irregular reduction zones and isolated bodies of 0.5 C type hal

Mostly chaotic mdstn/anh hal rock. Lower .3' shows bedded hal cross cut by a 1.5cm wide pit

Yellowish brown siltstn w/ disturbed intraclastic fabric & zones of large displacive hal hoppers (1-1.5cm). C-hal type filled fracture 10 cm long & 1.5cm wide in the center

-51-
Dark reddish brown & brown chaotic mdstn-hal w/ some muddy & anhydritic hal rock. Small anh nodules (.2-.5cm) occur w/in mud near 1874'. Pinkish clear chevron hal is found near 1930'. Several muddy interbeds occur throughout this unit from 2 to [illegible] interbeds contain either or both vertical orange hal filled fractures & displacive hal hoppers.

-6- 12
Dark reddish brown & brown chaotic mdstn, hal w/ some muddy & anhydritic hal [illegible]. 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.

-5- 45
Dark reddish brown highly contorted to massive very fine ss. Contains several isolated gray anh nodules (.2-2cm) & a few very tiny hal hoppers (.2cm). Poss [illegible] desiccation structures in lower half

-6- 22
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 1946.8'

-5- -5-
Reddish brown siltstn coarsening up section to very fine ss [illegible]
[illegible] an 11 cm long, 1cm wide vertical hal filled fracture [illegible] type

3-
Dark brown recrystallized anhydritic hal

41 -5
Dark reddish brown & yellowish brown mdstn [illegible] large [illegible]
& a few small gray anh nodules

68
Brown muddy & anh coarsely crystalline hal w/ numerous mdstn interbeds which commonly contain orange fibrous hal in vertical fractures and or [illegible] hoppers.

0
Brown & slightly reddish brown muddy & anh hal. Mostly recrystallized zones banding, vertical crystals & chevrons. A deep pit (10cm) occurs at the base of the unit.

37
Reddish orange & light brown chevron hal associated w/ ? type hal

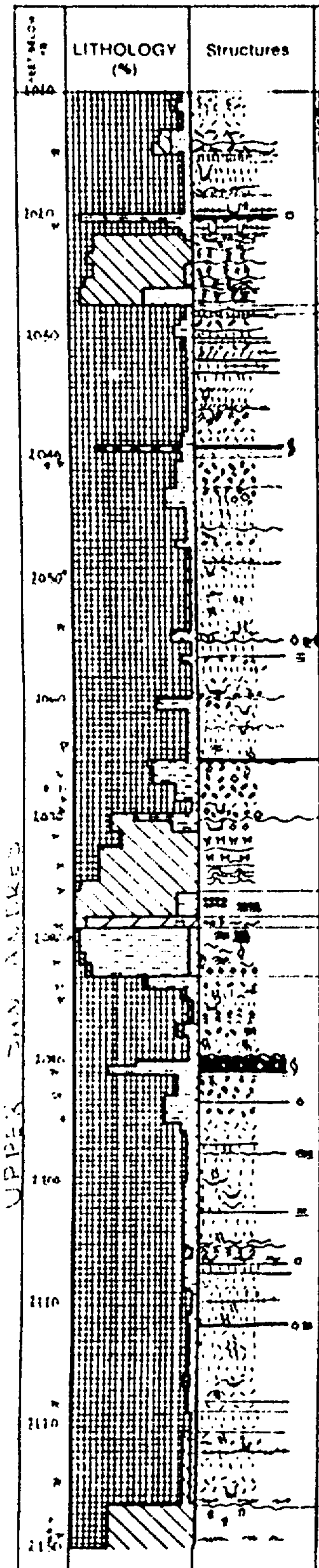
37 -9-
White felted anh & anl. Bottom 15cm becomes reddish gray & brown w/ hal pseudomorphs after gyp (1-3cm long at the base)

logged by CW date 4.85
date
checked [illegible] date [illegible]
transcribed by TA, BT date [illegible]
updated date
updated date

WELL J Friemel COUNTY Deaf Smith DATE September 1983

INTERVAL 2010 2130 UPPER SAN ANDRES LOGGED BY ST, RL, SN, LS, CW, WL, CH.

UPPER SAN ANDRES



COMMENTS

mud & anh grade into each other

1 5% anh

muddy top to anhydrite

well formed 8cm hal twinned pseudomorphs

ripple laminated very fine ss or siltstone draped over anhydrite

not recovered 2018.6 2029

Brown mud interbeds 1 3cm thick

mdstn interbed 10cm, 20% hal
mdstn interbed 1cm

mdstn interbed 1cm

mdstn interbed 2cm, & 1 thin mm-box coated drape

mdstn drapes

3 mdstn interbeds
mdstn interbeds 8cm, 50% hal
mdstn interbed 2cm laminated

mdstn interbed 1cm

mdstn interbed 1cm

thin mdstn drapes

2 mdstn interbeds

chaotic mudsalt w/ solution pit

large solution pit filled w/ mdstn, anh clasts & large hal hoppers

hal pseudomorphs after twinned gyp

salted anh fabric transition, 10cm

anh drapes

some inclusion zoning in hal

mdstn interbed 12cm 25% hal contains fracture lined w deep orange

mdstn interbed 4cm 10% hal; mdstn w euhedral displacive hal hoppers

mdstn interbeds w contorted laminations, 4cm, 60% hal

mdstn interbed 4cm 35% hal

& anh drapes

3 mdstn interbeds, apparent solution cavities? displacive hoppers, hal cubes capped by mdstn beds

mdstn interbeds, 8cm, 50% hal contains euhedral displacive hoppers, silty

B → E

mdstn interbed, 1cm

anh interbed, 5cm, 25% hal zone of salmon pink hal

Salted anh fabric transition, upper 5cm pseudomorphs, increasingly poorly preserved

CONTACTS

11 7, -1, 8, -6, 4 4, -6, 4, 8, 11 9, -3, 4, 9, 6, 4, 8, 6, 9, 4, 6, 15, -5, 14, -9, 87, 6, 69, 5, 5

LITHOLOGIC DESCRIPTION

Brown to reddish brown hal w/ numerous interbeds of both mud & anh vertically oriented crystals & dark banded hal grading up to recrystallized muddy & anh hal w/ zones of chaotic mdstn hal. Much of the mud grades into the anh and crystal sizes tend to coarsen upwards.

Light gray white & red laminated anh packed w/ hal pseudomorphs after gyp (1-3cm) includes displacive hal cubes (2cm) at top

Interbedded dark brown rippled very fine ss & red & white laminated anh w/ hal pseudomorphs after gyp (.1-1.5cm) w/ 4 3 cm E type hal at the top. Horizontal cracks & irregular voids in ss are hal filled.

Dark brown chaotic mdstn hal w/ some euhedral displacive hal cubes (1-2cm) in mud

Brown banded hal w/ vertically oriented crystals up to 4 cm long. Banding is cut by a pit 10 cm deep at 2034.6'.

Pink chevron hal rock w/ vertical crystals grades up to light brown in color

Color-banded vertically-oriented bedded (B-Type) hal transitional to anhedral muddy (E-Type) hal. Mdstn percentage varies from 2-30% , chaotic mudsalt is present in zones w/ high mdstn percentages; abundant mdstn interbeds, reddish brown to dark gray in color; 8cm of chevron hal at top.

Chaotic mud salt (D-Type) transitional to anhedral muddy (E type) hal, bottom portion is characterized by large solution pits containing thick reddish brown to dark gray mdstn, large displacive hal hoppers, & anh clasts. mdstn content & hal crystal size increases upward, small fracture filled w/ red fibrous hal at top

Light medium bluish gray anh (60-80%) composed of alternating contorted beds of anh & hal pseudomorphs after twinned gyp, pseudomorphs increase in size & become better formed upward; largest pseudomorph is 7 cm in length.

Medium dark gray nodular mosaic anh; interstices between nodules filled w/ gr. white mud; small (1-2mm) salt crystals at top of unit

Light olive gray dolostone, 20 cm contains red anh nodules, burrows & wispy laminations Reddish brown to olive gray very fine ss/siltstn, abrupt color change at 2075 & Contains displacive hal hoppers, disturbed intraclastic fabric & contorted laminae, vertical fractures filled w/ fibrous hal; red anh nodules in upper portion

Chaotic mudsalt (D-type hal) transitional to anhedral muddy (E type hal). Mdstn is reddish brown in color w/ some light olive gray reduction zones. Mdstn percentages vary from 15-25%, present as interstitial material between grain boundaries & as interbeds, interbed at 2090' is 35cm thick & contains displacive hal hoppers & vertical fracture filled w/ deep orange fibrous hal, zone of vertically oriented hal crystals, chevrons & cubic inclusion zoning at 2085.6'

Color banded, vertically oriented bedded (B-Type) hal w/ 3% reddish brown mdstn in the form of thin interbeds & interstitial between grain boundaries, less than 1% anh as thin interbeds & drapes & finely disseminated between grain boundaries, thin zone of chevron hal at 2106'

Vertically oriented bedded (B type) hal transitional to anhedral muddy (E type), contains 6-10% mdstn in the form of interbeds lining solution pit floors & interstitial between grain boundaries, bedded (B-type) hal is best preserved in basal & mid portions of unit & becomes less well preserved upward

Anhedral anh/hal w/ continuous & discontinuous anh interbeds & interstitial anh outlining grain boundaries, transitional to anhedral muddy hal (E-type) contains 15cm of vertically oriented (B-type) hal at 2121', small solution pipes & pits floored w/ anh.

Light medium bluish gray anh (about 75%) w/ small (1mm) hal filled cavities & hal pseudomorphs after zoned gyp crystals (up to 2 cm in long direction), discontinuous anh laminations at base.

logged by CW WL date 1.83

date

checked SH date 1.83

transcribed by RK, JH date 2.83

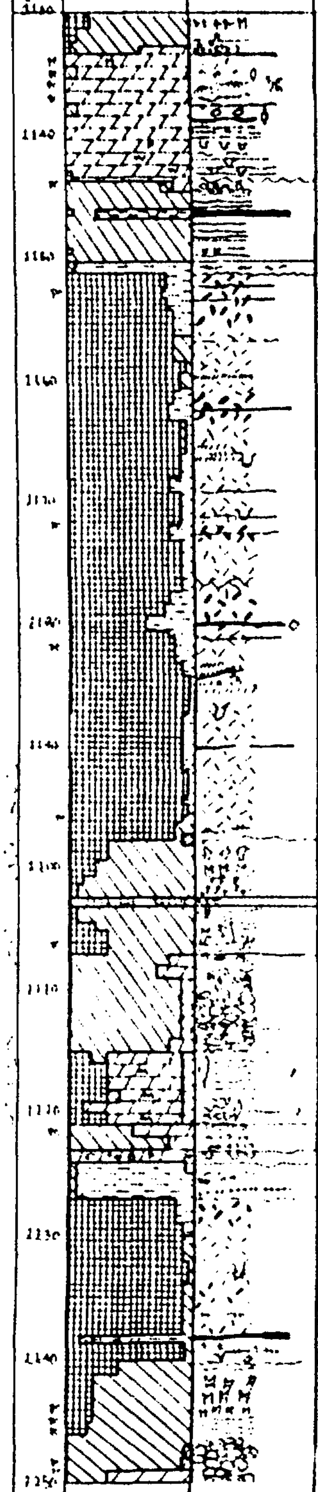
updated date

updated date

WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

INTERVAL 2130 2250 UPPER SAN ANDRES LOGGED BY [illegible]

Depth	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



COMMENTS

Pink color

[illegible] hal

[illegible] crystals

[illegible] type hal filling fractures

Reddish brown [illegible] nodules

pseudomorph [illegible] upper [illegible] cm

CONTACTS	LITHOLOGIC DESCRIPTION
	Gray thinly bedded anh w/ tiny hal pseudomorphs after gyp. Bottom [illegible] highly contorted dol & anh nodules (.1-1cm) & laminations
105	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 wispy laminations, bioturbation & ripples. Top 1.5' becomes highly fractured. Fractures randomly vertical orientation 5-3cm long.
66	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~~
56	Chaotic mdstn hal, reddish brown mud bodies .2-2.5cm
41	Mostly dark gray to brown recrystallized anh hal but sharp color change to moderate orange pink from 2157.6-2159.5
90	Chaotic mdstn hal, angular mud bodies (.5-2cm) vary in color from reddish brown at base to brown at the top
19	Recrystallized muddy hal mostly reddish brown & gray. Mud w/in & between crystals. Thin zone of cavity filling hal at 2171. Bedding (dark bands) [illegible] a 10cm deep pit at 2165'
	Very muddy recrystallized hal. Mud grades up section reddish brown to dark gray
40	Recrystallized hal w/ dark gray mud between crystals & reddish mud w/in crystals
	Recrystallized hal w/ large pieces of reddish mud (1.5cm) between & w/in crystals. Mud becomes grayer at the top.
37	Recrystallized muddy hal, mud is both red & gray.
	Bedded muddy hal
85	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
5	Recrystallized hal grading up section from dark brown to light yellow. Top [illegible] contains traces of hematitic mud
	Felted anh in hal matrix; trace mdstn at top
	Numerous large (3-6cm) 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 [illegible] contain crystallotopic anh
54	Nodular anh (.1-4cm) w/ mostly dol matrix. Nodules at base have yellow green or reddish centers
49	Yellowish 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
22	Gray anh nodules become supported in dol matrix 10cm
	Dol mdstn (tan) & pkstn (gray) burrowed
18	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
26	Dark banded hal w/ numerous truncations by pits & pipes of recrystallized hal w/ anh layers at the bases.
20	Minor discontinuous anh interbeds in hal. 2.5cm of anh just above mdstn interbed
19	Hal sparse chevrons, discontinuous anh partings, anh cavity floor?
	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/ internodular dol matrix. Dol proportion decreases up section.
	Yellow brown ripple laminated pkstn/gnstn, abundant anh nodules

logged by Cw date [illegible]

date

checked SH date [illegible]

transcribed by TA JSS date 3/85

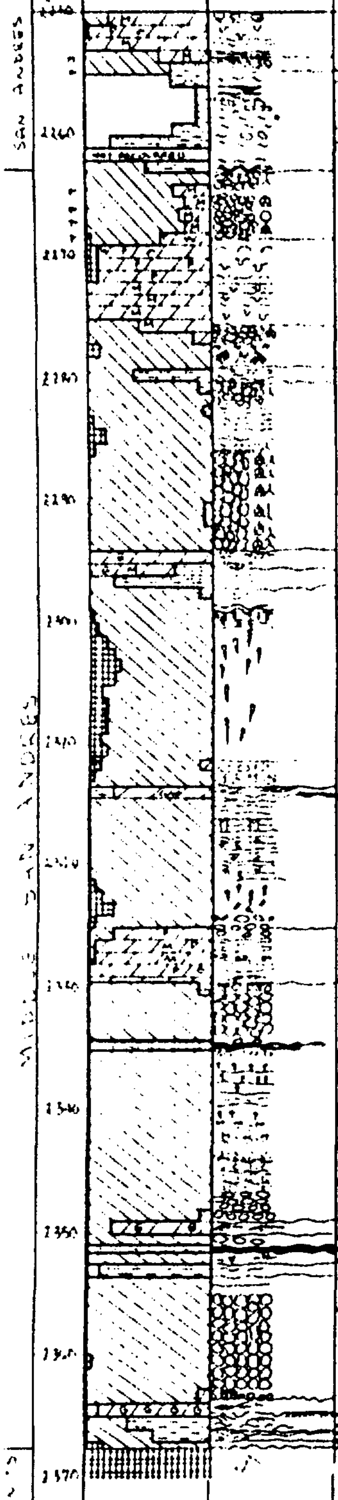
updated date

updated date

WELL [illegible] Friemel COUNTY Deaf Smith DATE August 198[illegible]

INTERVAL 2250 2370 UPPER SAN ANDRES, MIDDLE SAN ANDRES, LOWER SAN ANDRES-UNIT 5 LOGGED BY [illegible]

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



COMMENTS

ANH nodules
HAL replacement of allochems and patchy HAL cmt 2241.0-2252.0
dark
ANH nodules
HAL hoppers (small)
ANH nodules
red
1.0 cm DOL Mdstn layer at 2265.0
4.0 cm DOL Mdstn layer at 2266.7
Single fossil valves predominantly preferentially oriented
Remnant lg. scale herringbone pseudomorphs
1.0 cm clay rich anhydritic DOL layer at 2279.2
[illegible] horizontal fractures present at 2281.0
discontinuous mottled texture in ANH dark and light, upper contact has [illegible]
1" Dolomite [illegible]
dark mudstone ~ 3 cm
~10% Nodular ANH
Layer parallel [illegible] ripples
ANH nodules are cuboidal possible pseudomorphs
10 cm ripple lam. dol mudstone
nodular
tan ANH, ANH pseudo after gypsum
poorly preserved [illegible] texture 2-5% HAL in pits [illegible]
nodular ANH bedding preserved
nodular ANH
nodular ANH
dk gy mudstone
relict pseudomorphs after gypsum
black mudstone
red mudstone
ANH
red mudstone
ANH with HAL

LITHOLOGIC DESCRIPTION

Yellow white gray dol mdstn & pkstn. Burrowing present throughout in [illegible] concentrations
Medium gray bedded anh, nodular mosaic anh in upper portion
Highly disturbed mdstn/siltstn interbeds grading to hal cemented very fine [illegible] mdstn interbeds also highly disturbed. Mdstn interbeds less than 2.5 cm thick. Mostly gray medium gray at top, intraclastic
Medium gray nodular, nodular mosaic & mosaic anh w/ internodular dol mdstn
Wispy laminated olive gray dol mdstn w/ abundant compressed horizontal burrows 1.0cm x 0.5cm. Patchy hal cement, controlled by location of burrows. Grading up section to pkstn.
Nodular mosaic anh w/ internodular dol
Anh & hal pseudomorphs after gyp, remnant large scale herringbones.
Highly disturbed and dark gray anhydritic mdstn
Medium gray mosaic anh.
Minor dol & hal define layering in anh. Layering becomes disturbed & truncated by nodular growth in upper portion
Mosaic & nodular mosaic anh w/ dol mdstn present in internodular areas
Dol mdstn underlying dol pkstn composed of unidentifiable allochems (2mm in diameter. Anh filled vertical burrows present at 2295.2. 0.2mm anh nodules present.
Dark gray mdstn dolomitic at the top strongly disturbed & [illegible] base
Gray massive anh w/ irregular voids filled w/ hal & gray thinly laminated anh. Somewhat nodular in lower 2 feet
Light to dark yellow brown interbedded mdstn & wkstn, ripple laminated [illegible] olive gray mdstn at base.
Light brown, gray black thinly laminated anh (about 1cm thick). Laminae defined by subparallel horizontal layers of colored anh. Abundant poorly preserved small anh pseudomorphs after gyp
Gray massive anh w/ irregular vertical cavities (up to 2 cm) filled w/ hal, could be pseudomorphs after gyp
Light brown hal cemented thinly laminated dol mdstn w/ isolated layer parallel anh nodules.
Gray nodular mosaic anh, top 10cm & basal 25cm dol matrix
Gray anh, nodular w/ dol laminae at base, nodular fabric grades upward to laminated fabrics w/ pseudomorphs after gyp at top
Yellow brown thinly bedded dol w/ ripples, anh nodules at top
Interbedded dark gray anhydritic mdstn & nodular to bedded anh. Anh is stained red at contacts.
Gray crudely bedded anh.
Red brown mdstn disturbed intraclastic texture
Yellow gray, white nodular mosaic anh. Less than 5% NaCl. Nodules [illegible] finer less than 1 cm anh nodules in dol matrix 2? cm at base
Yellow gray ripple cross laminated dol [illegible] mdstn, laminations up to 2cm thick. Dol mdstn at top.
Moderate brown mdstn w/ chaotic texture, anh interbeds, soft sediment [illegible] & ripple cross laminated. Dark mdstn top 15cm slightly dolomitic
Light gray felted anh in hal matrix, hal masses, relict pseudomorphs after gyp

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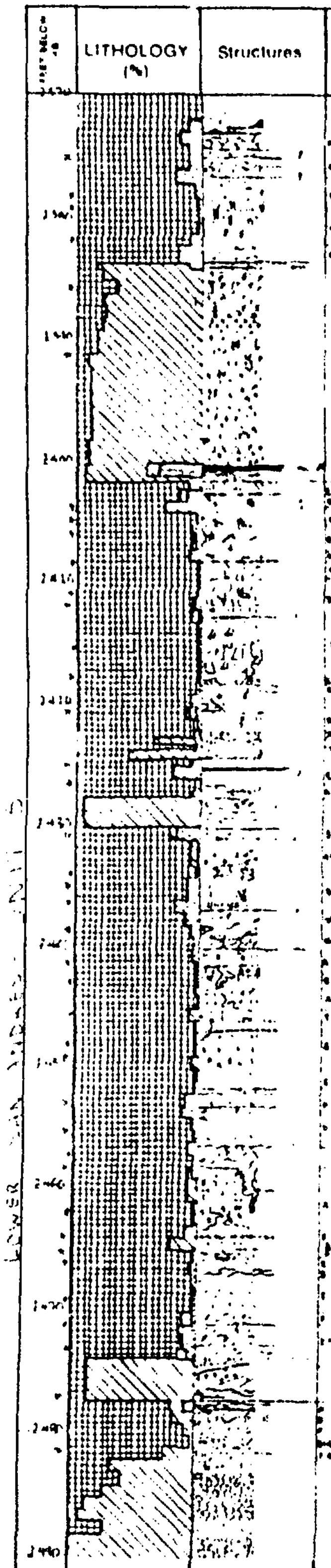
WELL J. Friemel COUNTY Deaf Smith DATE

INTERVAL 2370–2490' Lower San Andres - Unit 5 LOGGED BY

CONTACTS	LITHOLOGIC DESCRIPTION
45	Extremely coarse (8cm +) euhedral cavity fill. Fluid inclusion rich.
.9 15 .6	Bedded/banded hal cut by large pipe, cavity crystals 1 x 1 cm
17 .9	Bedded (B type) hal 30% recrystallized to recrystallized muddy hal (type C). Grades to 100% type F at 2379.1. Crystals subhedral polygons (0.5 to 1 cm). Grades up section to mudsalt w/ increasing mud
.6 .5	Typical chaotic mudsalt; crystals generally coarse (up to 2 cm), anhedral to subhedral w/ large interstitial bodies of mudsalt
18	Nodular/nodular mosaic anh w/ patchy interstitial hal. Grades up section to grassmat texture w/ hal replacing gypsum pseudomorphs first as some herringbone patterns then as well formed blocks & swallowtails. Pseudomorphs up to 17cm, average 7 mm. Pseudomorphs display growth bands. Minor mdstn at top, pseudomorphs preserved but host becomes anh/hal mixture. Interbed comprised of claystn & siltstn. Ripple lams.
	Coarse euhedral cavity fill, less than 1% disseminated mdstn, crystals 8cm.
	Recrystallized anhydritic hal w/ felty irregular anh bodies. Hal has reddish hue.
	Typical chaotic mudsalt.
45	Bedded hal grades up section to recrystallized (about 40%) muddy hal w/ some remnant primary bedding grading up section to 100% recrystallized hal
	Typical chaotic mudsalt (crystals anhedral/subhedral to 2cm). Bounded by [illegible] interbeds.
	Recrystallized muddy hal w/ some vertically oriented crystals [illegible] mdstn laminations.
	Bedded hal w/ mostly very dark impurities outlining crystal growth, some slight banding.
51	Recrystallized muddy hal; crystals from 1-1cm subhedral/anhedral polygonal in form. Mdstn finely disseminated throughout. Some vertically oriented crystals in top 2 feet
	Bedded hal w/ scattered zones of chevron concentration becoming increasingly disturbed & recrystallized from 2420 ft. Pipes & pits common throughout.
	Felty, crinkly anh bodies in a matrix of clear type F hal. Some small (less than 1mm) hal replaced gyp pseudomorphs
40	Recrystallized hal becoming increasingly muddy up section. Basal foot contains chevrons & some vertically oriented crystals & minor interstitial mud
	Massive bedded anh w/ lenses of highly disseminated hal replacement skeletal hal top .5'
	Typical chaotic mudsalt.
5	Chevron hal cut by numerous pipes filled w/ red brown mdstn, becomes increasingly recrystallized up section.
2.9	Bedded hal w/ interstitial dark reddish brown up section to black mdstn as numerous partings and interstitial material outlining vertical crystals.
	Recrystallized hal; crystals anhedral/subhedral reddish brown mdstn within crystals and as interstitial bodies.
	Extremely coarse euhedral pure cavity fill (type H). Crystals 6 cm. Cuts 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
	Recrystallized anhydritic hal & cavity fill w/ irregular anh bodies. Bottom .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.
	Recrystallized muddy hal (black reduced? mdstn), crystals subhedral up section euhedral cubes to 1 x 1 cm.
65	Recrystallized muddy hal (reddish brown mdstn) w/ chaotic zones near interbeds at 2456-2457 mdstn laminated interbed cuts core at angle to horizontal (see slit whole core description 2456.5-2456.9), crystals anhedral & coarse.
40	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.
34	Recrystallized muddy hal w/ the interstitial mud in varying degrees of anhydritization (type C going F). Some vertically oriented crystals top foot. Crystals generally anhedral/subhedral typically .5cm-1.5cm, the larger ones in bottom 2/3 of the unit
18	Contorted anh w/ interstitial hal finely disseminated throughout, also occurring in lenses & irregular bodies. Grades to tilted grassmat texture. Hal after gyp pseudomorphs contorted ripple laminated siltstn at 2484.0. Felty anh w/ hal skeletal growth top .3'
	Extremely coarse hal cavity fill (up to 4 x 4 cm) w/ contorted anhydrite interbeds, large fluid inclusions.
	Recrystallized anhydrite hal (crystals subhedral-anhedral) grades to bedded banded hal, yellowish impurities in bottom foot.
	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 internodularly.



COMMENTS

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

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transcribed by SJ date 4-84

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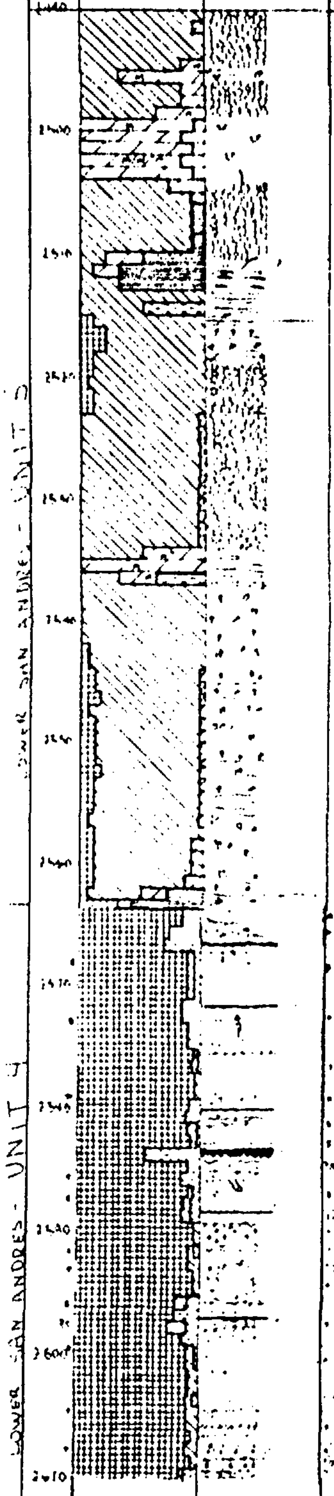
WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

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

LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



See Previous page

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

Medium gray nodular mosaic anh w/ dol as internodular material

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

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

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

Bedded, massive anh w/ minor terrigenous clay defining bedding

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

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

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

Medium gray to medium dark gray anh w/ yellow gray ripple laminations composed of dol

Gray black anhydritic claystn. Contorted intraclastic texture

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

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

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

Mixed E & F type hal w/ pipes at the base protruding into underlying A

Type A hal w/ chevron fluid inclusions & vertically oriented crystals 2 cm high.

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

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

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

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

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

See Next page

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

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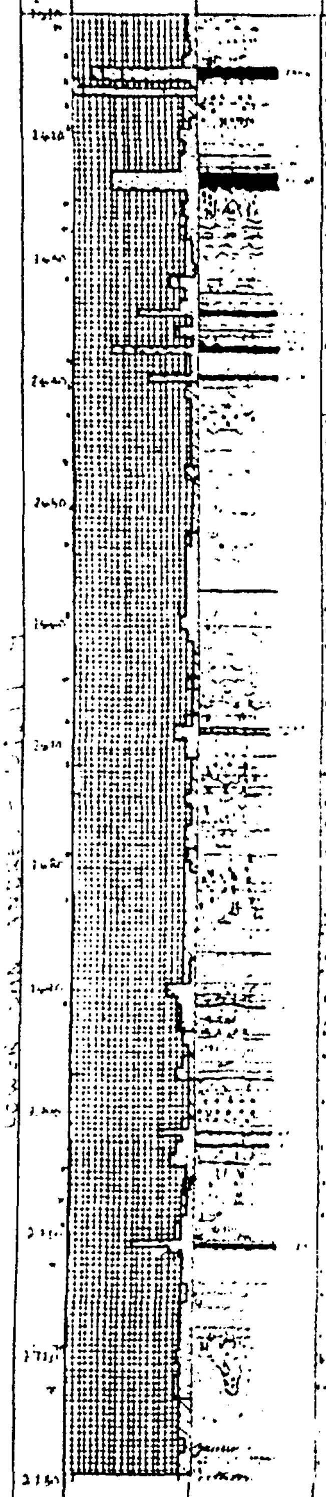
WELL [illegible] COUNTY Deaf Smith DATE [illegible]

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 upper contact it is mixed w/ some crystals containing chevrons

Red brown & pale green siltstn w/ mdstn drapes finely laminated [illegible] & disturbed.

Poorly developed A 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 color

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 preserved as 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 A type hal w/ chevron fluid inclusions at the top. Some mdstn & anh beds have horizontal orientations.

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 A type hal w/ chevron fluid inclusions & zones of E & F hal also of anhedral hal w/ interstitial laminations of mdstn & anh, laminations are discontinuous & fluid inclusions are few, these zones occur predominately bordering interbeds. Many mdstn beds are [illegible]

Anhedral hal w/ interstitial laminations of anh, little internal structure

Banded B type hal w/ pits & pipes filled w/ clear hal, banded hal has vertically oriented crystals & disseminated interstitial material

Chaotic mudsalt, D type hal, anhedral crystals w/ interstitial bodies of mdstn.

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

80 Bedded & banded B type hal, at the basal 1' it is mixed w/ A type hal w/ chevron fluid inclusions, both types are transected by pits w/ insoluable residue & pipes of coarser crystalline hal. Bedding is marked by disseminated bands of mdstn & anh w/ some interbeds of mdstn & anh drapes

50 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

60 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

40 Bedded hal w/ well developed chevrons fluid inclusions pipes cutting bedding & anh drapes & partings.

Predominately bedded B type hal w/ local zones of recrystallized zones F hal w/ interstitial anh & mdstn

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.

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.

Milky white bedded A type hal w/ abundant & well developed chevron fluid inclusions Crystals are vertically oriented, bedding 1-2 cm thick marked by anh drapes Bedding transected by few pipes.

40 Anhedral hal w/ angular & irregular shaped interstitial bodies of red brown mdstn D type hal, contains irregular & undulose mdstn interbeds cut across by orange fibrous hal filled fractures

Bedded & banded B type hal w/ vertically oriented crystal, some chevroned A type hal near top; chevrons poorly developed. Bands, transected by pipes of recrystallized hal, contains drapes & partings of anhydritic mdstn

10 D type Hal anhedral w/ interstitial bodies of dark red brown mdstn w/ disturbed silt laminae-chaotic or disorganized texture

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.

25 Banded B type hal w/ patches of vertically oriented crystals & disseminated bands of anh going to disturbed F type hal of anhedral hal w/ interstitial anh, contains disturbed irregular anh beds near contact w/ underlying anh.

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

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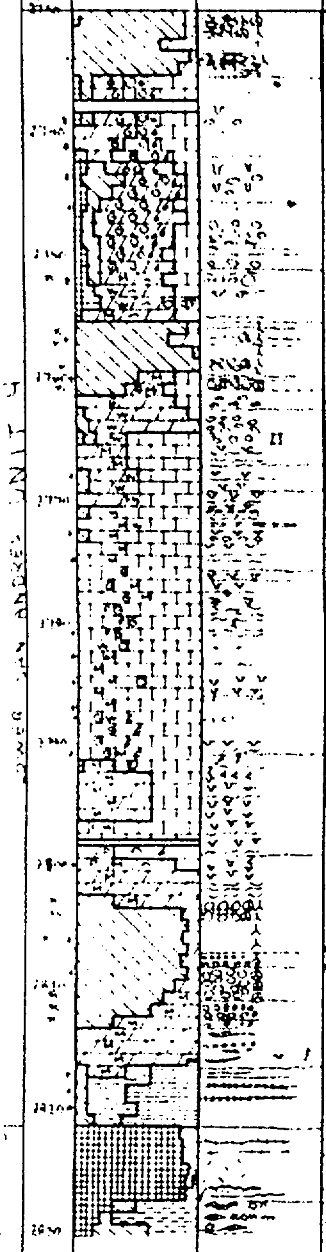
WELL [illegible] COUNTY Deaf Smith DATE [illegible]

INTERVAL [illegible] 2830 LOWER SAN ANDRES - UNIT 4 / UNIT 5 LOGGED BY [illegible]



COMMENTS

Laminations of dol mdstn inclined. Nodules in mosaic anh [illegible] 1.0cm [illegible]

Hal [illegible] possible [illegible]

Oolite [illegible] from [illegible] to [illegible] [illegible]

10 cm carbonate mdstn bed w/ [illegible]

Hal hoppers [illegible] present [illegible]

[illegible] w/ wkstn bed

[illegible] mdstn [illegible]

[illegible] nodules

[illegible]

[illegible] mdstn [illegible]

[illegible] nodules [illegible]

[illegible] mdstn layer [illegible]

[illegible] anh layers

[illegible]

CONTACTS	LITHOLOGIC DESCRIPTION
46	Medium gray nodular mosaic anh & interlaminated anh & dol
44	Oolite-fossil fragment gnstn w/ oolites well sorted, ranging [illegible] from grain size of 0.04mm to 0.4mm. Abundant anh & hal replacement of allochems. Mollusk fragments are up to 1.0cm in length
48	Mollusk fragments mdstn/wkstn, light olive gray in color Oncolites at 2754.2-.5 Intraclasts ? 2750-51
60	Medium dark gray nodular mosaic & mosaic anh w/ dol mdstn present as internodular material.
16	Yellow gray oolite gnstn w/ anh nodules & brachiopod fossil fragments. Oolites are 0.2mm.
44	Yellowish gray to grayish olive mdstn grading up section to wkstn. [illegible] of color variation suggests patchy hal cement.
12	Light olive gray to grayish olive burrowed wkstn. Burrows contain lower concentration of fossils, (Brachs/bivalves).
60	Yellow gray to light olive gray wispy laminated mdstn w/ compressed horizontal burrows. Hal/calcite cementation variations defined by patchy color differences
62	Brach-mollusk phylloid algae (?) pkstn/gnstn grading up section to a foram-mollusk gnstn w/ mdstn interbeds. Possible encrusting algae or bryozoans variably present.
50	Light olive gray mdstn w/ occasional organic wisps, compressed horizontal burrows. Patchy color variations define hal and calcite cement variations. [illegible] abundant
41	Light olive gray bryozoan mollusk fossil fragment pkstn, hal cement [illegible] lighter patches. Grading to wkstn then mdstn
81	Light olive gray bryozoan-mollusk pkstn grading upward to [illegible] dol mdstn [illegible] wisps present. Burrows slightly compressed. Wispy laminae present in [illegible] concentrations, up to highly concentrated. Brachiopod [illegible] abundant
40	Light olive gray to yellow white gray dol mdstn grading to pkstn [illegible] 0.1cm burrows. Allochems are mollusk fragments and unidentifiable [illegible]
110	Medium gray anh w/ internodular yellow gray dol mdstn
20	Yellowish gray sparsely wispy laminated bedded mdstn. Bedded nodular anh present, small nodules.
47	Poorly indurated grayish black claystn w/ disturbed siltstn layers & possible starved ripples, anh present as cement, discontinuous & continuous layers, nodules & bedded nodules.
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
[illegible]	Bedded B hal w/ mdstn laminations & vertically oriented [illegible]
15	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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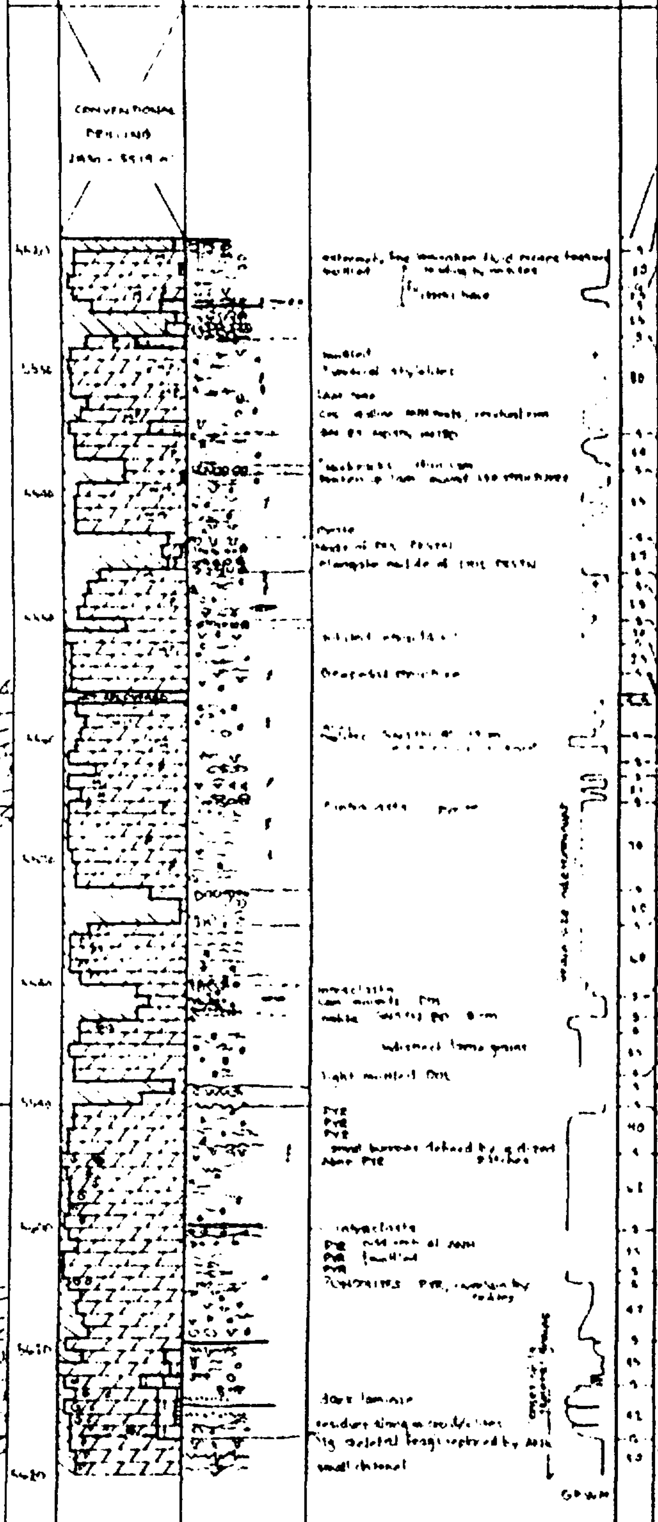
WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

INTERVAL 5500 - 5620 WICHITA, WOLFCAMP LOGGED BY [illegible]

DEPTH	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



Gray nodular mosaic anh

Olive gray to gray dol mdstn arranged in four gradational sequences [illegible] of wispy laminated burrowed mdstn overlain by parallel laminated mdstn. Laminations in uppermost sequence are slightly wavy & disturbed by vertical features(?) root traces

8.5 cm of wavy laminated & mud cracked dol mdstn overlain by [illegible] of [illegible] laminated dol pkstn w/ burrowing in abundance up section, spacing of laminations increasing up section also gradational

.6' dark olive gray fissile completely broken apart claystn sharply overlying gray nodular mosaic anh w/ interstitial claystn at the base & yellow gray dol pkstn upwards, upper most .3' consists of anh nodules in disturbed laminated dol pkstn

.3' gray green silty terrigenous mdstn sharply overlying mottled yellow gray & gray dol, dol ranges from mdstn to pkstn, grains are either very indistinct or not visible. There is a thin faintly laminated zone about 2 cm near 5531 & micro stylolites & thin stylolite occur throughout as well as crystallotopic anh, anh nodules are scattered. Near 5530 there are some fractures that become stylolites as they approach a vertical orientation

.3' gray nodular mosaic anh overlain by a 20 cm bed of thinly laminated dol mdstn w/ mud cracks overlying gray bioturbated dol(?) pkstn [illegible] overlying [illegible] dol pkstn overlying 1.1' faintly to moderately laminated dol mdstn

2' gray dol (?) wkstn/mdstn variably bioturbated w/ abundant crystallotopic anh overlying .6' mottled faintly laminated mdstn w/ anh nodules grading to 2' of variably bioturbated dol wkstn w/ wispy laminated micro stylolites, & crystallotopic anh overlying 1' of faintly to moderately developed laminated dol mdstn w/ a broken up mound-like structure

Gray nodular mosaic anh w/ interstitial zones of dol pkstn nodules & intraclasts in an argillaceous dol mdstn matrix w/ pyrite also

light gray dol? mdstn w/ vague wavy horizontal laminations, highlighted by crystallotopic anh, grades to pkstn upwards w/ horizontal bedding

Gray blue dol (?) pkstn - extreme etching shows grains w/ burrows, also [illegible], microstylolites, crystallotopic anh, anh nodules, vague [illegible] horizontal laminations

18cm of mottled yellow gray & gray bioturbated microstylolitic dol overlying 11 cm yellow gray vaguely horizontally laminated dol [illegible] indeterminate, overlain by 14cm nodular mosaic gray anh

Medium gray dol, highly recrystallized, no grains visible, also laminated & microstylolites present

Mottled yellow gray & gray heavily bioturbated dol, bioturbated [illegible] up section.

Yellow gray dol mdstn w/ abundant microstylolites, grade to intraclastic like texture upwards, bioturbated in uppermost portion

Mottled gray & yellow gray dol w/ a 'wormy' or 'curdled' texture

Medium gray dol mdstn w/ interbedded (?) about 5cm thick of [illegible] pkstn w/ indistinct ghosts of grains, contains abundant burrows

Yellow gray to olive gray dol pkstn w/ indistinct ghosts of grains, also laminations, microstylolites, & crystallotopic anh. Upper most [illegible] is an intraclastic dol pkstn w/ vague horizontal laminations & well developed stylolites

Gray nodular mosaic anh w/ interstitial dol pkstn

Olive gray dol (?) pkstn 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] mdstn w/ indistinct laminations. Sequence is capped by laminated mounds & mud cracks

Yellow gray oolite grnst w/ crystallotopic anh

Medium gray dol (?) pkstn, 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 mdstn w/ laminations defined by microstylolites.

Yellow gray dol, grain shapes sub-spheroidal, poorly defined pellet (?) pkstn contains crystallotopic anh, microstylolites, capped by [illegible] of yellow gray slightly mottled mdstn.

Yellow gray dol pkstn of oblate rounded grains-squashed oolites(?) & forams, abundance of forams 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 [illegible] lamination.

Yellow gray dol grnst of squashed oolites.(?) oncolites at the base

Light olive gray dol pkstn which grades up section to wkstn/mdstn, both extensively bioturbated, containing anh nodules & crystallotopic anh, stylolites & microstylolites

Light olive gray dol mdstn wkstn, wispy laminations of organic matter, highly bioturbated upwards. Contains anh nodules.

Yellow gray to gray blue dol grnst, extensively recrystallized, fossils not identified. Contains fossils replaced by anh, also anh nodules. Contains one interbed of dol mdstn, laminations otherwise unidentifiable

Very pale to pale yellowish brown dolomitic pkstn, mottled burrowed & vaguely laminated textures, anh is present as finely disseminated clusters

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WELL [illegible]

COUNTY [illegible]

DATE [illegible]

INTERVAL 5610 5740 WOLFCAMP

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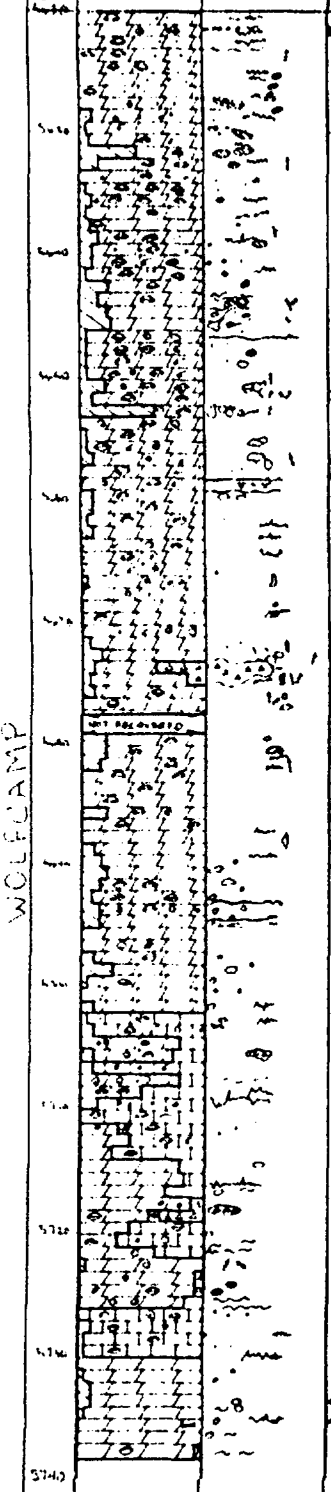

COMMENTS

- coarse fossil bed
- with irregular paste bedding
- Frac 3-5 cm long
- abundant microstylolites
- bluish gray slightly porous, & stylolitic
- large ANH nodules, ANH filled fractures radiating from them; patches of carbonate replaced by ANH
- gradually lighter color
- Angular ANH nodules and ANH filling fractures
- Lg [illegible] finely laminated ANH (chert?)
- ANH filling numerous small frac's
- larger [illegible]
- [illegible]
- 4-7cm [illegible] ANH nodules
- [illegible] w/ chert filled burrows ?
- Fusulinids replaced by CSIL and/or ANH
- Black clay in horizontal frac's & [illegible]
- Porous zone surrounds ANH nodules
- laminated [illegible]
- chert nodule
- Zone of porous ? chert
- ANH filling frac's and discontinuous stylolites
- black mud? filling vug 2.5 x 5 cm
- extremely coarse xstalline
- black DOL nodule
- black mud or oil stains(?) in core break, [illegible] microstylolites
- microstylolites
- black mud in frac's
- ANH filled frac's
- local large variation in porosity
- Fusulinids replaced by CSIL or ANH
- [illegible] ?
- Black mud stringers 5-1 cm
- ANH nodules surrounded by soft black mud
- ANH
- Chalcedony nodules
- Partly silicified ANH nodule (9 cm)
- chert nodule w/ fossil frags
- v coarse xstalline DOL pellets
- ANH nodules
- Gastropods in Chert nodule (16 cm)
- ANH nodules
- fractures filled w/ ANH 4-8cm
- Chert nodules (4-6 cm)
- Chert nodules (11 cm)
- v coarse xstalline ANH nodules
- v fine vertical fractures
- 5% calcite

CONTACTS	LITHOLOGIC DESCRIPTION
83	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. Basal plate is massive, cut by stylolites & microstylolites.
-6-	
41	Dark gray massive dol w/ dark blue angular anh nodules (2-7cm) & anh filling numerous fractures. Fusulinid molds filled w/ anh are dispersed throughout. Massive, no bedding defined.
-6-	
110	Gray massive dol w/ numerous thin fractures & abundant finely 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.
-5-	
40	Yellowish gray dol wkstn/pkstn w/ abundant anh disseminated throughout
-5-	
86	Gray & yellowish gray very porous, massive dolostone. All allochems are recrystallized remnants or filled w/ anh. Some anh nodules are partly silicified & solid chert occurs at 5673.2'. Much of the unit contains thin vertical fractures 1-10cm long. The top 1.5' appears less porous.
-5-	
29	Dark gray, porous coarse crystalline dolomitized wkstn/pkstn. Allochems have been leached away leaving large secondary porosity. Anh nodules generally increase up section in size & abundance & often are partially silicified w/ soft black mud rims.
-5-	
45	Massive partially dolomitized gnst/pkstn w/ fusulinids, crinoids, coarse-grained dol crystals & isolated anh, chert or chalcedony nodules (1-4cm). Completely dolomitized zone show contorted laminations at 5707.2'. The contact is an erosional surface.
-6-	
75	Dark gray & yellowish gray, contorted & wispy laminated, mostly dolomitized pkstn/gnst. Contains isolated coarse crystalline anh nodules (1-4cm) & a very large chert nodule at base which contains mollusk fragments. Very coarse crystalline dol occurs near the chert.
-6-	
18	Yellowish gray, coarse partially dolomitized pkstn. Contains fusulinids, crinoids, dol pellets & silicified grains. One anh nodule (2cm) at [illegible]
-6-	
42	Dark gray dolomitized Pkstn? Remnant allochems are fusulinids, crinoid columnals & bryozoans. Includes isolated silicified nodules & anh filling 4-8 cm fractures at 5722'.
-5-	
41	Coarse fusulinid pkstn/gnst w/ some dolomitized zones, chert nodules, & a few silicified grains. Fabric shows wispy laminations & is heavily stylolitized in bottom 15cm
-6-	
69	Dark gray wispy & contorted laminated dolostn 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'.

[illegible] intervals were point counted

logged by C[illegible] date [illegible]

date

checked S.h. date [illegible]

transcribed by [illegible] date [illegible]

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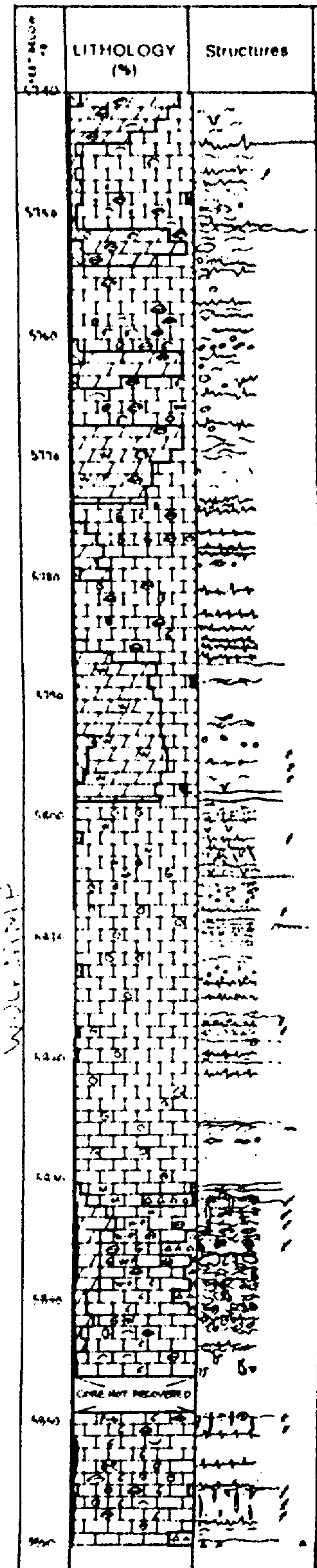
WELL J. Kriemel
COUNTY Deaf Smith
DATE
INTERVAL 5740-5860 WOLFCAMP
LOGGED BY ST SH BK SW LF TW FH JH

WOLFCAMP



COMMENTS

- Coarse and skeletal grains in fine matrix
- ½ cm thin vert. fracture
- replacement DOL in wispy laminae & stylolites
- chert bed 2.5 cm
- unusual dk pellets
- unusually sharp contact
- ANH nodules, displacive and fabric
- very heavily stylolitized
- biosparite
- biosparrudite
- micrite rims around nodules
- silica nodules
- ANH nodules w/ silica rim
- organic rich
- Fossil hash
- low angle x beds
- birdseye texture ?
- low angle x bed
- very porous
- very porous
- ANH frac fill
- fusulinid bed
- Silicified nodules — ⊘
- Breccia like texture
- Lg Porous vert burrows
- Lg Mollusc or brachiopod shell w/ Geopetal fill

very hal frost
very hal frost
Hal. & sol. rare. cements 1st, solvedcd today, hal frosted areas, less porous, washed out HAL ?
Fusulinid zone

CONTACTS	LITHOLOGIC DESCRIPTION
	see description above p 10
5 / 19	Massive fine grained pkstn w/ coarse dark crystalline dol grains dispersed throughout, becomes more fossiliferous at the top
6 / 41	Yellowish gray fine grained pkstn/gnstn w/ skeletal hash, silicified grains & a few sparse crystalline dol pellets. A chert bed at 5748.6'. Partial dolomitization occurs in wispy laminae & near stylolites
5 / 10	Dark gray dolomitized fusulinid pkstn grading up section to fusulinid wkstn. Forams are calcite, matrix is crystalline dol. Partially silicified anh nodules are up to 8 cm.
6 / 18	Fine grained pkstn/gnstn w/ isolated partly silicified anh nodules (2.5 cm). Allochems are fusulinids, skeletal fragments & silicified grains. Contains 1-2% replacement dol scattered throughout.
6 / 40	Coarse gray fusulinid gnstn grading up section to less fossiliferous pkstn-pkstn. Lower 7cm contains abundant small anh nodules.
G / 11	Gray fusulinid dolomitized wkstn/pkstn w/ 2.5cm anh nodules & silica nodules which are rimmed w/ mud. Fusulinids are all calcite. Down section dol at base shows nodular ghost dol displacing some fabric.
6 / 5	Lighter colored fine grained massive pkstn/gnstn w/ a few fine silicified grains.
16 / 6	Dark gray dolomitized wkstn w/ calcite fusulinids to 5mm.
17	Pkstn to wkstn up section becoming increasingly dolomitic & fossil poor. Fossils are calcite. Allochems include fusulinids, other forams, small snails & debris. Scattered anh fill (nodules?) 2 cm
5 / 115	Light gray to brown stylolitized gnstn. Allochems are generally small (less than 1 mm) & include multi-chambered globular-like forams, fusulinids, shell debris, gastropods, crinoid stems & unidentifiable coated grains. Grainsize is homogeneous giving unit massive appearance but some stratification may be present. Silica replaces many allochems.
5 / 115	Dark Gray dol wkstn, fossil allochems generally small (less than 1mm), calcareous & Predominately shell debris, bottom 2 feet contains fusulinids & rugose coral (heads to 1.5cm across). Anh in middle portions occurs as void fill (nodules?) up to 5cm & possibly as a replacement mineral in interstitial areas. Unit contains scattered vertical fractures, wispy laminations & mud seams
5	Stratified oolitic/foram gnstn w/ zones of shell hash. Numerous (about 5%) fossils & voids filled w/ spar
5 / 48	Bioturbated light tan/blue wkstn (?) w/ fossil allochems ranging from small (less than .5mm) spar filled coated round grains, to large 1cm urchin-like structures, to 1mm "mud" filled brachs, 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 pkstn.
5	Tan/blue porous oolitic gnstn w/ large amount of different cementation. "splotchy appearance". Brown areas less well cemented & contain larger void spaces
6 / 57	Light tan blue Porous oolitic gnstn 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 gnstn w/ numerous void spaces to 1mm in diameter birdseye texture? Anh fills some of these interstitial areas. There is a hint of stratification
110	Hal frosted (cemented?) light tan porous oolitic gnstn w/ scattered stylolites and low angle cross stratification defined by variations in cementation and oolite 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
5 / 115	Wispy laminated wkstns interplaced w/ disturbed pkstns, contains numerous silicified nodules often w/ anh filled fractures. Unit capped by wispy laminated mdstn also w/ silicified nodules.
6 / 115	Gray highly porous poorly sorted disturbed pkstn/gnstn. Allochems range in size from .25 mm to 4cm & includes forams, crinoids, mollusk/brachiopod shells often w/ geopetal fill & general debris. Unit has disturbed, bioturbated texture & contains a long (1.5') 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.
5 / 65	Gray porous gnstn; allochems are homogeneous 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.

logged by S.W. date 4.84
ST date 3.84
checked SW date 7.84
transcribed by FH SW date 4.84
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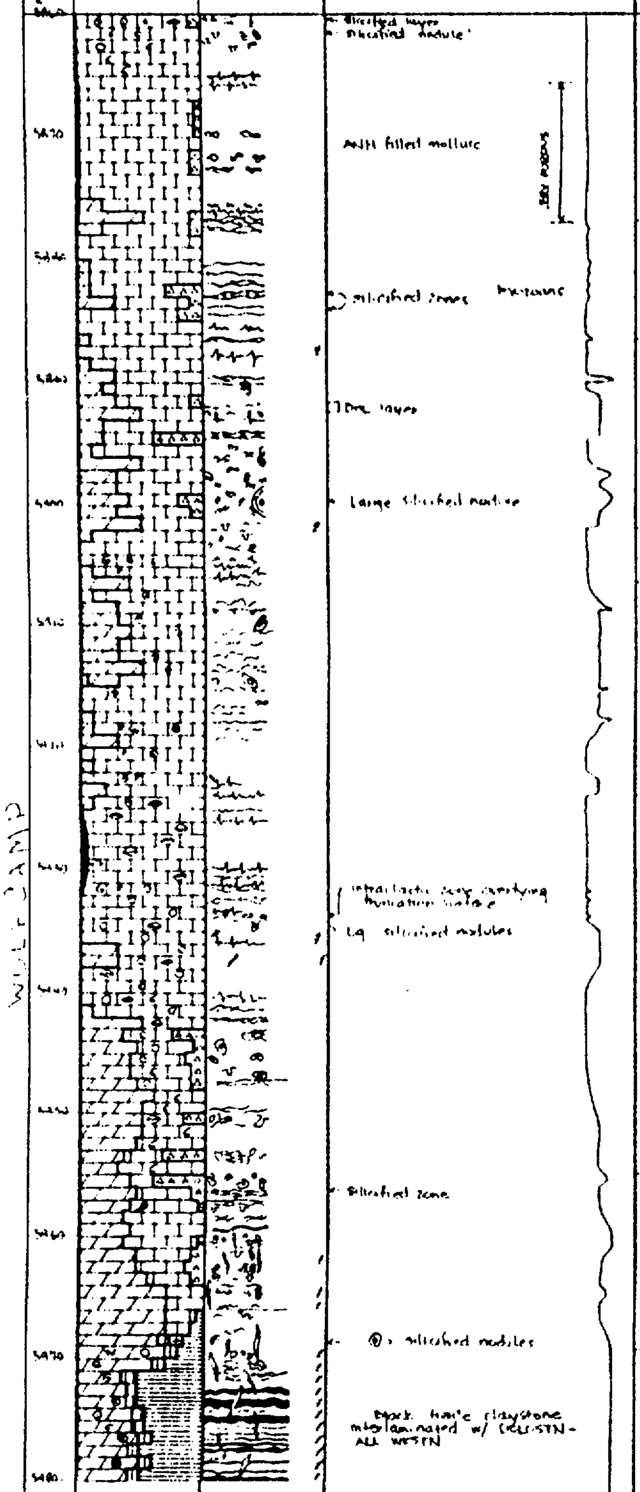
WELL J. Friemel COUNTY Deaf Smith DATE [illegible]

INTERVAL 5860 - 5980 WOLFCAMP LOGGED BY [illegible]

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



← silicified layer
← silicified nodule
Anh filled mollusc
⟩ silicified zones
] Dol. layer
← Large silicified nodule
{ intraclastic zone overlying hydration surface
← Lg silicified nodules
← silicified zone
← ® > silicified nodules
black, hard claystone interlaminated w/ (CLY-STN - ALL WKSTN

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.

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. Dominantly [illegible] porosity.

Series of coarsening upward sequences to light tan gnstns, coarsest grains between 5877.7-5879.5 & 5884-5885. Grains to 5mm. Contains two silicified zones 11cm & 13cm thick. Allochems; shell hash, crinoid columnals, bryozoans commonly silicified.

Light tan gnstns; allochems less than 1mm but scattered larger silicified crinoid columnals; generally fines up section vertical fractures upper foot

Wispy laminated organic rich wkstn/gnstn. Common large silicified bodies & zones throughout up to 15cm thick. Dolomitization patchy. Hal frost coats silicified areas. Decreasing organics up section
Allochems silicified crinoid stems, fusilinids, fossil has

Light tan gnsnt w/ anh filled voids. Increasing burrows & organic rich clay up section.

Highly stylolitized zone of light brown gnstn/pkstn. Slightly dolomitized lower foot.

Wispy laminated slightly dolomitic gnstn to wkstns. Wispy laminations disseminated throughout w/ common zones of concentrated dolomitization generally associated w/ wispy laminations. Concentrations [illegible]. 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

Porous foraminifera gnsnt 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

Tan pkstn & gnstns w/ scattered large silicified nodules up to 7cm long. More organics lower half. Allochems(1) from 5946 up section core is peppered w/ small (1 x 1 mm) silicified crinoid columns, also contains forams (some fusilinids), fossil debris and small round unidentifiable grains. (2) below 5946 scattered crinoid parts, some forams & unidentified grains.

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 across. Much smaller than those found below.

Interbedded dol wkstn & dol mdstn. 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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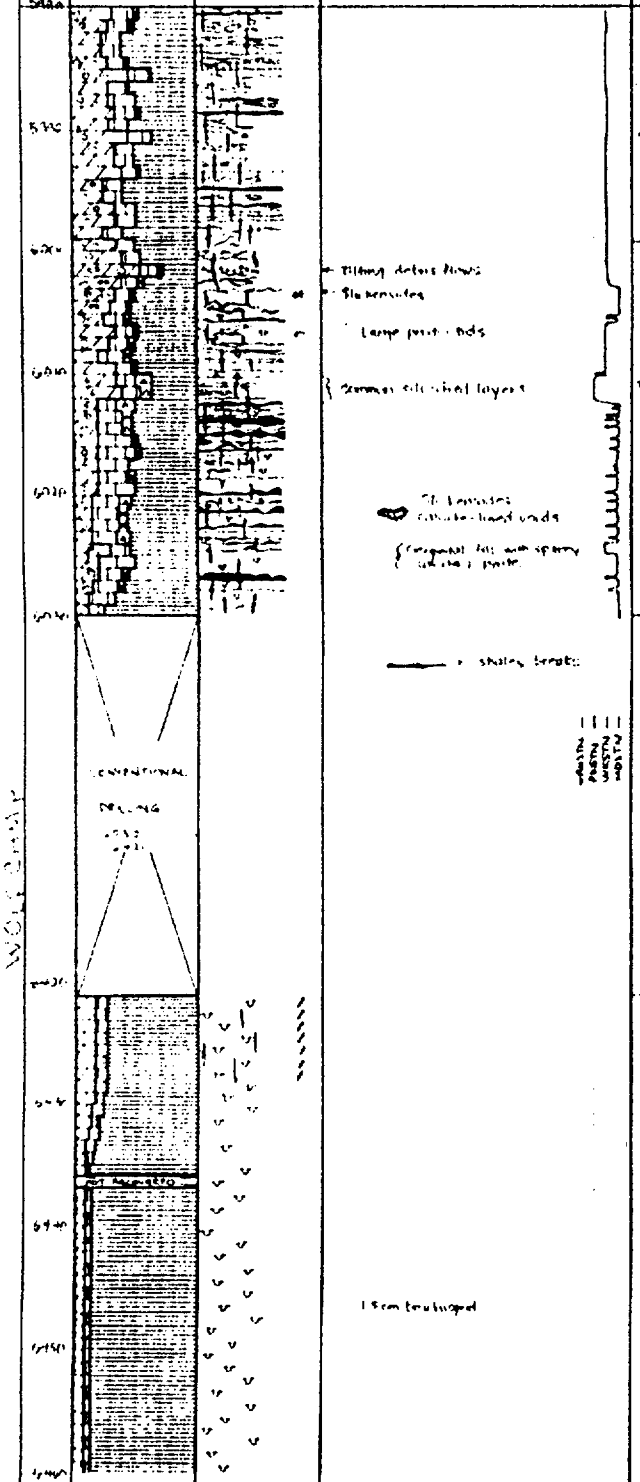
WELL J. Friemel COUNTY Deaf Smith DATE December '85

INTERVAL 5980 6460 WOLFCAMP LOGGED BY ST, GL, DJ, SR, GC

WOLFCAMP

FEET BELOW	LITHOLOGY (%)	Structures	COMMENTS	CONTACTS	LITHOLOGIC DESCRIPTION



4.9

Dolomitic, fairly well indurated, black mdstn/claystn to argillaceous dolostn w/ 10-20% fossil allochems primarily crinoid columnals & brachiopods often w/ geopetal fill. Fossils are generally partially silicified. Contains scattered zones & pockets of dolostn some w/ silicified edges. The mdstn/claystn appears bedded which may or may not be original. Has undergone deformation. Fossils don't appear deformed. Unit fractured throughout but fractures less numerous than underlying core.

-6

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 siliceous ring, are generally zoned inward: silica, dolomite, limestone mud w/ silica replaced fossil allochems. The lithology outside these 'nodules' is a melange of well indurated, bioturbated muddy dolomite & black shales w/ calcic allochems only partially silicified if at all, most common & the largest present, in the shaley zones.

Allochems include, crinoid columns (up to 2cm 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

Photo at 6010-6012.8 high diversity, small fossils average 1mm & sever 2 feet contains tilting, graded crinoid debris flows in lime mud matrix

Note: estimating lithologies in above core proved extremely difficult, especially delineating mud/clay & dol fractions, actual % of dol might prove to be less after petrographic analysis.

39

Black dolomitic clayshale becoming somewhat better indurated from 6442.3 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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transcribed by JH JH date 1 86

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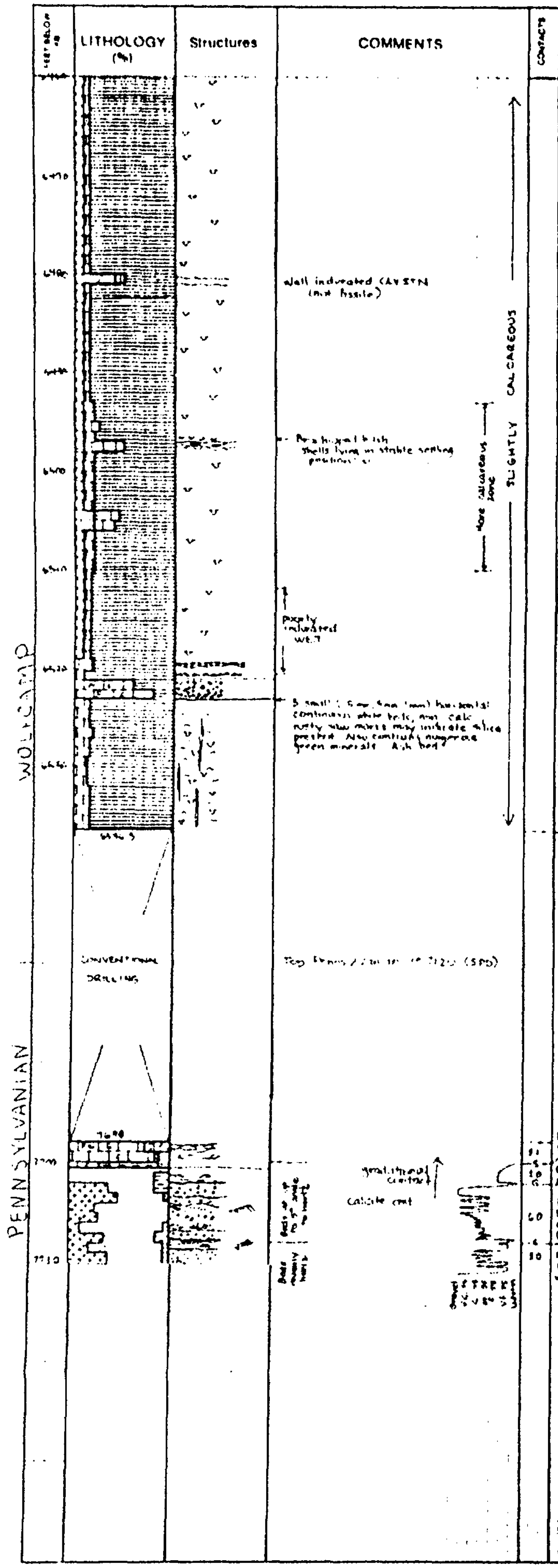
WELL J Friemel COUNTY Deaf Smith DATE

INTERVAL 6460-7110 WOLFCAMP, PENNSYLVANIAN LOGGED BY

FEET BELOW | LITHOLOGY (%) | Structures | COMMENTS | CONTACTS | LITHOLOGIC DESCRIPTION



Dolomitic & calcareous black mud shales, small horizontal burrows throughout section.

Laminated gray mdstn well indurated

Unusual breccia w/ black mdstn matrix. Clasts are angular, up to 6cm in size, & generally calcic. Clasts include broken & whole fossil debris (crinoid parts, mollusk/brachiopod shells & fusilinids) & carbonate (algal) 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 (to 7mm) thin shelled brachiopods (calcic) are present throughout. Entire section is vertically fractured. Section is slightly calcareous.

Black calcareous mdstn sharply overlain by broken muddy wkstn-pkstn 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 increase 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

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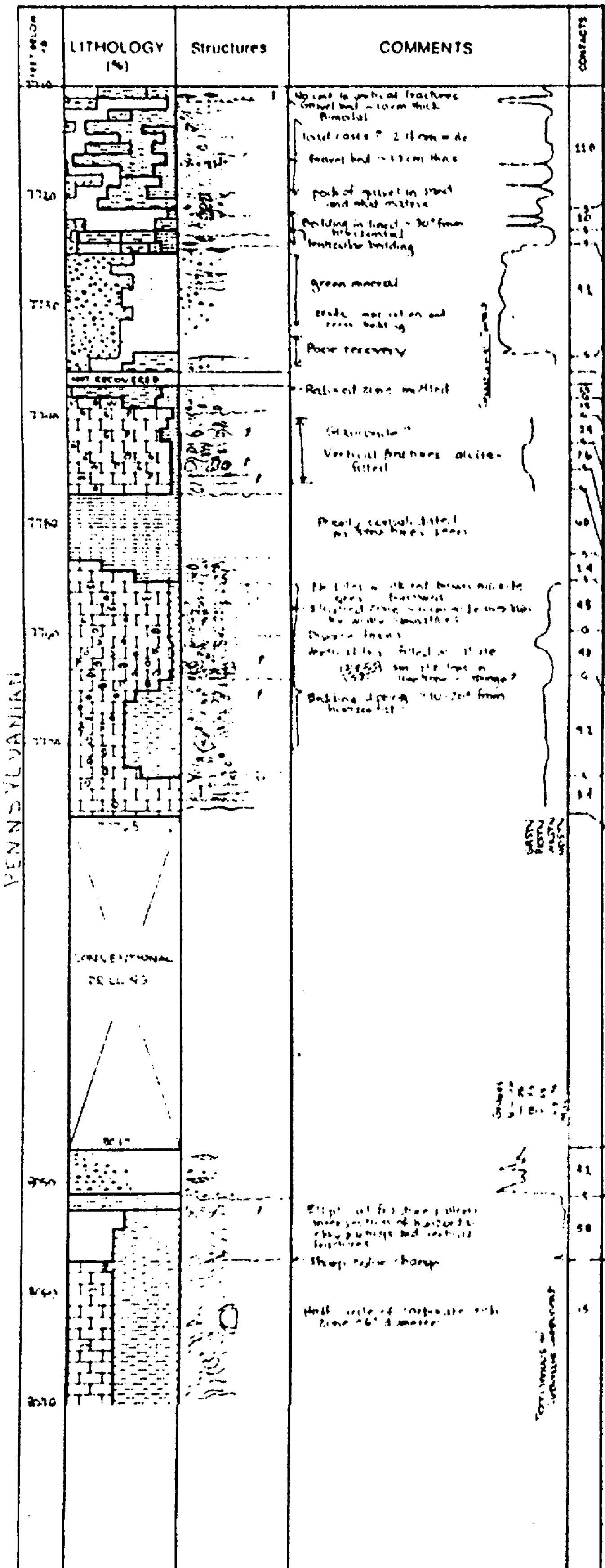
WELL J. Friemel COUNTY Deaf Smith DATE

INTERVAL 7710 8010 PENNSYLVANIAN LOGGED BY



CONTACTS	LITHOLOGIC DESCRIPTION
110	Dark red disturbed to wispy laminated mdstn containing several types of pink ss bodies w/ quartz & feldspar grains. 1) irregular lenses of gravel & sand grains surrounded by a mud matrix, 2) beds of subrounded to rounded gravel which appear to coarsen upward; 3) ungraded subangular granules floating in a mud matrix some w/wispy clay clasts; 4) irregular fine to medium ss beds, some w remnant cross-bedding. Some ss bodies contain dark platy mineral & are surrounded by an olive green zone
10	Pink cross laminated, generally coarsening upward sequences of fine ss to pebble congl, some laminations defined by dark green/black platy mineral
9	Alternating red/green/black disturbed ripple laminated mdstn containing small (about 3mm) irregular bodies & laminations of fine pink ss & areas of coarser grained sand disseminated in mud matrix.
41	Pink pebble/granule crudely cross laminated congl w/ coarse ss matrix, contains subangular to subrounded k-spar, quartz and green rock fragments. Carbonate cement Lower 1.5' has dark gray finer matrix.
6	Mottled gray/green & dark red disrupted siltstn/very fine ss w. irregular body of subrounded pebble sized feldspars at base & black wispy bodies (organics?) throughout.
15	Dark red wispy laminated carbonate cemented mdstn w/ shell fragments & clay partings decreasing in abundance upwards.
24	Pale yellow/white blue to olive green wispy to crudely cross laminated pkstn, contains silt sized grains of sand & k-spar (orange color). Allochems increase in abundance upwards, patchy carbonate cementation occurs lending a nodular appearance
76	Light olive green contortedly laminated argillaceous pkstn containing "nodules" of tan pkstn, some w/ fragments of bryozoans & mollusks. Nodules similar to those in overlying unit. Some laminations defined by organics
60	Pink/tan/gray shell hash pkstn/gnstn nodular appearing w/ dark olive green/black contorted laminations argillaceous pkstn surrounding pkstn, pkstn areas Allochems include crinoids, fusilinids, shell fragments. Contains silt sized grains of pink mineral (k-spar), pyrite, yellow red green minerals "staining" fossil fragments
	Tan massive stylolitized pkstn w/ increasing clay content down section
14	Dark reddish brown unconsolidated to poorly consolidated claystn, organic rich body at the top of the unit.
	Nodular tannish gray wkstn in dark red brown clay matrix w/ alternating contorted red and olive green laminations.
48	Tan/buff to light olive green mdstn/wkstn w/ "cheese curd" texture due to color change. Tan areas (1-6cm long) draped & surrounded by light green silty zones, becomes contortedly laminated w/ nodules (1-8cm long) at base.
40	Tan/light brown nodular to mottled shell hash pkstn w/ wispy laminations of olive green mud rich areas surrounding nodules. Some nodules have embayed surfaces filled w/ terrigenous-carbonated cemented areas. Silicified nodule at 7761. (See drawing in comments).
92	Black to dark tan/gray wispy laminated argillaceous crinoid pkstn. Some limey areas have burrows and show embayed contacts w/ darker organic rich finer zones. Black clay-rich areas drape and undercut coarser zones in upper portion of unit becoming more homogenous towards base and clay content increasing. Allochems also include shell fragments. Generally crinoids are disseminated throughout w/ some concentrations in zones. Calcite filled high angle (about 60 degrees) at 7766
34	Yellowish gray stylolitized massive wkstn w/ clay breaks, cal filled vertical fractures, stylolites and irregular voids (some suggesting replaced allochems filled w/ spar throughout. Contact w/ overlying unit is sharp w/ clay lenses in wkstn and irregular voids (burrows?) filled w/ clay and spar in top 1' of unit
41	Pink pebble crudely cross laminated congl/coarse ss, calcite cement and areas of pyrite cementation. Laminations more apparent in finer areas. Contains sub rounded/subangular qtz and pink feldspar grains
50	Greyish olive green wispy laminated siltstn/mdstn. The ss contains subrounded sand sized feldspar grains. Clay partings and fractures increase downwards and laminations become somewhat parallel. No calcite.
15	Grayish black wispy laminated limey mdstn/claystn w/ medium gray lenticular and irregularly shaped carbonate rich areas. Finer areas drape a large circular shaped carbonate zone and wispy laminations appear distorted below the zone. Unit contains a few bivalves and sand/pebble sized grains of feldspar. Bedding dips 10-15 degrees from horizontal.

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

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

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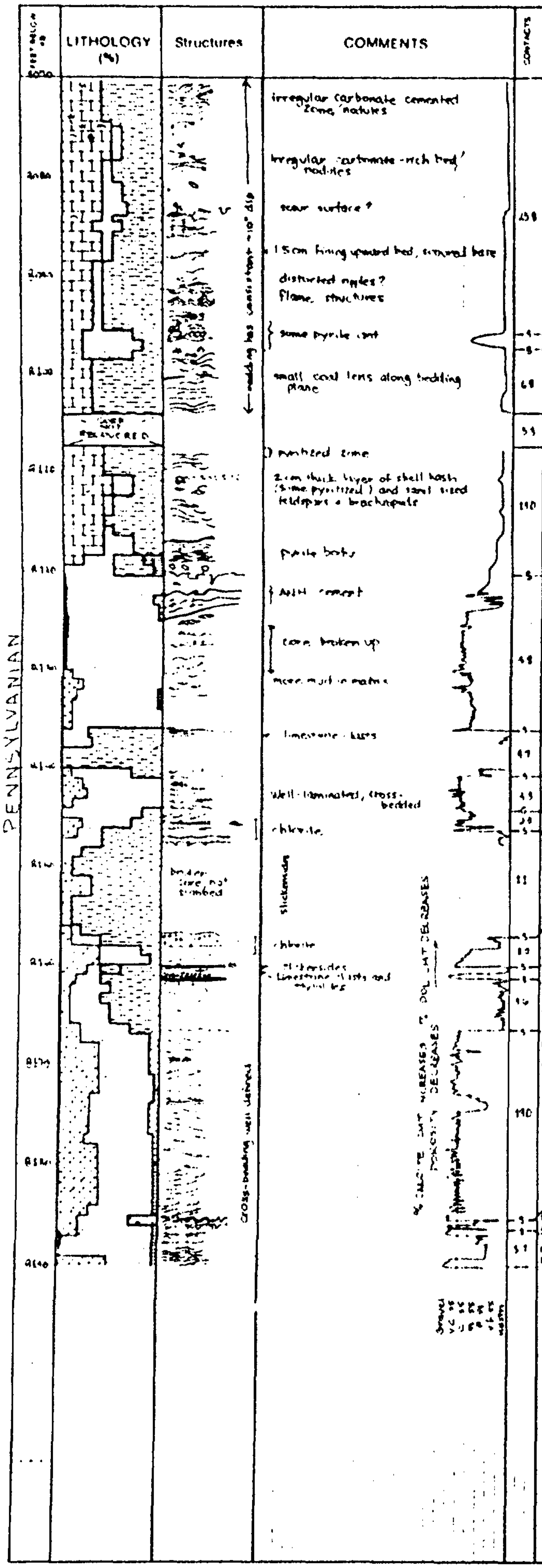
WELL [illegible]   COUNTY Deaf Smith   DATE [illegible]

INTERVAL 8070-8190   PENNSYLVANIAN   LOGGED BY [illegible]



LITHOLOGIC DESCRIPTION

Light gray/black muddy/silty contortedly laminated mdstn which contains sand and pebble sized grains of feldspars and granitic rock fragments. Sparse large skeletal grains, thin walled brachiopods.

Coarser material shows soft sediment deformation, some scour surfaces, distorted ripple laminations and is disseminated throughout in mud rich matrix. Suggested ripple laminations disturbed by burrowing or soft sediment deformation.

Rare allochems dispersed throughout the interval are mollusks, shell hash, brachiopods and gastropods. Some intervals show greater concentrations of allochems.

Wispy laminated soft sediment deformed ripples.

Highly distorted ss and muds intermingled as flame structures/ball and pillow structures or burrowing?

Carbonated cemented massive subround/round feldspar rich coarse ss w/ mud rich rip-up clasts (some rounded) and one gastropod shell filled w/ finer material.

Black/gray wispy laminated mdstn w/ carbonate component. Mdst contains sand sized feldspars in varying amounts, as irregular bodies and disseminated in mud matrix. Sand component increases towards base. Contains disseminated pyrite in top portions of unit and an elongate (1.5cm by 1cm) globular pyrite body at about 8118.5. Dispersed allochems are brachiopods.

Sand rich zone w/ clay rich drapes gives a nodular texture to interval just above contact.

Pink very coarse to fine cross laminated ss sequences w/ a few thin (max 3-4 mm (mm)) brownish gray silty interbeds. Top .7' of unit is very fine grained pink ss w/ coarser material disseminated and irregular wispy black (organic) mud bodies (from dewatering of sand?)

Olive green sandy mdstn w/ horizontal muddy sand beds top and bottom [illegible] mdstn clast top .5'

Pink poor/moderately sorted gravely sand w/ black organic mud stringers basal 2 feet. Graded beds most pronounced 8141.8-8143.0

Gravely poorly sorted sand w/ green mud matrix decreasing up section. Unit contains crudely graded beds.

Poorly consolidated black mdstn w/ green patches becomes brown mdstn at 8151.5 which becomes increasingly green up section. Upper and lower portions sandy.

Unit is broken, crumbly and contains numerous slickensides.

Well cemented gravely sand w/ green intergranular mud increasing up section. Grain size to 2mm

Pink sandy gravel w/ green mud matrix grades up section to green mdstn w/ lmstn clasts.

Olive green sandy gravely mdstn. Grain size to 3mm (pebble size). Texture appears highly disturbed, fractured?

Crudely cross stratified (about 10 degrees from horizontal) pink gravely coarse sand to sandy gravel cong. Contains numerous stacked, crudely graded beds, generally 5-10mm thick. Sorting is poor to moderate. Dol cement.

Lenticular and irregular shaped medium ss to granule cong in olive green silty mdstn. Matrix displaying characteristics of soft sediment loading.

Moderately sorted pink fine to medium sand. Sand generally coarsens up section. Pebble size grains appear at 8187.0. Sharply overlain by pink pebble congl.

logged by TH   date 2-84
SJ   date 3-84
checked SH   date 4/84
transcribed by TH [illegible]   date 5/84
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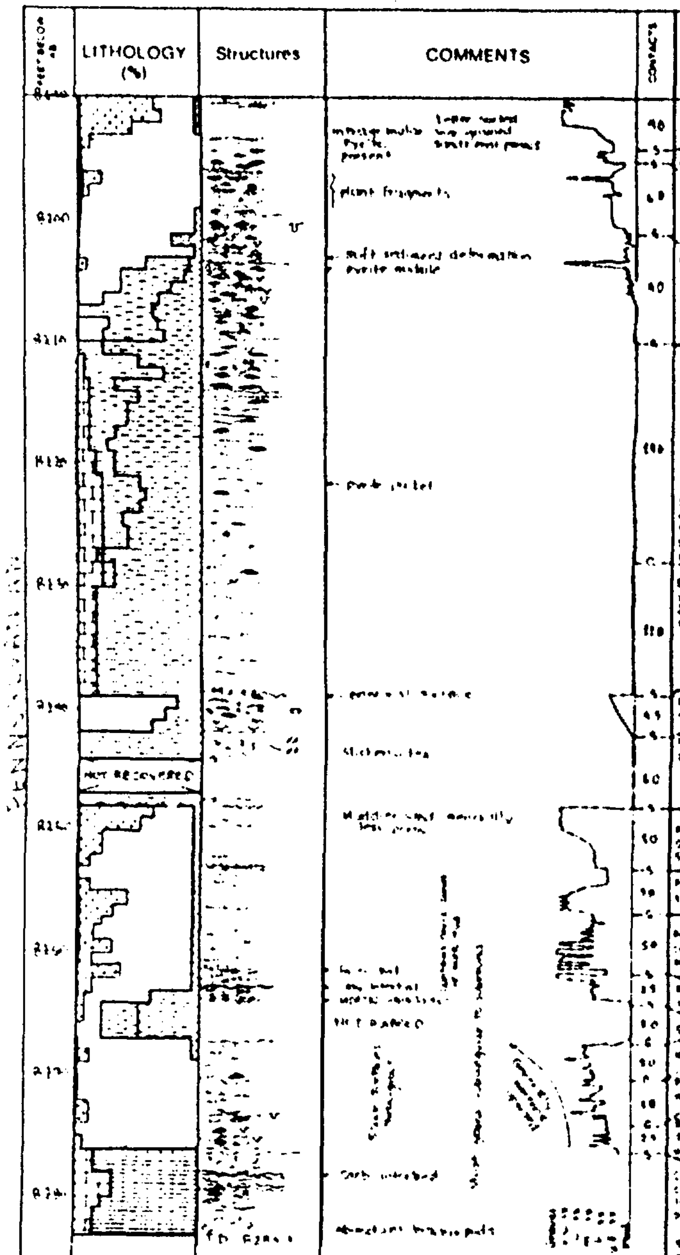
WELL 3. J. Friemel COUNTY Deaf Smith DATE February March, 81

INTERVAL 8090 8183.5 PENNSYLVANIAN LOGGED BY SF, BG, [illegible]



LITHOLOGIC DESCRIPTION

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

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

Very porous gray to pinkish very fine to fine ss containing repeating sedimentary structure sequences, of trough cross bedding, climbing ripples and fine parallel to undulatory ripple laminations. Black organics generally increase in each sequence up section and most abundant in rippling parallel laminations. [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. Silt & mdstn often forms small discontinuous lenses, 1cm long by 1mm high. [illegible] of [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 [illegible]. Siltstone grades from discontinuous lenses to continuous horizontal beds. Silt bed thickness and percentage silt increasing up section. [illegible] dispersed in 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 1cm) 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 gravely medium-coarse ss grades to sandy gravel (to pebble size). Gravel size increases up section. Contact w/ overlying mdstn marked by about 5-6cm immature gravel which contains green mud. Carbonate cement.

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

Repeating sequences of sandy gravel grading to coarse to medium ss following very coarse sands grading to medium sands up section. [illegible] generally become 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 [illegible] ss. Dol cement.

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

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

Carbonaceous black shale w/ scattered carbonate interbeds (up to 1 cm) and carbonate starved ripples. Carbonate (small) [illegible] also [illegible] faint laminations at about 20 degrees from horizontal. Large brachiopod valves [illegible] present upper and lower portions.

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

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

logged by SF date [illegible]

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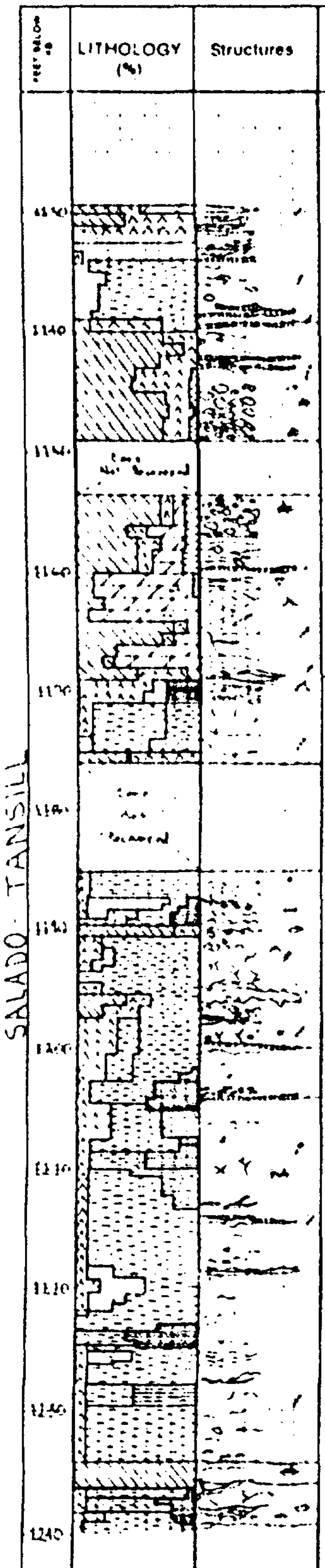
updated date

updated date

WELL Dallen COUNTY Deaf Smith DATE ·· 82

INTERVAL 1127 1240 SALADO - TANSILL LOGGED BY SF, HH, BL, MW, DP

SALADO - TANSILL



COMMENTS

Gyp fracture fill

ripples

Pink stain

fibrous gyp fracture fill

Pebbly gyp & anh replacement nodule. gyp

Anh replacing Dol

Gyp & Anh fracture fill

Gyp [illegible] slickensides

Reduced zone.

Fibrous Gyp fracture fill slickensides

Gyp sand?

Gyp fracture fill slickensides

Slightly brecciated

Fluid escape structures?

CONTACTS

LITHOLOGIC DESCRIPTION

Alternating layers of tan laminated dol & fibrous fracture fill gyp. [illegible] filled w/ scattered nodule like gyp replacing the dol. Bottom .6' contain ghost gyp pseudomorphs after grassmat swallowtail gyp. Dol laminated, ripple ? algal? fractures about 4 mm.

Grassmat; gyp & anh pseudomorphs after gyp, upper .6' & lower .2' fine crystalline gyp; mid .5' fine crystalline mixture of anh & gyp contains fibrous gyp fracture fill. Minor impurities.

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.

Ripple laminated very fine ss, well preserved cross bedding, subarkose, scale of structures about 7mm decreasing up sec tion; Mod red in color. 4 cm of pure fibrous gyp fracture fill at base. Cross beds low angle, gyp nodule, about 2 mm

Moderate reddish brown siltstn/sandy siltstn; Micaceous subarkose, 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 5mm is green clay

Bedded massive anh laminations parallel/slightly wavy; being converted to gyp. Gyp nodules scattered (1-5cm) coalescing & cut cross anh laminations. Upper .6' all gyp, fibrous & nodular. Fracture fill common fibrous gyp (15mm) nearly horizontal.

Gray nodular mosaic anh, zones of mosaic to bedded nodular mosaic. Red interstitial mud slightly dolomitic in lower footage. Nodules 1-30mm. Scattered gyp nodules (1-10mm) coalescing into larger nodules & zones. Replacement, structure (mdstn laminations) disrupted by gyp nodules. Common fibrous gyp fracture fill 2-8mm.

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 2-35mm scattered & patchy. Anh nodules appear "fuzzy".

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 5mm in mud & laminated dol (algal?) mdstn.

Green gray dol mdstn w/ green clay laminae parallel to wavy, highly stylolitized replacive crystallotopic anh. Dol mdstn may be ripple laminated

Gray dol mdstn w/ disturbed & broken bedding, intraclasts, stylolitized, green clay laminations & anh & gyp fracture fill.

Laminated anh w/ thin interbeds (less than 1 mm) of gray dol mdstn, anh beds .5-1 cm thick, parallel to slightly wavy & lie about 10 degrees from horizontal. Upper boundary stylolitic, Anh replacing dol

Laminated (algal) dol mdstn, laminations .25 to 1 mm & contain numerous vertically oriented cracks. Interbeds of anh .25 5mm, decreasing up section. Possible ripple laminations. Dol laminations contorted & increasingly broken up section until upper .6' contains no laminations, where it becomes intraclastic

Laminated anh w/ numerous gyp replacement nodules & 3 large fractures filled w fibrous gyp (1 cm thick) thin interbeds of gray dol (less than 1 mm). Zone 2 cm thick of dol mdstn, anh laminations 1-5mm (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

Moderate reddish brown siltstn; subarkose, 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 downward from top of section

12 Moderate reddish brown clay rich, sandy mdstn. Varying % sand & clay. Common gyp crystallotopic grains often in stringers. Scattered reduction spots 1-15mm) Interbeds of anh w/ nodular gyp replacement. Upper bed bedded massive lower bed massive w/ thin interstitial mud layers

9 Dark reddish brown mdstn. Scattered reductions spots w/ black cores (6-12mm) Contain crystallotopic 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

3.5 Moderate reddish brown gypsiferous siltstn/mdstn, displacive crystallotopic gyp crystals coalescing into nodular like morphology. Appears to have contorted possible bedding planes. Nodules about 2-5mm average. Possible detrital gyp

1.9 Dark reddish brown claystn/mdstn w/ nodular gyp growth up to 15mm also gyp fracture fill.

13 Moderate reddish orange siltstn w/ muddy & sandy zones which contain crystallotopic gyp. Gyp crystals coalescing in bands, nodules & irregular ropey morphologies. Fibrous gyp fracture fill. Gyp grains appear secondary but some maybe detrital

11 Alternating units of dark reddish brown claystn/mdstn w/ silty bedded micaceous siltstn/sandy siltstn; clay rich units contain minor amounts of gyp via fracture fill & widely spaced black centered reduction spots up to 1.5 cm) average 4mm) Siltstns 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 mm some w/ black cores. Sedimentary structures, scours, ripple laminations, silty laminations, deformed beds & rip up clasts.

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.

3.6 Highly fractured moderately reddish brown clayey siltstn 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).

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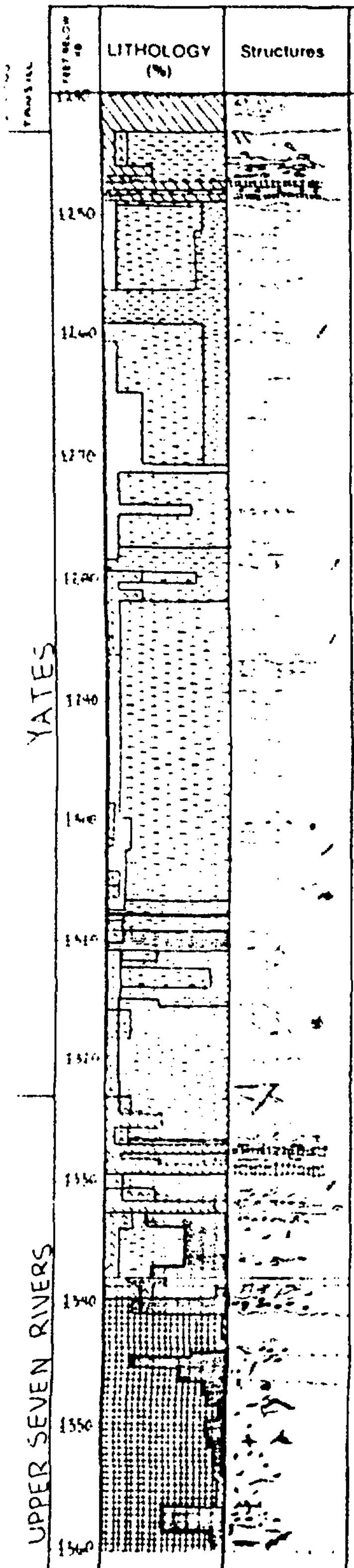
WELL Detten COUNTY Deaf Smith DATE [illegible]

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



COMMENTS

Reduction spots

contorted starved ripples

Reduction spots

disturbed crossbeds 2mm high

bimodal ss, disrupted placers

sharp textural break, although no visible erosion surface

Reduction spots

Reduced zone

Reduction spots

Reduced zone

Small rounded mud clasts define disturbed bedding

[illegible]

POLYHALITE, MAGNESITE

CONTACTS / **LITHOLOGIC DESCRIPTION**

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

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

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

White gray anh w/ pink laminations at 1245.6.

White gray laminated anh.

Insoluble residue; mud clasts, disturbed, about 5mm anh nodules. 2mm euhedral gyp crystals present.

White gray laminated anh

Description 1249'-1339'

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

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

Fine to medium very well rounded quartz grains in muddy coarse silt very fine sand matrix at 1276.75.

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

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

Very thin clay laminae in mdstn at 1307.7.

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

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

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

1.5 Distorted bedded nodular anhydrite.

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

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

Wispy laminated anh, nodular at contact.

Disrupted claystn, anh present as fracture fill

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

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

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

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

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

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

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

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

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

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

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

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

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

logged by DP, BL date 4/83

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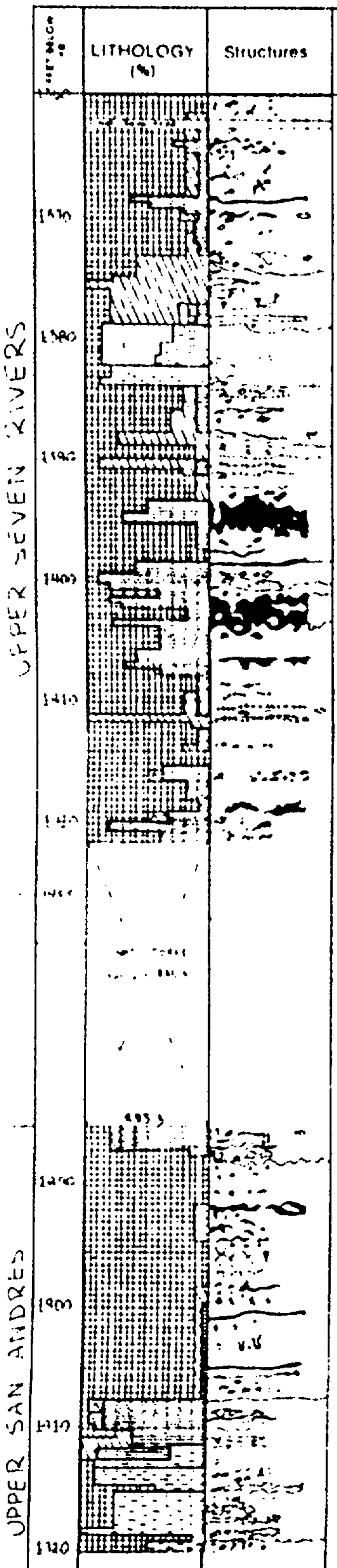
WELL Deffen COUNTY Deaf Smith DATE 11-82

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



COMMENTS	CONTACTS	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 equant 2 x 2 cm anh nodules at 1369.8. 4mm distorted claystn layer defines upper contact.
Polyhalite? ... bedded	5.6	Milky pink/orange/white anh w/ varying proportions of hal crystals aggregates of 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 1'. Hematite stained clay define wispy laminations.
	5.2	Moderate red brown siltstn grading to fine ss. Very faint intraclastic appearance. gyp predominate clastic grains. Sparse anh crystals aggregates. Hal & minor carbonate cement.
	3.0	Chaotic mud salt, anh layers present at 1387.0, 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
Diagonal chevrons	1.5	Sparse horizontal anh layers present. Salt crystals average .75 x .5cm
	--	Disrupted laminae.
	2.4	Recrystallized salt, occasional 1 cm x .5 cm anh nodules & anh stringers present. Hal crystals up to 3 x 3 cm.
	2	Hal w/ minor 2 cm x .5 cm anh nodules, very sparse 1 mm 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 2' has claystn w/ about 2cm hal crystals overlain by claystn w/ 4mm euhedral/subhedral salt crystals
	6	Chaotic mud salt. large clear to cloudy displacive hal crystals (up to 3 cm) Moderate red brown claystn in angular clasts. Distorted gyp nodule present (2cm) at about 1418.5. Undeformed mud drape present at 1415.3; high mud content below, less mud above.
patches of disturbed and undisturbed Chevrons very large hal cubes	2	Chaotic mud salt. Clear, subhedral hal crystals up to 2cm x 1 cm. Very disturbed laminations & intraclasts in claystn/mdstn defined by variations in hematite stain. Dispersed small (less than 1 mm) anh nodules
Color band, no recognizable primary fabric, may be dissolved, but no collapse intergranular porosity	11.2	Chaotic mud salt.
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 1912.5, 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 3 cm) present, with vugs, at 1911.7. Anh present as .5mm to 5 cm nodules from 1910.8-1909.1. Gyp within gray claystn at 1908.1.
Chevrons 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 1918.1.
	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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CORE TEST WELL
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D-01A (IMAGE 1 OF 2)
D-01B (IMAGE 2 OF 2)

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