

Spring 1-27-1964

Slope Deposits of the Pennsylvanian Haymond Formation, Marathon Region, Texas

Walter E. Dean Jr.

Follow this and additional works at: https://digitalrepository.unm.edu/eps_etds



Part of the [Geology Commons](#), [Hydrology Commons](#), and the [Other Earth Sciences Commons](#)

Recommended Citation

Dean, Walter E. Jr.. "Slope Deposits of the Pennsylvanian Haymond Formation, Marathon Region, Texas." (1964).
https://digitalrepository.unm.edu/eps_etds/136

This Thesis is brought to you for free and open access by the Electronic Theses and Dissertations at UNM Digital Repository. It has been accepted for inclusion in Earth and Planetary Sciences ETDs by an authorized administrator of UNM Digital Repository. For more information, please contact disc@unm.edu.

UNIVERSITY OF NEW MEXICO-UNIVERSITY LIBRARIES



A14429 082103

SCOPE DEPOSITS OF THE PENNSYLVANIAN HAYWIND FORMATION - - DEAN

378.789
U₃30de
1964
cop. 2

THE LIBRARY
UNIVERSITY OF NEW MEXICO



Call No.

Accession
Number

378.789
Un30de
1964
cop.2

321715

A14408 802946

IMPORTANT!

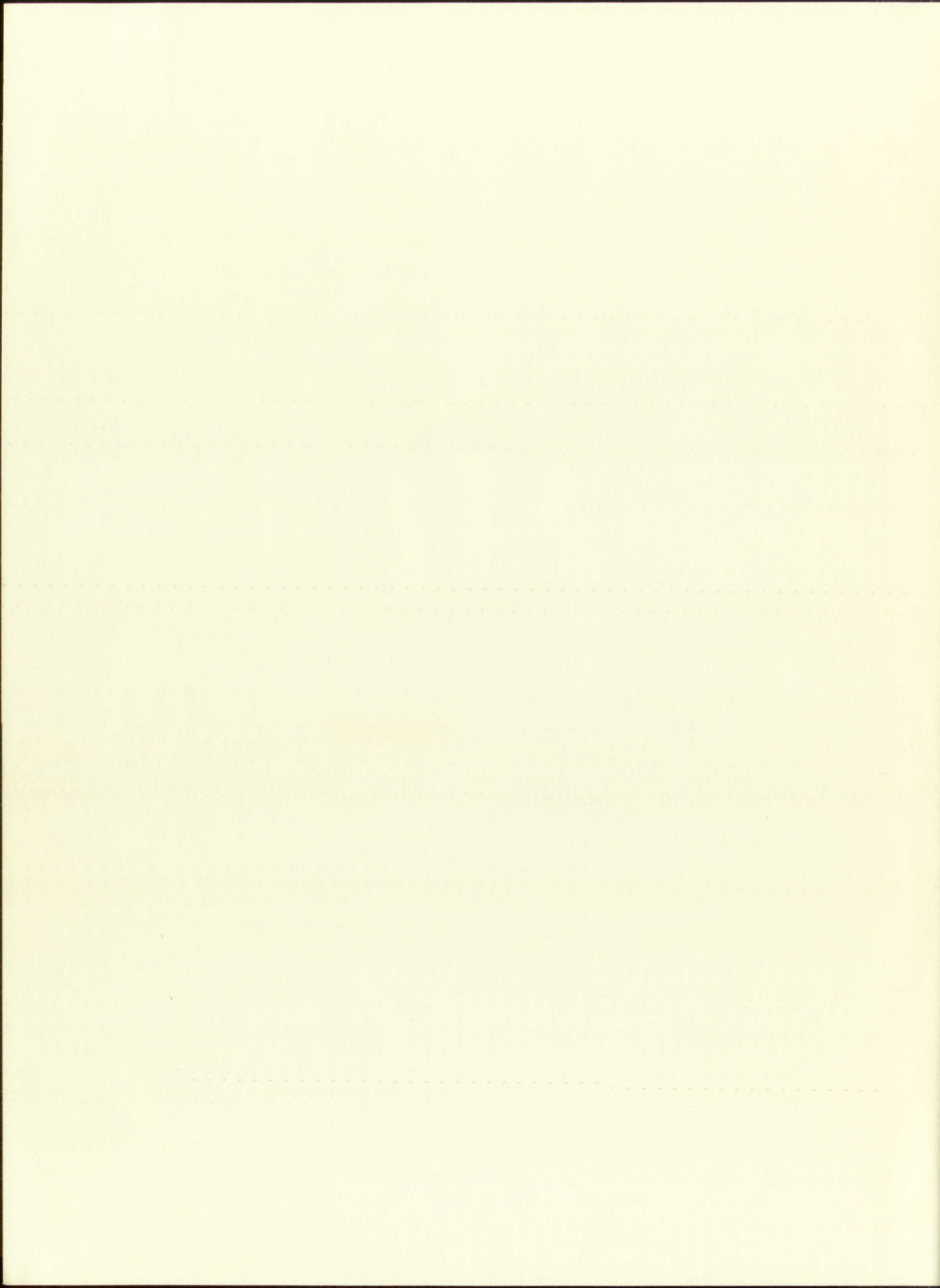
Special care should be taken to prevent damage of this volume. If lost or damaged must be paid for at the current rate of

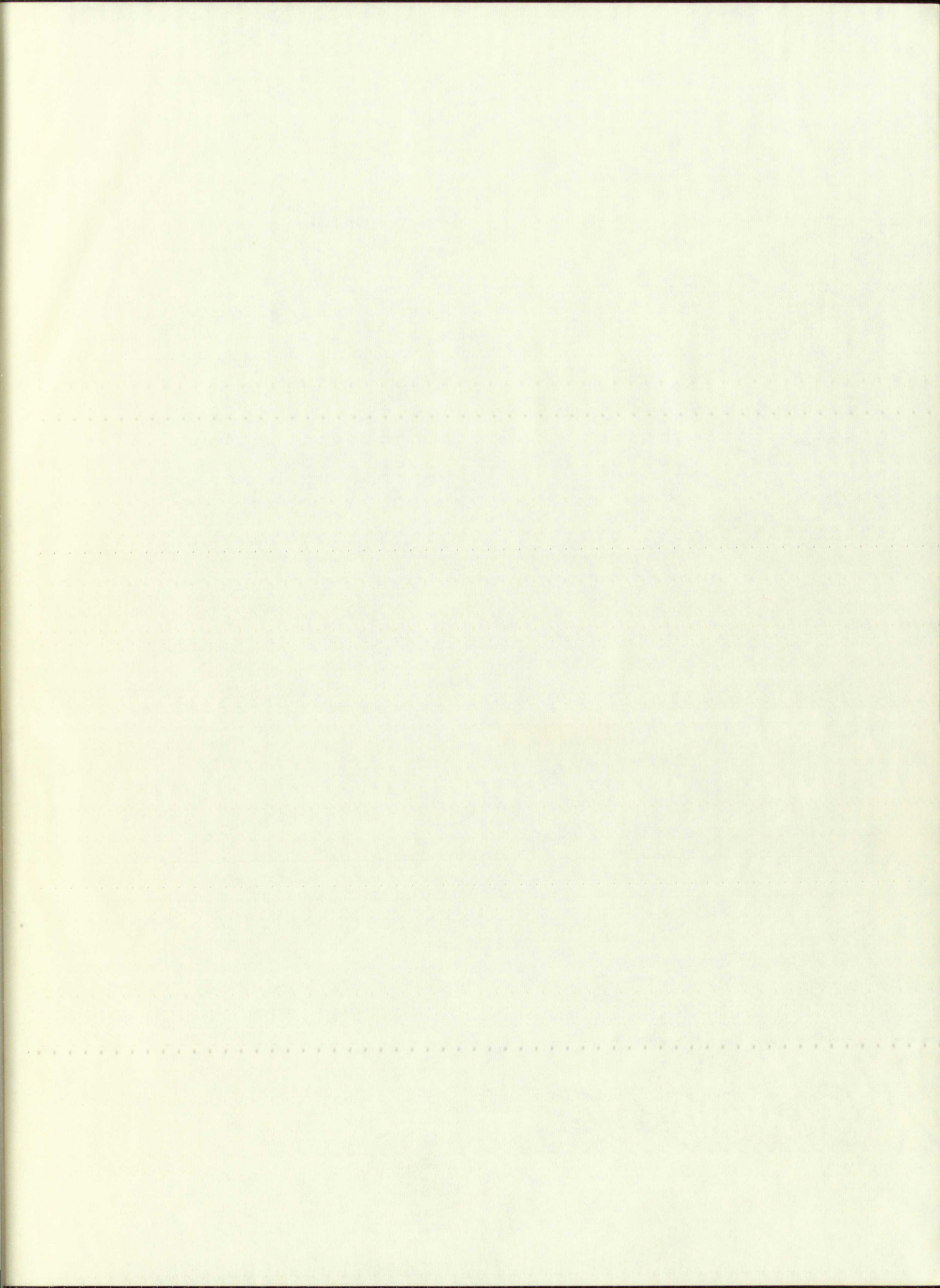
Each reader is required to read the regulations and sign his name on the sheet provided in the front of this thesis.

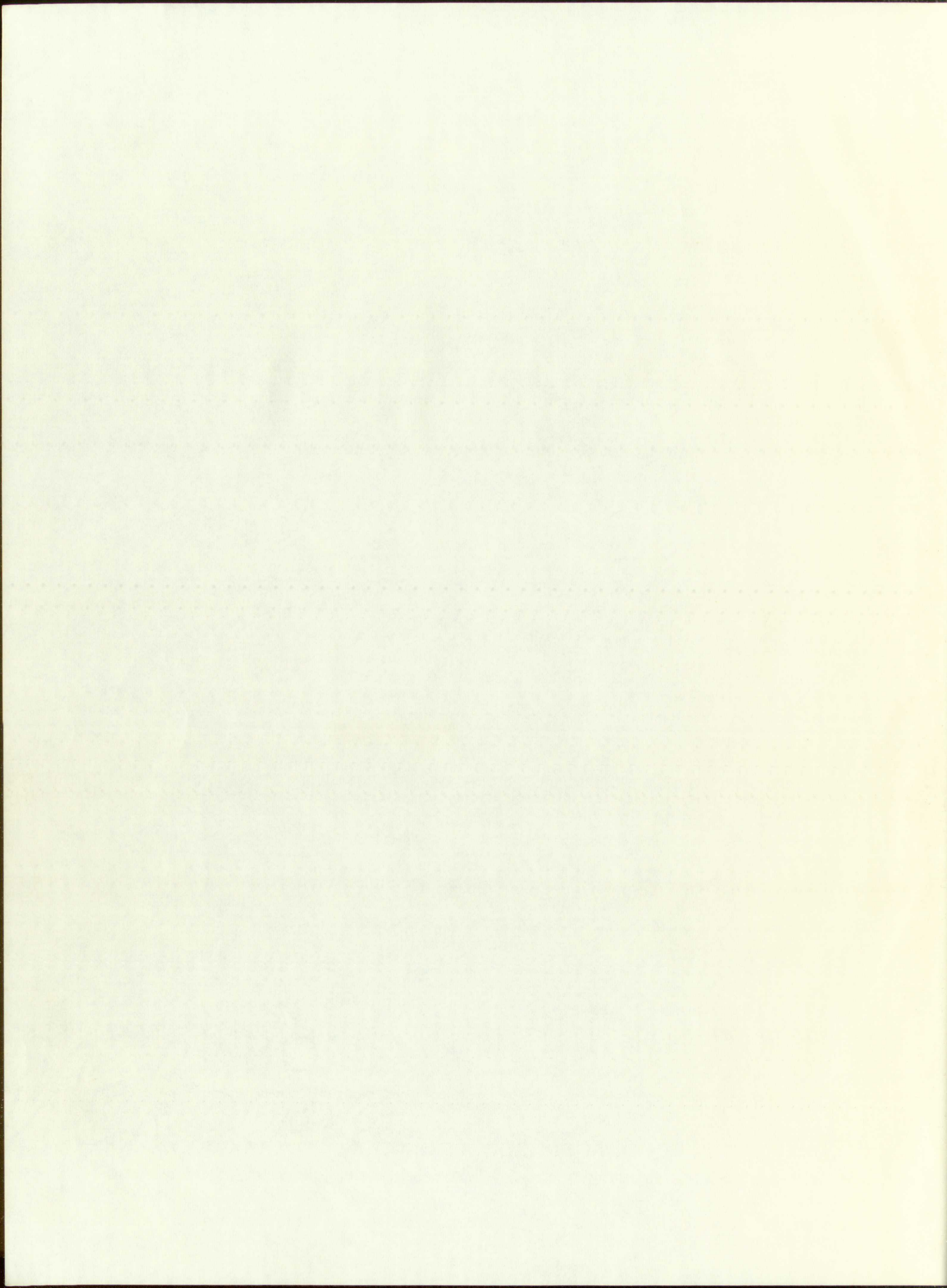
DATE DUE	
MAR 10 1965	
MAR-8 RECD	
JUN 11 1965	
JUN 14 RECD	
JUL 4 1968	
JUL 3 RECD	
JUL 26 '87	
JUL 11 '87	
GAYLORD	PRINTED IN U.S.A











UNIVERSITY OF NEW MEXICO LIBRARY

MANUSCRIPT THESES

Unpublished theses submitted for the Master's and Doctor's degrees and deposited in the University of New Mexico Library are open for inspection, but are to be used only with due regard to the rights of the authors. Bibliographical references may be noted, but passages may be copied only with the permission of the authors, and proper credit must be given in subsequent written or published work. Extensive copying or publication of the thesis in whole or in part requires also the consent of the Dean of the Graduate School of the University of New Mexico.

This thesis by Walter E. Dean, Jr.
has been used by the following persons, whose signatures attest their acceptance of the above restrictions.

A Library which borrows this thesis for use by its patrons is expected to secure the signature of each user.

NAME AND ADDRESS

DATE

<i>E. F. McBride</i>	<i>Dept. Geology Univ Texas</i>	<i>Feb 29 1968</i>
<i>E. F. McBride</i>	<i>Dept. Geology Univ Texas</i>	<i>May 20, 1965</i>
<i>N. Hamula</i>	<i>Plano Texas</i>	<i>June 27 1968</i>
<i>A. Sajoja</i>	<i>UNM-UC Some, NM</i>	<i>29 June 1987</i>

MANUSCRIPT THESIS

Unpublished thesis admitted to the University of New Mexico... given and deposited in the University of New Mexico... open for inspection, but are to be returned to the author... rights of the author. Biological researches and... passages may be copied for the general reader... proper credit must be given in a separate... work. Extensive copying or reproduction... part requires also the consent of the... of the University of New Mexico.

This thesis by _____
has been read by the following persons whose signatures and
acceptance of the above conditions

A library which borrows this thesis is
expected to secure the signature of each reader

NAME AND ADDRESS _____
DATE _____

E. F. ...
E. F. ...
E. F. ...

SLOPE DEPOSITS OF THE PENNSYLVANIAN HAYMOND
FORMATION, MARATHON REGION, TEXAS

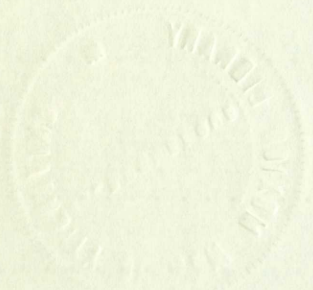
by

Walter E. Dean, Jr.

A Thesis

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Geology

The University of New Mexico
1964



This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

W. J. Parish

Dean

Jan. 27, 1964

Date

Thesis committee

Roger F. Anderson

Chairman

Shannon A. Wenzel

J. Paul Hutchinson

This thesis, directed and supervised by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTERS OF SCIENCE

_____ Date

MILLERS D

OLD DEER

500 COTTON

Thesis committee

Chairman

378.789
Unzode
1964
cop. 2

CONTENTS

	Page
Abstract	1
Introduction	3
Location	3
Purpose	5
Acknowledgments	5
Stratigraphy and structure	6
General characteristics	6
Age and stratigraphic relations	9
Structural history	10
Petrology	12
General description	12
Petrography	12
Siltstone	12
Quartz	16
Plagioclase feldspar	16
Garnet	16
Muscovite	16
Biotite	16
Clay	16
Plant fragments	17
Silty claystone	17
Shale	18
Chemical analyses	19
Calcium and magnesium carbonate	19
Iron	19
Organic nitrogen	20
Sedimentary structures	22
Stratification	22
Internal structures	23
Horizontal laminations	27
Cross-laminations	27
Convolute-laminations	28
Graded bedding	29
Sole markings	30
Statistical analyses	34
Correlation	39
Origin of stratification	42
Conclusions	47
References cited	49

CONTENTS

Page

Abstract 1

Introduction 2

Location 3

Purpose 4

Knowledge 5

Stratigraphy and structure 6

General characteristics 7

Age and stratigraphic relations 8

Geological history 9

Petrology 10

General description 11

Petrography 12

Gypsum 13

Waste 14

Glauconitic sandstone 15

Barren 16

..... 17

..... 18

..... 19

..... 20

..... 21

..... 22

..... 23

..... 24

..... 25

..... 26

..... 27

..... 28

..... 29

..... 30

..... 31

..... 32

..... 33

..... 34

..... 35

..... 36

..... 37

..... 38

..... 39

..... 40

..... 41

..... 42

..... 43

..... 44

..... 45

..... 46

..... 47

..... 48

..... 49

..... 50

..... 51

..... 52

..... 53

..... 54

..... 55

..... 56

..... 57

..... 58

..... 59

..... 60

..... 61

..... 62

..... 63

..... 64

..... 65

..... 66

..... 67

..... 68

..... 69

..... 70

..... 71

..... 72

..... 73

..... 74

..... 75

..... 76

..... 77

..... 78

..... 79

..... 80

..... 81

..... 82

..... 83

..... 84

..... 85

..... 86

..... 87

..... 88

..... 89

..... 90

..... 91

..... 92

..... 93

..... 94

..... 95

..... 96

..... 97

..... 98

..... 99

..... 100

	Page
Appendix I: Summary of the mineralogic composition of 18 samples from the Haymond Formation.....	56
Appendix II: Determination of organic (Kjeldahl) nitrogen, CaCO ₃ , MgCO ₃ , and total iron in the measured road-cut section of the Haymond Formation	57
Appendix III: Summary of flute and groove cast meas- urements on the bottom surfaces of silt beds of the Haymond Formation.....	59
Appendix IV: Silt, clay, and total couplet thickness (in feet) of the road-cut section of the Haymond Formation.....	63
Appendix V: Silt, clay, and total couplet thickness (in feet) of the railroad-cut section of the Haymond Formation.....	71
Appendix VI: Summary of the number of years between storms producing a sea level anomaly greater than 2 feet for 17 U. S. Coast and Geodetic Survey tide stations on the Atlantic and Gulf coasts.....	73

Appendix I: [Illegible text]

Appendix II: [Illegible text]

Appendix III: [Illegible text]

Appendix IV: [Illegible text]

Appendix V: [Illegible text]

Appendix VI: [Illegible text]

Appendix VII: [Illegible text]

Appendix VIII: [Illegible text]

Appendix IX: [Illegible text]

Appendix X: [Illegible text]

Appendix XI: [Illegible text]

Appendix XII: [Illegible text]

Appendix XIII: [Illegible text]

Appendix XIV: [Illegible text]

Appendix XV: [Illegible text]

Appendix XVI: [Illegible text]

Appendix XVII: [Illegible text]

Appendix XVIII: [Illegible text]

Appendix XIX: [Illegible text]

Appendix XX: [Illegible text]

Appendix XXI: [Illegible text]

Appendix XXII: [Illegible text]

Appendix XXIII: [Illegible text]

Appendix XXIV: [Illegible text]

Appendix XXV: [Illegible text]

Appendix XXVI: [Illegible text]

Appendix XXVII: [Illegible text]

Appendix XXVIII: [Illegible text]

Appendix XXIX: [Illegible text]

Appendix XXX: [Illegible text]

ILLUSTRATIONS

Figure		Page
1.	Outcrops of the Haymond Formation in the eastern part of the Marathon basin showing the locations of the two sections studied in this report.....	4
2.	Photographs of the two sections of the Haymond Formation studied in this report.....	7
3.	Photographs of the sections of the Haymond Formation used for correlation.	8
4.	Correlation of the Pennsylvanian System in southwest Texas, central Texas, and southern Oklahoma.....	10
5.	Grain size determinations of two siltstone samples of the Haymond Formation.	13
6.	Composition of siltstone, silty claystone, and shale of the Haymond Formation.....	13
7.	Summary of composition and paleo-current analyses of the road-cut section of the Haymond Formation.....	14
8.	Photomicrographs of siltstone, silty claystone, and shale of the Haymond Formation.....	15
9.	Variation of organic (Kjeldahl) nitrogen in the silty claystone, shale, and siltstone samples of the Haymond Formation.....	21
10.	Gradational contact between a siltstone and the overlying shale.....	22
11.	Sedimentary structures in two treated siltstone slabs from the Haymond Formation.....	25
12.	Sedimentary structures in two treated siltstone slabs from the Haymond Formation.....	26
13.	Variations in direction of flute and groove casts in the Haymond Formation..	33

1. General description of the study area
2. Description of the study area
3. Description of the study area
4. Description of the study area
5. Description of the study area
6. Description of the study area
7. Description of the study area
8. Description of the study area
9. Description of the study area
10. Description of the study area
11. Description of the study area
12. Description of the study area
13. Description of the study area
14. Description of the study area

Figure	Page
14. 31-unit moving average of silt-clay couplet thickness in the Haymond Formation.....	35
15. Silt-clay couplet thickness in the Haymond Formation.....	35
16. Silt layer thickness in the Haymond Formation.....	35
17. Clay layer thickness in the Haymond Formation.....	35
18. Stratigraphic columns of the road-cut and railroad-cut sections of the Haymond Formation.....	36
19. Percent frequency of siltstone and shale thickness for the road-cut and railroad-cut sections of the Haymond Formation.....	38
20. Monthly mean observed sea level and storm surge at 3 selected Coast and Geodetic Survey tide stations.....	45

Table

1. Upslope variation in silt and clay.....	41
--	----

- 1. 1-1-1900
- 2. 1-1-1900
- 3. 1-1-1900
- 4. 1-1-1900
- 5. 1-1-1900
- 6. 1-1-1900
- 7. 1-1-1900
- 8. 1-1-1900
- 9. 1-1-1900
- 10. 1-1-1900
- 11. 1-1-1900
- 12. 1-1-1900
- 13. 1-1-1900
- 14. 1-1-1900
- 15. 1-1-1900
- 16. 1-1-1900
- 17. 1-1-1900
- 18. 1-1-1900
- 19. 1-1-1900
- 20. 1-1-1900

ABSTRACT

The Haymond Formation of the Marathon basin, Texas consists mainly of a sequence of more than 12,000 siltstone-shale couplets which, combined with the similar couplets of the older Tesnus Formation, form a sequence of "flysch" sediments more than 10,000 feet thick deposited on the eastern slope of the subsiding Llanoria geosyncline. The Haymond Formation contains no diagnostic fossils; its age is known only as Lower Pennsylvanian, probably Atokan.

The siltstone and shale of the Haymond Formation differ in the relative amounts of quartz and clay matrix. There are also thin silty claystone layers which are closest to the shales in composition but resemble the siltstone layers in weathering characteristics. The silty claystone is believed to represent the downslope decrease of silt within siltstone layers. The calcium carbonate, magnesium carbonate, iron, and organic (Kjeldahl) nitrogen composition show little or no trends throughout the section.

The siltstone-shale couplets are the most obvious sedimentary structures in the Haymond Formation. The contact between a silt layer and the underlying clay layer is sharp, indicating rapid deposition by a silt-laden current. The gradational contact between the same silt layer and the overlying clay layer indicates a waning of the current and a reduction in the amount of silt, resulting in a sedimentologic silt-clay couplet.

Internal sedimentary structures, accentuated by X-radiographs and hydrofluoric acid etching, include horizontal micro-

The following table shows the results of the analysis of variance for the different factors considered in the present study. The results are given in terms of the F-ratios and the corresponding probabilities. The results are given in the following table.

Factor	F-ratio	Probability
Factor 1	12.34	0.001
Factor 2	5.67	0.01
Factor 3	3.21	0.05
Factor 4	1.89	0.1
Factor 5	0.98	0.3
Factor 6	0.54	0.5
Factor 7	0.23	0.6
Factor 8	0.12	0.7
Factor 9	0.08	0.8
Factor 10	0.05	0.9

The results of the analysis of variance are given in the following table. The results are given in terms of the F-ratios and the corresponding probabilities. The results are given in the following table.

laminations, cross-laminations, convolute-laminations, and graded bedding. The convolute-laminations are the result of plastic gravity deformation of horizontal or cross laminations in the upper part of silt layers. Vertical graded bedding is rarely noticeable except in the gradational contact between the silt and clay layers. Lateral grading is indicated by a 45 percent increase in thickness and a 46 percent increase in the number of silt layers within 5 miles in an upslope direction. Lateral persistence of the thickest layers is demonstrated by a +0.998 correlation coefficient over the 5 mile interval.

Directional measurements of 357 flute and groove casts on the lower bedding planes of silt layers indicate current azimuths, measured from south, ranging from 55° to 128° with a mean of 85° , implying an eastern source of material.

Thickness variations of the silt-clay couplets appear to be random although zones of thick couplets occur at the bottom and top of the section and exceptionally thick couplets were separated by an average of 40 thinner couplets. Seventy-five percent of all individual silt and clay layers are less than 0.2 foot thick.

The silt layers represent deposition by turbidity currents that were probably triggered by severe storms with an average frequency of less than 5 years. The downslope decrease in couplets indicates that not all of these storms were recorded as silt-clay couplets in the area of study.

directional relationships... The results of... plastic gravels... In the upper part of the... nearly horizontal... the clay and... 45 percent increase in... the number of... lateral persistence of... a 0.988 correlation coefficient... Directional relationships of... the lower bedding planes... thickness... a mean of 52... Thickness variations of the... the number... and top of the... separated by an average... percent of all... 0.15 foot thick... The all... that were probably... frequency of... counter... an all-clay... in this area of study.

INTRODUCTION

Location

The Haymond Formation is exposed in several northeast-trending synclinal valleys in the Marathon basin (Fig. 1). Located in the northern part of Brewster County in the Big Bend region of Texas, the Marathon topographic basin is 40 miles long and 30 miles wide and was formed by the erosion of a broad dome of Cretaceous limestone. The basin is bounded on the east, south, and west by gently dipping Cretaceous limestone and on the north by the Glass Mountains. Within the basin, tightly folded Paleozoic sediments form a series of northeast-trending ridges and valleys. The ridges are formed by the erosion of nonresistant shale enclosing two resistant formations, the Caballos Novaculite (Devonian ?) and the Dimple Limestone (Pennsylvanian). The Haymond Formation overlies the Dimple Limestone and forms several valleys to the east of Dimple ridges. Because of the mantle of alluvium, good exposures of the Haymond Formation are limited to cuts along U. S. Highway 90 and the Southern Pacific Railroad, and occasionally in stream banks. Two exposures of the Haymond Formation were chosen for this study. The first exposure is about 15 miles east of Marathon on U. S. Highway 90. The second exposure is in the type locality of the Haymond Formation about 2 miles east of Haymond station on the Southern Pacific Railroad (Fig. 1).

The following information is for your information only. It is not intended to be used as a substitute for professional advice. The information is provided for your information only and is not intended to be used as a substitute for professional advice. The information is provided for your information only and is not intended to be used as a substitute for professional advice.

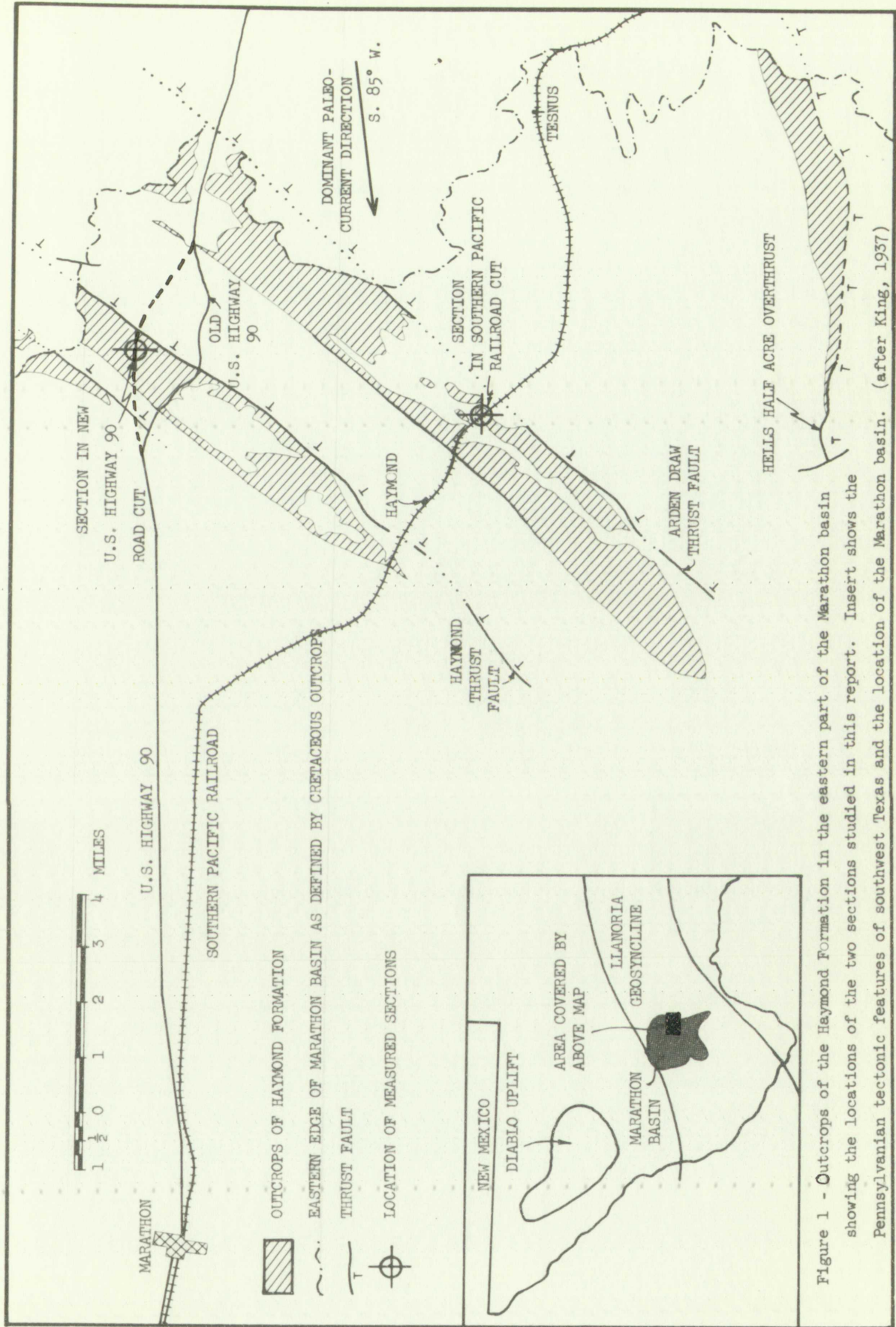


Figure 1 - Outcrops of the Haymond Formation in the eastern part of the Marathon basin showing the locations of the two sections studied in this report. Insert shows the Pennsylvanian tectonic features of southwest Texas and the location of the Marathon basin. (after King, 1937)



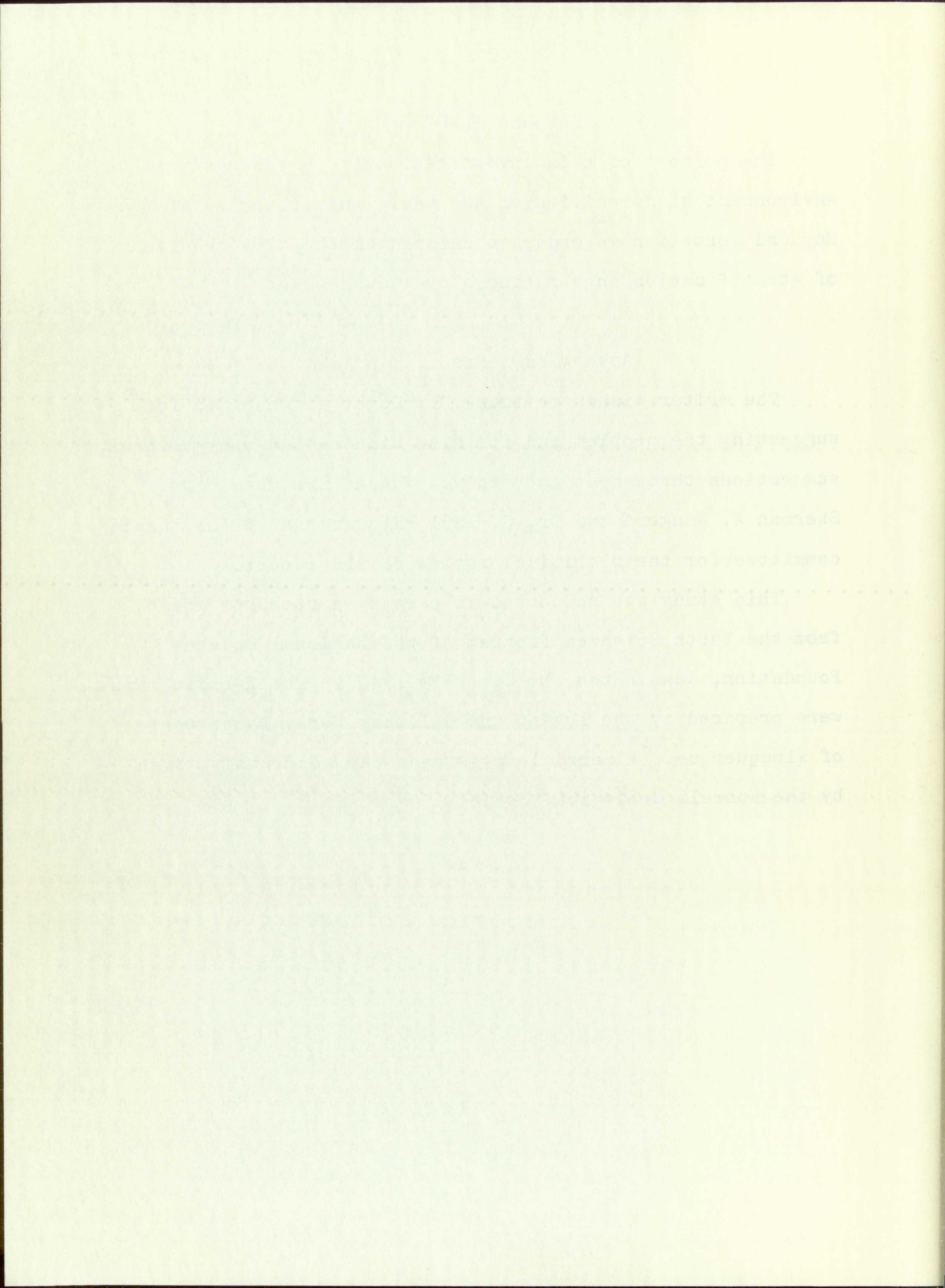
Purpose

The purpose of this investigation is to reconstruct the environment of deposition of the shale and siltstone of the Haymond Formation in order to understand the time relations of stratification in a marine slope environment.

Acknowledgments

The writer wishes to thank Dr. Roger Y. Anderson for suggesting the problem and for his guidance and many helpful suggestions throughout the study. Thanks are due to Dr. Sherman A. Wengerd and Dr. J. Paul Fitzsimmons of the thesis committee for their critical review of the report.

This study was supported in part by a research grant from the Earth Sciences Program of the National Science Foundation, Washington, D. C. (NSF-GP742). The X-radiographs were prepared by the Legant and Galloway X-ray Laboratories of Albuquerque. Financial assistance was generously given by the Roswell Geological Society.



STRATIGRAPHY AND STRUCTURE

The Haymond Formation was named by Baker (in Udden, Baker, and Böse, 1916, p. 46) from two exposures east and west of Haymond station on the Southern Pacific Railroad. Later, Baker (1917, p. 107) suggested that the Haymond Formation might actually be part of the Tesnus Formation that had been thrust across the Dimple Limestone. However, the validity of the Haymond Formation as a separate unit was demonstrated by King and King (1928, p. 113) with the discovery of boulders of Tesnus and Dimple in the boulder-bed member of the Haymond.

General characteristics

The Haymond Formation contains six members totaling over 3,000 feet in some places (King, 1937, p. 65). At the base of the formation, 300 feet of dark shale are followed by 1,000 feet of alternating siltstone and shale layers a fraction of an inch to over a foot thick (Figs. 2 and 3). These siltstone and shale layers are overlain by a thin (0-6 feet) layer of massive arkose followed by another sequence of alternating siltstone and shale 500 feet thick. This second siltstone-shale sequence is overlain by a 300 to 900 feet thick boulder-bed containing boulders of older **rocks** as long as 130 feet. At the top of the formation is a third sequence of alternating siltstone and shale 1,000 feet thick.

Figure 2 - Photographs of the two sections of the Haymond Formation studied in this report.

- A. Cut in U. S. Highway 90, 15 miles east of Marathon. Measured section is indicated by solid lines; part of the section used for correlation is indicated by dashed lines.
- B. Cut in Southern Pacific Railroad, 2 miles east of Haymond station. Section used for correlation is indicated by solid lines.

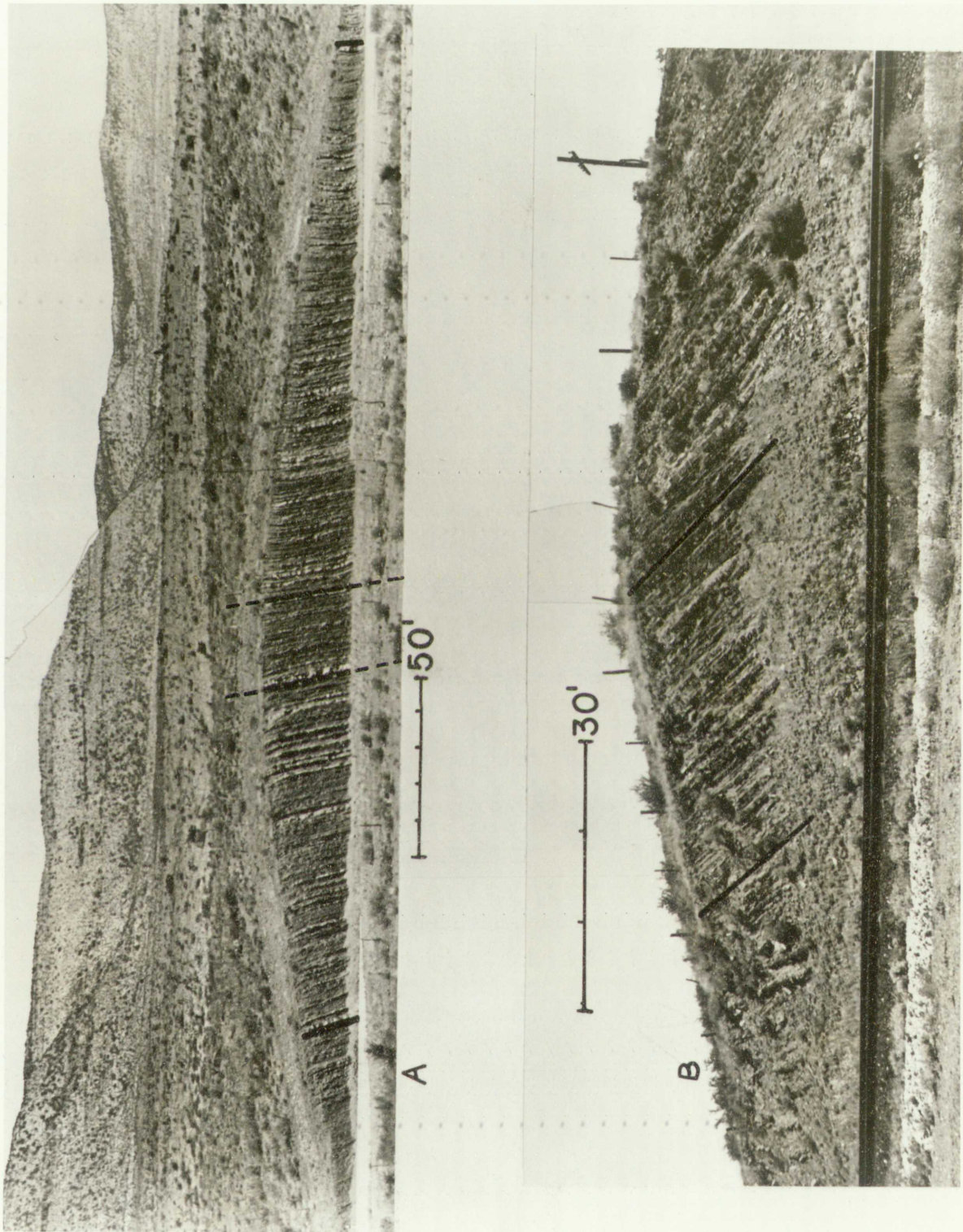




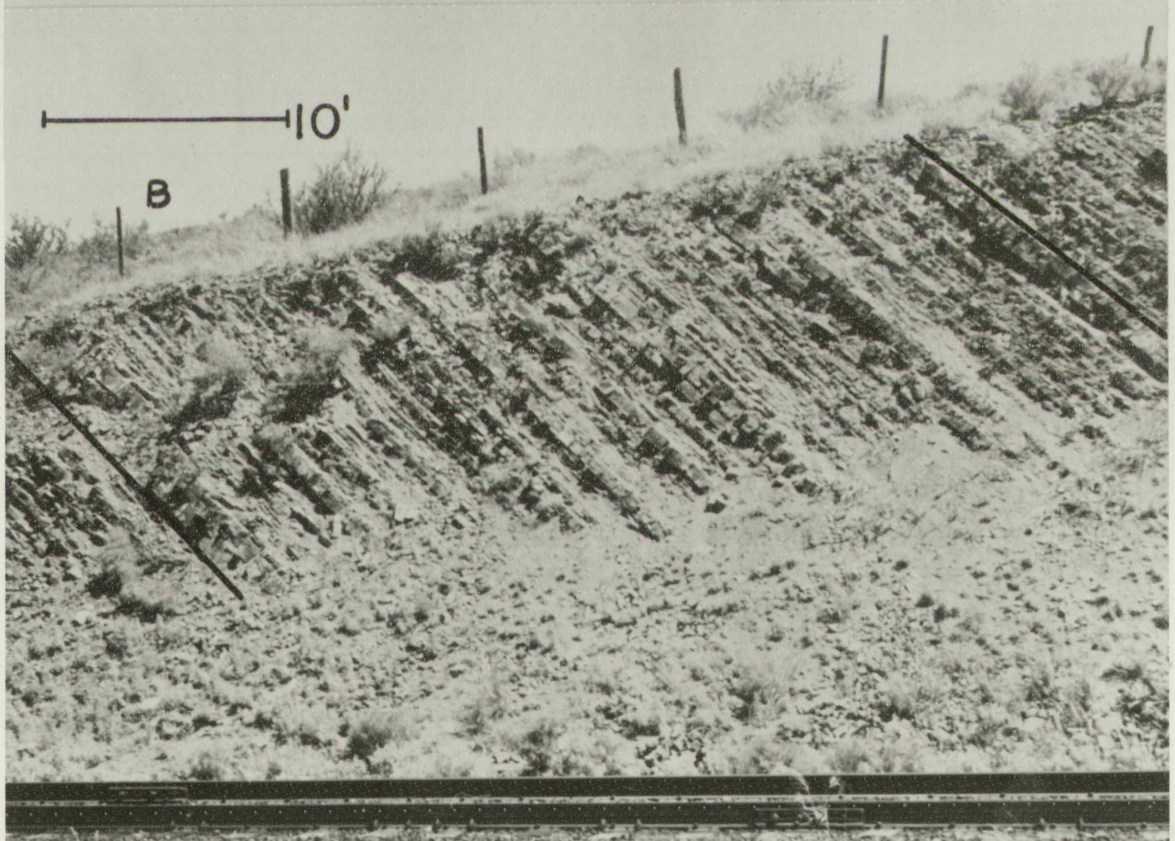
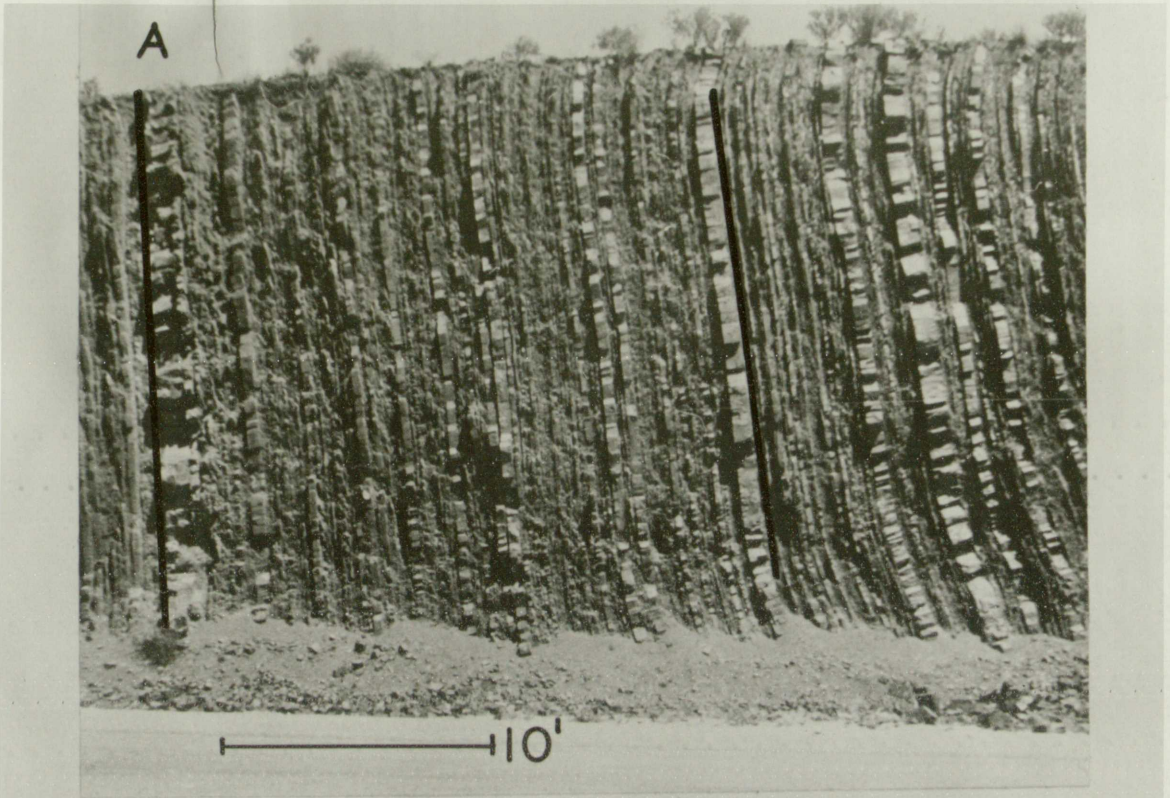
Figure 3 - Photographs of the sections of the Hammond
Formation used for correlation.

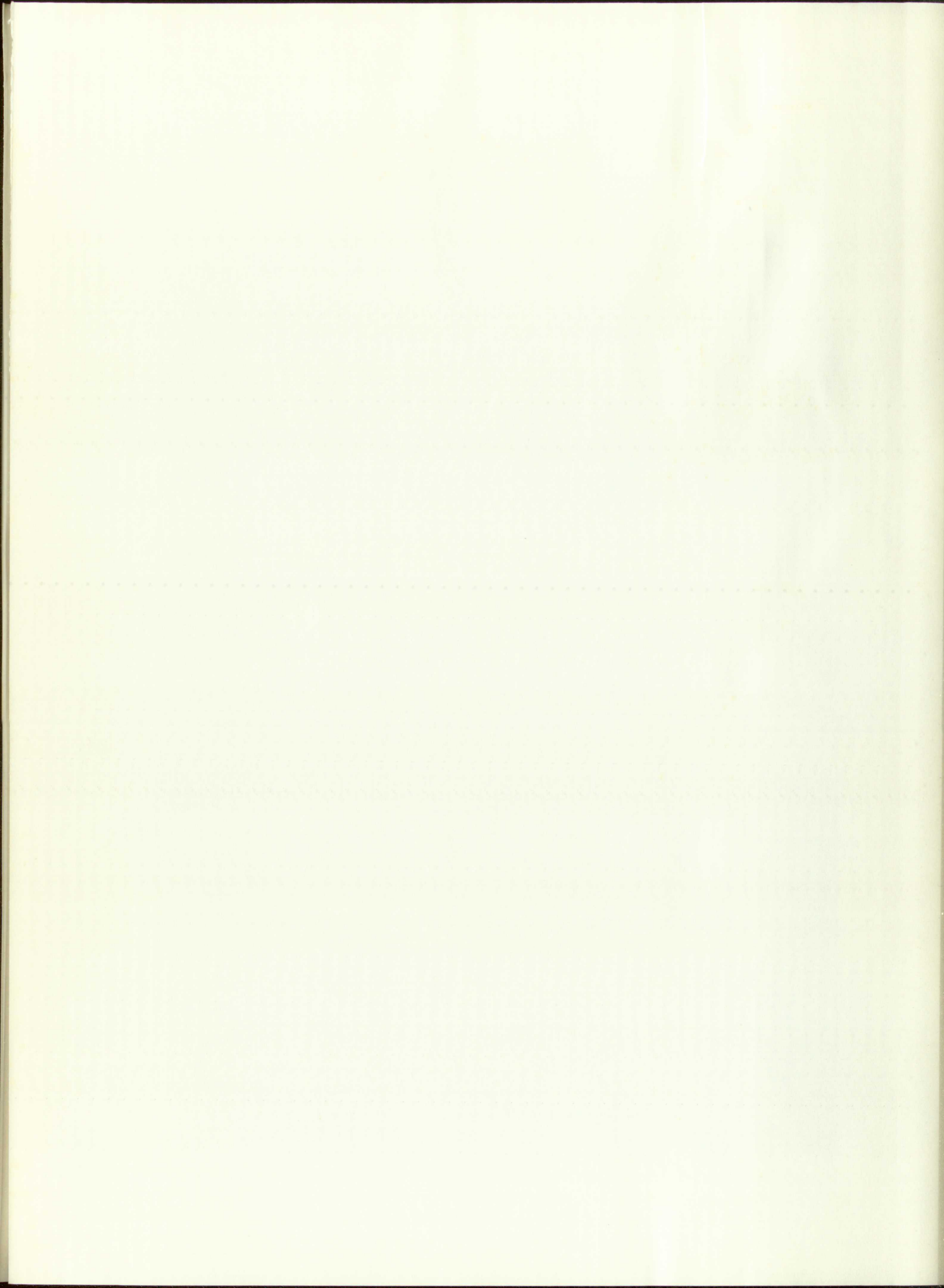
A. Cut in U. S. Highway 90, 15 miles
east of Marston.

B. Cut in Southern Pacific Railroad,
2 miles east of Hammond station.

Figure 3 - Photographs of the sections of the Haymond Formation used for correlation.

- A. Cut in U. S. Highway 90, 15 miles east of Marathon.
- B. Cut in Southern Pacific Railroad, 2 miles east of Haymond station.





Age and stratigraphic relations

The fossil content of the Haymond Formation consists mainly of abraded plant fragments a few of which were identified by David White and C. B. Read as being of Pottsville age (in King, 1937, p. 71). Fusulinids from the Haymond Formation collected by E. H. Sellards and C. L. Baker were identified as Fusulina by C. O. Dunbar (in King, 1937, p. 72). Fusulina ranges no higher than the Upper Desmoinesian Series (Strawn Series of central Texas). King concludes that the Haymond Formation is Lower Pennsylvanian as suggested by Girty (King, 1937, p. 72). Dunbar (1960, p. 224) places the Haymond Formation in the Atoka Series (Fig. 4).

The contact between the Haymond Formation and the underlying Dimple Limestone is vertically gradational for several hundred feet (King, 1937, p. 64; Sellards, Adkins, and Plummer, 1932). The Dimple Limestone represents a reduction in the supply of Tesnus material which was later resumed to produce the remarkably similar siltstone-shale alternations of the Haymond Formation. The contact between the siltstone and shale of the Haymond Formation and the overlying Chaetetes-bearing limestone of the Gaptank Formation is conformable and sharp (King, 1937, p. 72).

Based on subsurface data and lithologic similarity, the Haymond Formation has been correlated with the Smithwick and Big Spring Groups of central Texas and the Atoka Formation of southern Oklahoma (Plummer and Moore, 1921; Powers, 1928; Cheney, 1929; Moore, 1929; Miser and Sellards, 1931; Plummer, 1931; van der Gracht, 1931; King, 1937; Bokman, 1953; Hall, 1956; Cline, 1960; Dunbar, 1960; Miser and Hendricks, 1960).

1950

...

...

...

...

...

...

...

...

...

...

...

...

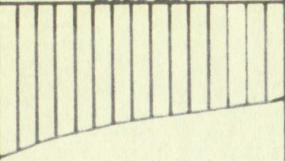
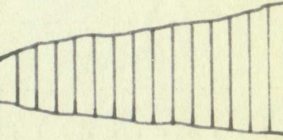
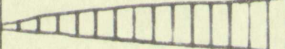
SERIES	MARATHON BASIN	CENTRAL TEXAS	OKLAHOMA	
Virgilian		Cisco Series	Vanoss Fm.	
			Ada Fm.	
			Vamoosa Fm.	
Missourian	Gaptank Formation	Canyon Series		
Francis Fm.				
Desmoinesian			Strawn Series	Wewoka Fm.
				Wetumka Shale
	Boggy Shale			
	Savanna Ss.			
Atokan	Haymond Formation	Smithwick Gr.	Atoka Formation	
		Big Spring Gr.		
Morrowan	Dimple Ls.	Marble Falls Limestone	Wapanucka ls.	
	Tesnus Fm.		Jackfork Ss. Stanley Shale	

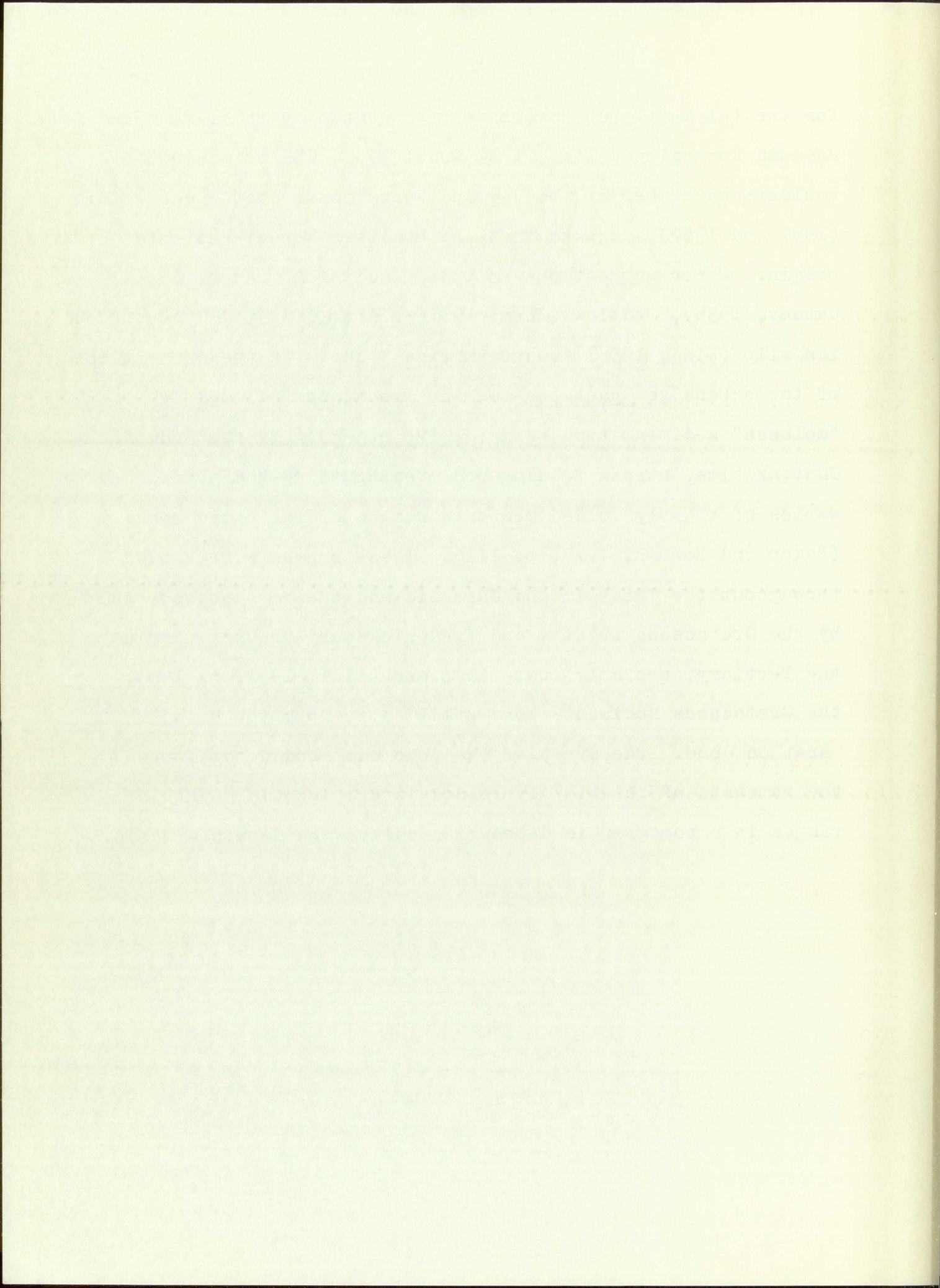
Figure 4 - Correlation of the Pennsylvanian System in southwest Texas, central Texas, and southern Oklahoma (after Dunbar, 1960, p. 224).

Structural history

Sedimentation was essentially continuous in the Marathon region during the Pennsylvanian. The sediments were deposited in the Llanoria geosyncline which was probably an extension of the Ouachita geosyncline of Oklahoma (Dunbar, 1960, p. 223; Sellards, Adkins, and Plummer, 1932, p. 129).

The beginning of the Pennsylvanian was marked by strong uplift of the hinterland (Llanoria) to the southeast exposing the granite, slate, and phyllite which provided the sediments

for the thick "flysch" sequence represented by the Tesnus and Haymond Formations (King, 1930 and 1937). The origin of the boulder-bed member of the Haymond Formation is not clear. Hall (1957 and 1959) suggests that the boulders are of tectonic origin. Other suggestions include glaciation (Baker, 1932; Carney, 1935), mudflow (King, 1937; Flawn, 1958), and subaqueous landslip (King, 1958). Gaptank time began with the deposition of the extensive Chaetetes-bearing limestone followed by "molasse" sedimentation (King, 1937, p. 88). By the end of Gaptank time, strong folding and overthrusting had produced a series of tightly folded mountain ranges of Paleozoic rocks (Baker and Bowman, 1917, p. 111). These ranges were eroded throughout the Triassic and Jurassic and the remnants covered by the Cretaceous Trinity and Fredericksburg Groups. During the Tertiary, probably post-Oligocene (King, 1937, p. 140), the Cretaceous sediments were uplifted to form the broad Marathon dome. The crest of the dome was eroded to expose the remnants of the tightly folded late Paleozoic mountain ranges in a topographic depression called the Marathon basin.



PETROLOGY

General description

The two sections of the Haymond Formation which were studied are interbedded lentils of dense siltstone and clay shale. Many of the shales are separated by a thin, silty claystone intermediate in composition between the siltstone and shale. The siltstone occurs in layers 0.01 to 1.67 feet thick with a mean of 0.31 feet for the road-cut section and 0.43 feet for the railroad-cut section. The associated shale occurs in layers 0.01 to 1.26 feet thick. The siltstone-shale couplets range in thickness from 0.05 to 2.12 feet.

Petrography

Siltstone

The siltstone of the Haymond Formation has the composition of a subgraywacke although more than 70 percent of the grains are smaller than very fine sand (Fig. 5). Summaries of the chemical and mineralogical compositions are given in appendixes I and II and Figures 6 and 7. A photomicrograph of a typical siltstone is shown in Figure 8C. There is no significant change in siltstone composition throughout the section studied, with the possible exception of a general increase in the percent of organic nitrogen from the bottom of the section to the top (Fig. 9). The mineralogic composition of a typical siltstone is approximately: 70 percent quartz; 23 percent clay matrix; 3 percent plant fragments; 2 percent mica; 1 percent

ABSTRACT

General description

The two sections of the ... studied are interbedded ... shale. Many of the ... claystone interbedded ... and shale. The ... block with a mean ... 0.45 feet for the ... occurs in layers ... shale consists ...

Petrography

Siltstone

The siltstone of the ... of a ... are smaller than very fine sand ... chemical and mineralogical composition ... I and II and Figures 6 and 7 ... siltstone is shown in Figure 8C. ... change in siltstone ... with the possible ... percent of organic ... the top (Fig. 9). The ... siltstone is ... silt; 6 percent ...

albite; 1 percent garnet. These constituents suggest igneous and possibly metamorphic terranes. King (1937, p. 70) concluded that the constituents of the Haymond siltstone were derived from granitic and metamorphic rocks with the granitic fragments predominating. McBride (1962b) concluded that the chief source area of the Haymond sediments was composed largely of plutonic rocks.

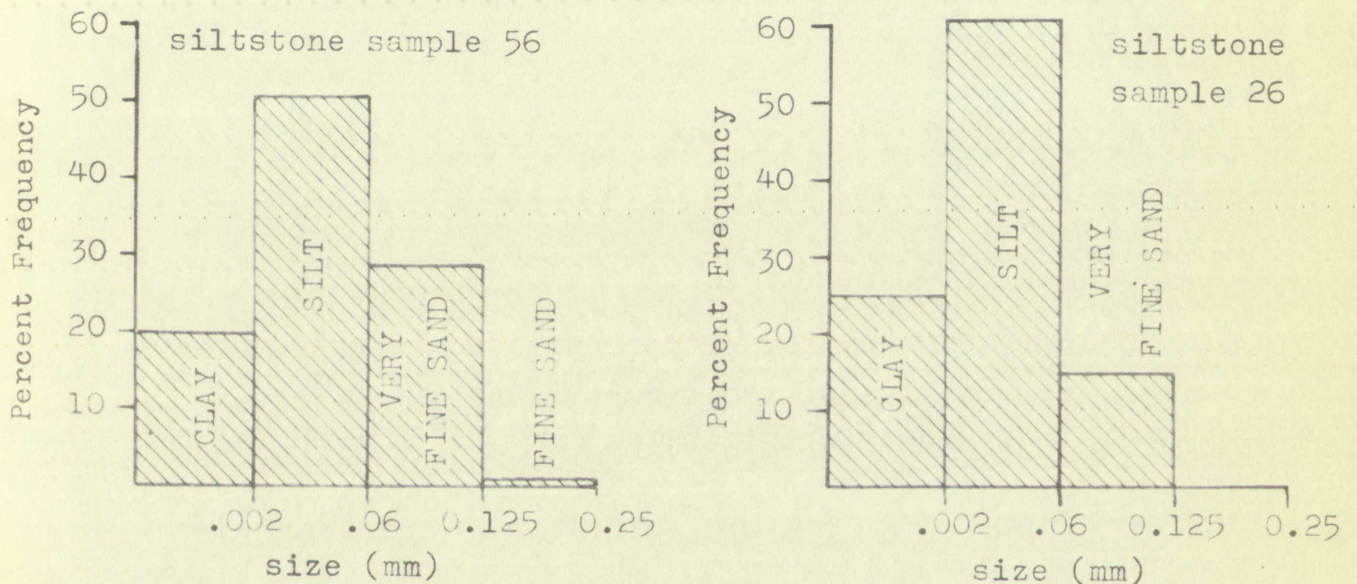


Figure 5 - Grain size determinations of two siltstone samples of the Haymond Formation. Percent clay was estimated; percent silt and sand were determined by counting about 500 grains in thinsection.

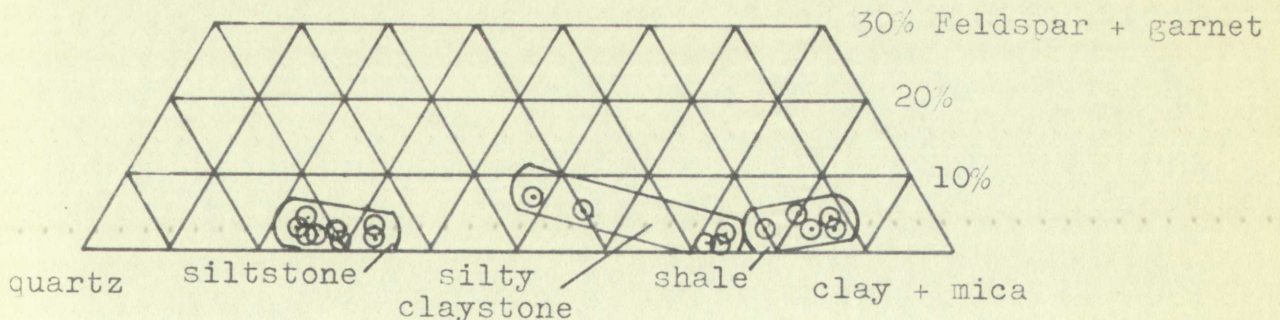


Figure 6 - Composition of siltstone, silty claystone, and shale of the Haymond Formation.

Figure 7 - Summary of composition and paleocurrent analyses of the road-cut section of the Haymond Formation.

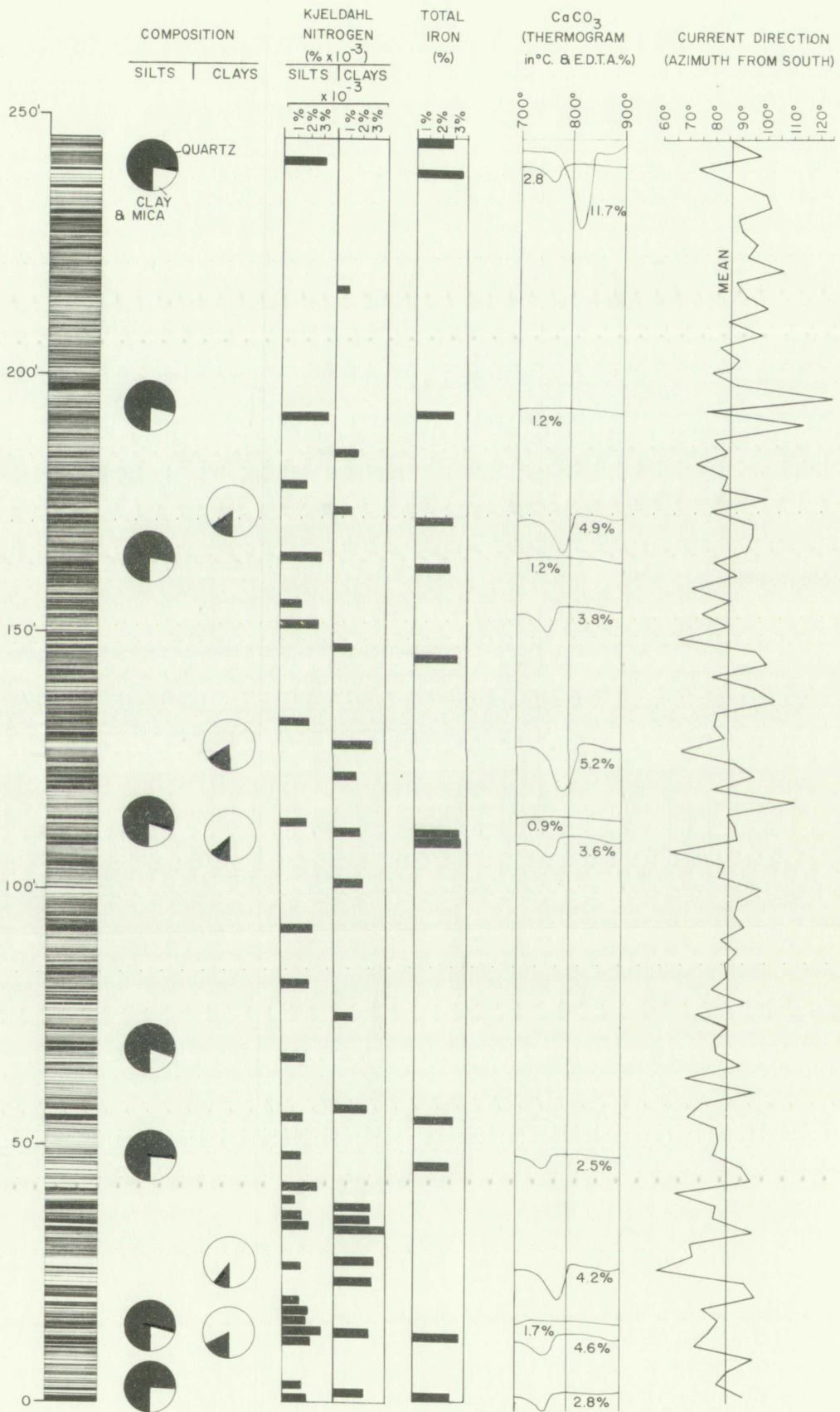
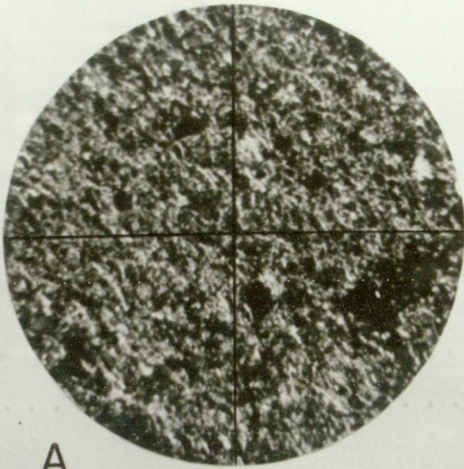
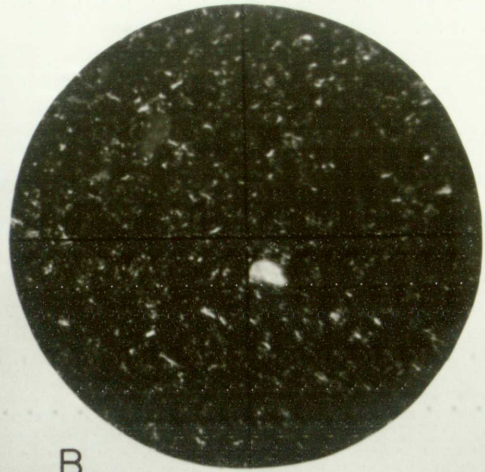


Figure 8 - Photomicrographs of siltstone, silty claystone, and shale of the Haymond Formation.

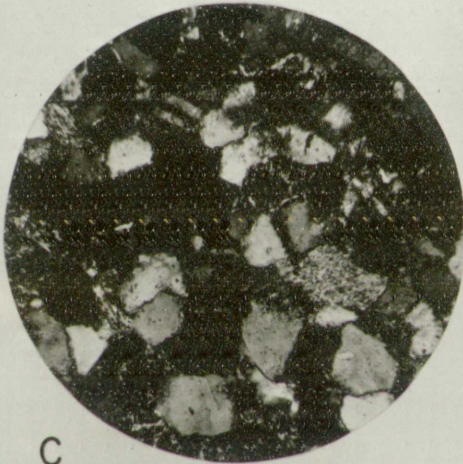
- A. Clay shale, crossed nicols, x300; linear mineral is muscovite.
- B. Same as A but rotated 45° ; note aggregate extinction.
- C. Siltstone, crossed nicols, x300; mainly quartz in a clay matrix.
- D. Silty claystone, ordinary light, x46; note dark layers formed by concentration of plant fragments and clay.
- E. Silty claystone, ordinary light, x150; enlargement of D.
- F. Same as E but with crossed nicols.



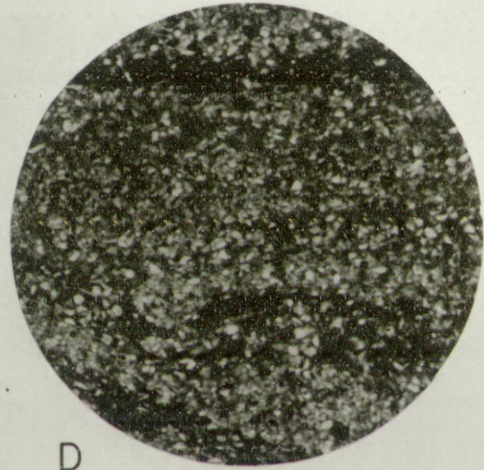
A



B



C



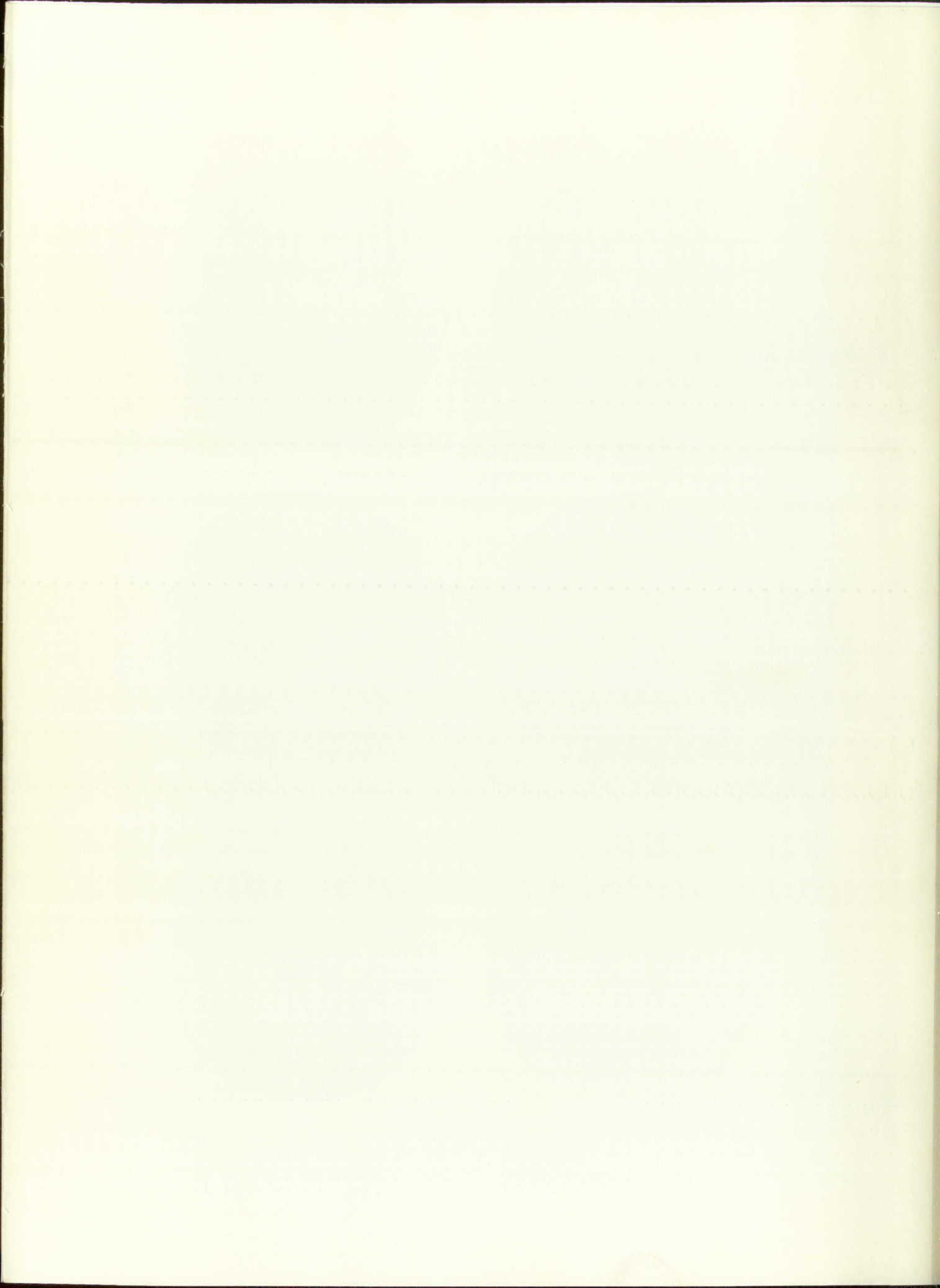
D



E



F



Quartz. - - Quartz occurs as angular, silt grains with numerous inclusions and few overgrowths. Where the grains are elongate, they are subparallel to the parallel fabric of the mica and clay minerals.

Plagioclase feldspar. - - Plagioclase occurs as angular, silt grains easily distinguished from quartz by the multiple albite extinction bands and lower index of refraction. The low extinction angles (17 degrees to 18 degrees) and low index of refraction place the plagioclase at the albite end of the albite-anorthite series (Kerr, 1959, p. 258).

Garnet. - - Garnet occurs as angular, pale yellow and pale pink silt grains. The grains are identified by their **isotropism** and high relief.

Muscovite. - - Muscovite occurs as colorless shreds parallel to stratification. Under crossed nicols, these shreds have a brilliant, high-order green or blue interference color and parallel extinction.

Biotite. - - In some samples, shreds of biotite were distinguished from muscovite shreds by their darker color and strong pleochroism.

Clay. - - A clay matrix constitutes as much as 26 percent of the siltstone. Positive identification of clay minerals other than small amounts of sericite was not possible in thin-section

The following table shows the results of the survey conducted in the year 1911.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1912.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1913.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1914.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1915.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1916.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1917.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1918.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1919.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1920.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1921.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1922.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1923.

The results of the survey are as follows:

The following table shows the results of the survey conducted in the year 1924.

The results of the survey are as follows:

but differential thermal analyses of 20 siltstone and shale samples indicated a probable mixture of chlorite and illite (Grim, 1953, p. 198).

Because thin-sections were cut normal to stratification, plates of clay and mica present an edge view parallel to the c-axis with consequent parallel extinction. This parallel extinction of individual minerals produces an aggregate extinction of the clay matrix as illustrated in Figures 8A and 8B.

Plant fragments. - - Six siltstone and shale samples were treated with hydrochloric, hydrofluoric, and nitric acids. The residue consisted almost entirely of black plant fragments. The concentration of plant fragments with clay and mica into layers parallel to stratification produces the laminated appearance of the shale and siltstone (Figs. 8D, 8E, and 8F). The plant fragments are also concentrated along cross-stratification planes in the siltstone.

Silty claystone

Intermediate in composition between the siltstone and shale are a group of laminae, generally less than 0.05 feet thick, classified as silty claystone. The quartz content of the silty claystone varies from 25 percent to 45 percent and the clay content from 25 percent to 60 percent (Appendix I; Fig. 6). Although the composition of the silty claystone is considerably more variable than that of either the siltstone or shale, it is closer to that of the shale. However, because the quartz content of the silty claystone is higher than that of the shale, the

but differential thermal analysis of 50°C intervals at 10°C
per minute indicated a probable change of crystallinity
(Tait, 1957, p. 153).

Because thin-sections were not made, the crystallinity
of clay and also presence of other minerals was
not determined. The crystallinity of the
extracted of individual lamellar structures
of the clay matrix was indicated in Figure 2.

Plant fragments. - Six silicates and one phosphate
were identified, hydrochloric, hydrofluoric, and
the residue consisted almost entirely of
The identification of plant fragments was
made special to stratification process the
appearance of the same and silicates (SiO₂, Al₂O₃, and Fe₂O₃)
The plant fragments are also concentrated in
stratification planes in the section.

Silty claystone.
Intermediate in composition between the silicate and
are a group of laminae, generally less than 1/2 inch
classified as silty claystone. The water content of these
claystone varies from 25 percent to 45 percent, the
content from 15 percent to 30 percent (Table 1).
Although the composition of the silty claystone is
one variable that of silty claystone, the
claystone is that of the silty claystone, the
of the silty claystone is higher than that of the

weathering characteristics closely resemble those of the siltstone. Consequently, the silty claystone was counted as siltstone in statistical analyses. The feasibility of this grouping will be demonstrated later in this report.

Shale

The mineralogical composition of a typical shale in the Haymond Formation is approximately: 73 percent clay minerals; 15 percent quartz; 5 percent mica; 4 percent plant fragments; 2 percent garnet; <1 percent albite. Summaries of the chemical and mineralogical compositions of the shale are given in Appendixes I and II and Figures 6 and 7. The descriptions of the specific minerals given for the siltstone also apply to the minerals of the shale. There is no significant change in the composition of the shale throughout the section with the possible exception of a general decrease in organic nitrogen content from bottom to top in the section (as opposed to an increase in organic nitrogen in the siltstone) (Fig. 9). Photomicrographs of a typical shale are shown in Figures 8A and 8B.

At the surface, the shale is fissile and erodes into small, lenticular chips. On a fresh surface, however, the fissility is obscure and the shale breaks into rounded discs several inches in diameter which further spall into thin concentric sheets. The tendency of the clays to split into thin sheets is the result of parallel alignment of the clay minerals and mica. The curving of the sheets is probably a result of rotation of the clay and mica during intense folding.

Chafe

The mineralogical composition of the ...
 beyond formation is ...
 is recent ...
 2 percent garnet ...
 and mineralogical composition of the ...
 Appendixes I and II ...
 the specific mineral ...
 the minerals of the ...
 the composition of the ...
 possible exception of a ...
 contact from ...
 increase in ...
 photomicrographs of ...
 At the surface, the ...
 fenestrate shape. On a ...
 is obscure and the ...
 in diameter with ...
 The tendency of ...
 of parallel ...
 curving of the ...
 city and ...

Chemical Analyses

Calcium and Magnesium Carbonate

The amount of calcium and magnesium carbonate in 15 samples was determined by titrating with disodium dihydrogen ethylenediamine tetracetate (Na_2EDTA or EDTA) (Bisque, 1961). As calcium from gypsum and illite may go into solution during treatment with hydrochloric acid, there is a certain amount of error to be expected by using this method to determine calcium and magnesium carbonate. Sulfate tests were run on two samples with results of 1.4 percent and 0.24 percent; thus the amount of gypsum present is negligible for the purpose of this study. Also, the amount of calcium derived from illite is probably negligible so that the results are probably correct to within 5 percent of the amount present. Neither calcium nor magnesium content show a significant trend throughout the section. The amount of calcium carbonate ranges from 0.9 percent to 11.7 percent. The amount of magnesium carbonate ranges from a trace to 1.0 percent. EDTA percentages of calcium and magnesium carbonate are listed in Appendix II. EDTA percentages of calcium carbonate are also given in Figure 7 with the corresponding thermogram peaks for calcium carbonate.

Iron

The amount of iron in 15 samples was determined by colorimetry. The results are expressed as ferric iron as all ferrous iron is oxidized during the procedure (Appendix II;

Fig. 7. The amount of organic matter in the soil...

The amount of organic matter in the soil...

obtained by the method of...

The amount of organic matter in the soil...

by the method of...

organic matter content...

percent. The amount of organic matter...

(Hilman and Perry, 1961, p. 200)

In general, the amount of organic matter...

and ally groups of organic matter...

section of the soil...

the effect of...

the location of the...

ally groups...

of organic matter in the soil...

in the part of the soil...

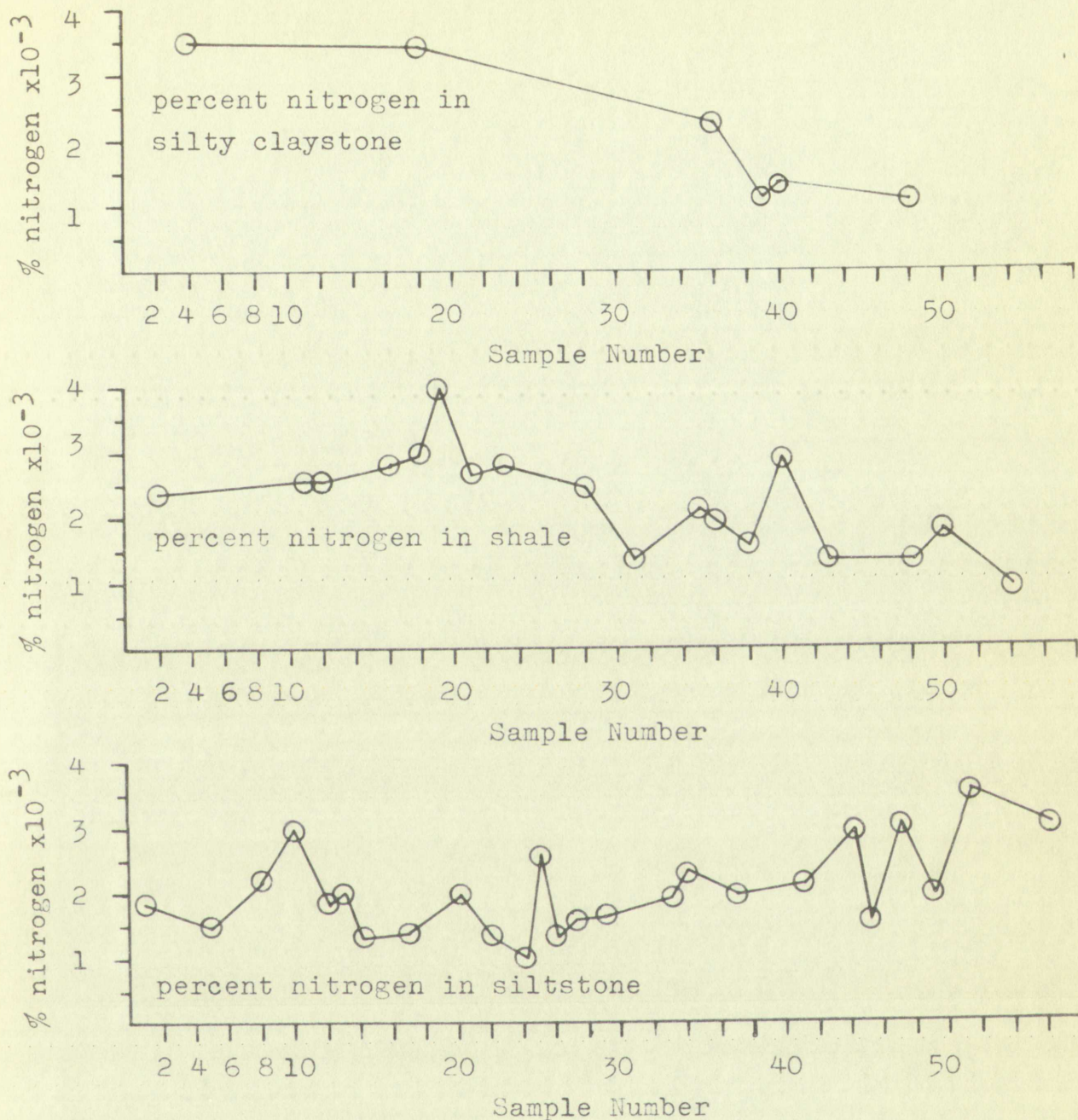


Figure 9 - Variation of organic (Kjeldahl) nitrogen in the silty claystone, shale, and siltstone samples of the Haymond Formation. (See Figure 18 for location of samples.)

Figure 1 - Relation of organic carbon content to soil depth



Figure 2 - Relation of organic carbon content to soil depth



Figure 3 - Relation of organic carbon content to soil depth

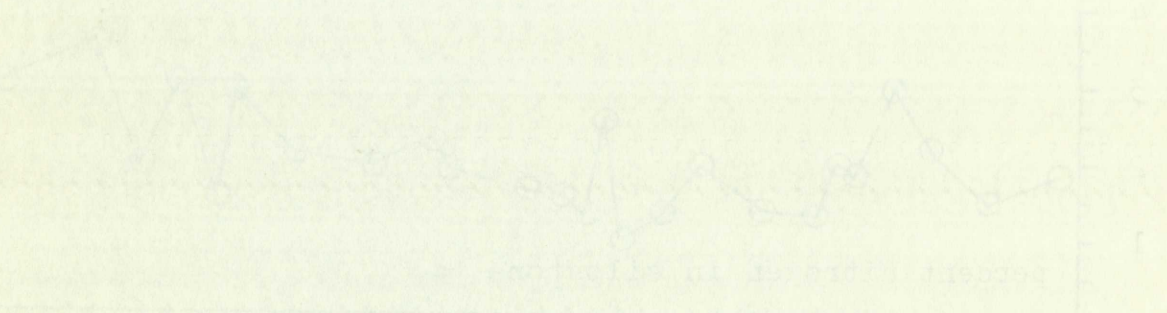


Figure 1 - Relation of organic carbon content to soil depth for topsoil (C-011). The organic carbon content decreases from 8.5% at the surface to 1.5% at 100 cm depth. Figure 2 - Relation of organic carbon content to soil depth for subsoil (C-012). The organic carbon content increases from 2.5% at the surface to 7.5% at 100 cm depth. Figure 3 - Relation of organic carbon content to soil depth for subsoil (C-013). The organic carbon content increases from 3.0% at the surface to 8.0% at 100 cm depth.

Sedimentary structures

Stratification

The alternations of siltstone and shale, repeated thousands of times throughout several thousand feet of section, are the most obvious sedimentary structures in the Haymond Formation (Figs. 2 and 3). At a distance, the boundaries between the siltstone and shale appear sharp. On closer inspection, it is apparent that the contact between a siltstone and the underlying shale is always sharp whereas the same siltstone grades more or less rapidly into the overlying shale (Fig. 10). The gradation is one of composition with an increase

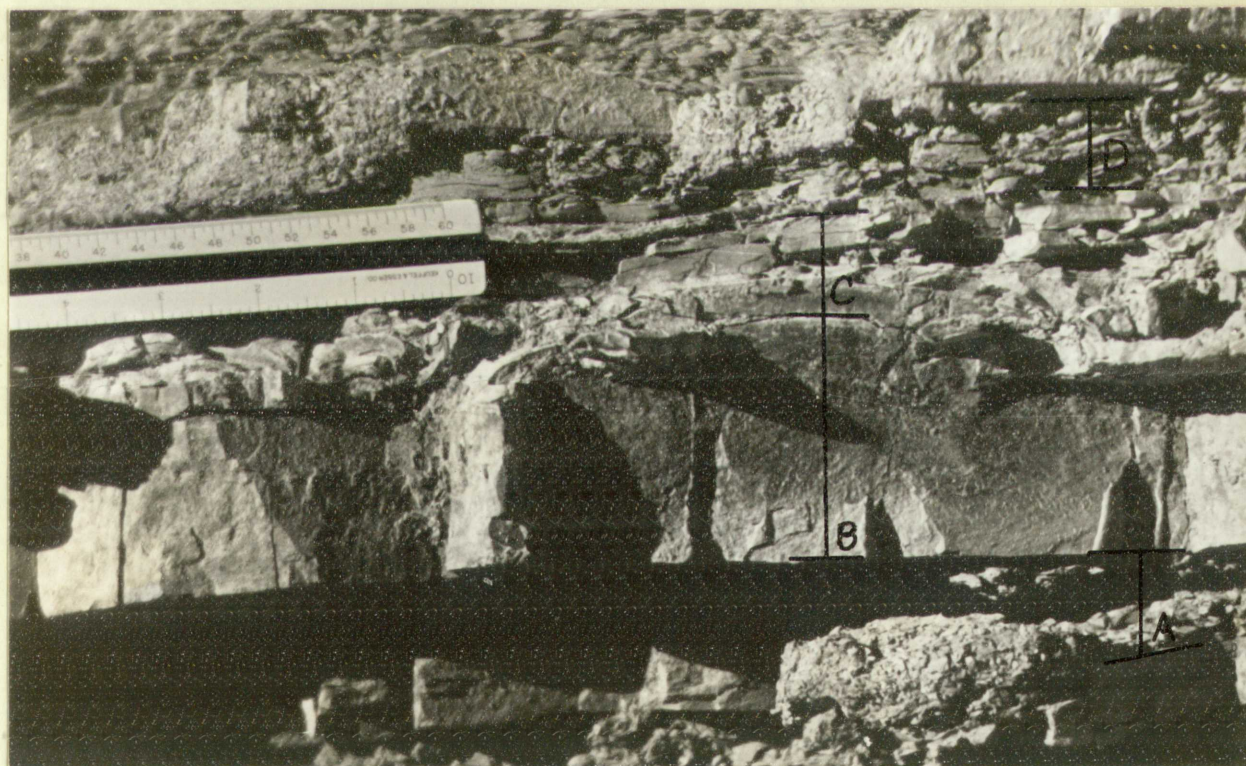


Figure 10 - Gradational contact (C) between a siltstone (B) and the overlying shale (D); note the sharp contact between the siltstone (B) and the underlying shale (A).

Classification

The classification of alkaloids and their related

thousands of times through several thousand years of history

and the last obvious taxonomic characters in the system

classification (Fig. 1 and 2) are a significant, but somewhat

between the alkaloids and their related groups. On closer

inspection, it is apparent that the alkaloids are a

and the alkaloids share in many common features and are

some of the most important groups of alkaloids.

(Fig. 10) The alkaloids in one of the following groups

Group 10 - Steroidal alkaloids (Fig. 10) are a group of alkaloids that are characterized by the presence of a steroid nucleus. They are found in a variety of plants and are known for their pharmacological activity.

in clay and a decrease in quartz between the siltstone and shale. As most of the quartz is silt, this gradation is also one of size. As a consequence, the difference in bedding of the siltstone and shale is the result of differences in composition; however, the differences in composition are the result of a decrease in silt, thereby increasing the relative proportions of clay.

A variation in grain size can be the result of one or a combination of two factors: 1. the amount and type of sediment available and 2. the efficacy of the scattering agent. Because of the frequency with which the siltstone layers recur, it does not seem probable that the cyclic alternations are a function of availability although the availability may effect long term cyclic or non-cyclic variations (Fig. 14). It is probable, therefore, that the deposition of a silt layer is initiated by a current capable of transporting silt and waning of the current permitting settling of clay.

Internal structures

Recognition of most internal sedimentary structures is based on differences in color, composition, or texture which are the result of physical processes operative at the time of deposition. The siltstone and shale layers of the Haymond Formation have sedimentary structures so subtle that they are barely visible even on polished surfaces. To accentuate these structures, four techniques were applied to slabs of siltstone cut normal to stratification: infra-red photography, dye staining, X-radiography, and etching with hydrofluoric acid.

Only the last two techniques succeeded in accentuating the internal sedimentary structures (Figs. 11 and 12). Exposing a slab to infra-red sensitive film using only an infra-red light source produced results no better than those obtained using white light and panchromatic film. Compositional differences apparently were not great enough to permit differential absorption of infra-red light. These small compositional differences in addition to very low permeability prevented the use of dye staining techniques (Hamblin, 1962a; Pantin, 1960).

Recently, application of X-radiography to the study of internal sedimentary structures has been successful in both consolidated (Hamblin, 1962b) and unconsolidated sediments (Calvert and Veevers, 1962). The technique is based on the concept that there should be vertical as well as lateral variations in every sedimentary rock. These variations should produce corresponding variations in density even though there may be no corresponding variation in color or texture. The transmission of X-rays through a slab of a sedimentary rock records density variations by differential absorption of radiation. Slabs of several siltstone samples approximately 3 mm thick were placed directly on X-ray film and exposed at a distance of about one meter at 50 kilovolts and 125 milliamperes for one second using a General Electric medical X-ray unit. Positive prints of radiographs are shown in Figures 11C, 11D, 12B, and 12E. In most slabs, remarkably clear outlines of internal sedimentary structures were obtained even though the structures were invisible or only faintly visible on polished slabs (Figs. 11A, 11B, 12A, and 12D). This technique was particularly useful in accentuating cross-laminations.

Figure 11 - Sedimentary structures in two treated siltstone slabs from the Haymond Formation.

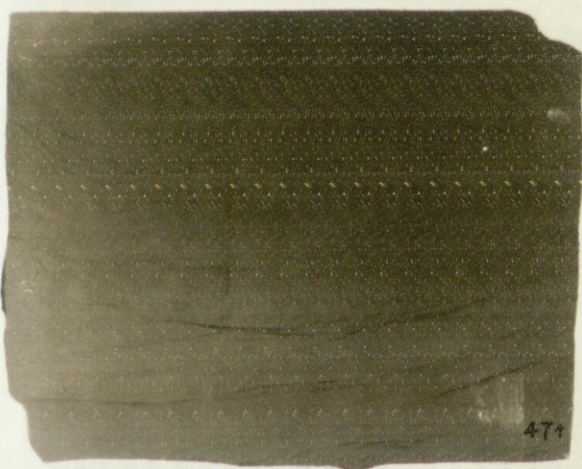
- A. Polished siltstone slab.
- B. Polished siltstone slab.
- C. X-radiograph of siltstone slab in A.
- D. X-radiograph of siltstone slab in B.
- E. Hydrofluoric acid etch of siltstone slab in A.
- F. Hydrofluoric acid etch of siltstone slab in B.



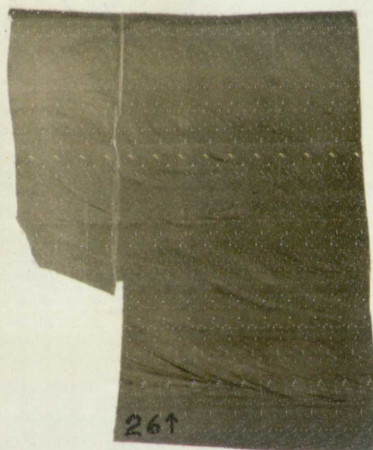
A



B



C



D



E



F

—|— 1 inch

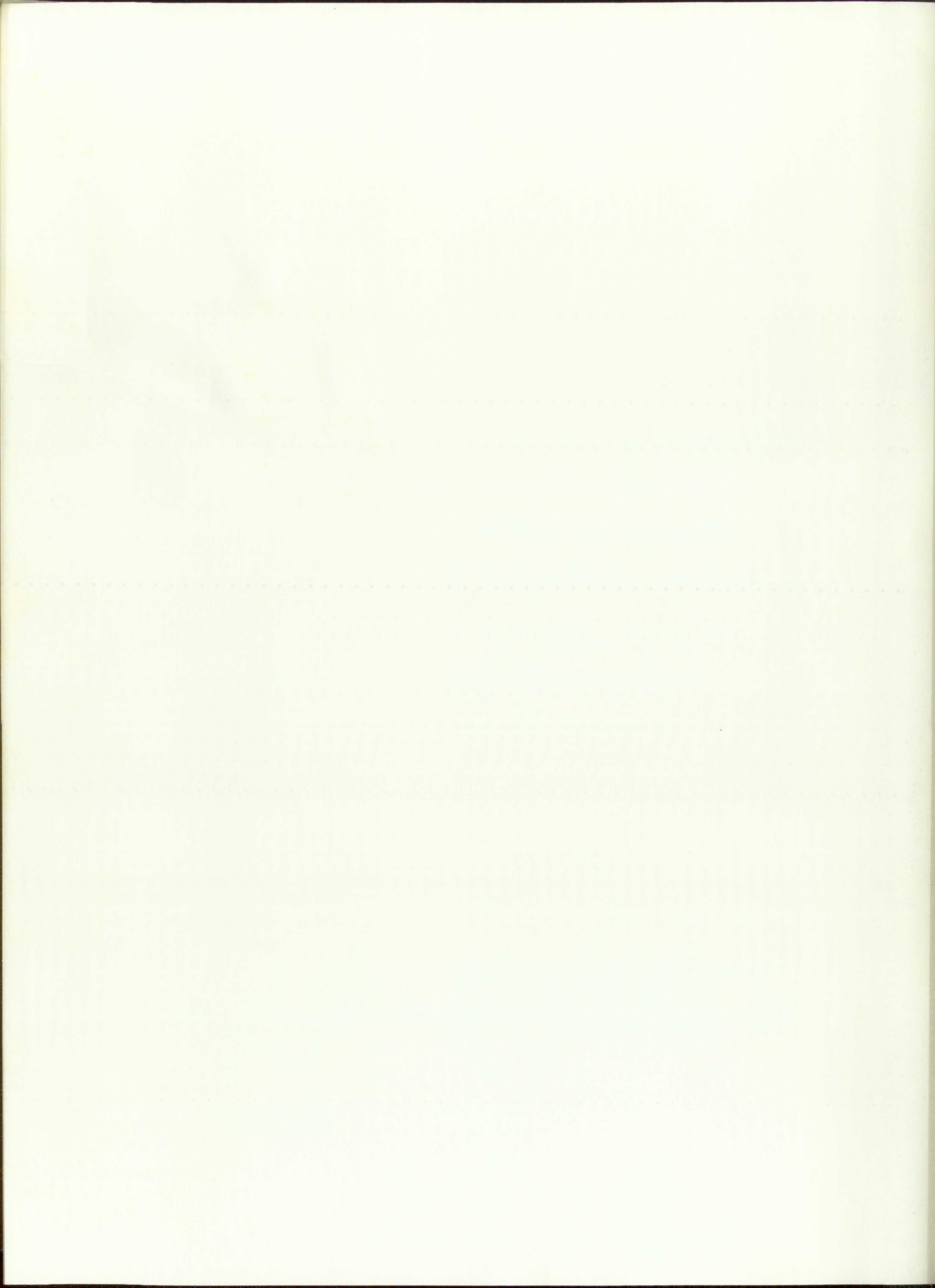
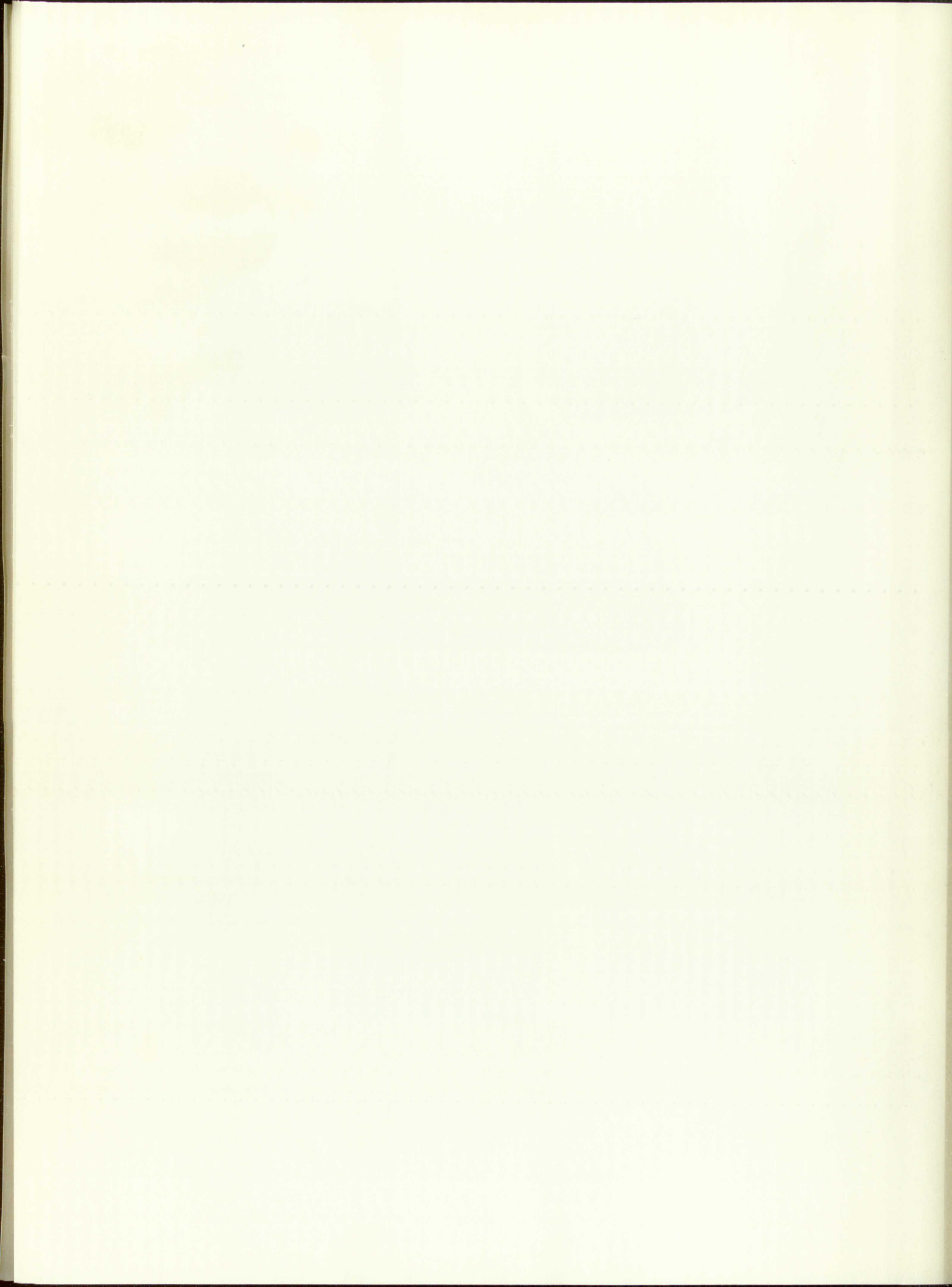


Figure 12 - Sedimentary structures in two treated
siltstone slabs from the Haymond Formation.

- A. Polished siltstone slab.
- B. X-radiograph of siltstone slab in A.
- C. Hydrofluoric acid etch of siltstone
slab in A.
- D. Polished siltstone slab.
- E. X-radiograph of siltstone slab in D.
- F. Hydrofluoric acid etch of siltstone
slab in D.

Figure 12 - Sedimentary structures in two treated siltstone slabs from the Haymond Formation.

- A. Polished siltstone slab.
- B. X-radiograph of siltstone slab in A.
- C. Hydrofluoric acid etch of siltstone slab in A.
- D. Polished siltstone slab.
- E. X-radiograph of siltstone slab in D.
- F. Hydrofluoric acid etch of siltstone slab in D.



In most slabs, internal structures, particularly convolute folds, were emphasized by etching with hydrofluoric acid. This was done by immersing a slab or a flat surface of siltstone in concentrated hydrofluoric acid for several hours. After the etched surfaces had been washed and dried, they were photographed using a single low-angle light source. Photographs of etched siltstones are shown in Figures 11E, 11F, 12C, and 12F.

Horizontal laminations. - - In addition to the gross stratification or lamination, some of the individual siltstone or shale layers are also laminated on a semi-microscopic scale. These micro-laminations are the result of the concentration of plant fragments, clay, and mica into dark bands parallel to stratification (Figs. 8D, 8F, and 8F). Micro-laminations in the shale are almost always horizontal whereas those in the siltstone are more often contorted into convolute folds (Figs. 11E and 11F). The micro-laminations are not sedimentary units but represent "transitory phases" or minor chance fluctuations in the velocity of the depositing current" (Pettijohn, 1957, p. 163).

Cross-laminations. - - Small-scale tabular cross-laminations are present in many of the siltstone layers. Although cross-laminations are usually confined to the lower part of the layer (Figs. 11C to 11F), some layers are cross-laminated throughout their entire thickness (Fig. 12C). The cross-laminations represent deposition by unidirectional laminar current flow. Although most of the cross-laminations are tabular, several scour-and-fill cross-laminations were also noted (Figs. 12D to 12F).

Convolute-laminations. - - Convolute-laminations, as applied here, refer to contorted or wavy laminae observed in the upper part of many siltstone layers. The contortions range from gentle crenulations to highly contorted folds which die out downward into undisturbed cross-laminations in the lower part of the layer (Figs. 11E and 11F). Folded patterns generally consist of a series of steeply dipping, usually overturned anticlines separated by broad shallow synclines. The convolute-laminations were probably deposited as horizontal or cross-laminations which were later contorted. Convolute-laminations have been the subject of frequent discussions in the literature (Kindle, 1917; Bain, 1931; Rettger, 1935; Jones, 1937; Baldry, 1938; Lamont, 1938; Beets, 1946; Cope, 1946; Kuenen, 1949; Rich, 1950 and 1951; Kuenen, 1953; Greensmith, 1956; Stewart, 1956; Ten Haaf, 1956; Sullwold, 1959; Holland, 1960; Prentice, 1960; Sanders, 1960; Williams, 1960; Dott and Howard, 1962; McBride, 1962a). Most agree that the contortions are the result of plastic deformation in response to gravity. The uniform lateral thickness of the siltstone layers, even though the laminae within the layer are highly contorted, precludes mass downslope translation or slump. Saturated with water, the silt layer was essentially a viscous fluid with a tendency to flow downslope under the influence of gravity. Adhesion and cohesion, resulting from a combination of electrolytic attractions, van der Waals forces, and surface adsorption of water (Dott and Howard, 1962, p. 115), prevented the mass from actually flowing. Instead, a certain amount of internal adjustment took place producing varying degrees of distortion. Most of this adjustment took

convolute-laminations, as applied
 here, refer to contorted or wavy laminae observed in the upper
 part of many silstone layers. The convolute layer
 gentle undulations or slightly contorted folds which die out
 downward into undisturbed cross-laminations in the lower part
 of the layer (figs. 11a and 11b). Folded patterns generally
 consist of a series of steeply dipping, usually overturned
 anticlines separated by broad shallow synclines. The convolute-
 laminations were probably deposited as horizontal or cross-
 laminations which were later contorted. Convolute-laminations
 have been the subject of frequent discussion in the literature
 (Karl, 1917; Bain, 1931; Reutter, 1935; Jones, 1937; Bailey,
 1938; Lamont, 1938; Foste, 1946; Cooper, 1946; Kennan, 1947; Rich,
 1950 and 1951; Keenan, 1955; Greenstein, 1955; Brewster, 1956;
 Van Hael, 1956; Salin, 1959; Holland, 1960; Frenkel, 1960;
 Sanders, 1960; Williams, 1960; Doot and Howard, 1962; Korb,
 1962). Most agree that the contortions are the result of
 plastic deformation in response to gravity. The uniform lateral
 thickness of the silstone layers, even through the laminae
 within the layer are highly contorted, precludes any downward
 translation or slump. Saturated with water, the silty layer was
 essentially a viscous fluid with a tendency to flow downward
 under the influence of gravity. Adhesion and cohesion, resulting
 from a combination of electrostatic attractions, van der Waals
 forces, and surface attraction of water (Doot and Howard, 1962,
 p. 113), prevented the mass from normally flowing. Instead, a
 certain amount of lateral adjustment took place producing
 varying degrees of distortion. Most of this adjustment took

place before deposition of the overlying clay so that the upper part of the silt layer was less confined than the lower part of the layer. As a result, the upper part of the layer was more distorted, the contortions dying out downward into the lower part of the layer which remained in place due to increased internal cohesion and adhesion and friction between the silt layer and the underlying clay layer. This explanation seems to fit best the origin of the convolute siltstone laminae in the Haymond Formation.

Graded bedding. - - Graded bedding is present in the siltstone layers of the Haymond Formation only in a subtle form. The most noticeable grading is in the upper part of the siltstone which grades into the overlying shale by a decrease in silt. Bailey (1930) concluded that cross bedding and graded bedding represent deposition under two different conditions. Cross bedding is a document of current deposition whereas graded bedding is a document of gravity settling in still water. Recent studies by Kuenen (Kuenen and Migliorini, 1950; Kuenen and Menard, 1952; Kuenen, 1953), have led to the conclusion that, in most cases, graded bedding implies turbidity currents. Unfortunately, recent workers have frequently reversed this implication, i.e. turbidity currents imply graded bedding. This latter implication is dependent upon the position of the particular section being studied with respect to the slope and the bottom of the basin of deposition. At the bottom of the basin, the turbidity current encounters a decrease in slope and the suspended load is "dumped". Turbulence continues,

place before deposition of the overlying clay so that the upper part of the silt layer was less confined than the lower part of the layer. As a result, the upper part of the layer was more disturbed, the conditions being not downward into the lower part of the layer which remained in place due to increased lateral cohesion and friction between the silt layer and the underlying clay layer. This explanation seems to fit best the origin of the convolute structures found in the Haymond formation.

Graded bedding - - Graded bedding is present in the siltstone

layers of the Haymond formation only in a subtle form. The most noticeable grading is in the upper part of the siltstone which grades into the overlying shale by a decrease in silt. Bailey (1950) concluded that cross bedding and graded bedding represent deposition under two different conditions. Cross bedding is a document of current deposition whereas graded bedding is a document of gravity settling in still water. Recent studies by Kuenen (Kuenen and Migliorini, 1950; Kuenen and Menard, 1952; Kuenen, 1953), have led to the conclusion that, in most cases, graded bedding implies turbidity currents. Unfortunately, recent workers have frequently reversed this implication, i.e. turbidity currents imply graded bedding. This latter implication is dependent upon the position of the particular section being studied with respect to the slope and the bottom of the basin of deposition. At the bottom of the basin, the turbidity current encounters a decrease in slope and the suspended load is "dumped", forming cross-bedding.

however, with little lateral movement until downslope movement has ceased. Because currents are absent, differential settling in response to gravity produces a graded sequence. On the slope, this "dumping" does not take place. Instead, the velocity of the turbidity current gradually decreases until laminar flow permits settling of material which is then deposited in cross-laminations.

Sole markings

Many of the lower bedding planes of siltstone layers of the Haymond Formation contain subparallel flute casts (Crowell, 1955, p. 1359) and groove casts (Shrock, 1948, p. 163). The flute and groove marks or depressions were formed on the upper surface of a clay layer by a silt-laden current. As the silt was deposited, it filled in the depressions in the underlying clay, forming a cast which was preserved on the lower bedding plane or sole of the silt layer. Features which seem to fit the description of flute casts as suggested by Crowell (1955, p. 1359) have been called lobate rill marks (Clarke, 1918; Shrock, 1948), flow markings (Rich, 1950 and 1951; Kuenen and Carozzi, 1953; Kuenen and Sanders, 1956), flow-roll markings (Rich, 1950), *Strömungs-Marken* (Rücklin, 1938), *Gefliess-Marken* (Richter, 1935), and spatulate casts (Pettijohn, 1957). For additional information on the origin and classification of these and similar markings, see the works of Rich and Wilson (1950), Prentice (1956 and 1960), Kelling and Walton (1957), Kuenen (1957), Kuenen and Prentice (1957), Crowell (1958), Glaessner (1958), Hsu (1958 and 1959), Kuenen and Ten Haaf (1958), Sullwold (1959), Holland (1960), Johnson (1962), and McBride (1962b).

however, the literature is not

has been, however, the

in response to which, it is

the "bumping" does not

the ability to

particular, the

limitations.

Some markings

Many of the

the present

1955, p. 135) and

line and groove

surface of a

was deposited,

clay, forming

plane or side

one-directional

p. 135) have

Brook, 1940;

Garrett, 1955;

(Rice, 1950);

W. R. (1955);

for additional

these and other

(1950), Pringle

Kuenen (1957);

Glaesner (1951);

Salvati (1959);

The orientations of 357 flute and groove casts were measured on the lower bedding planes of 107 siltstone layers throughout the road-cut section of the Haymond Formation. Strike and dip of individual layers were recorded along with the rake of each flute or groove cast. Using a stereonet, the layers were rotated to horizontal and the true orientations of the casts determined, (Billings, 1954, p.485). Because the casts are linear features, their orientations may have one of two directions. The correct direction was determined by noting the bulbose (upcurrent) end of the flute cast.

Corrected directions of all flute and groove casts range from 55 degrees to 128 degrees (azimuth from the south) with a mean of 85.71 degrees and a standard deviation of 13.5 degrees. The directions were divided into 15 class intervals of 5 degrees each and the frequency distributions plotted as a histogram and as a rose diagram (Fig. 13). In the rose diagram, the length of each arrow, plotted on the midpoint of the class interval, is proportional to the number of measurements within that class interval. In addition, the mean direction was determined for each siltstone from which measurements were obtained and plotted in Figure 7. A summary tabulation of these measurements is given in Appendix III.

Figure 13 indicates an east to west paleocurrent direction with relatively little variation. These results confirm McBride's report (1962a) of an eastern source area with turbidity current flow ranging from transverse to parallel to the basin axis. Each point on the current variation curve (Fig. 7) represents the dominant current direction during deposition of

The orientation of VSV ticks and grooves were determined on the lower surface of the 10% agarose plates throughout the post-out section of the beyond formation. Ectopic and tip of individual features were recorded along with the rate of each line or groove cast. Using a stereonet, the features were rotated to horizontal and the five orientations of the casts determined (Billings, 1974, p. 485). Because the casts are linear features, their orientations may have one of two directions - the correct direction was determined by noting the bulge (apertures) and of the line cast.

Corrected direct one of all lines and groove casts range from 55 degrees to 158 degrees (measured from the south) with a mean of 82.7 degrees and a standard deviation of 17.5 degrees. The directions were divided into 15 class intervals of 5 degrees each and the frequency distributions plotted as a rose diagram as a rose diagram (Fig. 13). In the rose diagram, the length of each arrow, plotted on the radius of the class interval, is proportional to the number of measurements within that class interval. In addition, the mean direction was determined for each direction from which measurements were obtained and plotted in Figure 7. A summary tabulation of these measurements is given in Appendix III.

Figure 13 indicates an east to west palaeogeographic direction with relatively little variation. These results confirm Holliday's report (1962a) of an eastern source area with westerly current flow coming from thence to parallel to the main axis, each point on the trend variation curve (Fig. 7) represents the dominant current direction during deposition of

that particular silt layer. Although the variations in direction appear random, there is a noticeable trend from a southwesterly to a northwesterly direction perhaps indicating a minor change in the configuration of the edge of the basin (Fig. 7).

these conditions will be met. Although the variation in
direction about random, there is a noticeable trend
necessarily to a non-randomly directed pattern
a sharp change in the configuration of the edge of the

(Fig. 7)

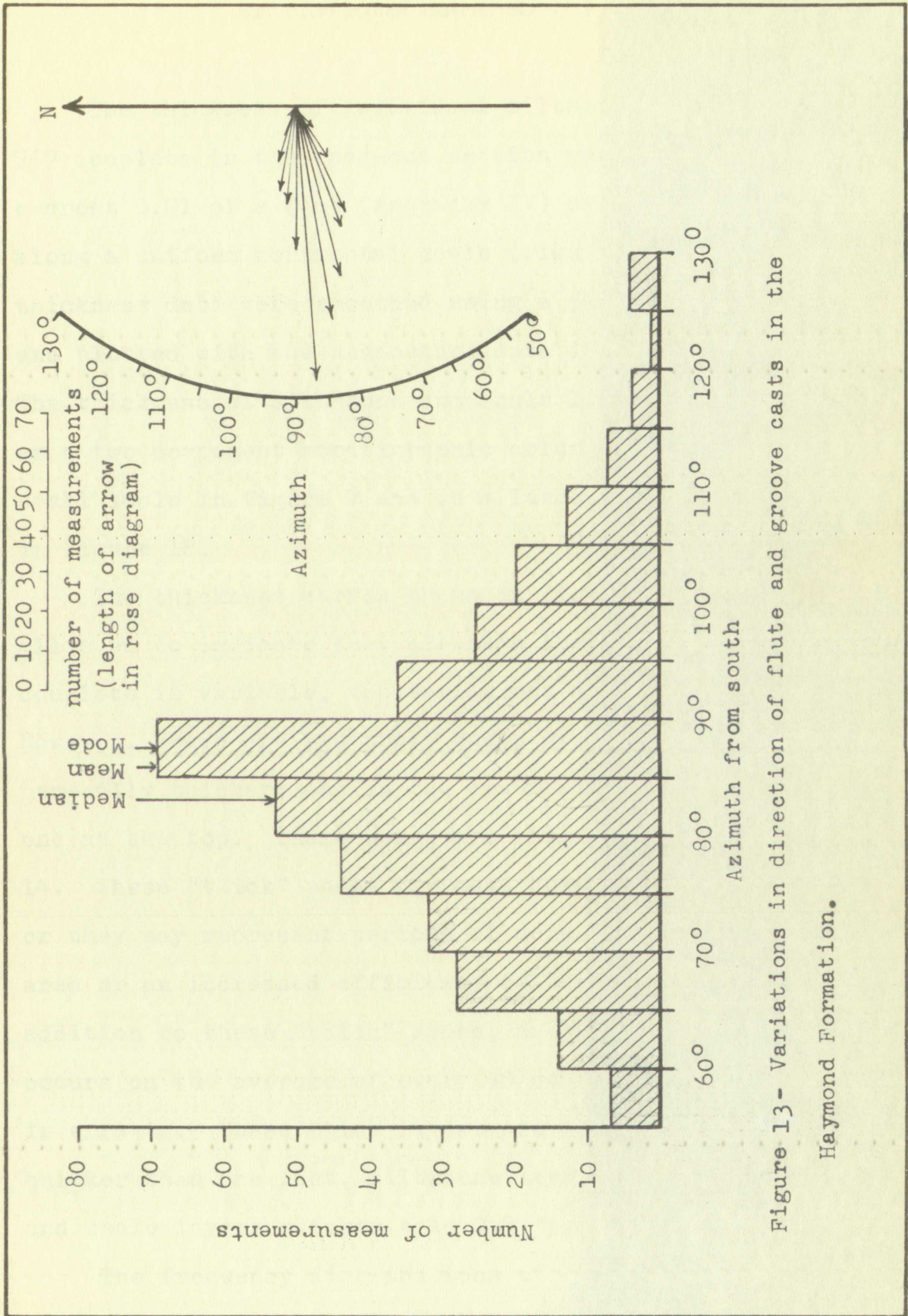
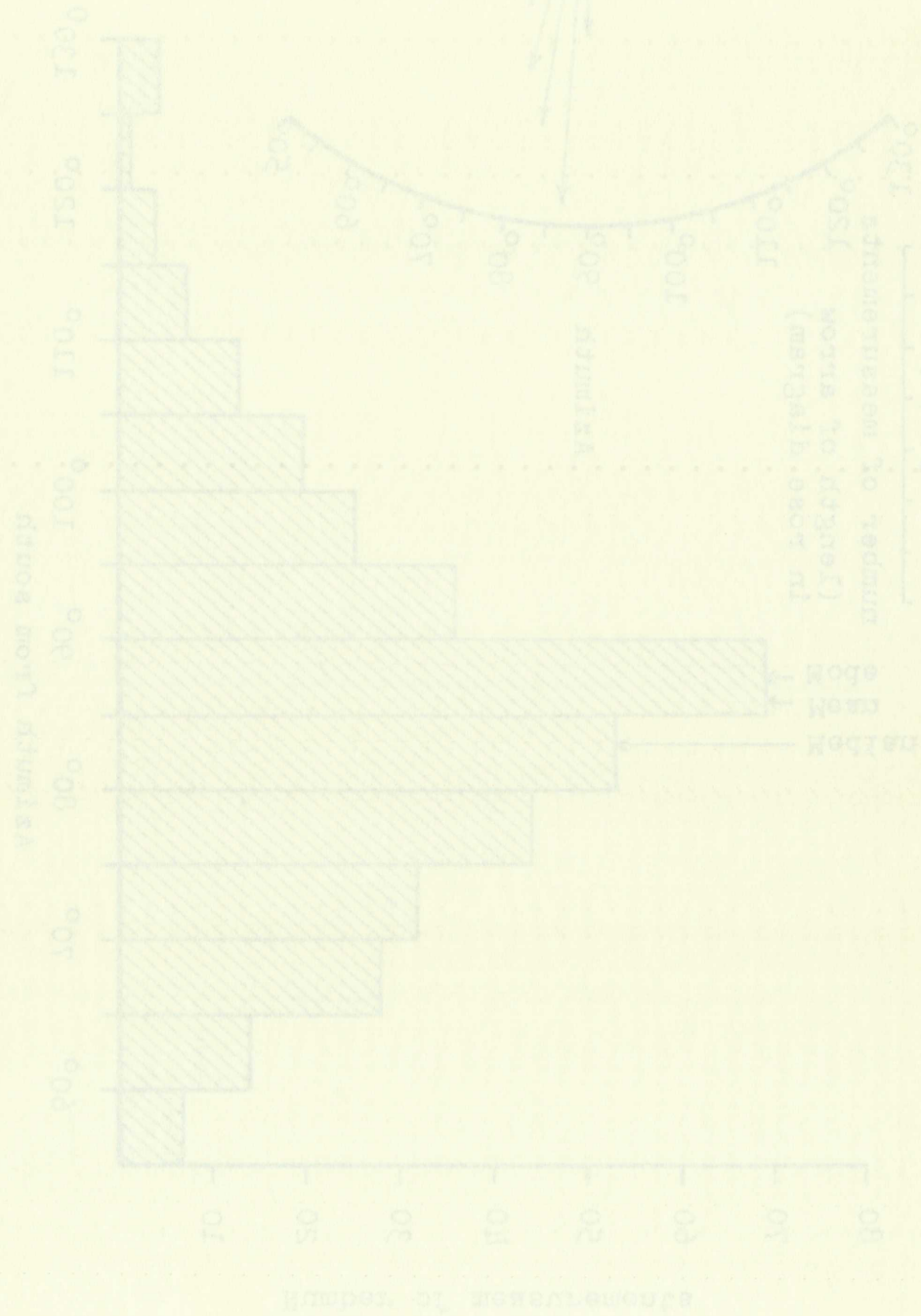


Figure 13- Variations in direction of flute and groove casts in the Haymond Formation.

Рис. 13. Изменения в направлении ветра и скорости ветра в 1950 г.

Рис. 13 - Изменения в направлении и силе ветра в 1950 г.



STATISTICAL ANALYSES

The thickness of individual siltstone and shale layers of 767 couplets in the road-cut section were measured to the nearest 0.01 of a foot (Appendix IV) and plotted separately along a uniform horizontal scale (Figs. 16 and 17). Couplet thickness data were smoothed using a 31-unit moving average and plotted with the unsmoothed data in Figures 14 and 15. The thickness of siltstone and shale layers were then plotted as a two component stratigraphic column and presented on a small scale in Figure 7 and on a larger scale in 5 segments in Figure 18.

The thickness curves shown in Figures 14, 15, 16, and 17 all seem to indicate that although the thickness of individual couplets is variable, the variations are essentially random. However, there are two broad zones where the couplets are generally thicker; one in the lower quarter of the section and one at the top. These zones are the prominent highs in Figure 14. These "thick" zones may have some climatic significance, or they may represent periods of more active uplift of the source area or an increased efficiency of the scattering agent. In addition to these "thick" zones, an individual thick layer occurs on the average of every 40 couplets although the variation is erratic. These thick layers are represented by couplets thicker than one foot, siltstone layers thicker than 0.6 foot, and shale layers thicker than 0.5 foot (Figs. 15, 16, and 17).

The frequency distributions of siltstone and shale thickness for both the road-cut and railroad-cut sections are skewed to the

Dean-slope-
deposits-
Haymond-
formation

Let first the rock-cores and sections be shown to the
the thickness distribution of glaciolite and shale thickness
and shale layers between 0.5 foot (Plate 13, 14, and 15).
between each the rock-cores glaciolite layers between 0.5 foot
is shown. These rock-cores are represented by circles
occur on the average of every 50 feet although the variation
addition to these "block" zones, an individual color layer
area or an increased efficiency of the sedimentation. In
on they are represented by dots of some active point of the source
In these "block" zones may have some glaciolite thickness,
one in the top. There were are the thickness shown in Figure
thickness, 1.5 feet; one in the lower portion of the section in
between these and two block zones where the corollary are
complete in variable, the variation are essentially random,
all as to include that through the thickness of individual
The thickness curves shown in Figures 12, 13, 14, and 15
in Figure 14.
shall be in Figure 7 and one lower scale in 2.5 centimeter
as a two component effect, rapid column and presented one
The thickness of glaciolite and shale layers were then plotted
and plotted with the measured data in Figure 14 and 15.
Thickness data were presented using a slightly modified average
along a uniform horizontal scale (Plate 16 and 17). Consider
between 0.10 of a foot (Plate 17) and plotted separately
NES complete in the rock-cores section were mounted to the
the thickness of individual glaciolite and shale layers of

STATISTICAL ANALYSIS

Figure 14 - 31-unit moving average of silt-clay couplet thickness in the Haymond Formation

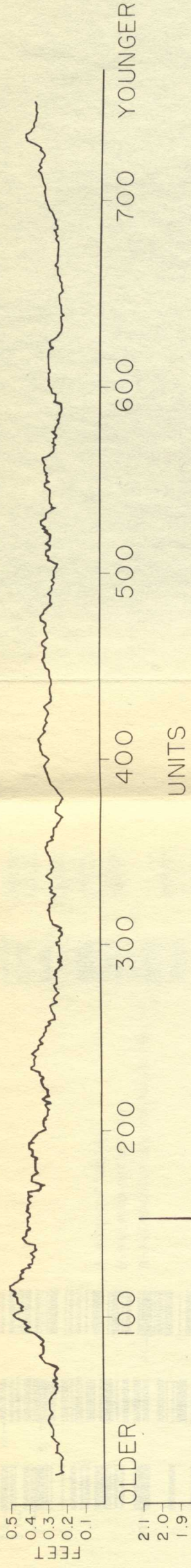


Figure 15 - silt-clay couplet thickness in the Haymond Formation

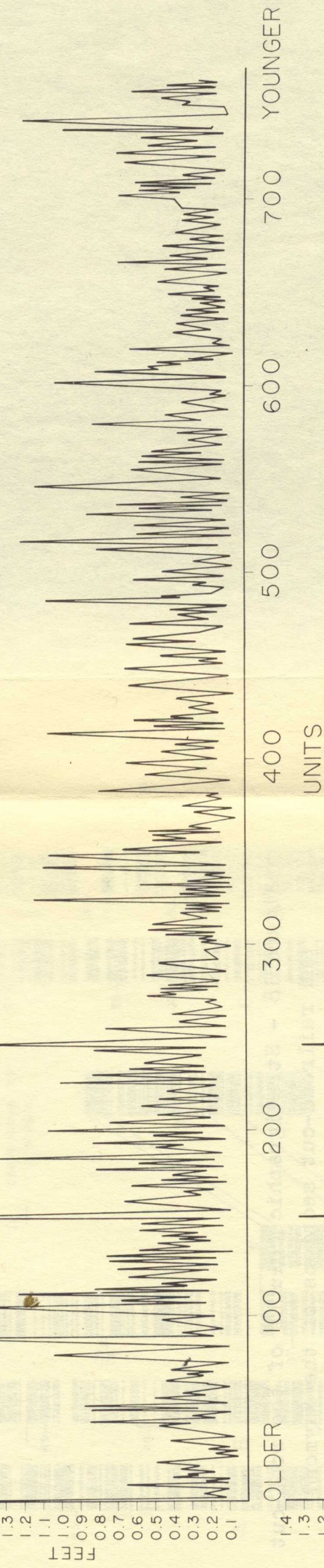


Figure 16 - silt layer thickness in the Haymond Formation

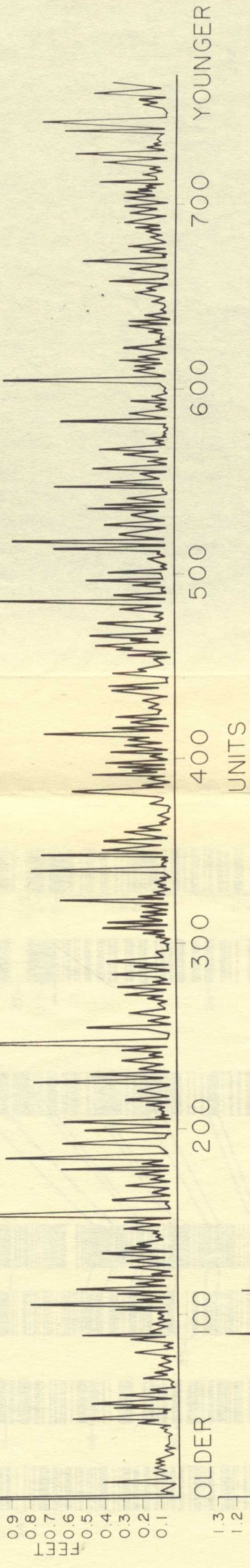


Figure 17 - clay layer thickness in the Haymond Formation

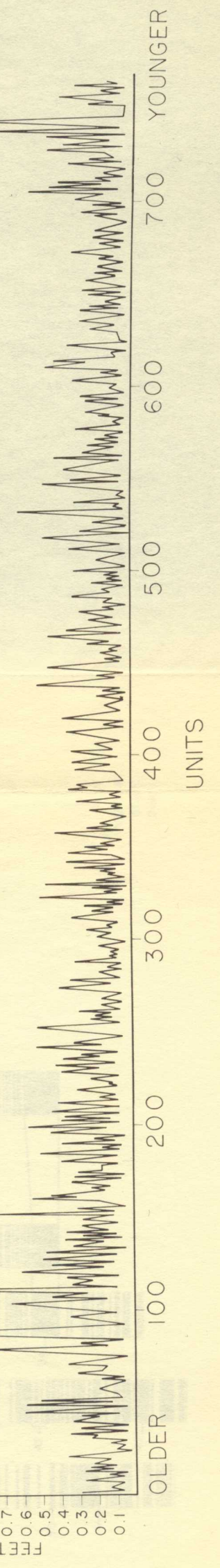
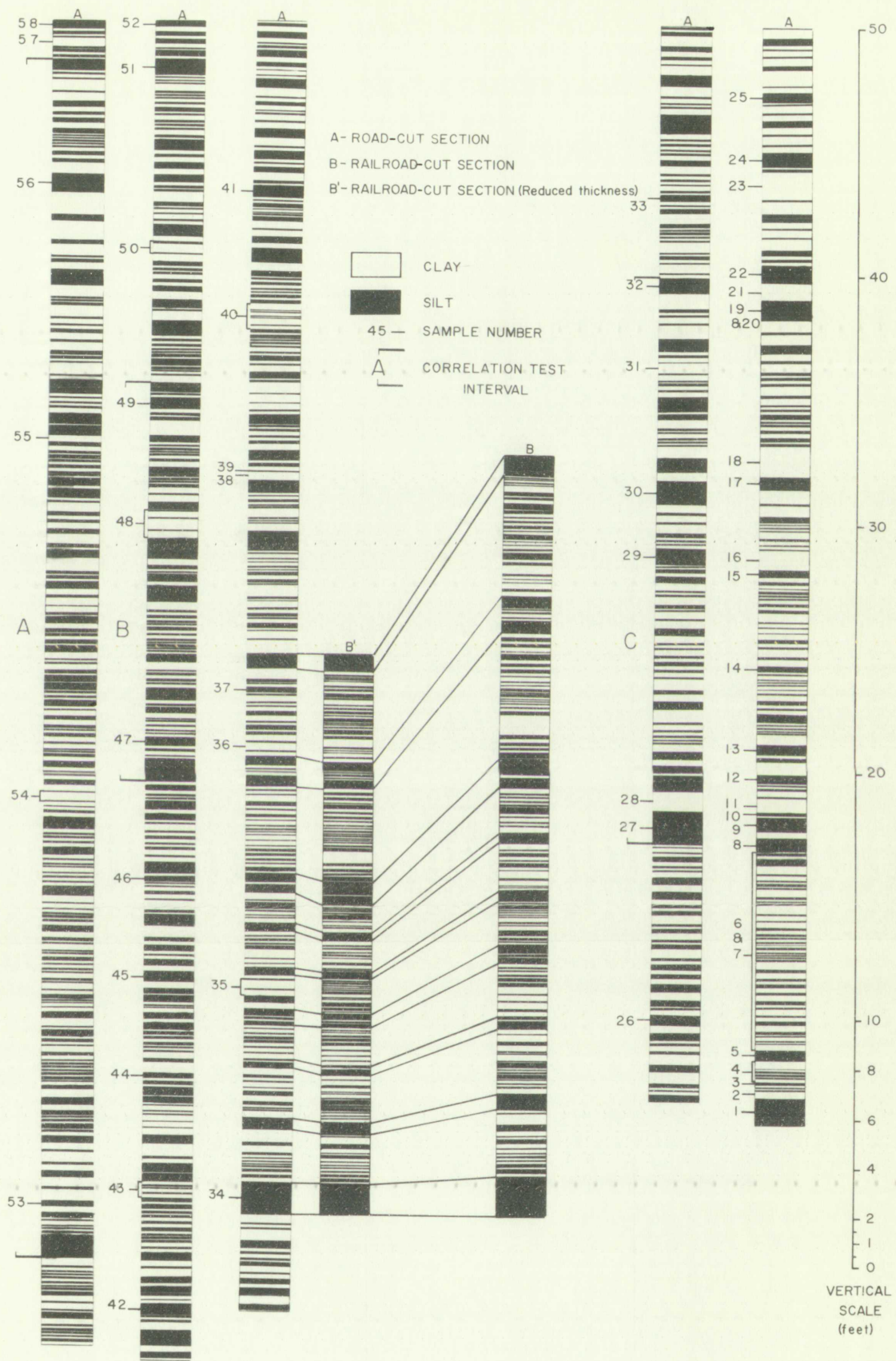
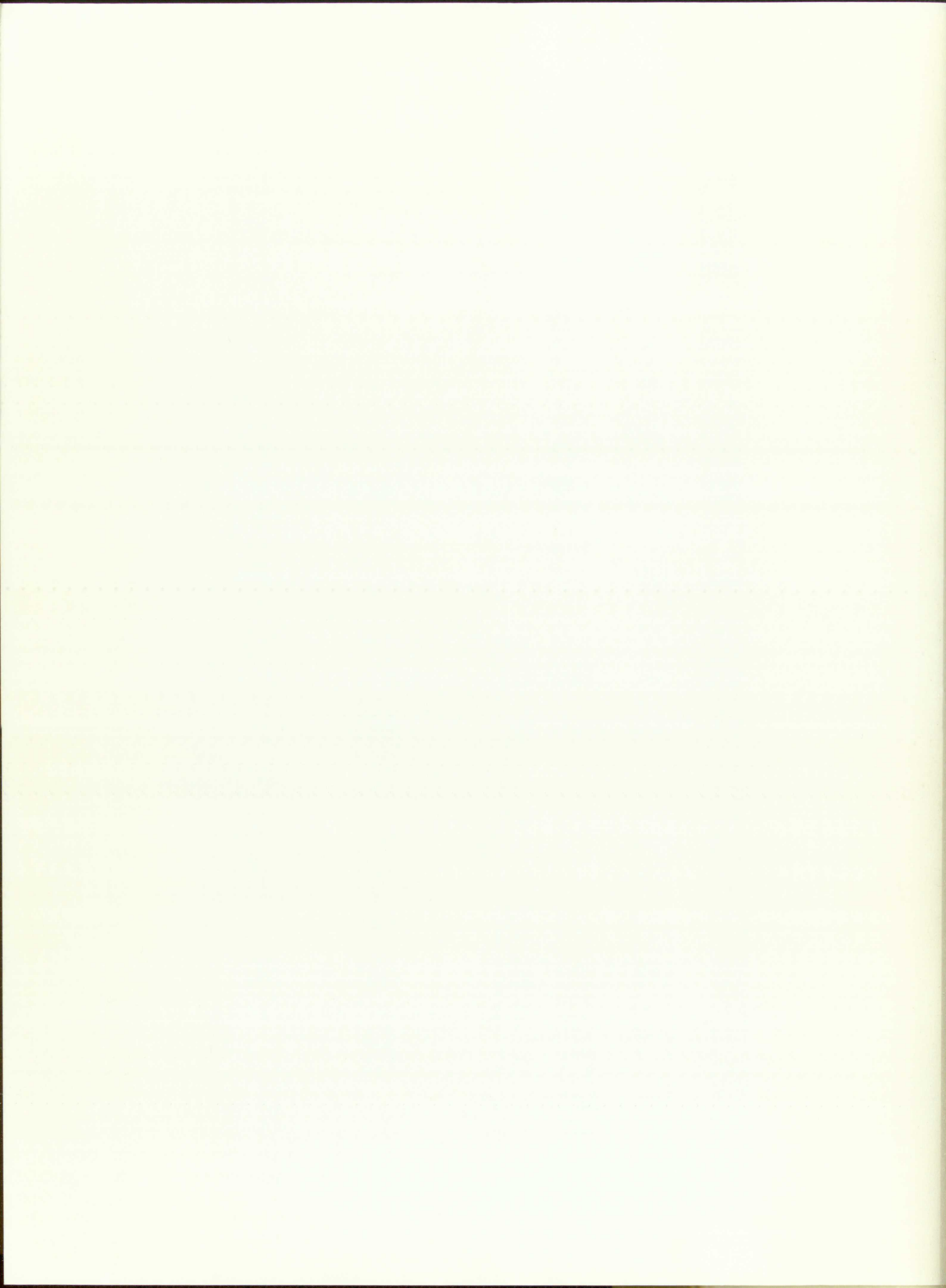


Figure 18 - Stratigraphic columns of the road-cut
and railroad-cut sections of the Haymond
Formation.





left (Fig. 19). The siltstone thickness distributions are essentially the same for both the road-cut and railroad-cut sections with more than 75 percent of the layers less than 0.2 foot thick and modes in the 0.0 to 0.1 foot class interval. The shale thickness distributions are alike in that more than 75 percent of the layers are less than 0.2 foot thick but they differ in that the mode for the road-cut shale falls in the 0.1 to 0.2 foot class interval while the mode for the railroad-cut shale falls in the 0.0 to 0.1 foot class interval.

1012 (Fig. 19). The thickness distribution is essentially the same for both the road-cut and road-cut sections with more than 75 percent of the layers less than 100 thick and more in the 0.1 to 0.1 foot class interval. The shale thickness distributions are alike in that 75 percent of the layers are less than 0.5 foot thick and differ in that the road-cut shale falls in the 0.1 to 0.5 foot class interval while the road-cut shale falls in the 0.1 to 0.1 foot class interval.

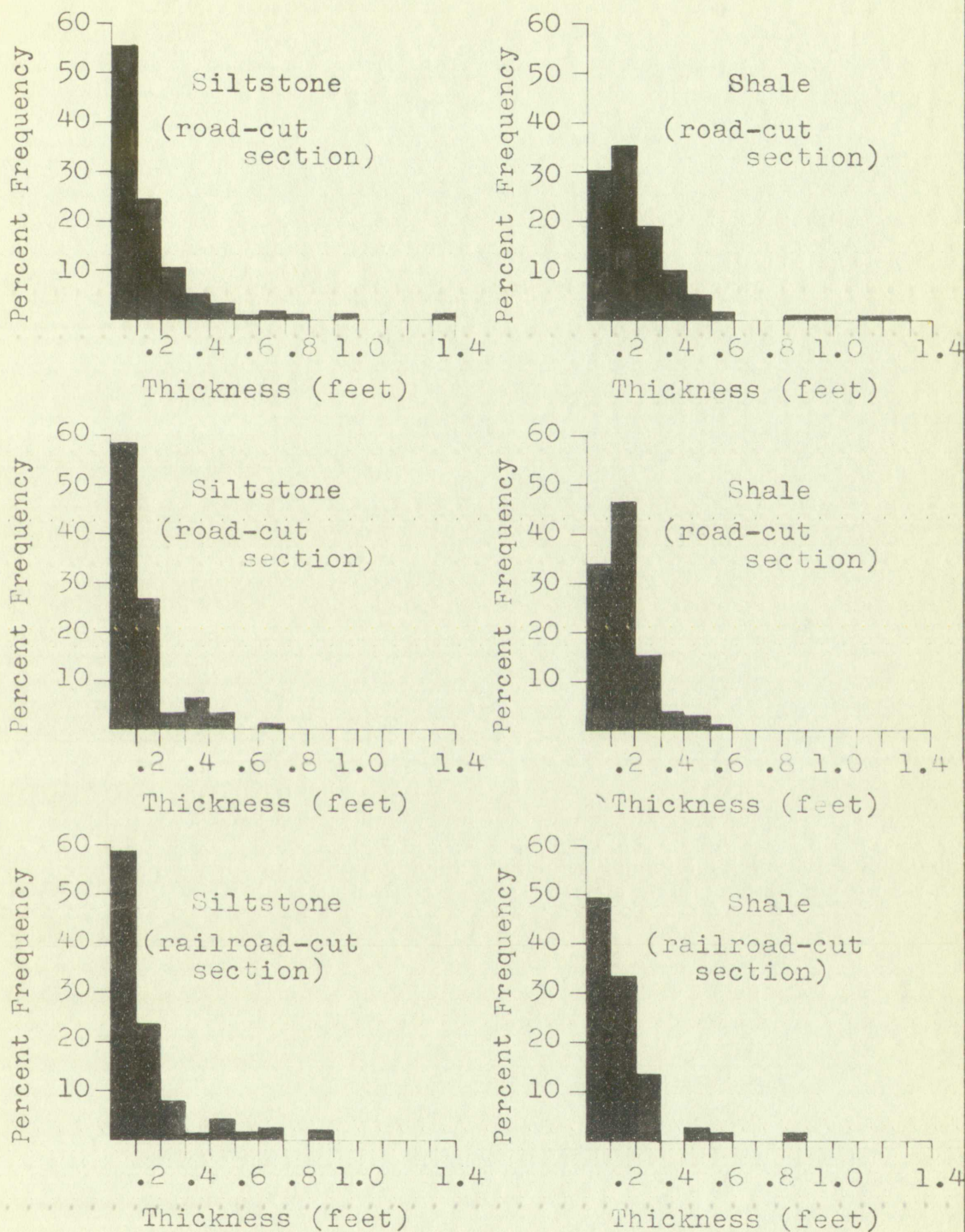


Figure 19 - Percent frequency of siltstone and shale thickness for the road-cut and railroad-cut sections of the Haymond Formation.

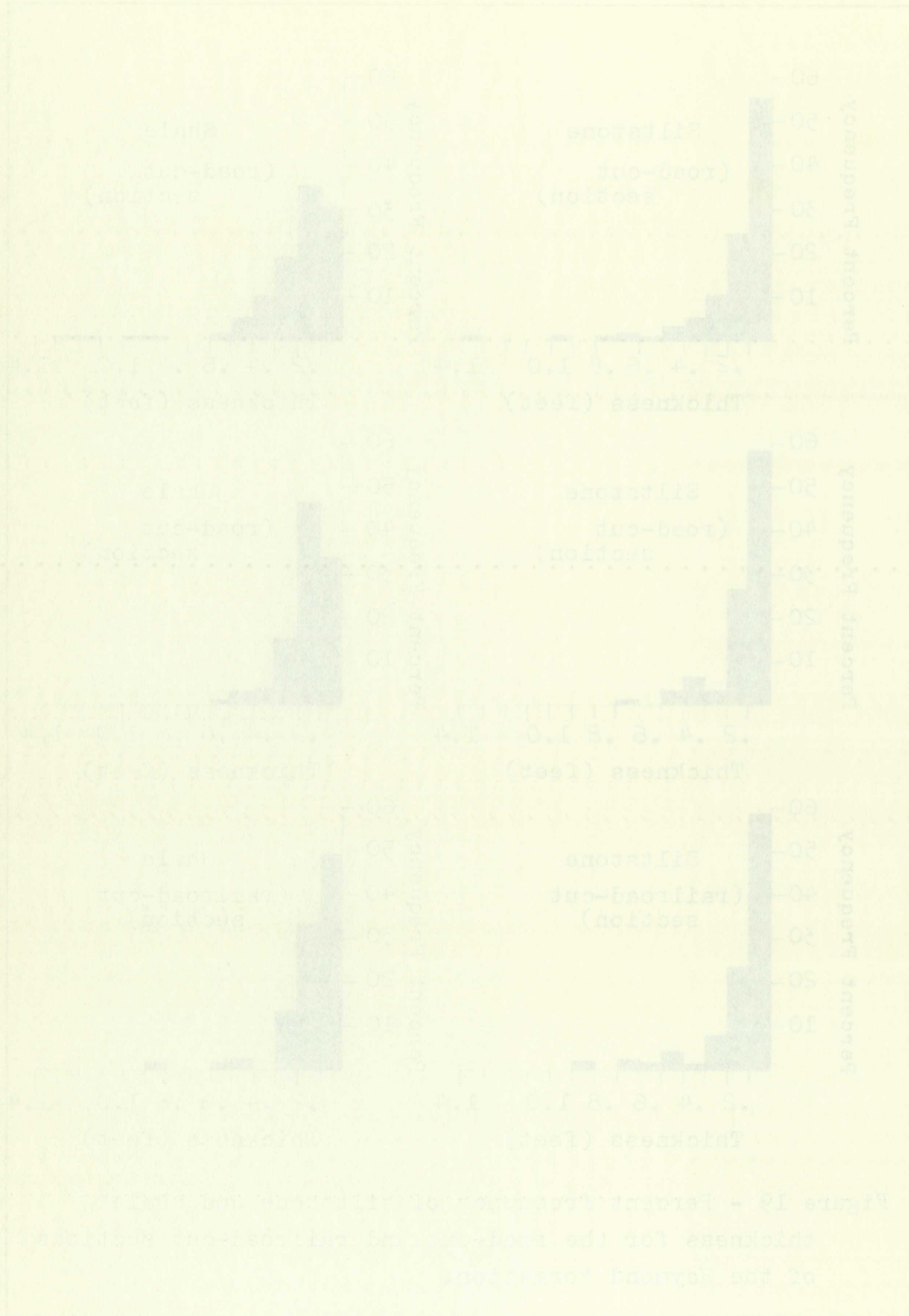


Figure 19 - Percent frequency of thickness for the road-cut and railroad-cut sections of the various formations.

CORRELATION

The part of the Haymond Formation which crops out along the southern Pacific Railroad 2 miles east of Haymond station was correlated 8 miles in the field with part of the Haymond exposed in the road-cut in U. S. Highway 90 (Fig. 1). This field correlation was based on certain key beds and distinctive groups of beds (Figs. 2 and 3).

The individual layers of the railroad-cut section were plotted as a two component stratigraphic column to the correct scale in Figure 18 (column B). For better visual comparison, the section was reduced to 22 feet, the thickness of the assumed corresponding part of the road-cut section, by multiplying the thickness of each layer by 0.745. This reduced section is plotted as column B' in figure 18.

As the railroad-cut section contains more couplets than the corresponding part of the road-cut section, it was not possible to obtain a correlation coefficient using raw thickness data. As the thinner layers are probably the most variable laterally (see p. 40), all siltstone layers thinner than one standard deviation above the mean were grouped with the enclosing shale layers. Nine siltstone layers remained in both the railroad-cut section and the corresponding part of the road-cut section which, combined with the intervals between (shale plus siltstone layers less than the mean) gave 18 units in each section.

These 18 units were used to compute a correlation coefficient between the two sections of +0.998, almost perfect positive

CONCLUSION

The part of the highway formation which crops out along the southern part of the road is a typical example of a road-cut section. It is composed of a series of beds, the thickness of which varies from 1 to 2 feet. The beds are separated by thin layers of clay. The beds are exposed in the road-cut in the vicinity of the road-cut. This field correlation was based on certain key beds and distinctive groups of beds (see, for example, pages 5 and 6).

The individual layers of the road-cut section are listed as a two component stratigraphic column in the column in Figure 18 (column 2). For better visual comparison, the section was reduced to 25 feet, the thickness of the as- shown road-cut section. The road-cut section, by multiplying the thickness of each layer by 0.75. This reduced section is listed as column 2 in Figure 18.

As the road-cut section contains more correlative than the corresponding part of the road-cut section, it was not possible to obtain a correlation coefficient satisfactory to the data. As the thinner layers are probably the most variable laterally (see p. 40), all lithologic layers thinner than one standard deviation above the mean were grouped with the enclosing massive layers. Since massive layers remained in both the road-cut section and the corresponding part of the road-cut section which, combined with the intervals between (massive) massive layers, less than the mean (see 15 miles in width) section.

These data were used to compute a correlation coefficient between the two sections of 0.92, almost perfect positive

correlation (Mills, 1955). This relatively objective, mathematical correlation indicates that the assumed field correlation was correct. To further strengthen this correlation, three other areas within the road-cut section were tested for correlation using the same procedure (Fig. 18, correlation test intervals A, B, and C). The following correlation coefficients were obtained: test interval A, +0.663; test interval B, +0.337; test interval C, +0.350. The assumed field correlation is thus further substantiated.

Lateral grading would be expected as a result of downslope size sorting, depositing relatively greater amounts of clay further downslope. Theoretically, a greater amount of silt would be deposited on the upper part of the slope so that any silt layer would thicken in an upslope direction. These lateral variations in size and thickness can be used to explain two features observed in the Haymond Formation. The first feature is the presence of silty claystone which has a composition between that of the siltstone and shale. Each silty claystone probably represents a thicker siltstone further upslope and a thinner shale layer downslope that is indistinguishable from the enclosing shale layers as a result of downslope decrease in grain size. The second feature is the combined upslope increase in: 1. the number of siltstone layers, 2. the thickness of the siltstone layers, and 3. the relative amount of silt. Based on paleocurrent analyses, the railroad-cut section of the Haymond Formation is upslope and to the south of the road-cut section (Fig. 1). Table 1 summarizes some of the silt-clay relationships between the road-cut section and

the railroad-cut section. As can be seen from the table, there is an increase in number and thickness of both silt and clay layers from the road-cut section to the railroad-cut section (upslope). However, the increase in clay is smaller, relative to the increase in silt, so that the amount of silt increases from 48 percent of the total thickness (silt:clay = 0.92) in the road-cut section to 52 percent of the total thickness (silt:clay = 1.07) in the railroad-cut section. These upslope increases are easily explained by lateral gradation resulting in a downslope increase in clay relative to silt.

Table 1: Upslope variation in silt and clay

SECTION	THICKNESS	NUMBER OF LAYERS	SILT:CLAY
Road-cut	22.37		0.92
silt	10.74	80	
clay	11.63	79	
Railroad-cut	30.31		1.07
silt	15.68	117	
clay	14.63	116	

the railroad-cut section. An analysis of the data shows that as the thickness of the clay increases, the amount of silt increases. However, the increase in clay is not relative to the thickness of the total section (silt + clay = 1.00) in the railroad-cut section. These results indicate that the clay is not uniformly distributed in the section. The clay is concentrated in a zone near the top of the section. This is evident from the fact that the clay content of the total section (silt + clay = 1.00) in the railroad-cut section is 0.35, while the clay content of the total section in the road-cut section is 0.25. These results indicate that the clay is not uniformly distributed in the section. The clay is concentrated in a zone near the top of the section. This is evident from the fact that the clay content of the total section (silt + clay = 1.00) in the railroad-cut section is 0.35, while the clay content of the total section in the road-cut section is 0.25.

Table 1: Percent variation in silt and clay

SECTION	THICKNESS	NUMBER OF YEARS	SILT:CLAY
road-cut	25.0		0.35
silt	50.0	80	
clay	11.0	20	
railroad-cut	20.0		1.00
silt	15.0	11	
clay	14.0	11	

ORIGIN OF STRATIFICATION

The siltstone-shale alternations of the Haymond Formation have many of the characteristics of geosynclinal sequences called "flysch". The Flysch Formation of the Alps is a Tertiary sequence over 10,000 feet thick, poor in fossils, and composed of interstratified marl, shale, and sandstone layers (Sujkowski, 1957). Van der Gracht (1931) described the Flysch as "a marine sequence of poorly fossiliferous clayey muds, with more or less sandy beds intercalated in shales, laid down to a great thickness". The term "flysch" has been applied, with slight variations in meaning, to similar sequences of different countries and ages. The term was first applied to the Haymond Formation by van der Gracht (1931).

According to Sujkowski (1957, p. 543), "flysch" sequences are characterized by great thicknesses of geosynclinal slope deposits, chiefly alternating marine shale and sandstone. Bokman (1953, p. 153) lists the following as characteristics of geosynclinal sediments: 1. great thicknesses of sediments, predominantly clastics, deposited in a relatively short period of time, 2. dark color, 3. scarcity of fossils, 4. rhythmic and/or graded shale and graywacke, and 5. presence of associated volcanics and radiolarites. Rich (1950 and 1951) calls such sequences slope or "clino" deposits characterized by bedding which is thin, persistent, and extremely even; alternating silt and clay; thinning downslope away from the edge of the shelf; features of downslope movement; and sparsity of fossils. He concludes that alternating silt and clay layers are the chief

The lithological characteristics of the ...
 have many of the characteristic of ...
 called "lithon". The lithon consists of ...
 mainly composed of ...
 and composed of ...
 layers (Sujkowski, 1957).
 the lithon as "a series of poorly ...
 clayey ends, with more or less ...
 shales, laid down to a great ...
 has been applied, with ...
 sequence of ...
 applied to the ...
 According to Sujkowski (1957), ...
 are characterized by great ...
 deposits, chiefly ...
 (1957, p. 155) lists the ...
 of ...
 predominantly ...
 of fine, ...
 and/or ...
 volcanic and ...
 sequence ...
 which is ...
 and clay ...
 features of ...
 concludes that ...

characteristics of slope deposits. McBride (1962b, p. 47) reached the same conclusions for the Martinsburg Formation, an Ordovician "flysch" sequence in the central Appalachians.

Several lines of evidence suggest that the couplets of the Haymond Formation and similar sequences were deposited by storm-generated turbidity currents with an average frequency of 2 to 10 years. Riveroll and Jones (1954) report a strong 22.8 year double sunspot cycle in the varved Puente (Miocene) Formation of California which they attribute to storm activity. They also found a 7.5 year cycle similar to cycles widely reported in weather, tree ring, and varve thickness data. Hülsmann and Emery (1961) were able to calibrate turbidity current layers in recent sediments of the Santa Barbara basin, California using varves. Each of the diatom-detrital varve groups separating turbidity current layers contains 1 to 43 couplets with a mean of about 5 indicating an average of about 5 years between turbidity currents. A similar calibration was obtained by Anderson (report in preparation) for the Oligocene Florissant lake beds of Colorado where the normal diatomite-sapropel varve couplets are interrupted by graded turbidity layers on an average of every 4 or 5 years.

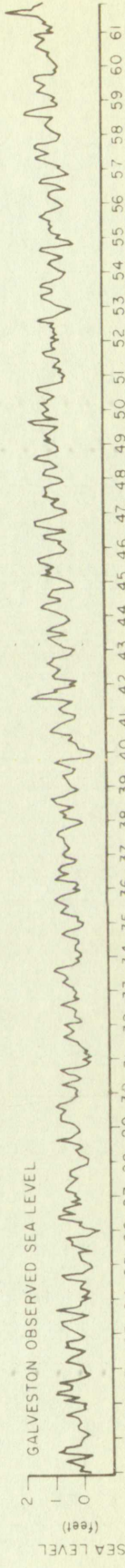
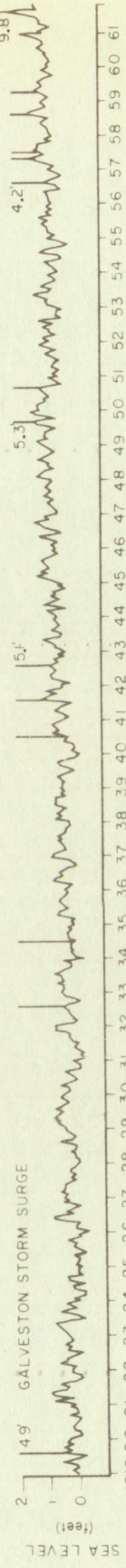
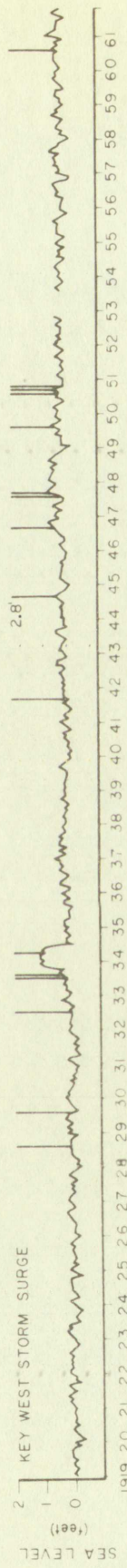
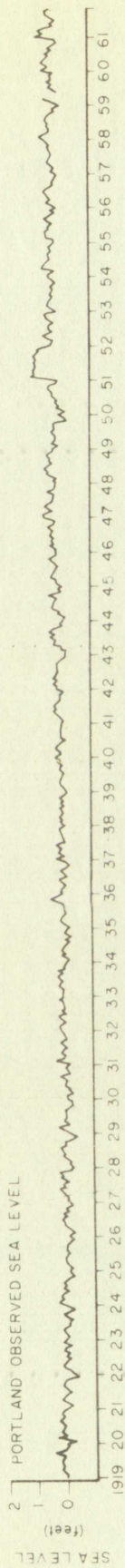
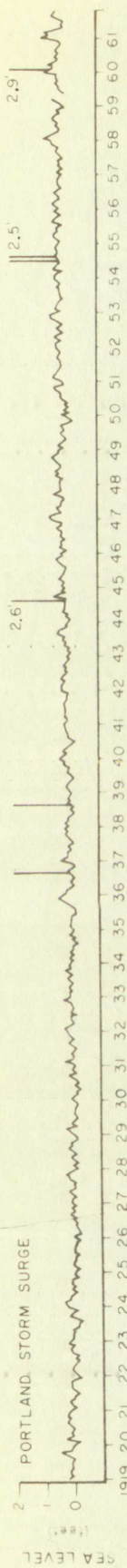
Studies on the characteristics of recent storms are currently being conducted by the Storm Surge Research Project of the U. S. Weather Bureau. A storm surge is defined as "the difference between the observed water level and that which would have been expected at the same place in the absence of the storm" (Harris, 1963, p. 2). The use of storm surge

characteristic of high-frequency oscillations (1950, p. 100).
The same conditions for the formation of
an oscillating "lyric" sequence in the central part of the
several lines of evidence suggest that the formation of
the lyric formation and related phenomena was determined by
storm-generated disturbances which occur over the Pacific
of 5 to 10 years. Riveroll and Cohen (1959) reported a mean
22.8 year double annual oscillation in the central part of the
formation of California which they attributed to a disturbance
They also found a 7.5 year cycle similar to oscillations
reported in weather, tree rings, and other phenomena.
Hussain and Emery (1961) were also able to identify
certain layers in their studies of the central part of
California. Each of the three distinct
groups exhibiting further common layers contains
cycles with a mean of about 7.5 years in an oscillating
5 years between turbid currents. A similar oscillation was
obtained by Anderson (1960) in his study of the
Florida lake beds of Holston where the mean interval
asymptotic wave cycles are interrupted by small
layers on an average of every 7.5 years.
Studies on the characteristics of these oscillations
currently being conducted by the author have been
of the U. S. weather service. A good source is the
the difference between the observed and the
which would have been expected if the
of the storm" (p. 100, 1950). The use of storm

analyses eliminates the cycles caused by normal astronomic tides leaving only the effects on sea level caused by storms. Variations in monthly mean sea level and the corresponding storm surge charts for 3 U. S. Coast and Geodetic Survey tide stations on the Atlantic and Gulf coasts of the United States are shown in Figure 20. The storm surge data were computed by subtracting the normal sea level from the observed sea level (Harris, 1963, Fig. 0.3) for a particular month. The vertical lines superimposed on the storm surge charts represent sea level anomalies greater than two feet. The actual size of the anomaly is indicated wherever information was available. A summary of the frequency of these anomalies is given in Appendix VI for 17 U. S. Coast and Geodetic Survey tide stations along the Atlantic and Gulf coasts. Regional means range from 1.57 to 3.87 years between anomalies.

Assuming that the turbidity currents which deposited the silt layers of the Haymond Formation were generated by a storm process with a frequency of the same order of magnitude as the above examples, then each silt-clay couplet in the Haymond should represent a time interval of 2 to 5 years. Although every silt layer may be a record of a storm, there are several reasons why every storm would not be recorded by a silt layer. It is possible that several severe storms could have occurred within one year (Fig. 20) with insufficient time between storms for silt to accumulate. If we assume that the axes of structures presently exposed in the Marathon basin are parallel to the axis and edge of the Llanoria geosyncline, then the railroad-cut section of the Haymond Formation is 5 miles upslope from the

Figure 20 - Monthly mean observed sea level and storm surge at 3 selected Coast and Geodetic Survey tide stations. The year number is plotted on June. Marks indicate the occurrence of a storm which produced a tide anomaly as much as 2 feet at any hourly observation; the actual size of the anomaly is indicated by the figures wherever information was available (after Harris, 1963).



road-cut section (distance corrected for folding and faulting). In this 5 miles, the number of silt layers has increased 46 percent. If we further assume that the siltstone layers in the railroad-cut section represent all storms capable of generating a turbidity current, then each siltstone layer in the railroad-cut section probably represents a time interval of 2 to 5 years and each siltstone in the road-cut probably represents a time interval of 4 to 10 years. These are minimum time intervals as the siltstone layers in the railroad-cut section probably represent only a fraction of the storms capable of generating a turbidity current.

road-cut section (distance measured in feet) and is shown
in this figure, the number of soil layers has increased to
percent. It is further assumed that the alluvial layers in
the road-cut section represent all strata capable of
generating a turbidity current, then each alluvial layer in
the road-cut section probably represents a time interval
of 2 to 5 years and each alluvial layer in the road-cut probably
represents a time interval of 4 to 10 years. These are
minimum time intervals as the alluvial layers in the road-cut
cut section probably represent only a fraction of the strata
capable of generating a turbidity current.

CONCLUSIONS

The silt-clay alternations of the Haymond Formation accumulated rapidly without important interruption on the slope of the Llanoria geosyncline. Paleocurrent and petrographic analyses indicate that the sediments were derived from an igneous and metamorphic terrane to the east. Each silt layer was deposited in a very short time by a turbidity current. The frequency of the turbidity currents was probably controlled by the storm frequency and availability of detrital material. Applying what is known about the characteristics of turbidity currents, the following sequence of events is suggested for the deposition of a typical silt-clay couplet in the Haymond Formation:

1. Silt and clay on the shelf were continually worked along the bottom by currents to the upper part of the slope. Waves and currents of a storm, stirred the accumulated sediments into suspension and generated a turbidity current which scoured and grooved the top surface of the underlying clay layer.

2. The turbidity current eventually lost momentum and the suspended material began to settle. At first, the settling was too rapid to permit size sorting. The current continued as laminar flow, reworking the silt and clay and redepositing them as cross laminations with a subparallel arrangement of platy and elongate grains. At this phase of laminar flow, scour-and-fill structures were formed by certain irregularities in flow. As the current continued to wane, slight changes in current velocity resulted in the periodic concentration of clay and plant fragments into horizontal micro-laminations.

CONCLUSIONS

The clay-aluminum silicates of the lower section accumulated rapidly without apparent interposition of the edge of the fibrous geosyncline. Paleogeographic and petrographic analyses indicate that the sediments were derived from an igneous and metamorphic terrain to the east. Each silt layer was deposited in a very short time by a turbidity current. The frequency of the turbidity currents was probably controlled by the storm frequency and availability of material material. A point is made about the characteristics of turbidity currents, the following sequence of events is suggested for the deposition of a typical silt layer:

in the Hayden formation:

1. Silt and clay on the shelf were eventually worked

along the bottom by currents to the water center of the shelf

and currents of a storm, stirred the suspended sediment

into suspension and generated a turbidity current which moved

and covered the top surface of the underlying silt layer.

2. The turbidity current eventually lost momentum and

the suspended material began to settle. At first, the settling

was too rapid to permit size sorting. The current continued

an laminar flow, reworking the silt and clay and depositing

them as cross laminations with a horizontal arrangement of

clay and elongate grains. At this phase of laminar flow,

small and fine structures were formed by certain irregularities

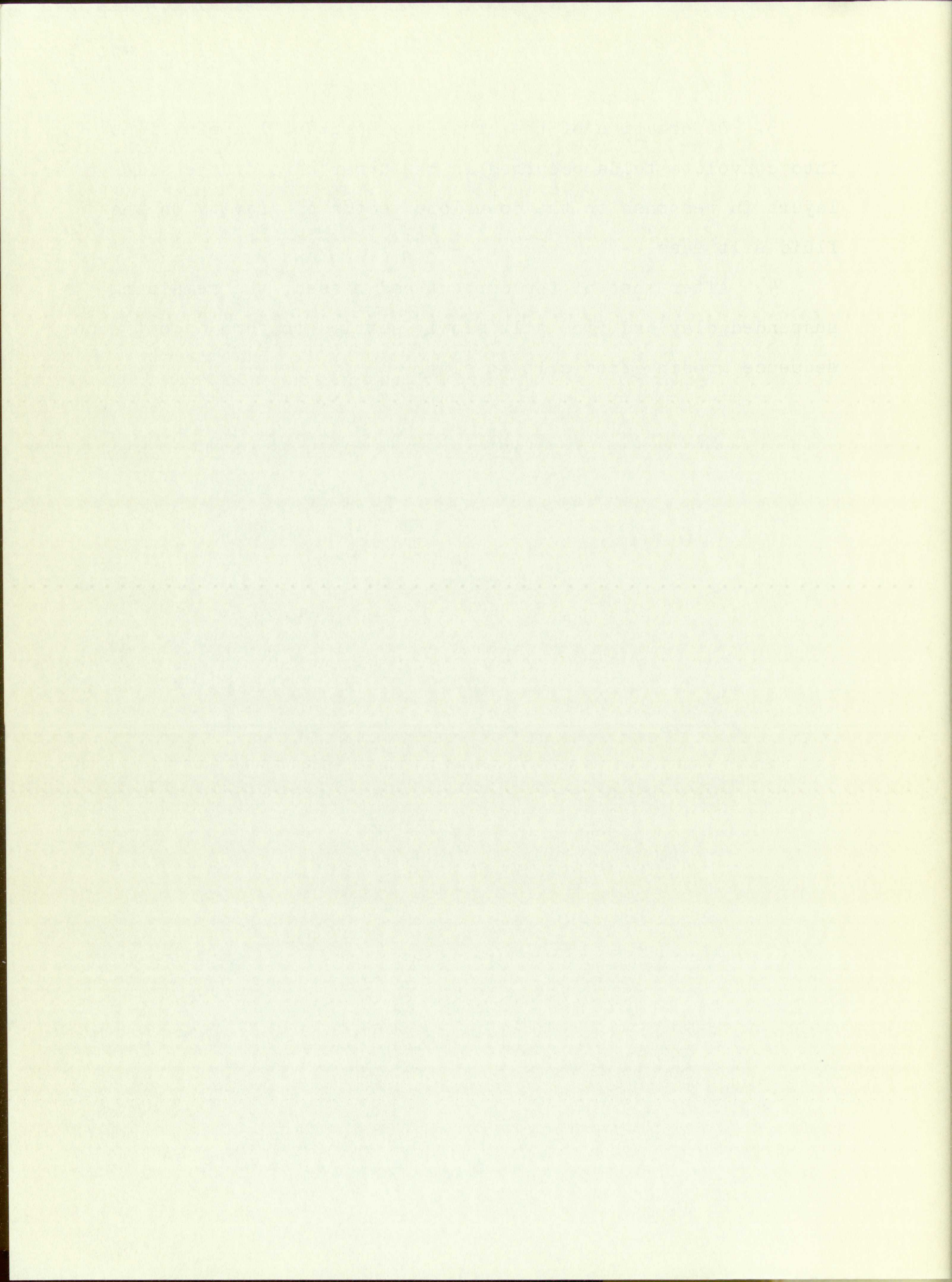
in flow. As the current continued to wane, silt and clay

current velocity resulted in the turbidity current

clay and silt passages into horizontal laminae.

3. Deformation of the cross and horizontal laminations into convolute folds occurred in the upper part of the silt layers in response to the downslope vector of gravity on the fluid silt mass.

4. After most of the current had passed, the remaining suspended clay and fine silt slowly settled to form a continuous sequence grading from silt to clay.



REFERENCES CITED

- Bailey, E. B., 1930, Sedimentation in relation to tectonics: Geol. Soc. America Bull., v. 47, p. 1713-1726.
- Bain, G. W., 1931, Flowage folding: Am. Jour. Sci., 5th ser., v. 22, p. 503-530.
- Baker, C. L., 1932, Erratics and arkoses in the Middle Pennsylvanian Haymond Formation of the Marathon area, trans-Pecos Texas: Jour. Geology, v. 40, p. 577-607.
- Baker, C. L. and Bowman, W. F., 1917, Geologic exploration of the southeastern Front Range of trans-Pecos Texas: Texas Univ. Bull. 1753, p. 61-172.
- Baldry, R. A., 1938, On a theory of gravitational sliding applied to the Tertiary of Ancon, Ecuador: Geol. Soc. London Quart. Jour., v. 94, p. 359-370.
- Beets, C., 1946, Miocene submarine disturbances of strata in northern Italy: Jour. Geology, v. 54, p. 229-245.
- Billings, M. P., 1954, Structural geology: New York, Prentice-Hall, Inc., 514 p.
- Bisque, R. E., 1961, Analysis of carbonate rocks for calcium, magnesium, iron and aluminum with EDTA: Jour. Sedimentary Petrology, v. 31, p. 113-122.
- Bokman, J., 1953, Lithology and petrology of the Stanley and Jackfork Formations: Jour. Geology, v. 61, p. 152-170.
- Calvert, S. E. and Veevers, J. J., 1962, Minor structures of unconsolidated marine sediments revealed by X-radiography: Sedimentology, v. 1, p. 287-295.
- Carney, F., 1935, Glacial beds of Pennsylvanian age in Texas (abstract): Geol. Soc. America Proc. for 1934, p. 70.
- Cheney, M. G., 1929, Stratigraphic and structural studies in north-central Texas: Texas Univ. Bull. 2913, 27 p.

- Clarke, J. M., 1918, Strand and undertow markings of Upper Devonian time as indications of the prevailing climate: New York State Mus. Bull. 196, p. 199-238.
- Cline, L. M., 1960, Late Paleozoic rocks of the Ouachita Mountains: Oklahoma Geol. Survey Bull. 85, 113 p.
- Cope, F. W., 1946, Intraformational contorted rocks in the upper Carboniferous of the southern Pennines: Geol. Soc. London Quart. Jour., v. 101, p. 139-176.
- Crowell, J. C., 1955, Directional current structures from pre-Alpine Flysch, Switzerland: Geol. Soc. America Bull. v. 66, p. 1351-1384.
- 1958, Sole markings of graded graywacke beds; a discussion: Jour. Geology, v. 66, p. 333-335.
- Dott, R. H. and Howard, J. K., 1962, Convolute laminations in non-graded sequences: Jour. Geology, v. 70, p. 114-121.
- Dunbar, C. O., 1960, Historical geology: New York, John Wiley and Sons, Inc., 500 p.
- Flawn, P. T., 1958, Genesis of Haymond boulder beds; discussion: Am. Assoc. Petroleum Geologists Bull., v. 42, p. 1734-1735.
- Glaessner, M. F., 1958, Sedimentary flow structures on bedding planes: Jour. Geology, v. 66, p. 1-7.
- Greensmith, J. T., 1956, Sedimentary structures in the upper Carboniferous of north and central Derbyshire: Jour. Sedimentary Petrology, v. 26, p. 343-355.
- Grim, R. E., 1953, Clay mineralogy: New York, McGraw-Hill Book Company, Inc., 384 p.
- Haaf, E. ten, 1956, Significance of convolute lamination: Geol. en Mijnbouw, v. 18, p. 188-194.
- Hall, W. E., 1956, Marathon folded belt in Big Bend area of Texas: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 2247-2255.
- 1957, Genesis of Haymond boulder beds, Marathon basin, west Texas: Am. Assoc. Petroleum Geologists Bull., v. 41, p. 1633-1637.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

Journal of Geology, v. 65, p. 139-141.

- 1959, Genesis of "Haymond boulder beds," Marathon basin, west Texas; discussion: Am. Assoc. Petroleum Geologists Bull., v. 43, p. 238-239.
- Hamblin, W. K., 1962a, Staining and etching techniques for studying obscure structures in clastic rocks: Jour. Sedimentary Petrology, v. 32, p. 530-533.
- 1962b, X-radiography in the study of structures in homogeneous sediments: Jour. Sedimentary Petrology, v. 32, p. 201-210.
- Harris, D. L., 1963, Characteristics of the hurricane storm surge: U.S. Weather Bur. Tech. Paper 48, 139 p.
- Holland, C. H., 1960, Load cast terminology and origin of convolute bedding; some comments: Geol. Soc. America Bull., v. 71, p. 633.
- Hsu, K. J., 1958, Paleocurrent structures in Ultrahelvetic Flysch of Swiss Alps and their paleogeographic and paleotectonic significances (abstract): Geol. Soc. America Bull., v. 69, p. 1588-1589.
- 1959, Flute-and groove-casts in the pre-Alpine Flysch, Switzerland: Am. Jour. Sci., 5th ser., v. 257, p. 529-536.
- Hülsmann, J. and Emery, K. O., 1961, Stratification in recent sediments of Santa Barbara basin as controlled by organisms and water character: Jour. Geology, V. 69, p. 279-290.
- Johnson, K. E., 1962, Paleocurrent study of the Tesnus Formation, Marathon basin, Texas: Jour. Sedimentary Petrology, v. 32, p. 781-792.
- Jones, O. T., 1937, On the sliding of slumping of submarine sediments in Denbighshire, North Wales, during the Ludlow Period: Geol. Soc. London Quart. Jourl, v. 93, p. 241-283.
- Kelling, G. and Walton, E. K., 1957, Load cast structures; their relationship to upper surface structures and their mode of formation: Geol. Mag., v. 94, p. 481-490.
- Kerr, P. F., 1959, Optical mineralogy: New York, McGraw-Hill Book Company, Inc., 442 p.

1977, *Journal of Neurophysiology*, 40, 100-110
1978, *Journal of Neurophysiology*, 41, 100-110
1979, *Journal of Neurophysiology*, 42, 100-110

Hanftin, W. E., 1982a, *Journal of Neurophysiology*, 47, 100-110
1982b, *Journal of Neurophysiology*, 47, 100-110
1982c, *Journal of Neurophysiology*, 47, 100-110

1983, *Journal of Neurophysiology*, 48, 100-110
1984, *Journal of Neurophysiology*, 49, 100-110
1985, *Journal of Neurophysiology*, 50, 100-110

Harris, G. W., 1968, *Journal of Neurophysiology*, 31, 100-110
1969, *Journal of Neurophysiology*, 32, 100-110
1970, *Journal of Neurophysiology*, 33, 100-110

Hollard, E. W., 1960, *Journal of Neurophysiology*, 23, 100-110
1961, *Journal of Neurophysiology*, 24, 100-110
1962, *Journal of Neurophysiology*, 25, 100-110

Hsu, K. L., 1975, *Journal of Neurophysiology*, 38, 100-110
1976, *Journal of Neurophysiology*, 39, 100-110
1977, *Journal of Neurophysiology*, 40, 100-110

1978, *Journal of Neurophysiology*, 41, 100-110
1979, *Journal of Neurophysiology*, 42, 100-110
1980, *Journal of Neurophysiology*, 43, 100-110

Hilman, G. W., 1965, *Journal of Neurophysiology*, 28, 100-110
1966, *Journal of Neurophysiology*, 29, 100-110
1967, *Journal of Neurophysiology*, 30, 100-110

1968, *Journal of Neurophysiology*, 31, 100-110
1969, *Journal of Neurophysiology*, 32, 100-110
1970, *Journal of Neurophysiology*, 33, 100-110

Johnson, K. W., 1962, *Journal of Neurophysiology*, 25, 100-110
1963, *Journal of Neurophysiology*, 26, 100-110
1964, *Journal of Neurophysiology*, 27, 100-110

1965, *Journal of Neurophysiology*, 28, 100-110
1966, *Journal of Neurophysiology*, 29, 100-110
1967, *Journal of Neurophysiology*, 30, 100-110

- Kindle, E. M., 1917, Deformation of unconsolidated beds in Nova Scotia and southern Ontario: Am. Assoc. Petroleum Geologists Bull., v. 28, p. 323-334.
- King, P. B., 1930, Geology of the Glass Mountains; Part 1, descriptive geology: Texas Univ. Bull. 3038, 166 p.
- 1937, Geology of the Marathon region, Texas: U.S. Geol. Survey Prof. Paper 187, 148 p.
- 1958, Problems of boulder beds of Haymond Formation, Marathon basin, Texas: Am. Assoc. Petroleum Geologists Bull., v. 42, p. 1731-1734.
- King, P. B. and King, R. E., 1928, The Pennsylvanian and Permian stratigraphy of the Glass Mountains: Texas Univ. Bull. 2801, p. 109-145.
- Kuenen, Ph. H., 1949, Slumping in the Carboniferous rocks of Pembrokeshire: Geol. Soc. London Quart. Jour., v. 104, p. 365-385.
- 1953, Significant features of graded bedding: Am. Assoc. Petroleum Geologists Bull., v. 37, p. 1044-1066.
- 1957, Sole markings of graded graywacke beds: Jour. Geology, v. 65, p. 231-258.
- Kuenen, Ph. H. and Carozzi, A., 1953, Turbidity currents and sliding in geosynclinal basins in the Alps: Jour. Geology, v. 61, p. 363-372.
- Kuenen, Ph. H. and Menard, H. W., 1952, Turbidity currents, graded and nongraded deposits: Jour. Sedimentary Petrology, v. 22, p. 83-96.
- Kuenen, Ph. H. and Migliorini, G. I., 1950, Turbidity currents as a cause of graded bedding: Jour. Geology, v. 58, p. 91-126.
- Kuenen, Ph. H. and Prentice, J. E., 1957, Flow-markings and load-casts: Geol. Mag., vol. 94, p. 173-174.

- Kuenen, Ph. H. and Sanders, J., 1956, Sedimentation phenomena in Kulm and Flötzleeres Graywackes, Sauerland and Oberharz, Germany: *Am. Jour. Sci.*, 5th ser., v. 254, p. 649-671.
- Kuenen, Ph. H. and Ten Haaf, E., 1958, Sole markings of graded graywacke beds; a reply: *Jour. Geology*, v. 66, p. 335-337.
- Lamont, A., 1938, "Contemporaneous slumping and other problems at Bray Series, Ordovician, and lower Carboniferous horizons, in County Dublin: *Royal Irish Acad. Proc.*, v. 45, p. 1-32.
- McBride, E. F., 1962a, Flysch and associated beds of the Martinsburg Formation (Ordovician), central Appalachians: *Jour. Sedimentary Petrology*, v. 32, p. 39-91.
- 1962b, Sedimentology of the Haymond Formation (Pennsylvanian flysch), Marathon basin, Texas (abstract): *Geol. Soc. America Sp. Paper* 73, p. 204.
- Mills, F. C., 1955, *Statistical methods*: New York, Henry Holt and Company, 746 p.
- Miser, H. D., and Hendricks, T. A., 1960, Age of Johns Valley Shale, Jackfork Sandstone, and Stanley Shale: *Am. Assoc. Petroleum Geologists Bull.*, v. 44, p. 1829-1834.
- Miser, H. D. and Sellards, E. H., 1931, Pre-Cretaceous rocks found in wells in Gulf Coastal Plain south of Ouachita Mountains: *Am. Assoc. Petroleum Geologists Bull.*, v. 15, p. 801-818.
- Moore, R. C., 1929, Correlation of Pennsylvanian formations of Texas and Oklahoma: *Am. Assoc. Petroleum Geologists Bull.*, v. 13, p. 883-902.
- Pantin, H. M., 1960, Dye-staining technique for examination of sedimentary microstructures in cores: *Jour. Sedimentary Petrology*, v. 30, p. 314-316.
- Pettijohn, F. J., 1957, *Sedimentary rocks*: New York, Harper and Brothers, 718 p.
- Plummer, F. B., 1931, Pennsylvanian sedimentation in Texas: *Illinois Geol. Survey Bull.* 60, p. 259-269.

- Plummer, F. B. and Moore, R. C., 1921, Stratigraphy of the Pennsylvanian formations of north-central Texas: Texas Univ. Bull. 2132, 237 p.
- Powers, S., 1928, Age of folding of the Oklahoma Mountains; the Ouachita, Arbuckle, and Wichita Mountains of Oklahoma and the Llano-Burnet and Marathon Uplifts of Texas: Geol. Soc. America Bull., v. 39, p. 1030-1072.
- Prentice, J. E., 1956, The interpretation of flow markings and load casts: Geol. Mag., v. 93, p. 393-400.
- 1960, Flow structures in sedimentary rocks: Jour. Geology, v. 58, p. 217-225.
- Rettger, R. E., 1935, Experiments in soft rock deformation: Am. Assoc. Petroleum Geologists Bull., v. 19, p. 271-290.
- Rich, J. L., 1950, Flow markings, groovings, and intra-stratal crumplings as criteria for the recognition of slope deposits, with illustrations from Silurian rocks of Wales: Am. Assoc. Petroleum Geologists Bull., v. 34, p. 717-741.
- 1951, Three critical environments of deposition and criteria for recognition of rocks deposited in each of them: Geol. Soc. America Bull., v. 62, p. 1-19.
- Rich, J. L. and Wilson, W.J., 1950, Paleogeographic and stratigraphic significance of subaqueous flow markings in the Lower Mississippian strata of south-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 61, p. 1496.
- Richter, R., 1935, Marken und Spuren im Hunsrück-Schiefer; I, Gefliess-Marken: Senckenberg. Naturf. Gesell. Abh., v. 17, p. 244-263.
- Riveroll, D. D. and Jones, B. C., 1954, Varves and foraminifera of a portion of the upper Puente Formation (upper Miocene), Puente, California: Jour. Paleontology, v. 28, p. 121-131.
- Rücklin, H., 1938, Strömungs-Marken im unteren Muschelkalk des Saarlandes: Senckenberg. Naturf. Gesell. Abh., v. 20, p. 94-114.

... and Moore, H. C., 1951, Distribution of the Pennsylvanian formations of north-central Texas, Texas Geol. Surv. Bull., 577 p.

Howe, D., 1928, Age of folding of the Oklahoma mountains and the Oklahoma, Arkansas, and Texas mountains of Oklahoma and the Lincoln-Burns and Marston hills of Texas, Geol. Soc. America Bull., v. 39, p. 1070-1072.

Hunter, J. B., 1928, The interpretation of the Oklahoma and Lincoln-Burns hills, v. 39, p. 391-400.

1930, Flow structures in sedimentary rocks, Jour. Geology, v. 38, p. 417-422.

Isinger, R. E., 1922, Experiments in soft rock deformation, Am. Assoc. Petroleum Geologists Bull., v. 19, p. 231-239.

Rich, J. L., 1920, Flow markings, cross-beds, and lineations in sandstone, v. 31, p. 1-13.

1921, These critical environments of deposition and ... with illustrations from Illinois rocks of Lake, Am. Assoc. Petroleum Geologists Bull., v. 18, p. 717-741.

1921, These critical environments of deposition and ... in the lower Mississippian strata of north-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 31, p. 149.

1921, These critical environments of deposition and ... in the lower Mississippian strata of north-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 31, p. 149.

1921, These critical environments of deposition and ... in the lower Mississippian strata of north-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 31, p. 149.

1921, These critical environments of deposition and ... in the lower Mississippian strata of north-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 31, p. 149.

1921, These critical environments of deposition and ... in the lower Mississippian strata of north-central Ohio and adjacent parts of Kentucky (abstract): Geol. Soc. America Bull., v. 31, p. 149.

- Sanders, J. E., 1960, Origin of convolute laminae: Geol. Mag., v. 97, p. 409-421.
- Sellards, E. H., Adkins, W. S., and Plummer, F. B., 1932, The geology of Texas; vol. 1, stratigraphy: Texas Univ. Bull. 3232, p. 117-127.
- Shrock, R. R., 1948, Sequences in layered rocks: New York, McGraw-Hill Book Company, Inc., 507 p.
- Stewart, H. B., 1956, Contorted sediments in modern coastal lagoon explained by laboratory experiments: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 153-179.
- Sujkowski, Z. C., 1957, Flysch sedimentation: Geol. Soc. America Bull., v. 68, p. 543-554.
- Sullwold, H. H., Jr., 1959, Nomenclature of load deformation in turbidites: Geol. Soc. America Bull., v. 70, p. 1247-1248.
- Udden, J. A., Baker, C. L., and Bose, E., 1916, Review of the Geology of Texas: Texas Univ. Bull. 44, 164 p.
- Van der Gracht, W. A. J. M. van Waterschoot, 1931, Permo-Carboniferous orogeny in south-central United States: Am. Assoc. Petroleum Geologists Bull., v. 15, p. 991-1057.
- Williams, E., 1960, Intra-stratal flow and convolute folding: Geol. Mag., v. 97, p. 208-214.

APPENDIX I

Summary of the mineralogic composition of 18 samples from the Haymond Formation. Percentages were estimated from thin sections.

tr. = one grain observed

-1 = more than one grain but less than 1 percent observed

SAMPLE #	QUARTZ	ALBITE	GARNET	MUSCOVITE	BIOTITE	CLAY	PLANT FRAGMENTS
Siltstone:							
5	67	-1	-1	1	tr.	26	5
12	72	1	2	3	tr.	20	2
26	66	2	1	3	1	25	2
30	73	-1	-1	-1	tr.	23	2
37	73	-1	1	2	tr.	20	3
47	70	-1	-1	2	tr.	20	7
52	73	-1	-1	-1	tr.	23	2
56	70	1	1	3	tr.	20	5
Silty Claystone:							
11	70	-1	-1	5	tr.	60	6
18	25	1	1	1	tr.	60	12
36	45	4	3	2	1	25	20
40	40	2	1	1	tr.	46	10
48	25	-1	1	5	tr.	60	8
Shale:							
11	20	-1	1	8	tr.	69	2
18	10	-1	2	3	tr.	82	3
36	10	-1	3	3	tr.	80	4
40	15	-1	4	8	tr.	67	5
48	15	-1	2	5	tr.	75	3

COMPANY OF THE ...
 FROM THE ...
 WITH ...
 BY ...
 -1-

TABLE I. ...

...
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
68	68	68	68
69	69	69	69
70	70	70	70
71	71	71	71
72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

APPENDIX II

Determination of organic (Kjeldahl) nitrogen, CaCO_3 , MgCO_3 , and total iron in the measured road-cut section of the Haymond Formation.

nd = no determination made
tr. = trace

SAMPLE	LITHOLOGY	% N x 10^{-3} (Kjeldahl)	% CaCO_3	% MgCO_3	% Fe^{+3}
1	siltstone	1.8	nd	nd	nd
2	shale	2.3	nd	nd	nd
5	siltstone	1.5	2.8	0.2	2.9
8	siltstone	2.2	nd	nd	nd
10	siltstone	3.0	nd	nd	nd
11	shale	2.6	4.6	0.2	3.1
12	siltstone	1.8	1.7	0.6	3.6
13	siltstone	2.0	nd	nd	nd
14	siltstone	1.3	nd	nd	nd
16	shale	2.8	nd	nd	nd
17	siltstone	1.4	nd	nd	nd
18	shale	3.0	4.2	tr.	3.4
19	shale	4.0	nd	nd	nd
21	shale	2.7	nd	nd	nd
22	siltstone	1.4	nd	nd	nd
23	shale	2.8	nd	nd	nd
24	siltstone	1.0	nd	nd	nd
25	siltstone	2.7	nd	nd	nd
26	siltstone	1.4	2.5	0.3	2.7
27	siltstone	1.6	nd	nd	nd
28	shale	2.5	5.2	0.6	3.0
29	siltstone	1.7	nd	nd	nd
31	shale	1.4	nd	nd	nd
33	siltstone	2.0	nd	nd	nd
34	siltstone	2.4	nd	nd	nd
35	shale	2.2	nd	nd	nd
36	shale	2.0	3.6	0.4	3.5

APPENDIX II

Determination of organic (Kjeldahl) nitrogen, CaCO₃, MgCO₃, and total iron in the measured road-cut section of the ...

SAMPLE NUMBER	ORGANIC NITROGEN (Kjeldahl) $\times 10^{-3}$	CaCO ₃	MgCO ₃	Fe
1	1.5	nd	nd	nd
2	2.5	nd	nd	nd
3	1.5	2.8	0.15	2.9
4	2.5	nd	nd	nd
10	3.0	nd	nd	nd
11	2.5	4.5	0.5	3.1
12	1.5	1.5	0.5	1.5
13	2.0	nd	nd	nd
14	1.5	nd	nd	nd
15	2.8	nd	nd	nd
17	1.4	nd	nd	nd
18	3.0	4.5	0.5	3.4
19	4.0	nd	nd	nd
21	2.5	nd	nd	nd
22	1.4	nd	nd	nd
23	2.8	nd	nd	nd
24	1.0	nd	nd	nd
25	2.5	nd	nd	nd
26	1.4	2.5	0.3	2.5
27	1.5	nd	nd	nd
28	2.5	2.5	0.5	2.0
29	1.5	nd	nd	nd
31	1.4	nd	nd	nd
33	2.0	nd	nd	nd
34	2.4	nd	nd	nd
35	2.5	nd	nd	nd
36	2.0	2.5	0.5	2.5

nd = no determination made
tr. = trace

SAMPLE	LITHOLOGY	% N x 10 ⁻³ (Kjeldahl)	% CaCO ₃	% MgCO ₃	% Fe ⁺³
37	siltstone	2.0	0.9	0.4	3.4
38	shale	1.7	nd	nd	nd
40	shale	3.0	5.0	0.1	3.0
41	siltstone	2.2	nd	nd	nd
43	shale	1.4	3.8	tr.	3.3
44	siltstone	3.0	nd	nd	nd
45	siltstone	1.6	nd	nd	nd
47	siltstone	3.1	1.2	tr.	2.7
48	shale	1.4	4.9	tr.	2.9
49	siltstone	2.0	nd	nd	nd
50	shale	1.9	nd	nd	nd
51	siltstone	3.6	nd	nd	nd
52	siltstone	nd	1.2	0.1	3.0
54	shale	1.0	nd	nd	nd
56	siltstone	3.1	2.8	1.0	3.6
57	shale	nd	11.7	0.2	2.9

APPENDIX III

Summary of flute and groove cast measurements on the bottom surfaces of silt beds of the Haymond Formation.

ns = no sample collected

SAMPLE	BED THICKNESS (feet)	NUMBER OF MEASUREMENTS	MEAN AZIMUTH (°)	SPREAD (°)
1	1.10	3	92	10
5	0.41	6	82	28
8	0.57	12	80	29
12	0.35	3	86	29
13	0.47	1	96	-
14	0.19	3	73	23
ns	0.26	3	78	23
ns	0.34	6	82	21
22	0.69	3	76	31
ns	0.33	3	96	24
24	0.55	2	92	11
ns	0.29	1	58	-
ns	0.29	1	72	-
27	1.32	1	71	-
ns	0.66	1	95	-
ns	0.31	2	80	18
29	0.63	3	81	18
30	0.94	5	65	21
ns	0.55	4	94	55
ns	0.50	4	91	12
32	0.61	10	80	21
33	0.28	4	82	19
ns	0.21	3	81	9
ns	0.77	6	70	22
ns	0.46	4	76	17
ns	0.13	2	97	14
ns	0.30	5	69	12
ns	0.09	2	90	11

APPENDIX III

Summary of 1950 and 1951 measurements on the bottom surface of all beds of the Hayward Formation. na - no sample collected

SAMPLE	BED THICKNESS (feet)	NUMBER OF MEASUREMENTS	MIDN. ALTITUDE (°)	SPREAD (°)
1	1.10	3	92	10
2	0.41	2	82	28
3	0.52	12	80	29
12	0.32	3	86	29
13	0.42	1	96	-
14	0.19	2	73	23
na	0.26	2	78	23
na	0.34	2	82	21
22	0.69	3	76	31
na	0.33	2	94	24
24	0.22	2	92	11
na	0.29	1	28	-
na	0.29	1	72	-
27	1.32	1	91	-
na	0.66	1	95	-
na	0.31	2	80	18
29	0.63	2	81	18
30	0.94	2	85	21
na	0.24	4	94	22
na	0.20	4	91	12
32	0.61	10	80	21
33	0.28	4	82	19
na	0.21	2	81	9
na	0.77	6	70	22
na	0.46	4	76	17
na	0.12	2	97	14
na	0.30	2	69	12
na	0.09	2	90	11

SAMPLE	BED THICKNESS (feet)	NUMBER OF MEASUREMENTS	MEAN AZIMUTH (o)	SPREAD (o)
ns	0.30	3	81	7
34	1.30	20	80	17
ns	0.48	3	85	26
ns	0.16	1	73	-
ns	0.26	3	92	19
ns	0.28	2	79	11
ns	0.38	7	85	27
ns	0.40	2	84	9
ns	0.63	6	89	7
ns	0.20	3	83	9
ns	0.72	1	92	-
ns	0.13	2	88	8
ns	0.39	2	89	-
ns	0.28	2	98	16
ns	0.20	3	82	25
ns	0.14	1	84	-
ns	0.11	1	63	-
ns	0.56	8	89	30
ns	0.15	2	88	8
ns	0.23	1	85	-
ns	0.31	3	111	3
ns	0.38	2	79	5
ns	0.45	3	95	19
ns	0.28	3	88	27
ns	0.27	2	67	7
42	0.34	7	84	20
ns	0.24	1	80	-
ns	0.23	2	81	2
ns	0.32	4	103	31
ns	0.35	3	95	20
ns	0.36	2	79	10
ns	0.57	7	100	35
ns	0.10	3	96	9
ns	0.10	2	66	12
ns	0.32	6	85	31

STATION	DEPTH (feet)	TEMPERATURE (F)	DIRECTION	VELOCITY (knots)
1	0	68.0	000	0.0
2	10	67.5	000	0.0
3	20	67.0	000	0.0
4	30	66.5	000	0.0
5	40	66.0	000	0.0
6	50	65.5	000	0.0
7	60	65.0	000	0.0
8	70	64.5	000	0.0
9	80	64.0	000	0.0
10	90	63.5	000	0.0
11	100	63.0	000	0.0
12	110	62.5	000	0.0
13	120	62.0	000	0.0
14	130	61.5	000	0.0
15	140	61.0	000	0.0
16	150	60.5	000	0.0
17	160	60.0	000	0.0
18	170	59.5	000	0.0
19	180	59.0	000	0.0
20	190	58.5	000	0.0
21	200	58.0	000	0.0
22	210	57.5	000	0.0
23	220	57.0	000	0.0
24	230	56.5	000	0.0
25	240	56.0	000	0.0
26	250	55.5	000	0.0
27	260	55.0	000	0.0
28	270	54.5	000	0.0
29	280	54.0	000	0.0
30	290	53.5	000	0.0
31	300	53.0	000	0.0
32	310	52.5	000	0.0
33	320	52.0	000	0.0
34	330	51.5	000	0.0
35	340	51.0	000	0.0
36	350	50.5	000	0.0
37	360	50.0	000	0.0
38	370	49.5	000	0.0
39	380	49.0	000	0.0
40	390	48.5	000	0.0
41	400	48.0	000	0.0
42	410	47.5	000	0.0
43	420	47.0	000	0.0
44	430	46.5	000	0.0
45	440	46.0	000	0.0
46	450	45.5	000	0.0
47	460	45.0	000	0.0
48	470	44.5	000	0.0
49	480	44.0	000	0.0
50	490	43.5	000	0.0
51	500	43.0	000	0.0
52	510	42.5	000	0.0
53	520	42.0	000	0.0
54	530	41.5	000	0.0
55	540	41.0	000	0.0
56	550	40.5	000	0.0
57	560	40.0	000	0.0
58	570	39.5	000	0.0
59	580	39.0	000	0.0
60	590	38.5	000	0.0
61	600	38.0	000	0.0
62	610	37.5	000	0.0
63	620	37.0	000	0.0
64	630	36.5	000	0.0
65	640	36.0	000	0.0
66	650	35.5	000	0.0
67	660	35.0	000	0.0
68	670	34.5	000	0.0
69	680	34.0	000	0.0
70	690	33.5	000	0.0
71	700	33.0	000	0.0
72	710	32.5	000	0.0
73	720	32.0	000	0.0
74	730	31.5	000	0.0
75	740	31.0	000	0.0
76	750	30.5	000	0.0
77	760	30.0	000	0.0
78	770	29.5	000	0.0
79	780	29.0	000	0.0
80	790	28.5	000	0.0
81	800	28.0	000	0.0
82	810	27.5	000	0.0
83	820	27.0	000	0.0
84	830	26.5	000	0.0
85	840	26.0	000	0.0
86	850	25.5	000	0.0
87	860	25.0	000	0.0
88	870	24.5	000	0.0
89	880	24.0	000	0.0
90	890	23.5	000	0.0
91	900	23.0	000	0.0
92	910	22.5	000	0.0
93	920	22.0	000	0.0
94	930	21.5	000	0.0
95	940	21.0	000	0.0
96	950	20.5	000	0.0
97	960	20.0	000	0.0
98	970	19.5	000	0.0
99	980	19.0	000	0.0
100	990	18.5	000	0.0
101	1000	18.0	000	0.0

SAMPLE	BED THICKNESS (feet)	NUMBER OF MEASUREMENTS	MEAN AZIMUTH (o)	SPREAD (o)
45	0.43	4	75	11
ns	0.24	2	86	1
ns	0.46	3	71	18
46	0.21	2	88	42
ns	0.42	3	79	24
ns	0.25	4	92	11
ns	0.30	2	94	15
ns	0.97	2	94	12
47	0.33	1	78	-
ns	0.23	1	100	-
ns	0.09	2	83	16
ns	0.36	4	85	24
ns	0.65	4	73	29
ns	0.30	4	85	15
ns	0.88	1	80	-
ns	0.30	3	114	31
ns	0.38	3	77	25
ns	0.38	3	125	6
ns	0.37	6	89	32
ns	0.65	3	79	22
ns	0.20	3	89	21
ns	0.45	4	82	8
ns	0.15	2	98	37
ns	0.09	2	85	6
ns	0.28	5	100	16
ns	0.27	5	92	19
ns	0.41	3	88	10
ns	0.16	1	106	-
51	0.69	3	92	5
52	0.25	5	96	12
ns	0.24	1	90	-
ns	0.93	2	89	-
53	0.23	4	101	8
ns	0.27	3	99	17
ns	0.25	3	84	18

SAMPLE	WATER	WATER	WATER	WATER
(L)	(L)	(L)	(L)	(L)
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00
38	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00
41	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00
43	0.00	0.00	0.00	0.00
44	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00
46	0.00	0.00	0.00	0.00
47	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00
49	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.00

SAMPLE	BED THICKNESS (feet)	NUMBER OF MEASUREMENTS	MEAN AZIMUTH (°)	SPREAD (°)
ns	0.50	4	83	21
ns	0.27	2	97	16
ns	0.38	2	83	11
ns	0.40	2	65	4
ns	0.54	4	83	20
ns	0.60	3	80	6
56	0.72	2	73	21
ns	0.44	1	97	-
58	0.34	3	86	20

DEPTH (m)	TEMPERATURE (°C)	WIND VELOCITY (km/h)	WIND DIRECTION (°)	SEA STATE
20	28	3	100	ns
15	27	3	100	ns
10	26	3	100	ns
5	25	3	100	ns
0	24	3	100	ns
10	23	3	100	ns
15	22	3	100	ns
20	21	3	100	ns

APPENDIX IV

Silt, clay and total couplet thickness (in feet) of the road-cut section of the Haymond Formation.

silt	clay	couplet	silt	clay	couplet	silt	clay	couplet
1.10	0.30	1.40	0.05	0.05	0.10	0.15	0.20	0.35
0.05	0.07	0.12	0.06	0.15	0.21	0.05	0.16	0.21
0.03	0.07	0.12	0.06	0.24	0.30	0.02	0.16	0.18
0.03	0.11	0.14	0.06	0.21	0.27	0.04	0.08	0.12
0.10	0.14	0.24	0.06	0.36	0.42	0.04	0.06	0.10
0.07	0.13	0.20	0.04	0.04	0.08	0.03	0.19	0.27
0.05	0.08	0.13	0.05	0.08	0.13	0.05	0.07	0.12
0.03	0.07	0.10	0.08	0.30	0.38	0.19	0.25	0.44
0.02	0.28	0.30	0.06	0.05	0.11	0.06	0.31	0.37
0.41	0.24	0.65	0.10	0.08	0.18	0.07	0.59	0.66
0.04	0.07	0.11	0.04	0.22	0.26	0.52	1.26	1.78
0.07	0.15	0.22	0.07	0.34	0.41	0.09	0.10	0.19
0.05	0.05	0.10	0.22	0.26	0.48	0.15	0.20	0.35
0.12	0.28	0.40	0.11	0.20	0.31	0.10	0.19	0.29
0.14	0.13	0.27	0.57	0.28	0.85	0.07	0.06	0.13
0.07	0.25	0.32	0.12	0.09	0.21	0.06	0.14	0.20
0.07	0.11	0.18	0.12	0.60	0.72	0.14	0.14	0.28
0.13	0.23	0.36	0.06	0.24	0.30	0.09	0.12	0.21
0.08	0.19	0.27	0.08	0.12	0.20	0.04	0.28	0.32
0.13	0.14	0.27	0.04	0.05	0.09	0.11	0.35	0.46
0.08	0.23	0.31	0.35	0.49	0.84	0.08	0.16	0.24
0.12	0.37	0.49	0.14	0.13	0.27	0.08	0.10	0.18
0.07	0.06	0.13	0.47	0.41	0.88	0.11	0.34	0.45
0.05	0.05	0.10	0.04	0.07	0.11	0.06	0.31	0.37
0.03	0.03	0.06	0.05	0.08	0.13	0.34	0.43	0.77
0.05	0.11	0.16	0.06	0.09	0.15	0.07	0.54	0.61
0.08	0.08	0.16	0.04	0.10	0.14	0.79	0.67	1.46
0.02	0.06	0.08	0.32	0.18	0.50	0.69	0.17	0.86
0.07	0.14	0.21	0.06	0.17	0.23	0.08	0.15	0.23

APPENDIX I

Table showing the results of the tests conducted on the road-out section of the ...

Run No.	Time (min)	Temp (°C)	Pressure (psi)	Flow (gpm)	Notes
1	1.10	0.30	1.40	0.05	
2	0.07	0.07	0.12	0.02	
3	0.03	0.07	0.12	0.02	
4	0.03	0.11	0.14	0.02	
5	0.10	0.14	0.24	0.02	
6	0.07	0.13	0.20	0.02	
7	0.03	0.08	0.13	0.02	
8	0.03	0.07	0.10	0.02	
9	0.03	0.07	0.10	0.02	
10	0.03	0.07	0.10	0.02	
11	0.03	0.07	0.10	0.02	
12	0.03	0.07	0.10	0.02	
13	0.03	0.07	0.10	0.02	
14	0.03	0.07	0.10	0.02	
15	0.03	0.07	0.10	0.02	
16	0.03	0.07	0.10	0.02	
17	0.03	0.07	0.10	0.02	
18	0.03	0.07	0.10	0.02	
19	0.03	0.07	0.10	0.02	
20	0.03	0.07	0.10	0.02	
21	0.03	0.07	0.10	0.02	
22	0.03	0.07	0.10	0.02	
23	0.03	0.07	0.10	0.02	
24	0.03	0.07	0.10	0.02	
25	0.03	0.07	0.10	0.02	
26	0.03	0.07	0.10	0.02	
27	0.03	0.07	0.10	0.02	
28	0.03	0.07	0.10	0.02	
29	0.03	0.07	0.10	0.02	
30	0.03	0.07	0.10	0.02	
31	0.03	0.07	0.10	0.02	
32	0.03	0.07	0.10	0.02	
33	0.03	0.07	0.10	0.02	
34	0.03	0.07	0.10	0.02	
35	0.03	0.07	0.10	0.02	
36	0.03	0.07	0.10	0.02	
37	0.03	0.07	0.10	0.02	
38	0.03	0.07	0.10	0.02	
39	0.03	0.07	0.10	0.02	
40	0.03	0.07	0.10	0.02	
41	0.03	0.07	0.10	0.02	
42	0.03	0.07	0.10	0.02	
43	0.03	0.07	0.10	0.02	
44	0.03	0.07	0.10	0.02	
45	0.03	0.07	0.10	0.02	
46	0.03	0.07	0.10	0.02	
47	0.03	0.07	0.10	0.02	
48	0.03	0.07	0.10	0.02	
49	0.03	0.07	0.10	0.02	
50	0.03	0.07	0.10	0.02	
51	0.03	0.07	0.10	0.02	
52	0.03	0.07	0.10	0.02	
53	0.03	0.07	0.10	0.02	
54	0.03	0.07	0.10	0.02	
55	0.03	0.07	0.10	0.02	
56	0.03	0.07	0.10	0.02	
57	0.03	0.07	0.10	0.02	
58	0.03	0.07	0.10	0.02	
59	0.03	0.07	0.10	0.02	
60	0.03	0.07	0.10	0.02	
61	0.03	0.07	0.10	0.02	
62	0.03	0.07	0.10	0.02	
63	0.03	0.07	0.10	0.02	
64	0.03	0.07	0.10	0.02	
65	0.03	0.07	0.10	0.02	
66	0.03	0.07	0.10	0.02	
67	0.03	0.07	0.10	0.02	
68	0.03	0.07	0.10	0.02	
69	0.03	0.07	0.10	0.02	
70	0.03	0.07	0.10	0.02	
71	0.03	0.07	0.10	0.02	
72	0.03	0.07	0.10	0.02	
73	0.03	0.07	0.10	0.02	
74	0.03	0.07	0.10	0.02	
75	0.03	0.07	0.10	0.02	
76	0.03	0.07	0.10	0.02	
77	0.03	0.07	0.10	0.02	
78	0.03	0.07	0.10	0.02	
79	0.03	0.07	0.10	0.02	
80	0.03	0.07	0.10	0.02	
81	0.03	0.07	0.10	0.02	
82	0.03	0.07	0.10	0.02	
83	0.03	0.07	0.10	0.02	
84	0.03	0.07	0.10	0.02	
85	0.03	0.07	0.10	0.02	
86	0.03	0.07	0.10	0.02	
87	0.03	0.07	0.10	0.02	
88	0.03	0.07	0.10	0.02	
89	0.03	0.07	0.10	0.02	
90	0.03	0.07	0.10	0.02	
91	0.03	0.07	0.10	0.02	
92	0.03	0.07	0.10	0.02	
93	0.03	0.07	0.10	0.02	
94	0.03	0.07	0.10	0.02	
95	0.03	0.07	0.10	0.02	
96	0.03	0.07	0.10	0.02	
97	0.03	0.07	0.10	0.02	
98	0.03	0.07	0.10	0.02	
99	0.03	0.07	0.10	0.02	
100	0.03	0.07	0.10	0.02	

silt clay couplet			silt clay couplet			silt clay couplet		
0.22	0.45	0.67	0.13	0.14	0.27	0.04	0.09	0.13
0.04	0.30	0.34	0.10	0.20	0.30	0.07	0.18	0.25
0.05	0.26	0.31	0.29	0.29	0.58	0.19	0.39	0.58
0.33	0.48	0.81	0.29	0.21	0.50	0.08	0.28	0.36
0.06	1.17	1.23	0.04	0.09	0.13	0.09	0.09	0.18
0.11	0.10	0.21	0.06	0.25	0.31	0.94	0.39	1.33
0.55	0.27	0.82	0.29	0.28	0.57	0.55	0.51	1.06
0.07	0.34	0.41	0.10	0.23	0.33	0.05	0.08	0.13
0.07	0.27	0.34	0.04	0.11	0.15	0.07	0.08	0.15
0.23	0.23	0.46	1.32	0.80	2.12	0.08	0.17	0.25
0.07	0.37	0.44	0.66	0.11	0.77	0.07	0.07	0.14
0.08	0.09	0.17	0.26	0.26	0.52	0.10	0.39	0.49
0.38	0.21	0.59	0.31	0.31	0.62	0.23	0.11	0.34
0.03	0.61	0.64	0.04	0.05	0.09	0.62	0.21	0.83
0.14	0.31	0.45	0.04	0.09	0.13	0.07	0.18	0.25
0.04	0.25	0.29	0.05	0.16	0.21	0.07	0.05	0.12
0.04	0.17	0.21	0.07	0.20	0.27	0.06	0.25	0.31
0.25	0.45	0.70	0.05	0.55	0.60	0.06	0.45	0.51
0.27	0.13	0.40	0.35	0.31	0.66	0.03	0.21	0.24
0.04	0.11	0.15	0.19	0.45	0.64	0.10	0.15	0.25
0.13	0.50	0.63	0.04	0.21	0.25	0.50	0.57	1.07
0.28	0.46	0.74	0.12	0.16	0.28	0.06	0.14	0.20
0.12	0.22	0.34	0.14	0.16	0.30	0.04	0.08	0.12
0.07	0.10	0.17	0.11	0.23	0.34	0.12	0.39	0.51
0.28	0.48	0.76	0.05	0.13	0.18	0.61	0.13	0.74
0.41	0.26	0.67	0.10	0.28	0.38	0.04	0.37	0.41
0.03	0.05	0.08	0.28	0.34	0.62	0.04	0.16	0.20
0.25	0.33	0.58	0.06	0.31	0.37	0.12	0.08	0.20
0.28	0.21	0.49	0.04	0.07	0.11	0.12	0.08	0.20
0.14	0.17	0.31	0.14	0.32	0.46	0.04	0.44	0.48
0.21	0.17	0.38	0.08	0.06	0.14	0.08	0.10	0.18
0.10	0.38	0.48	0.07	0.30	0.37	0.07	0.09	0.16
0.13	0.07	0.20	0.23	0.17	0.40	0.10	0.08	0.18
0.08	0.28	0.56	0.14	0.18	0.32	0.06	0.11	0.17
0.12	0.10	0.22	0.05	0.17	0.22	0.17	0.08	0.25
0.09	0.37	0.46	0.63	0.18	0.81	0.16	0.41	0.57

silt clay couplet			silt clay couplet			silt clay couplet		
0.05	0.11	0.16	0.04	0.12	0.16	0.23	0.06	0.29
0.28	0.19	0.47	0.10	0.28	0.38	0.05	0.31	0.36
0.08	0.10	0.18	0.15	0.52	0.67	0.32	0.11	0.43
0.04	0.11	0.15	0.48	0.28	0.76	0.38	0.09	0.47
0.07	0.14	0.21	0.04	0.07	0.11	0.14	0.12	0.26
0.09	0.31	0.40	0.03	0.11	0.14	0.07	0.08	0.15
0.21	0.22	0.43	0.13	0.23	0.36	0.08	0.11	0.19
0.09	0.09	0.18	0.16	0.11	0.27	0.10	0.08	0.18
0.07	0.13	0.20	0.05	0.20	0.25	0.11	0.09	0.20
0.07	0.10	0.17	0.04	0.12	0.16	0.04	0.18	0.22
0.06	0.21	0.27	0.11	0.29	0.40	0.04	0.18	0.22
0.77	0.23	1.00	0.26	0.08	0.34	0.05	0.05	0.10
0.08	0.08	0.16	0.09	0.20	0.29	0.04	0.04	0.08
0.07	0.20	0.27	0.06	0.16	0.22	0.09	0.09	0.18
0.10	0.39	0.49	0.06	0.17	0.23	0.05	0.19	0.24
0.46	0.37	0.83	0.09	0.06	0.15	0.03	0.13	0.16
0.04	0.18	0.22	0.10	0.08	0.18	0.11	0.14	0.25
0.11	0.20	0.31	0.05	0.17	0.22	0.06	0.12	0.18
0.21	0.42	0.63	0.06	0.10	0.16	0.18	0.25	0.43
0.13	0.10	0.23	0.16	0.09	0.25	0.06	0.11	0.17
0.07	0.16	0.23	0.07	0.06	0.13	0.08	0.13	0.21
0.17	0.38	0.55	0.28	0.25	0.53	0.40	0.13	0.53
0.30	0.18	0.48	0.16	0.22	0.38	0.04	0.08	0.12
0.21	0.18	0.39	0.05	0.40	0.45	0.05	0.11	0.16
0.07	0.28	0.35	0.08	0.13	0.21	0.37	0.13	0.50
0.15	0.09	0.24	0.32	0.14	0.46	0.05	0.33	0.38
0.08	0.19	0.27	0.03	0.12	0.15	0.07	0.37	0.44
0.09	0.19	0.28	0.08	0.34	0.42	0.11	0.10	0.21
0.30	0.52	0.82	0.13	0.07	0.20	0.19	0.10	0.29
0.05	0.17	0.22	0.05	0.10	0.15	0.05	0.22	0.27
0.05	0.32	0.37	0.09	0.10	0.19	0.18	0.17	0.35
1.30	0.16	1.46	0.04	0.17	0.21	0.04	0.10	0.14
0.11	0.12	0.23	0.35	0.18	0.53	0.06	0.26	0.32
0.10	0.08	0.18	0.05	0.06	0.11	0.08	0.05	0.13
0.06	0.06	0.12	0.04	0.14	0.18	0.19	0.13	0.32
0.05	0.09	0.14	0.04	0.08	0.12	0.05	0.04	0.09
0.04	0.09	0.13	0.10	0.44	0.54	0.63	0.51	1.14

Year	Value	Year	Value
1900	100.0	1900	100.0
1901	101.0	1901	101.0
1902	102.0	1902	102.0
1903	103.0	1903	103.0
1904	104.0	1904	104.0
1905	105.0	1905	105.0
1906	106.0	1906	106.0
1907	107.0	1907	107.0
1908	108.0	1908	108.0
1909	109.0	1909	109.0
1910	110.0	1910	110.0
1911	111.0	1911	111.0
1912	112.0	1912	112.0
1913	113.0	1913	113.0
1914	114.0	1914	114.0
1915	115.0	1915	115.0
1916	116.0	1916	116.0
1917	117.0	1917	117.0
1918	118.0	1918	118.0
1919	119.0	1919	119.0
1920	120.0	1920	120.0
1921	121.0	1921	121.0
1922	122.0	1922	122.0
1923	123.0	1923	123.0
1924	124.0	1924	124.0
1925	125.0	1925	125.0
1926	126.0	1926	126.0
1927	127.0	1927	127.0
1928	128.0	1928	128.0
1929	129.0	1929	129.0
1930	130.0	1930	130.0
1931	131.0	1931	131.0
1932	132.0	1932	132.0
1933	133.0	1933	133.0
1934	134.0	1934	134.0
1935	135.0	1935	135.0
1936	136.0	1936	136.0
1937	137.0	1937	137.0
1938	138.0	1938	138.0
1939	139.0	1939	139.0
1940	140.0	1940	140.0
1941	141.0	1941	141.0
1942	142.0	1942	142.0
1943	143.0	1943	143.0
1944	144.0	1944	144.0
1945	145.0	1945	145.0
1946	146.0	1946	146.0
1947	147.0	1947	147.0
1948	148.0	1948	148.0
1949	149.0	1949	149.0
1950	150.0	1950	150.0
1951	151.0	1951	151.0
1952	152.0	1952	152.0
1953	153.0	1953	153.0
1954	154.0	1954	154.0
1955	155.0	1955	155.0
1956	156.0	1956	156.0
1957	157.0	1957	157.0
1958	158.0	1958	158.0
1959	159.0	1959	159.0
1960	160.0	1960	160.0
1961	161.0	1961	161.0
1962	162.0	1962	162.0
1963	163.0	1963	163.0
1964	164.0	1964	164.0
1965	165.0	1965	165.0
1966	166.0	1966	166.0
1967	167.0	1967	167.0
1968	168.0	1968	168.0
1969	169.0	1969	169.0
1970	170.0	1970	170.0
1971	171.0	1971	171.0
1972	172.0	1972	172.0
1973	173.0	1973	173.0
1974	174.0	1974	174.0
1975	175.0	1975	175.0
1976	176.0	1976	176.0
1977	177.0	1977	177.0
1978	178.0	1978	178.0
1979	179.0	1979	179.0
1980	180.0	1980	180.0
1981	181.0	1981	181.0
1982	182.0	1982	182.0
1983	183.0	1983	183.0
1984	184.0	1984	184.0
1985	185.0	1985	185.0
1986	186.0	1986	186.0
1987	187.0	1987	187.0
1988	188.0	1988	188.0
1989	189.0	1989	189.0
1990	190.0	1990	190.0
1991	191.0	1991	191.0
1992	192.0	1992	192.0
1993	193.0	1993	193.0
1994	194.0	1994	194.0
1995	195.0	1995	195.0
1996	196.0	1996	196.0
1997	197.0	1997	197.0
1998	198.0	1998	198.0
1999	199.0	1999	199.0
2000	200.0	2000	200.0

silt clay couplet			silt clay couplet			silt clay couplet		
0.08	0.30	0.38	0.28	0.24	0.52	0.06	0.32	0.38
0.06	0.08	0.14	0.08	0.11	0.19	0.38	0.26	0.64
0.20	0.15	0.35	0.20	0.10	0.30	0.07	0.24	0.31
0.06	0.05	0.11	0.07	0.17	0.24	0.08	0.07	0.15
0.12	0.15	0.27	0.05	0.09	0.14	0.04	0.19	0.23
0.10	0.22	0.32	0.09	0.06	0.15	0.14	0.13	0.27
0.03	0.04	0.07	0.04	0.06	0.10	0.07	0.33	0.40
0.10	0.47	0.57	0.03	0.03	0.06	0.35	0.10	0.45
0.05	0.04	0.09	0.07	0.09	0.16	0.04	0.15	0.19
0.12	0.19	0.31	0.10	0.14	0.24	0.04	0.16	0.20
0.12	0.06	0.18	0.05	0.23	0.28	0.18	0.20	0.38
0.04	0.04	0.08	0.04	0.05	0.09	0.28	0.10	0.38
0.09	0.13	0.22	0.04	0.11	0.15	0.09	0.06	0.15
0.03	0.09	0.12	0.03	0.05	0.08	0.07	0.18	0.25
0.04	0.17	0.21	0.04	0.30	0.34	0.26	0.21	0.47
0.06	0.09	0.15	0.14	0.12	0.26	0.14	0.23	0.37
0.78	0.31	1.09	0.11	0.09	0.20	0.27	0.23	0.50
0.05	0.04	0.09	0.07	0.06	0.13	0.71	0.35	1.06
0.08	0.35	0.43	0.06	0.12	0.18	0.08	0.12	0.20
0.07	0.04	0.11	0.10	0.11	0.21	0.07	0.04	0.11
0.04	0.08	0.12	0.09	0.06	0.15	0.34	0.15	0.49
0.08	0.10	0.18	0.22	0.34	0.56	0.03	0.14	0.17
0.04	0.11	0.15	0.56	0.23	0.79	0.08	0.04	0.12
0.72	0.34	1.06	0.26	0.25	0.51	0.24	0.15	0.39
0.07	0.19	0.26	0.06	0.30	0.36	0.23	0.37	0.60
0.12	0.13	0.25	0.18	0.06	0.24	0.05	0.23	0.28
0.40	0.26	0.66	0.05	0.04	0.09	0.32	0.18	0.50
0.13	0.10	0.23	0.04	0.07	0.11	0.09	0.14	0.23
0.09	0.17	0.26	0.03	0.08	0.11	0.09	0.06	0.15
0.09	0.08	0.17	0.15	0.07	0.22	0.09	0.06	0.15
0.08	0.05	0.13	0.06	0.07	0.13	0.07	0.10	0.17
0.39	0.11	0.50	0.45	0.09	0.54	0.15	0.15	0.30
0.07	0.25	0.32	0.10	0.31	0.41	0.11	0.13	0.24
0.04	0.31	0.35	0.23	0.13	0.36	0.09	0.08	0.17
0.08	0.42	0.50	0.06	0.15	0.21	0.09	0.10	0.19
0.10	0.04	0.14	0.31	0.11	0.42	0.16	0.08	0.24

silt clay couplet			silt clay couplet			silt clay couplet		
0.18	0.19	0.37	0.06	0.18	0.24	0.08	0.06	0.14
0.06	0.13	0.19	0.13	0.15	0.28	0.05	0.03	0.08
0.04	0.03	0.07	0.05	0.10	0.15	0.08	0.19	0.27
0.06	0.16	0.22	0.07	0.05	0.12	0.08	0.16	0.24
0.30	0.06	0.36	0.21	0.10	0.31	0.15	0.08	0.23
0.35	0.19	0.54	0.42	0.20	0.62	0.05	0.03	0.08
0.09	0.51	0.60	0.07	0.23	0.30	0.08	0.12	0.20
0.36	0.26	0.62	0.10	0.10	0.20	0.10	0.13	0.23
0.05	0.23	0.28	0.06	0.14	0.20	0.08	0.34	0.42
0.04	0.23	0.27	0.11	0.12	0.23	0.65	0.15	0.80
0.05	0.09	0.14	0.08	0.28	0.36	0.30	0.06	0.36
0.05	0.19	0.24	0.06	0.09	0.15	0.05	0.09	0.14
0.04	0.05	0.09	0.25	0.15	0.40	0.10	0.25	0.35
0.23	0.05	0.28	0.30	0.05	0.35	0.88	0.33	1.21
0.34	0.10	0.44	0.07	0.03	0.10	0.06	0.48	0.54
0.15	0.16	0.31	0.08	0.15	0.23	0.06	0.22	0.28
0.19	0.45	0.64	0.18	0.13	0.31	0.05	0.02	0.07
0.14	0.26	0.40	0.97	0.10	1.07	0.30	0.28	0.58
0.08	0.08	0.16	0.05	0.32	0.37	0.08	0.26	0.34
0.06	0.06	0.12	0.10	0.25	0.35	0.11	0.08	0.19
0.10	0.14	0.24	0.33	0.11	0.44	0.05	0.03	0.08
0.10	0.05	0.15	0.05	0.12	0.17	0.07	0.07	0.14
0.12	0.09	0.21	0.05	0.16	0.21	0.38	0.21	0.59
0.30	0.15	0.45	0.07	0.11	0.18	0.11	0.14	0.25
0.26	0.17	0.43	0.07	0.04	0.11	0.06	0.04	0.10
0.04	0.07	0.11	0.05	0.21	0.26	0.05	0.06	0.11
0.05	0.12	0.17	0.23	0.05	0.28	0.09	0.08	0.17
0.32	0.05	0.37	0.08	0.13	0.21	0.06	0.11	0.17
0.23	0.24	0.47	0.48	0.12	0.60	0.24	0.61	0.85
0.43	0.21	0.64	0.06	0.06	0.12	0.14	0.05	0.19
0.26	0.12	0.38	0.12	0.15	0.27	0.09	0.08	0.17
0.09	0.18	0.27	0.09	0.07	0.16	0.47	0.10	0.57
0.24	0.15	0.39	0.07	0.31	0.38	0.05	0.07	0.12
0.15	0.45	0.60	0.36	0.08	0.44	0.38	0.31	0.69
0.46	0.06	0.52	0.04	0.06	0.10	0.06	0.09	0.15
0.10	0.35	0.45	0.05	0.03	0.08	0.06	0.03	0.09

silt clay couplet			silt clay couplet			silt clay couplet		
0.10	0.07	0.17	0.07	0.05	0.12	0.23	0.47	0.70
0.26	0.08	0.34	0.05	0.04	0.09	0.10	0.36	0.46
0.11	0.07	0.18	0.06	0.30	0.36	0.22	0.25	0.47
0.04	0.04	0.08	0.04	0.08	0.12	0.09	0.42	0.51
0.04	0.08	0.12	0.04	0.08	0.12	0.06	0.28	0.34
0.07	0.13	0.20	0.06	0.06	0.12	0.30	0.17	0.47
0.06	0.13	0.19	0.05	0.06	0.11	0.08	0.09	0.17
0.65	0.48	1.13	0.62	0.10	0.72	0.20	0.10	0.30
0.07	0.07	0.14	0.23	0.04	0.27	0.08	0.08	0.16
0.35	0.33	0.68	0.05	0.18	0.23	0.05	0.05	0.10
0.20	0.17	0.37	0.20	0.12	0.32	0.05	0.02	0.07
0.10	0.17	0.27	0.15	0.25	0.40	0.10	0.23	0.33
0.08	0.05	0.13	0.25	0.18	0.43	0.27	0.35	0.62
0.10	0.10	0.20	0.11	0.11	0.22	0.16	0.10	0.26
0.19	0.17	0.36	0.04	0.08	0.12	0.05	0.03	0.08
0.05	0.37	0.42	0.05	0.04	0.09	0.10	0.07	0.17
0.09	0.24	0.33	0.11	0.09	0.20	0.09	0.05	0.14
0.45	0.16	0.61	0.05	0.25	0.30	0.05	0.07	0.12
0.08	0.18	0.26	0.24	0.08	0.32	0.08	0.05	0.13
0.04	0.13	0.17	0.04	0.28	0.32	0.08	0.08	0.16
0.05	0.07	0.12	0.07	0.26	0.33	0.07	0.17	0.24
0.15	0.42	0.57	0.13	0.06	0.19	0.15	0.23	0.38
0.06	0.05	0.11	0.06	0.04	0.10	0.07	0.11	0.18
0.09	0.17	0.26	0.04	0.09	0.13	0.13	0.10	0.23
0.28	0.27	0.55	0.06	0.12	0.18	0.25	0.10	0.35
0.27	0.21	0.48	0.04	0.10	0.14	0.04	0.28	0.32
0.09	0.14	0.23	0.05	0.08	0.13	0.25	0.12	0.37
0.21	0.29	0.50	0.07	0.12	0.19	0.03	0.17	0.20
0.09	0.24	0.33	0.08	0.32	0.40	0.03	0.06	0.09
0.07	0.08	0.15	0.93	0.09	1.02	0.06	0.04	0.10
0.05	0.07	0.12	0.08	0.09	0.17	0.17	0.17	0.34
0.11	0.20	0.31	0.06	0.05	0.11	0.05	0.28	0.33
0.06	0.07	0.13	0.05	0.17	0.22	0.07	0.07	0.14
0.16	0.14	0.30	0.04	0.08	0.12	0.08	0.23	0.31
0.05	0.13	0.18	0.22	0.33	0.55	0.05	0.06	0.11

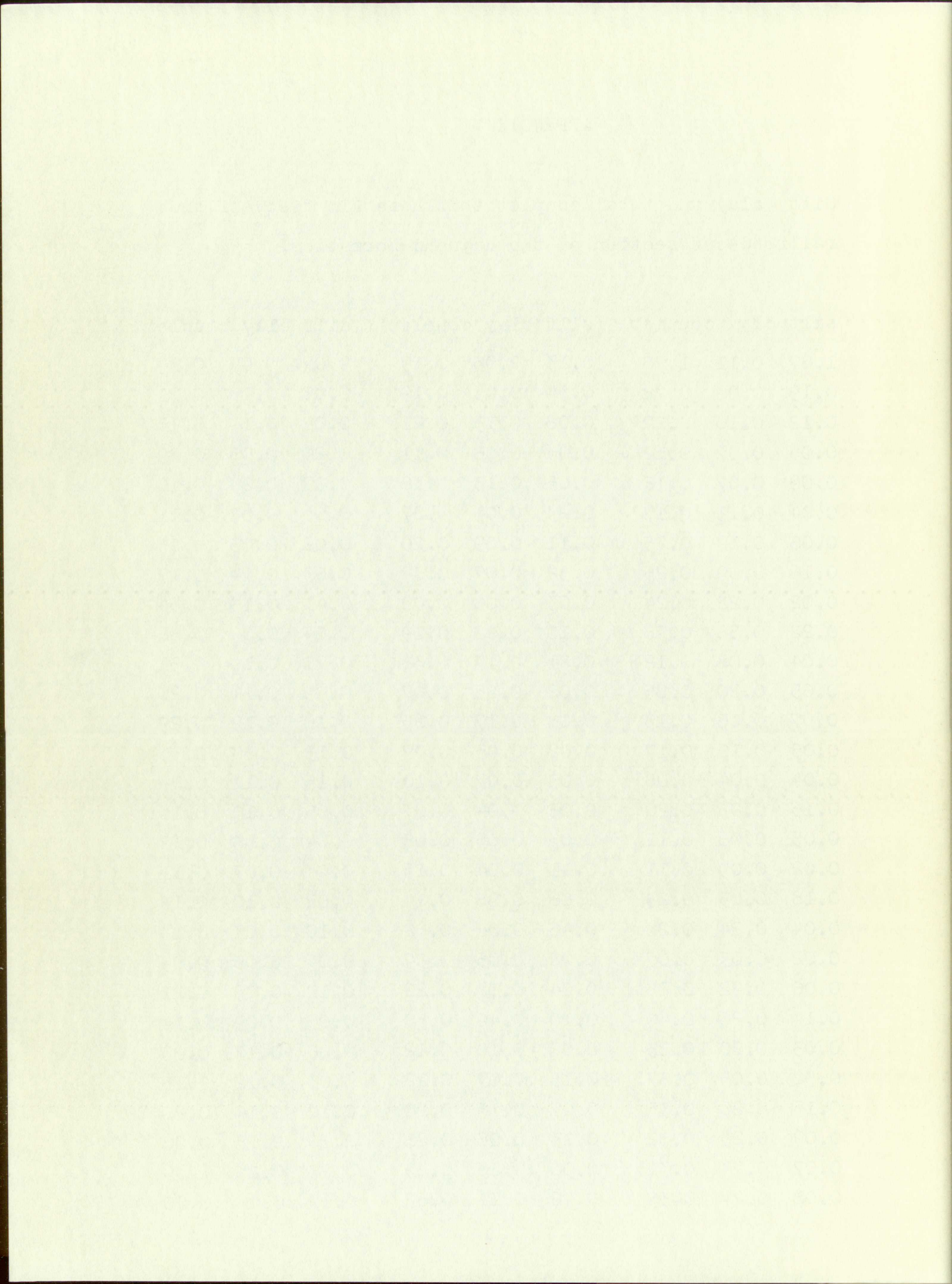
silt clay couplet			silt clay couplet			silt clay couplet		
0.05	0.13	0.18	0.04	0.08	0.12	0.08	0.23	0.31
0.06	0.13	0.19	0.22	0.33	0.55	0.05	0.06	0.11
0.13	0.11	0.24	0.23	0.47	0.70	0.05	0.13	0.18
0.07	0.03	0.10	0.10	0.36	0.46	0.06	0.13	0.19
0.05	0.23	0.28	0.22	0.25	0.47	0.13	0.11	0.24
0.07	0.06	0.13	0.09	0.42	0.51	0.07	0.03	0.10
0.14	0.27	0.41	0.06	0.28	0.34	0.05	0.23	0.28
0.22	0.16	0.38	0.30	0.17	0.47	0.07	0.06	0.13
0.10	0.06	0.16	0.08	0.09	0.17	0.14	0.27	0.41
0.15	0.10	0.25	0.20	0.10	0.30	0.22	0.16	0.38
0.23	0.04	0.27	0.08	0.08	0.16	0.10	0.06	0.16
0.05	0.18	0.23	0.05	0.05	0.10	0.15	0.03	0.18
0.20	0.12	0.32	0.04	0.03	0.07	0.11	0.11	0.22
0.15	0.25	0.40	0.10	0.23	0.33	0.04	0.10	0.14
0.25	0.18	0.43	0.27	0.35	0.62	0.06	0.25	0.31
0.11	0.11	0.22	0.16	0.10	0.26	0.36	0.11	0.47
0.04	0.08	0.12	0.05	0.03	0.08	0.06	0.15	0.21
0.05	0.04	0.09	0.10	0.07	0.17	0.08	0.09	0.17
0.11	0.09	0.20	0.09	0.05	0.14	0.04	0.20	0.24
0.05	0.25	0.30	0.05	0.07	0.12	0.04	0.05	0.09
0.24	0.08	0.32	0.08	0.05	0.13	0.08	0.10	0.18
0.04	0.28	0.32	0.08	0.08	0.16	0.08	0.18	0.26
0.07	0.26	0.33	0.06	0.18	0.24	0.25	0.18	0.43
0.13	0.06	0.19	0.15	0.23	0.38	0.07	0.11	0.18
0.06	0.04	0.10	0.07	0.11	0.18	0.05	0.05	0.10
0.04	0.09	0.13	0.13	0.10	0.23	0.04	0.16	0.20
0.06	0.12	0.18	0.25	0.10	0.35	0.50	0.18	0.68
0.05	0.09	0.14	0.04	0.28	0.32	0.10	0.10	0.20
0.05	0.08	0.13	0.25	0.12	0.37	0.05	0.16	0.21
0.07	0.12	0.19	0.03	0.17	0.20	0.07	0.33	0.40
0.08	0.32	0.40	0.03	0.07	0.10	0.04	0.25	0.29
0.93	0.09	1.02	0.06	0.04	0.10	0.19	0.14	0.33
0.08	0.09	0.17	0.17	0.17	0.34	0.05	0.06	0.11
0.06	0.05	0.11	0.05	0.28	0.33	0.06	0.15	0.21
0.05	0.17	0.22	0.07	0.07	0.14	0.26	0.18	0.44

silt clay couplet			silt clay couplet			silt clay couplet		
0.10	0.05	0.15	0.10	0.06	0.16	0.05	0.05	0.10
0.05	0.06	0.11	0.11	0.15	0.26	0.06	0.05	0.11
0.05	0.21	0.26	0.18	0.15	0.33	0.07	0.04	0.11
0.08	0.21	0.29	0.11	0.13	0.24	0.10	0.24	0.34
0.14	0.13	0.27	0.07	0.04	0.11	0.18	0.12	0.30
0.07	0.05	0.12	0.14	0.08	0.22	0.10	0.21	0.31
0.12	0.20	0.32	0.08	0.31	0.39	0.20	0.24	0.44
0.17	0.20	0.37	0.19	0.35	0.54	0.05	0.40	0.45
0.08	0.12	0.20	0.38	0.06	0.44	0.07	0.11	0.18
0.22	0.07	0.29	0.40	0.24	0.64	0.08	0.07	0.15
0.08	0.10	0.18	0.06	0.10	0.16	0.44	0.17	0.61
0.09	0.04	0.13	0.06	0.17	0.23	0.14	0.15	0.29
0.28	0.03	0.31	0.05	0.14	0.19	0.15	0.05	0.20
0.24	0.09	0.33	0.54	0.15	0.69	0.10	0.32	0.42
0.13	0.21	0.34	0.06	0.46	0.52	0.06	0.09	0.15
0.07	0.08	0.15	0.07	0.14	0.21	0.11	0.14	0.25
0.05	0.27	0.32	0.10	0.06	0.16			
0.25	0.08	0.33	0.16	0.38	0.54			
0.16	0.12	0.28	0.08	0.25	0.33			
0.10	0.04	0.14	0.12	0.13	0.25			
0.12	0.22	0.34	0.08	0.20	0.28			
0.28	0.06	0.34	0.09	0.47	0.56			
0.09	0.25	0.34	0.10	0.05	0.15			
0.04	0.32	0.36	0.08	0.04	0.12			
0.10	0.28	0.38	0.06	0.77	0.83			
0.28	0.10	0.38	0.60	0.38	0.98			
0.11	0.06	0.17	0.10	0.08	0.18			
0.11	0.57	0.68	0.06	0.46	0.52			
0.26	0.09	0.35	0.12	0.68	0.80			
0.12	0.45	0.57	0.23	0.87	1.10			
0.20	0.24	0.44	0.72	0.48	1.20			
0.10	0.17	0.27	0.14	0.18	0.32			
0.16	0.40	0.56	0.16	0.17	0.33			
0.06	0.12	0.18	0.05	0.06	0.11			
0.41	0.18	0.59	0.04	0.05	0.09			
0.10	0.20	0.30	0.05	0.05	0.10			

APPENDIX V

Silt, clay, and total couplet thickness (in feet) of the railroad-cut section of the Haymond Formation.

silt clay couplet			silt clay couplet			silt clay couplet		
1.67	0.11	1.78	0.13	0.06	0.19	0.07	0.07	0.14
0.19	0.09	0.28	0.14	0.05	0.19	0.05	0.16	0.21
0.12	0.10	0.22	0.08	0.13	0.21	0.02	0.14	0.16
0.05	0.07	0.12	0.05	0.06	0.11	0.26	0.03	0.29
0.09	0.07	0.16	0.05	0.13	0.18	0.07	0.09	0.16
0.04	0.13	0.17	0.23	0.04	0.27	0.04	0.07	0.11
0.06	0.19	0.25	0.11	0.09	0.20	0.02	0.03	0.05
0.16	0.09	0.25	0.32	0.07	0.39	0.03	0.14	0.17
0.02	0.22	0.24	0.03	0.06	0.09	0.41	0.13	0.54
0.22	0.56	0.78	0.10	0.08	0.19	0.64	0.04	0.68
0.04	0.08	0.12	0.21	0.17	0.38	0.21	0.10	0.31
0.65	0.20	0.85	0.02	0.05	0.07	0.09	0.11	0.20
0.07	0.06	0.13	0.08	0.17	0.25	0.10	0.19	0.29
0.05	0.12	0.17	0.02	0.05	0.07	0.15	0.80	0.95
0.04	0.04	0.08	0.03	0.07	0.10	0.15	0.11	0.26
0.15	0.05	0.20	0.03	0.04	0.07	0.05	0.10	0.14
0.05	0.06	0.11	0.03	0.05	0.08	0.04	0.08	0.12
0.02	0.09	0.11	0.11	0.04	0.15	0.04	0.07	0.11
0.18	0.05	0.23	0.06	0.08	0.14	0.02	0.10	0.12
0.04	0.24	0.28	0.46	0.06	0.52	0.10	0.03	0.13
0.02	0.05	0.07	0.02	0.05	0.07	0.04	0.05	0.09
0.06	0.22	0.28	0.04	0.18	0.22	0.12	0.09	0.21
0.14	0.26	0.40	0.10	0.40	0.50	0.05	0.09	0.14
0.03	0.20	0.23	0.02	0.10	0.12	0.06	0.17	0.23
0.32	0.05	0.37	0.15	0.07	0.22	0.03	0.12	0.15
0.15	0.20	0.35	0.07	0.13	0.20	0.12	0.14	0.26
0.09	0.23	0.32	0.13	0.08	0.21	0.10	0.18	0.28
0.07	0.24	0.31	0.06	0.23	0.29	0.23	0.07	0.30
0.08	0.27	0.35	0.46	0.21	0.67	0.02	0.18	0.20



silt clay couplet

0.10	0.12	0.22
0.14	0.19	0.33
0.50	0.07	0.57
0.05	0.12	0.17
0.07	0.07	0.14
0.03	0.07	0.10
0.49	0.19	0.68
0.09	0.22	0.31
0.02	0.12	0.14
0.02	0.11	0.13
0.09	0.47	0.56
0.14	0.14	0.28
0.24	0.08	0.32
0.08	0.11	0.19
0.02	0.10	0.12
0.02	0.09	0.11
0.21	0.08	0.29
0.03	0.10	0.13
0.10	0.12	0.22
0.09	0.09	0.18
0.05	0.20	0.25
0.10	0.04	0.14
0.24	0.16	0.40
0.07	0.07	0.14
0.15	0.25	0.40
0.02	0.05	0.07
0.04	0.08	0.12
0.02	0.03	0.05
0.05	0.12	0.17

Table 1

0.10	0.10	0.10
0.11	0.11	0.11
0.12	0.12	0.12
0.13	0.13	0.13
0.14	0.14	0.14
0.15	0.15	0.15
0.16	0.16	0.16
0.17	0.17	0.17
0.18	0.18	0.18
0.19	0.19	0.19
0.20	0.20	0.20
0.21	0.21	0.21
0.22	0.22	0.22
0.23	0.23	0.23
0.24	0.24	0.24
0.25	0.25	0.25
0.26	0.26	0.26
0.27	0.27	0.27
0.28	0.28	0.28
0.29	0.29	0.29
0.30	0.30	0.30
0.31	0.31	0.31
0.32	0.32	0.32
0.33	0.33	0.33
0.34	0.34	0.34
0.35	0.35	0.35
0.36	0.36	0.36
0.37	0.37	0.37
0.38	0.38	0.38
0.39	0.39	0.39
0.40	0.40	0.40
0.41	0.41	0.41
0.42	0.42	0.42
0.43	0.43	0.43
0.44	0.44	0.44
0.45	0.45	0.45
0.46	0.46	0.46
0.47	0.47	0.47
0.48	0.48	0.48
0.49	0.49	0.49
0.50	0.50	0.50
0.51	0.51	0.51
0.52	0.52	0.52
0.53	0.53	0.53
0.54	0.54	0.54
0.55	0.55	0.55
0.56	0.56	0.56
0.57	0.57	0.57
0.58	0.58	0.58
0.59	0.59	0.59
0.60	0.60	0.60
0.61	0.61	0.61
0.62	0.62	0.62
0.63	0.63	0.63
0.64	0.64	0.64
0.65	0.65	0.65
0.66	0.66	0.66
0.67	0.67	0.67
0.68	0.68	0.68
0.69	0.69	0.69
0.70	0.70	0.70
0.71	0.71	0.71
0.72	0.72	0.72
0.73	0.73	0.73
0.74	0.74	0.74
0.75	0.75	0.75
0.76	0.76	0.76
0.77	0.77	0.77
0.78	0.78	0.78
0.79	0.79	0.79
0.80	0.80	0.80
0.81	0.81	0.81
0.82	0.82	0.82
0.83	0.83	0.83
0.84	0.84	0.84
0.85	0.85	0.85
0.86	0.86	0.86
0.87	0.87	0.87
0.88	0.88	0.88
0.89	0.89	0.89
0.90	0.90	0.90
0.91	0.91	0.91
0.92	0.92	0.92
0.93	0.93	0.93
0.94	0.94	0.94
0.95	0.95	0.95
0.96	0.96	0.96
0.97	0.97	0.97
0.98	0.98	0.98
0.99	0.99	0.99
1.00	1.00	1.00

APPENDIX VI

Summary of the number of years between storms producing a sea level anomaly greater than 2 feet for 17 U. S. Coast and Geodetic Survey tide stations on the Atlantic and Gulf coasts (data from Harris, 1963).

Station	Number of years between storms	Regional means
North Atlantic:		3.87
Eastport	4.36	
Portland	6.81	
Boston	3.45	
Newport	2.60	
Battery	2.11	
Atlantic City	1.71	
South Atlantic:		1.57
Hampton Roads	1.68	
Southport	1.47	
Charleston	1.33	
Mayport	1.30	
Miami	1.96	
Gulf coast:		2.41
Key West	2.30	
Tampa	1.52	
Ceder Keys	1.60	
Pensacola	2.57	
Galveston	2.84	
Port Isabel	3.60	



Faint, illegible text, possibly a header or introductory paragraph, located in the upper right quadrant of the page.

Faint, illegible text, possibly a list or a series of short paragraphs, located in the middle right section of the page.

Faint, illegible text, possibly a continuation of the list or paragraphs, located in the lower middle right section of the page.

Faint, illegible text, possibly a concluding paragraph or a signature block, located in the bottom right section of the page.

Faint, illegible text, possibly a footer or a date, located at the very bottom right of the page.

