

GEOLOGICAL SURVEY OF CANADA
OPEN FILE REPORT 1193

FACIES ANALYSIS AND RESERVOIR GEOMETRY
OF THE CRYSTAL VIKING FIELD,
Tp. 45 and 46, Rg. 3 and 4W5,
CENTRAL ALBERTA

by
G.E. Reinson, Ph.D., P. Geol.
REINSON CONSULTANTS LTD.

Dept. of Energy, Mines and Resources
Institute of Sedimentary and Petroleum Geology
3303-33rd Street N.W.
Calgary, Alberta
T2L 2A7

Contract No.: OISG 23294-4-0692
Contract Title: Geological Modelling of a Clastic Reservoir as a Basis for Enhanced
Oil Recovery - Demonstration Study

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

CONTENTS

	Abstract	
	Acknowledgments	
1	Introduction	
1	Study area	
7	Objectives	
7	Method and data base	
8	Facies analysis	
8	Regional facies	
11	Estuarine channel facies	
19	Estuary bay-fill facies	
20	Upper contact zone facies	
20	Discussion	
21	Facies geometry and depositional relationships	
21	Stratigraphic relationships-regional Viking versus Crystal Viking	
22	Channel stages	
25	Depositional model	
26	Depositional controls on reservoir characteristics	
34	Summary and conclusions	
36	References	
37	Appendix I - Core lithologs	
123	Appendix II - Depth plots of core-analysis data from selected well cores	
166	Appendix III - List of core samples submitted with this report	

Illustrations

Figures

- | | |
|----|---|
| 2 | 1. Location of the Crystal Field relative to other Viking oil fields in south-central Alberta. |
| 3 | 2. Crystal Field - pool limits and well control. |
| 4 | 3. Isopach map of total thickness of sandstone plus conglomerate lithofacies (gross pay map). (Isopach line interval - 5 m.) |
| 5 | 4. Map of the Crystal Viking 'A' zone pool showing the positions of the gas/oil and oil/water contacts. |
| 6 | 5. Map of the Crystal Viking 'H' zone pool showing the positions of the gas/oil and oil/water contacts. |
| 9 | 6. Map showing locations of the large-scale stratigraphic cross-sections (A-A' to G'-G'') which form part of the enclosure supplement to this report. |
| 10 | 7. Interpretive litholog of the cored sequence in the 13-5-46-3W5 well. |
| 13 | 8. Interpretive litholog of the cored sequence in the 10-1-46-4W5 well. |
| 14 | 9. Interpretive litholog of the cored sequence in the 14-1-46- W5 well. |
| 15 | 10. Interpretive lithologs of cores from the 8-11-46-4W5 and 8-20-46-3W5 wells. |
| 16 | 11. Interpretive lithologs of cores from the 10-18-46-3W5 and 12-19-46-3W5 wells. |
| 17 | 12. Isopach map of conglomerate facies. (Isopach line interval is 5 m, with the 1 m line also shown.) |
| 18 | 13. GR log-lithology cross-section from the eastern margin to the centre of the field, showing the unconformable relationship between the Crystal deposit and regional Viking facies. |

Figures (cont.)

- | | |
|----|---|
| 23 | 14. Location of GR log sections illustrated in the cross-section mosaics of North and South Crystal. |
| 24 | 15. Schematic diagram interpreted from the GR cross-section mosaics, illustrating the varying relationship of the three channel depositional stages and the estuary bay-fill stage. |
| 27 | 16. Schematic of the depositional model proposed for the Viking deposits in the Crystal area. |
| 29 | 17. Isopach map of stage 'H' sandstone (shallow channel-bar complex subfacies of the estuary bay-fill facies). |
| 31 | 18. Isopach map of the total thickness of channel stage 'B' plus 'C' deposits (isopach line interval - 5 m). |
| 32 | 19. Isopach map of channel stage 'C' deposits (isopach line interval - 5 m). |
| 33 | 20. Schematic map highlighting the principal reservoir trends that are governed by depositional factors. |

ENCLOSURES

Eight Log Stratigraphic Cross-sections (A-A', B-B', C-C', D-D', E-E', F-F', G-G' G-G'') - vertical scale: 5 cm = 24 m.

Isopach Map of Total Sandstone and Conglomerate (equivalent to gross pay) - scale 1:20,000.

Isopach Map of Conglomerate Lithofacies - scale 1:50,000.

Isopach Map of: 1) Total thickness of Stage 'B' and Stage 'C'
2) Total thickness of Stage 'H' sandstone
(Both on same 1:20,000 scale map)

Isopach Map of Channel Stage 'C' deposits - scale 1:20,000.

Two Gamma-Ray Cross-sections Mosaics of North and South Halves of Crystal Field (Mosaics indicate correlation of depositional stages, and major facies and unconformity relationships) - vertical scale: 5 cm = 24 m.

ABSTRACT

The Viking Formation in the Crystal field contains a linear sandstone-conglomerate deposit which attains thicknesses of 30 m and is aligned in a north-south direction. The thickness and alignment trends of this reservoir 'sand' body contrast sharply with other established Viking sandstone reservoirs, which are generally much thinner and oriented more in a northwest-southeast direction. Another contrasting feature of Crystal compared to other Viking oil fields, is that the producing reservoir consists of two distinct, hydrodynamically-separated oil pools ('A' and 'H' pool). The Crystal Viking 'A' pool contains ninety-six per cent of the estimated recoverable reserves of $5.8 \times 10^6 \text{ m}^3$, with the 'H' pool being situated higher stratigraphically, and partially overlapping the main producing zone on the western side.

Two major facies constitute the Viking Formation at Crystal, channel and estuary-bay fill. The combined association of the two facies represents an estuarine tidal channel-bay complex. Detailed log and core correlations indicate that: 1) the estuarine channel-bay complex is unconformable with underlying and adjacent inner shelf-lower shoreface deposits of the regional Viking facies and; 2) the linear reservoir sand body consists of four depositional units; the lower three units are representative of successive and partially-superimposed channel-fill stages (A, B, C), and the uppermost unit (H) is a shallow channel-bar deposit representative of the final episode of estuary bay-fill deposition. The multistage channel depositional events are interpreted to be the record of progressive estuarine valley fill under conditions of rising sea level, with each channel depositional stage corresponding to a stillstand during an overall transgressive period. Each channel stage modified the estuary on the eastern side while subtidal estuary-fill muddy deposits accumulated as facies equivalents to the channel-fill deposits, on the western side. The superimposed channel-fill deposits (A, B, C), constitute the bulk of the reservoir and form the Crystal Viking 'A' pool, whereas the shallow channel-bar deposits (H) constitute the much smaller producing zone of the Crystal Viking 'H' pool.

The occurrence of two separate pools, and the variability in reservoir capacity, continuity and performance trends of the 'A' pool, are controlled directly by depositional factors. The depositional model of progressive estuarine valley fill under transgressive conditions readily explains the presence of the 'H' pool as a discrete reservoir separated from the main oil-bearing 'A' zone pool. The highly productive wells of the 'A' pool correspond to specific channel stage deposits, or are situated in the areas where channel deposits of successive stages are highly superimposed. In contrast, marginally productive wells and poor reservoir communication between producing wells, occur in the areas where the different channel-stage deposits are shown to diverge. Given the observed relationship between depositional trends and overall reservoir behavior, it is apparent that facies distribution and channel-stage geometries must be considered during both the planning and evaluation phases of any secondary recovery scheme.

ACKNOWLEDGMENTS

Financial support for this study was provided by the Department of Energy, Mines and Resources under contract no. 01SG. 23294-4-0692. Westcoast Petroleum Limited (principal operator of the Crystal field) provided base maps and access to well logs and core-analysis data. In particular, John E. Clark (senior exploitation geologist, Westcoast) was extremely helpful, both through discussion of specific problems of Crystal reservoir geology, and by provision of information pertaining to pool boundaries, estimated recoverable reserves, and porosity-depth plots (Appendix II).

INTRODUCTION

Study area

The Cystal Viking Field is situated in Tps. 45 and 46, Rgs. 3 and 4W5, some 25 km north and 80 km west, of the Gilby-Bentley and Joarcam Viking oil-producing trends respectively (Fig. 1). The Crystal field is the most recent significant Viking oil find, having been discovered in the fall of 1978. The original discovery well (6-7-46-3W5) encountered a thick, but apparently low-porosity sand interval which was not tested or cored, but thought to be gas-bearing as other previous wells in the area. The 6-7 well was cased for later completion as a gas well. In early 1979 a subsequent well (3-8-46-3W5), situated on the eastern side of the present field (Fig. 2), yielded 400 m of oil on drill-stem testing, and was completed as an oil well. This prompted a second 'look' at the 6-7 well, and it was subsequently completed, also as a producing oil well. The next well to be drilled was in 1981 at location 13-5-46-3W5, on the eastern limit of the present field. This well also yielded oil, and development drilling began in earnest in 1981. The result is a fairly substantial producing field with estimated recoverable reserves totalling $5.8 \times 10^6 \text{ m}^3$ from two separate pools, 'A' and 'H' pool (Fig. 2). Ninety-six percent of these recoverable reserves are contained within the 'A' pool.

The Crystal field is rather unique compared to older established Viking oil fields such as Joffre, Gilby-Bentley and Provost (Love, 1955, 1960; Koldijk, 1976; Lerand and Thompson, 1976; Alho et al., 1977), in that the reservoir sand body is over 30 m thick and elongated in a north-south direction (Fig. 3). The other Viking oil fields are elongated either northwest-southeast or west northwest-east southeast and cover much larger areas, with reservoir zones being in the order of 5 m thick, or less.

Another unique feature of Crystal relative to other Viking oil-bearing fields is the occurrence of two separate oil pools, each with their own gas cap, situated adjacent to, and partially overlapping one another (figs. 4, 5). Gas of the 'H' pool is

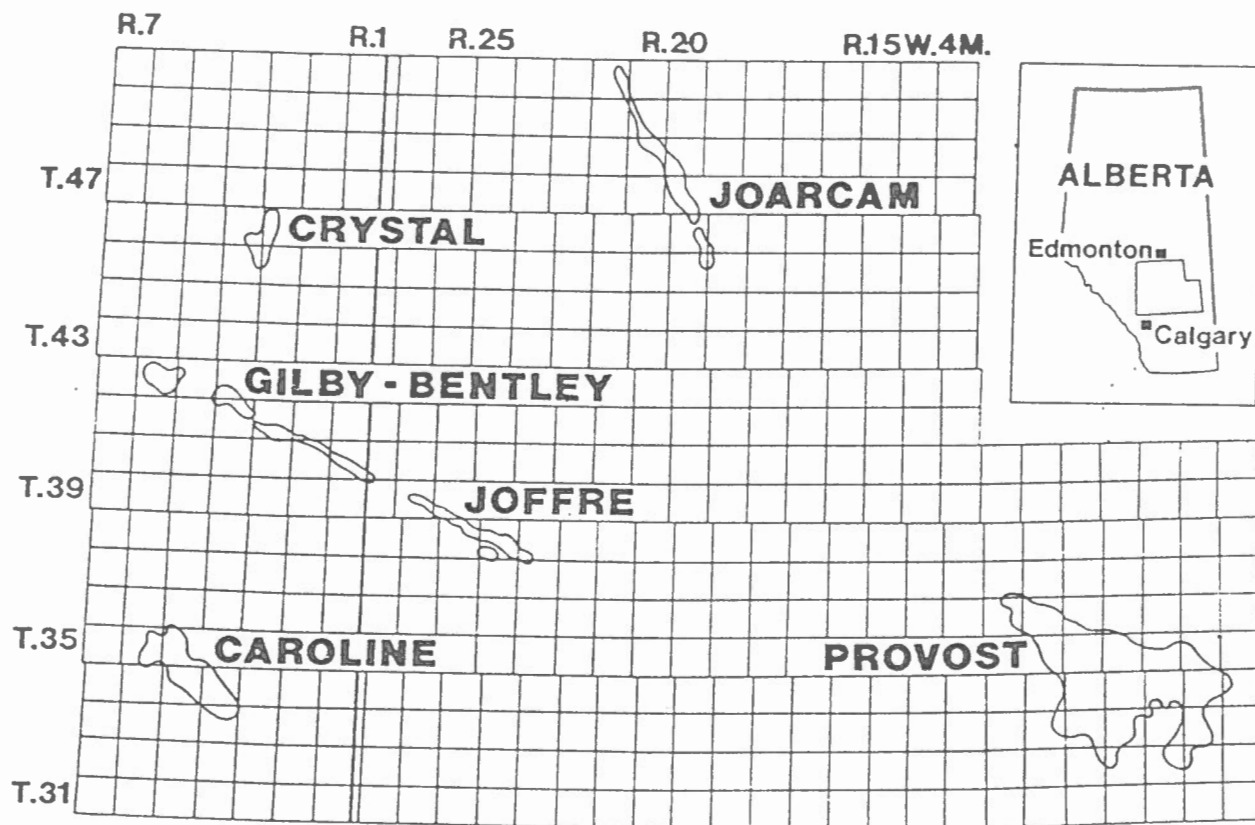


Figure 1. Location of the Crystal Field relative to other Viking oil fields in south-central Alberta.

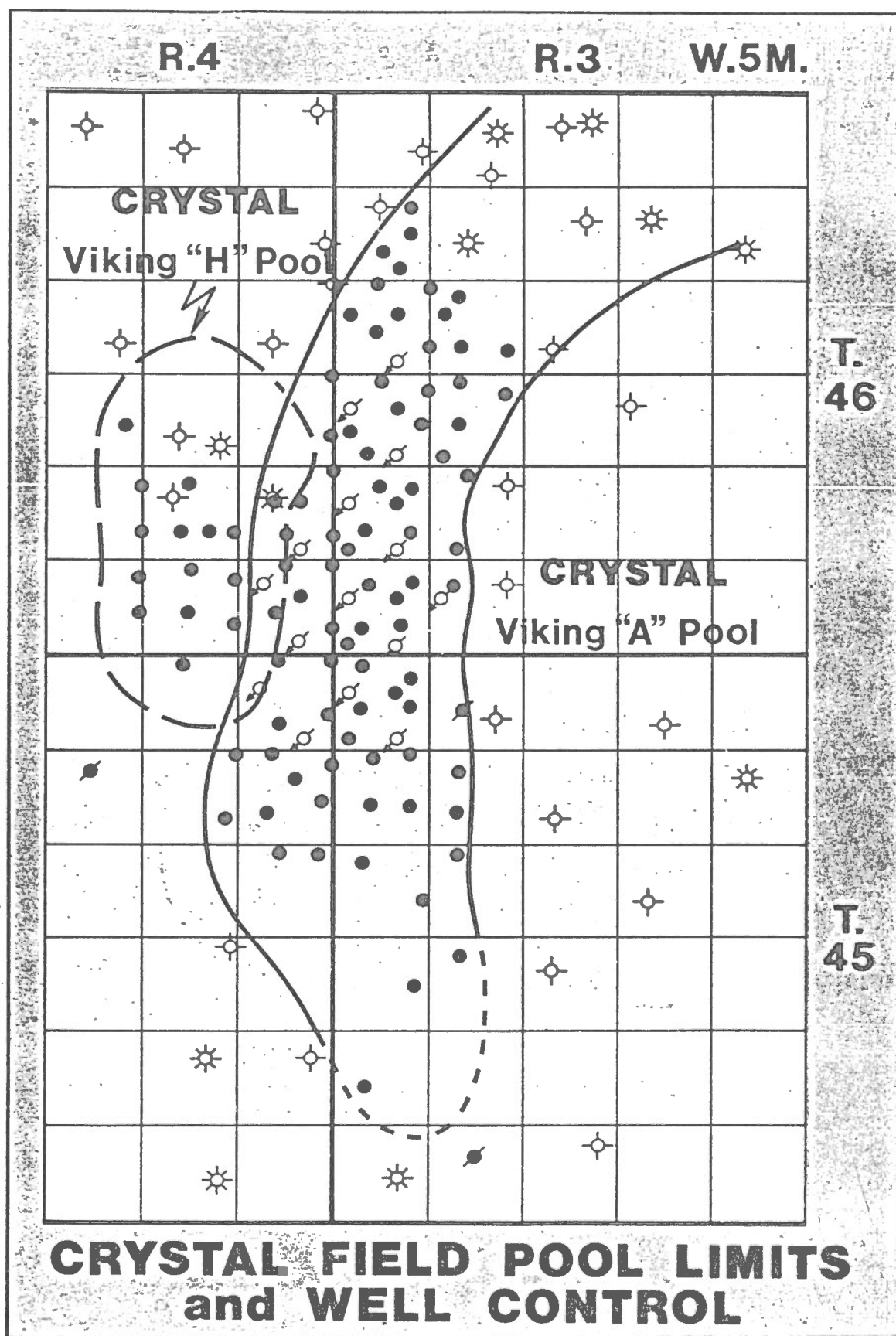


Figure 2. Crystal field - pool limits and well control.

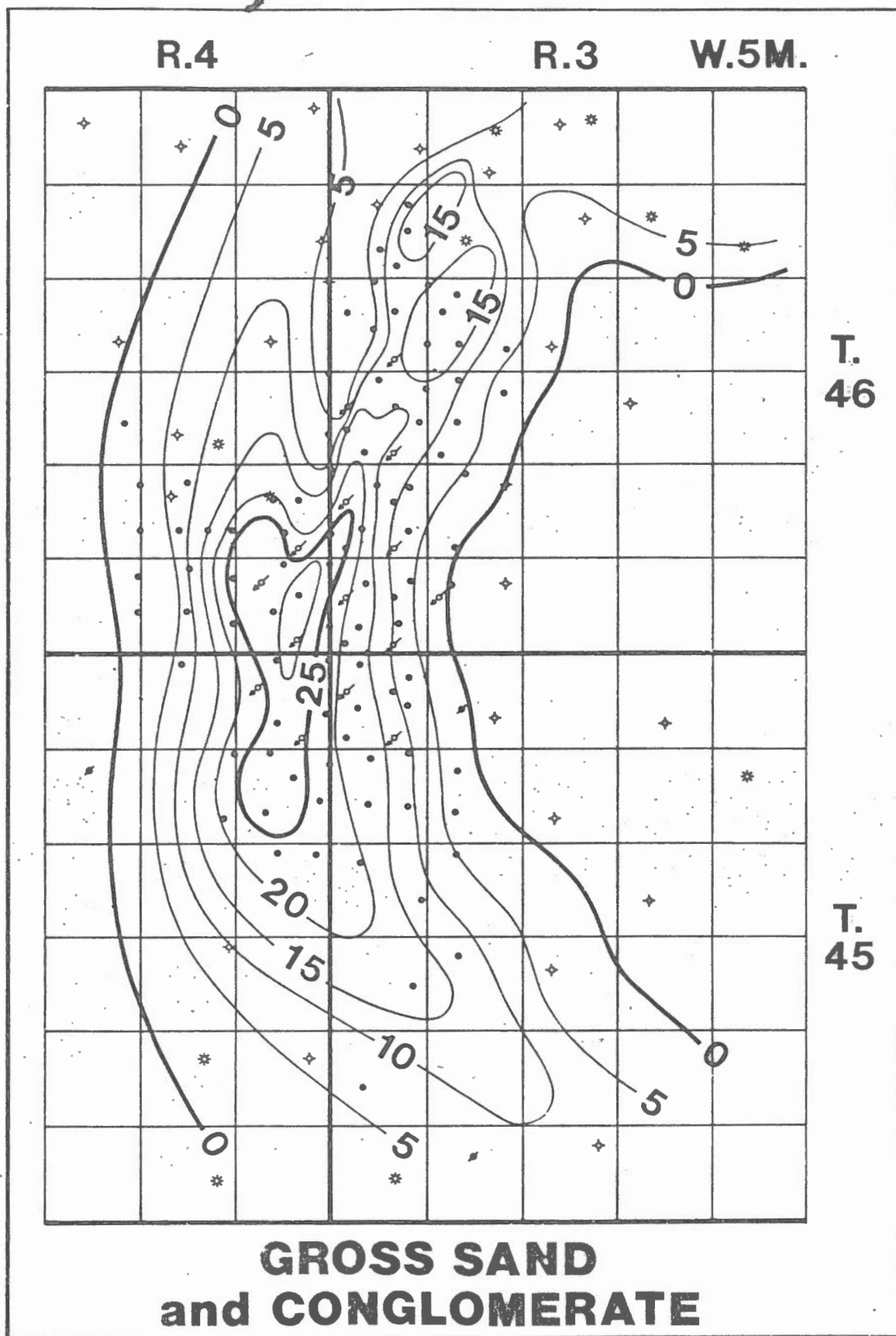


Figure 3. Isopach map of total thickness of sandstone plus conglomerate lithofacies (gross pay map). (Isopach line interval - 5 m.)

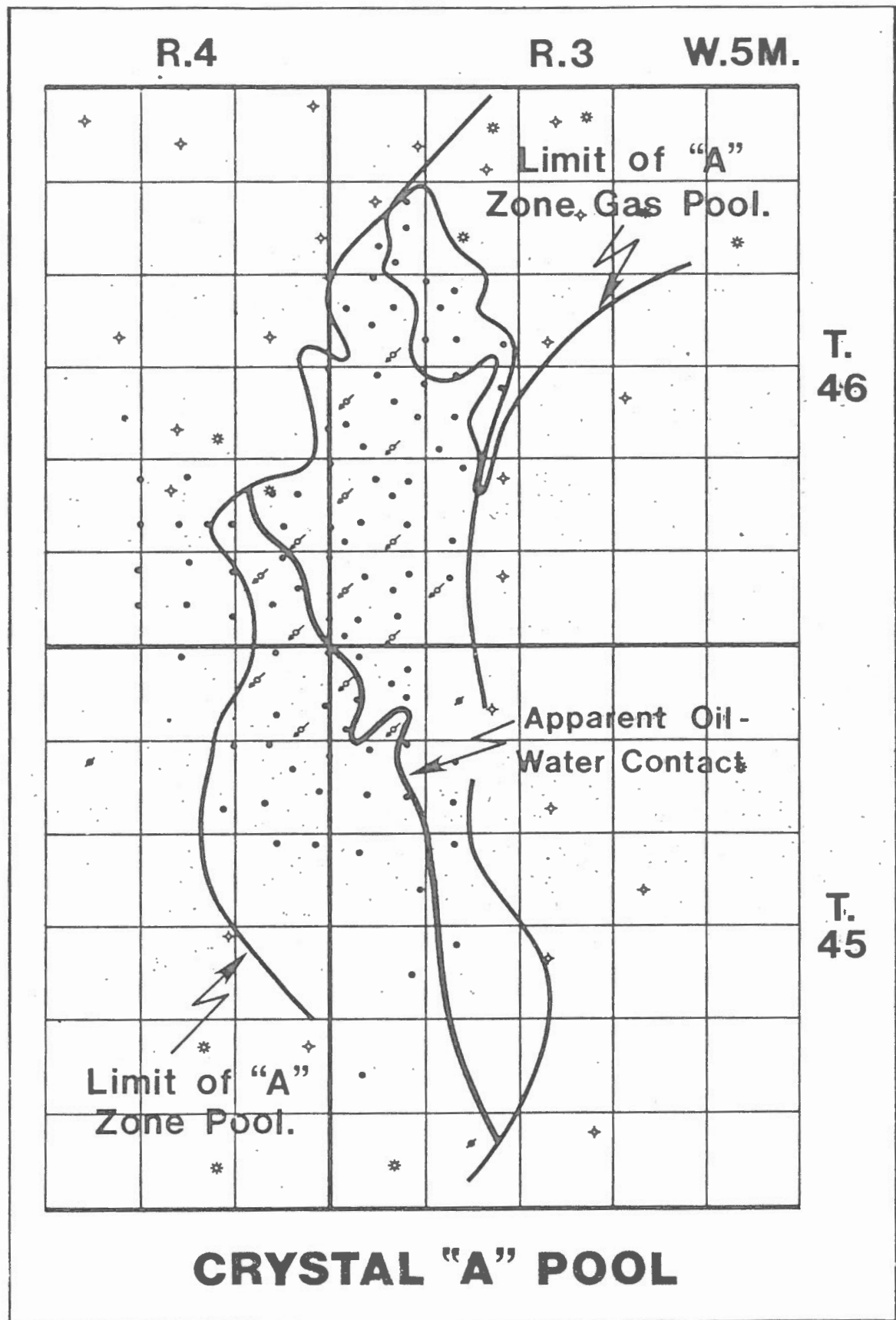


Figure 4. Map of the Crystal Viking 'A' zone pool showing the positions of the gas/oil and oil/water contacts.

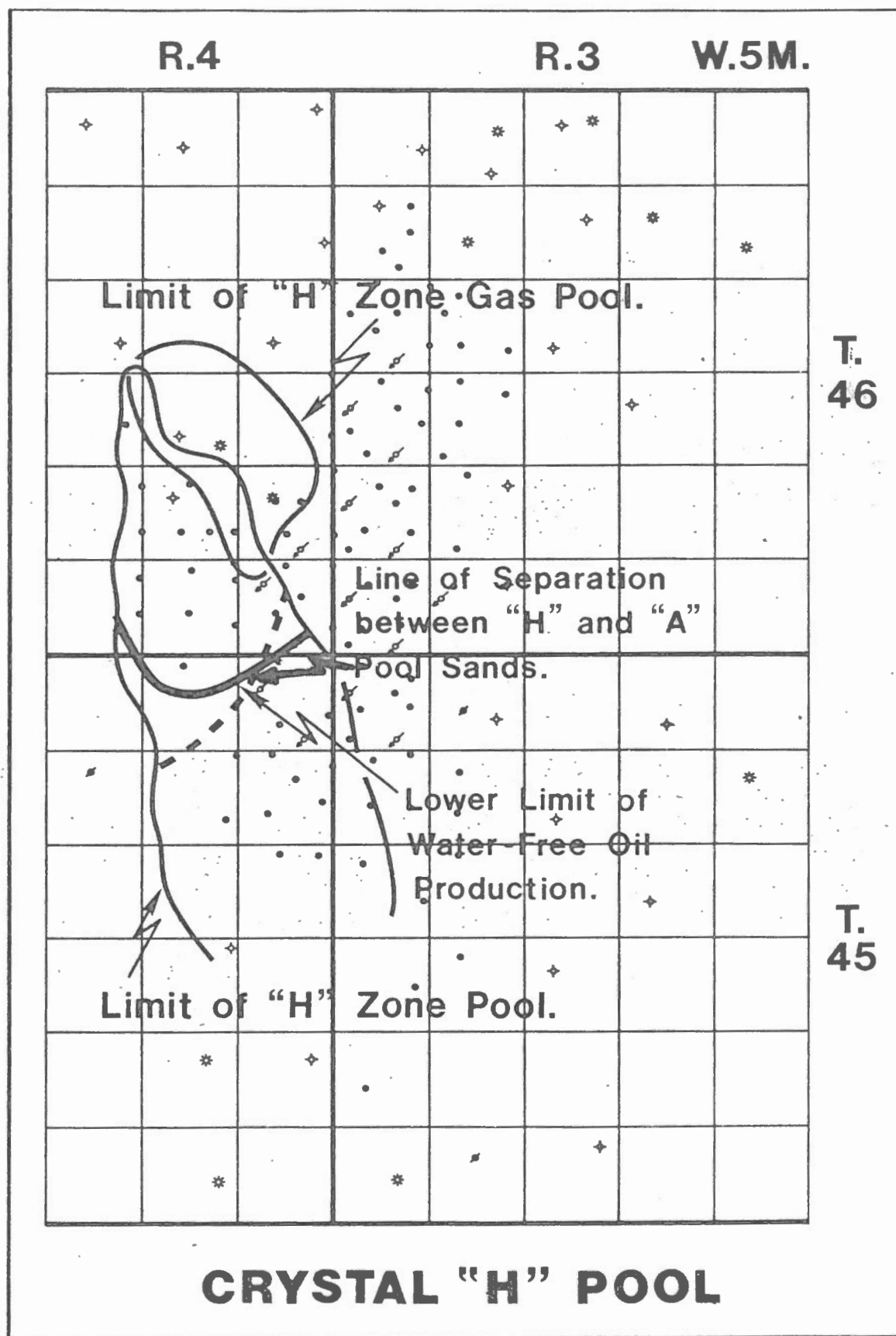


Figure 5. Map of the Crystal Viking 'H' zone pool showing the positions of the gas/oil and oil/water contacts, and the approximate position at which 'H' pool sandstone becomes separated from underlying 'A' pool sandstone.

situated structurally lower than oil of the 'A' pool, and this is an unusual situation in sandstone stratigraphic traps of this type.

Objectives

The objectives of this study were as follows: 1) to develop a sedimentological model of the facies geometry and depositional environment of the Crystal Viking Formation through detailed microfacies sequence identification and correlation and, 2) to evaluate this model with respect to depositional controls on continuity, and internal geometry of the producing reservoir zone. A further objective presently being considered in concert with Westcoast Petroleum Ltd., is the utilization of this facies mapping study for assessing the primary recovery trends of the producing reservoir, and for evaluating any secondary recovery schemes presently being planned or in progress.

Method and data base

An extensive, high-quality, log and core data-base exists on the Crystal Viking field. This is due both to the recent discovery and development, and the unique reservoir complexities, of Crystal relative to other Viking oil fields. Cores are available from almost all of the wells within the field, along with corresponding conventional core-analysis data (ϕ , K, Sw, Sor). A suite of high-quality geophysical logs (sonic, density, electrical) is also available for all wells.

Core and mechanical logs from 140 wells were utilized during the course of this study. In this type of geological study it is necessary to examine well data adjacent to the Crystal pool boundaries, as well as within them. Some 110 of these wells lie within either the 'A' or 'H' pool boundaries.

A total of 74 well cores were described in detail in litholog format (Appendix I), enabling the graphic delineation of vertical facies sequences and depositional stages. The facies sequences in cores were compared with the mechanical logs and with

conventional core analysis data, thus facilitating the identification and correlation of specific facies throughout the field.

The log stratigraphic cross-sections, and various facies maps were constructed using a combination of mechanical logs, core lithologs, and porosity-permeability core analyses. All types of mechanical logs were utilized for determining the position of important marker beds, and facies unit thicknesses.

Log stratigraphic cross-sections, designated A-A' to G'-G'', are included as enclosures to this report, with the cross-section localities indicated on Figure 6. Detailed gamma-ray cross-section mosaics of the north and south parts of the field, are also included in the enclosures, with the mosaic section localities depicted in Figure 14. All of the maps occur in page-size format within the text, and in undrafted large scale format as separate enclosures.

FACIES ANALYSIS

The Viking Formation in the Crystal area can be grouped into three major facies based upon interpretation of lithofacies sequences in cores: 1) Regional facies, 2) Channel facies and, 3) Estuary bay-fill facies. The term "regional facies" refers to the lithofacies sequence that characterizes the Viking Formation in the areas surrounding the Crystal field. Numerous studies indicate that the Viking Formation exhibits a relatively uniform facies sequence throughout many parts of south-central and central Alberta (Reinson et al, 1983; Reinson, 1984; Reinson and Foscolos, in press; Beaumont, 1984), including the region adjacent to the Crystal field. It is necessary to delineate what constitutes this 'normal' regional sequence in order to interpret the 'abnormal' Viking sequences that occur within the Crystal field.

Regional facies

The core illustrated in Figure 7, situated on the eastern margin of the Crystal field, is characteristic of the lithological sequence encountered in the Viking Formation throughout central and south-central Alberta. For the most part, the

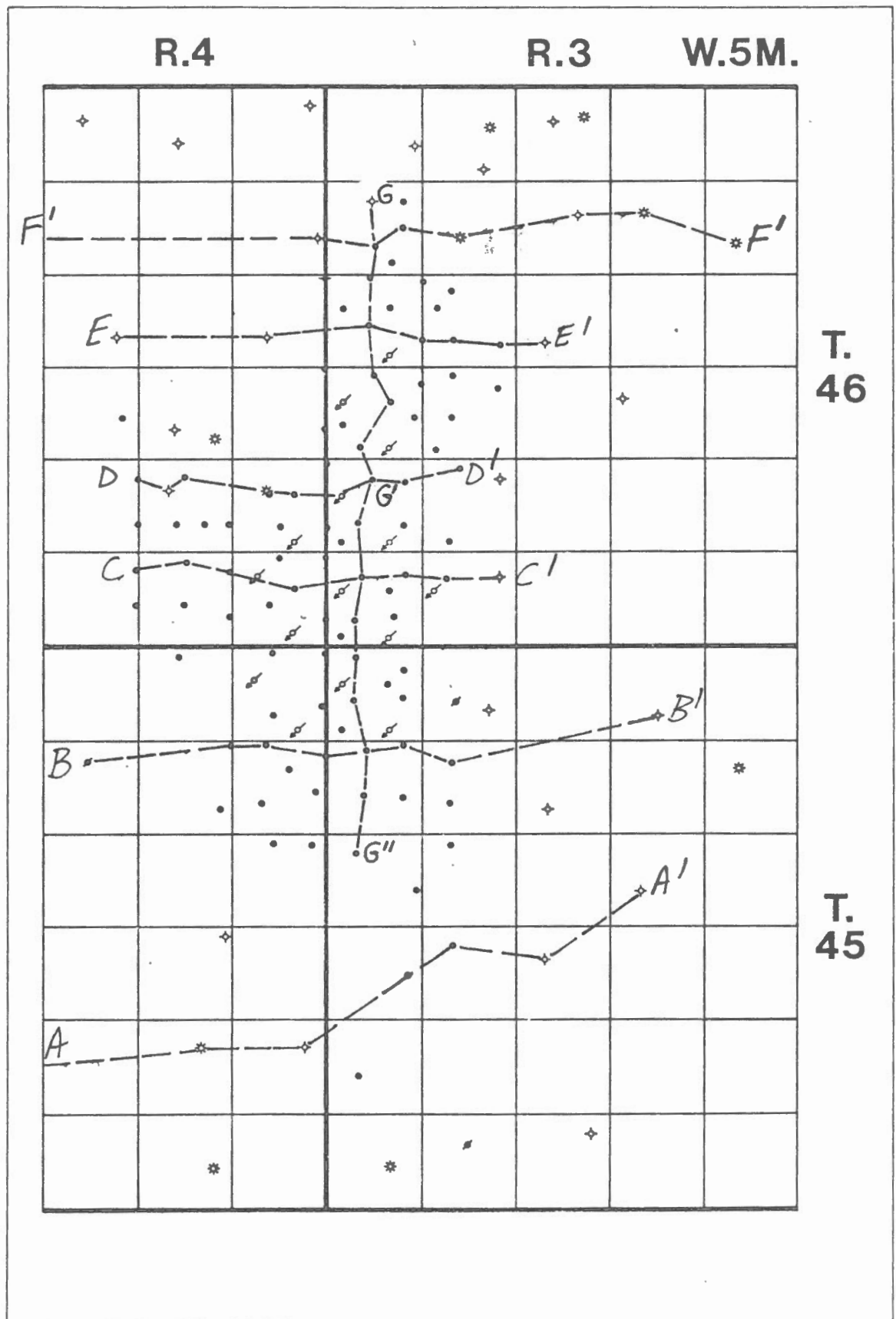


Figure 6. Map showing locations of the large-scale stratigraphic cross-sections (A-A' to G'-G'') which form part of the enclosure supplement to this report.

CRYSTAL 13-5-46-3W.5M.

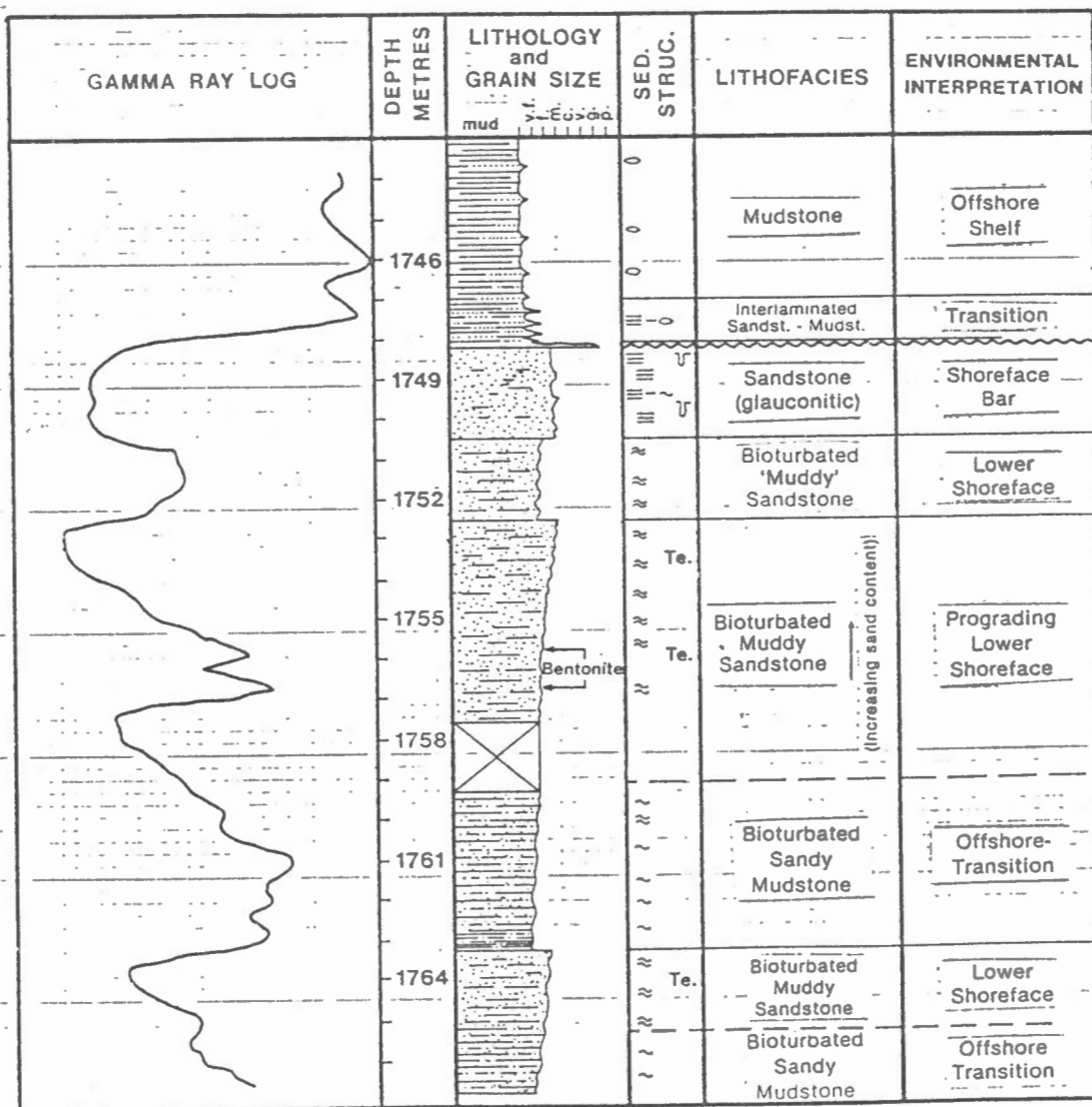


Figure 7. Interpretive litholog of the cored sequence in the 13-5-46-3W5 well. This cored sequence is typical of the 'regional facies' sequence.

regional Viking deposits consist of a series of coarsening-upward, bioturbated sandy mudstone to bioturbated muddy sandstone sequences. The bioturbated sandy mudstones are interpreted to represent offshore-transitional deposits, while the bioturbated muddy sandstones represent lower shoreface deposits resulting from progradation of the shoreface sediment wedge. Almost the entire formation is made up of four or five of these cyclic sequences, with the uppermost sequence often being capped by a 'clean', fine-grained shoreface bar sandstone lithofacies such as in the 13-5 well (Figure 7). The shoreface bar sandstone forms a marginal oil and/or gas reservoir at many isolated localities throughout the region. A fourth lithofacies, laminated to bioturbated sandstone-mudstone, though not present in all cored sequences, is a variant of the bioturbated muddy sandstone lithofacies (i.e: 8-7-46-3W5, Appendix I). Where present, it overlies and interbeds with bioturbated muddy sandstones, and represents the gradational interval between the bioturbated muddy sandstones and succeeding 'clean' bar sandstone deposits.

The cyclic coarsening-upward sequences of the regional Viking deposits impart a distinct log signature with the top of each cycle being expressed by a pronounced 'kick' on the gamma-ray log (Fig. 7). These kicks provide extremely useful markers for log-correlation purposes (i.e. see log cross-sections, marker B). Present within the regional Viking sequence are two bentonite layers, less than 1 cm thick, which give a characteristic 'double kick' on the gamma-ray log (Fig. 7). This kick was also used as a correlative marker and is designated 'bentonite marker' on the correlative cross-sections. A third correlative log marker, termed 'marker A' on the cross-sections, corresponds to another thin bentonite layer situated near the base of the formation.

Estuarine channel facies

Based on detailed examination of cores throughout the field, the Crystal sand body is interpreted as a multistage estuarine channel-fill deposit. The deposit consists of several channel-associated lithofacies including conglomerate, conglomeratic

sandstone, interbedded sandstone-conglomerate, fine- to medium-grained sandstone, fine-grained shaly sandstone, and partially bioturbated shaly sandstone (figs. 8-11). The variation in sand lithologies reflects different channel subfacies corresponding to the various subenvironments within the overall channel complex. Fine-grained shaly sandstones and partially bioturbated shaly sandstones are indicative of subtidal bar and bar-margin deposition along the laterally accreting or convex side of the channel complex. The principal reservoir-grade lithofacies, conglomerate, conglomeratic sandstone, and fine- to medium-grained sandstone, reflect deposition proximal to the axis, or on the scouring or concave margin, of the channel complex. The thick conglomerate lithofacies sequences are restricted to two localized areas (Fig. 12), with the bulk of the reservoir body being comprised of channel sandstone subfacies.

The channel origin of the sand body, as interpreted from cores, is corroborated by well-log correlations as illustrated in Figure 13. The distinctive marker horizons of the regional Viking facies sequence situated on the eastern margin of the field, are successively truncated as the sand body thickens to the west.

The correlation in Figure 13 would suggest a simple channel situation with progressively deeper channel incisement into older regional facies as the channel axis is approached. The variation in vertical facies successions from one core locality to another however, clearly indicates that the Crystal deposit is far more complex than that which could result from downcutting and in-fill by a single channel phase. This complexity is emphasized by the well cores illustrated in figures 8 and 9 which are located less than 0.5 km apart, yet contain completely contrasting vertical lithofacies successions.

At least three major superimposed channel-fill stages are recognizable in several cored sequences situated in the centre of the field (figs. 8, 9), whereas on the east and northeast sides only a single channel-fill event is evident (Fig. 10). In the southern part of the field, thick sandstone successions lacking conglomerate intervals, display

CRYSTAL 10-1-46-4W.5M.

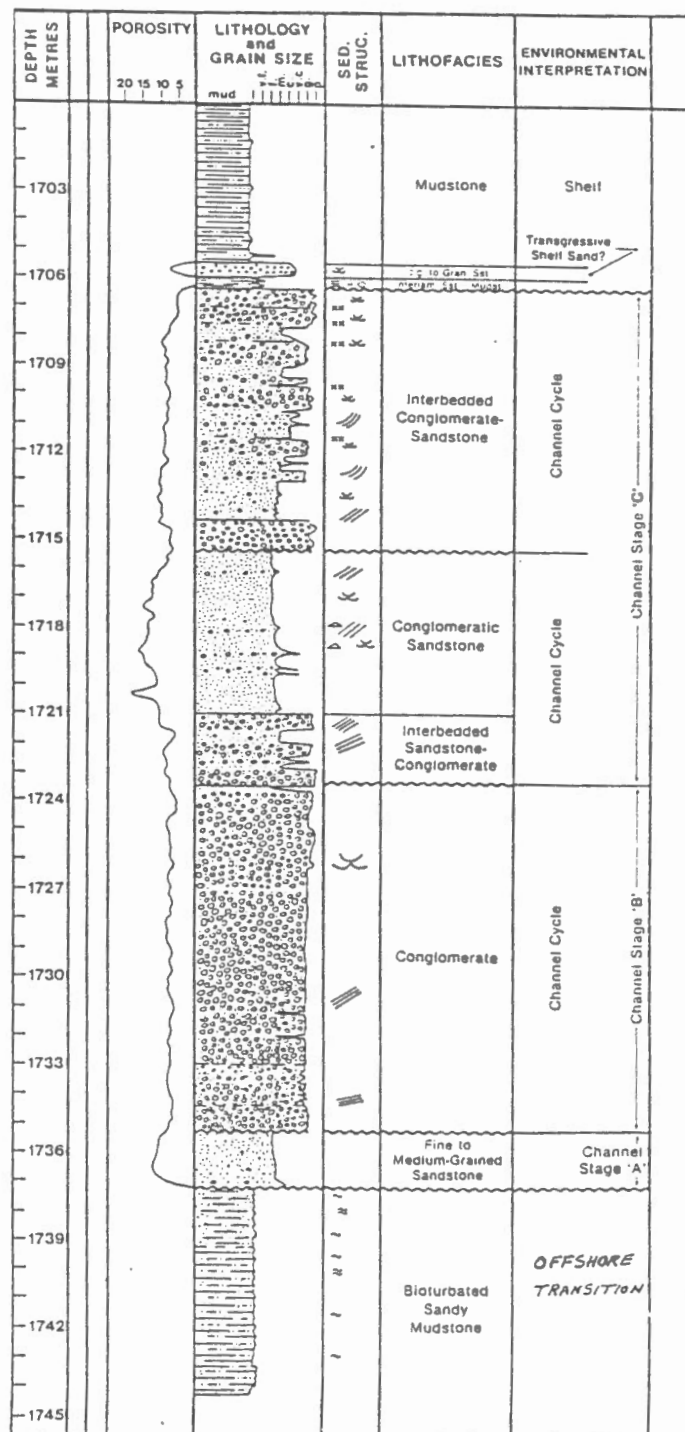


Figure 8. Interpretive litholog of the cored sequence in the 10-1-46-4W5 well. (This core is located less than 0.5 km from the core illustrated in Figure 9).

CRYSTAL 14-1-46-4W.5M.

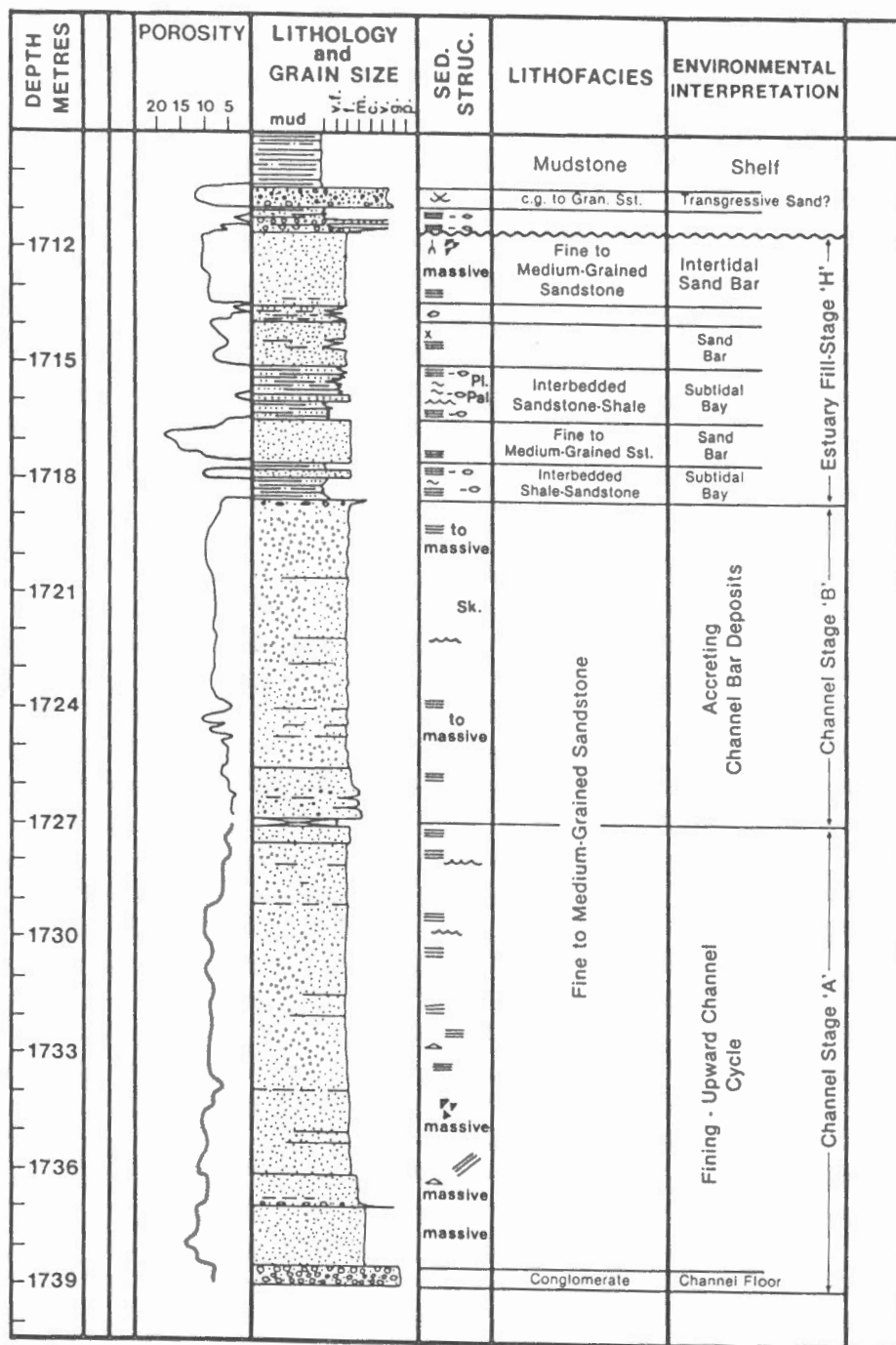
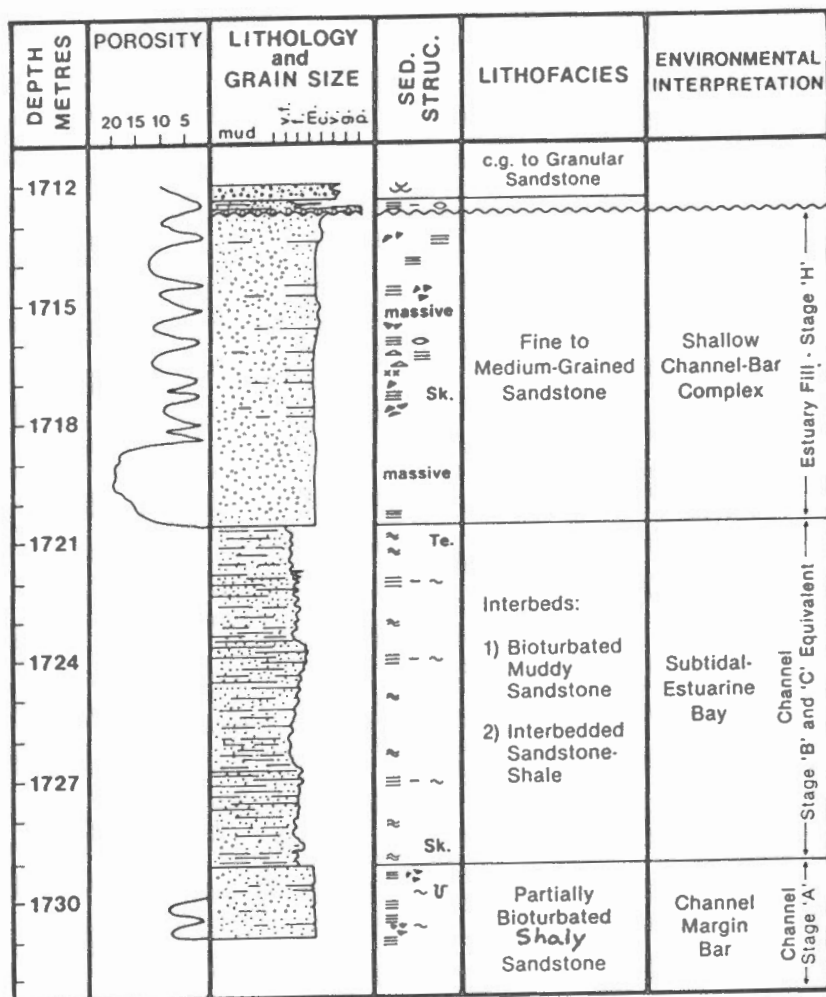


Figure 9. Interpretive litholog of the cored sequence in the 14-1-46-4W5 well.

CRYSTAL 8-11-46-4W.5M.



CRYSTAL 8-20-46-3W.5M.

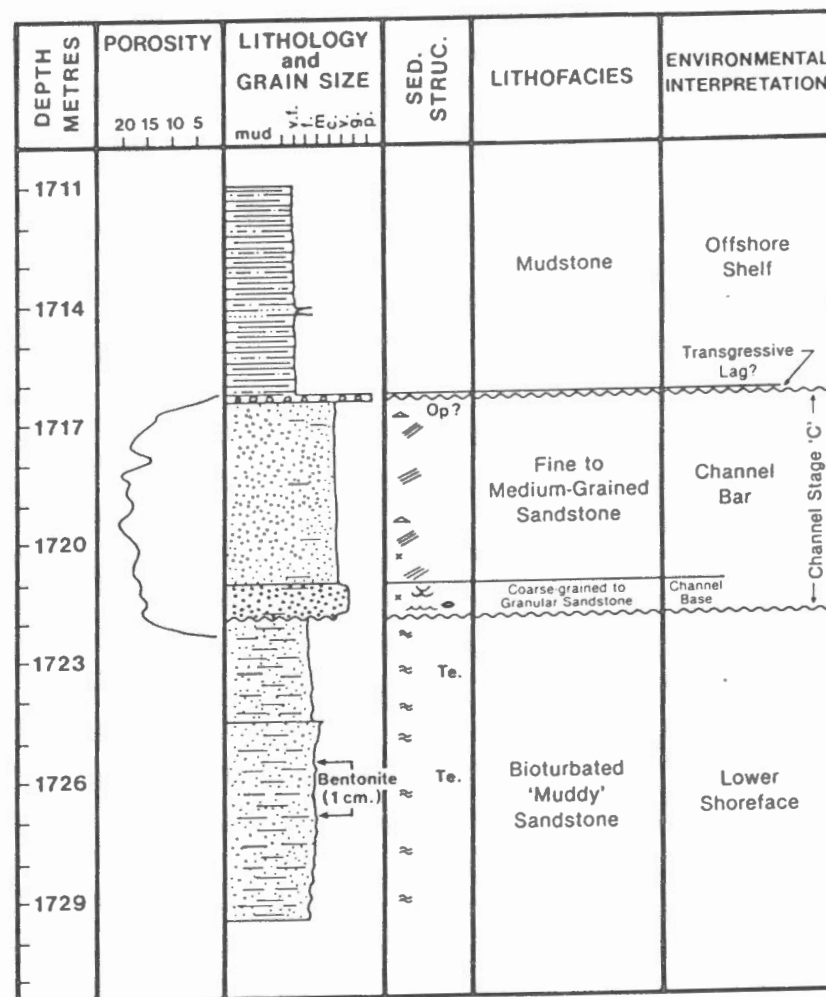


Figure 10. Interpretive lithologs of cores from the 8-11-46-4W5 and 8-20-46-3W5 wells. Note the contrasting facies sequences exhibited by the two well cores.

DEPTH METRES	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUC.	LITHOFACIES	ENVIRONMENTAL INTERPRETATION
	20 15 10 5				
		mud		Mudstone	Shelf Transgressive Lag?
1716			massive massive massive	Fine to Medium-Grained Sandstone	Marginal Channel Bar
1719			massive		
1722			Sk.	Fine-Grained Shaly Sandstone	Accreting Channel Margin Deposits with Scoured Base
1725			Sk.	Partially-Bioturb. Shaly Sandstone	
1728				Fine-Grained Shaly Sandstone	
1731			Te.	Bioturbated Muddy Sandstone	
1734				Bioturbated Sandy Mudstone	Offshore Transition
1737			Te.	Bioturbated Muddy Sandstone	Lower Shoreface
1740					

DEPTH METRES	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUC.	LITHOFACIES	ENVIRONMENTAL INTERPRETATION
1733				Mudstone	Offshore Shelf
1736			Te.	Bioturbated Muddy Sandstone	Estuarine Bay Fill
1739			Te.	Interbedded Shale-Sandstone	
1742			F to MG Sst		
1745			Sk. massive	Fine-Grained Shaly Sandstone	Accreting Channel Margin
1748			Te.	Bioturbated Sandy Mudstone	Offshore-Transition
1751			Te.	Bioturbated Muddy Sandstone	Lower Shoreface
1754					
1757					

- 16 -

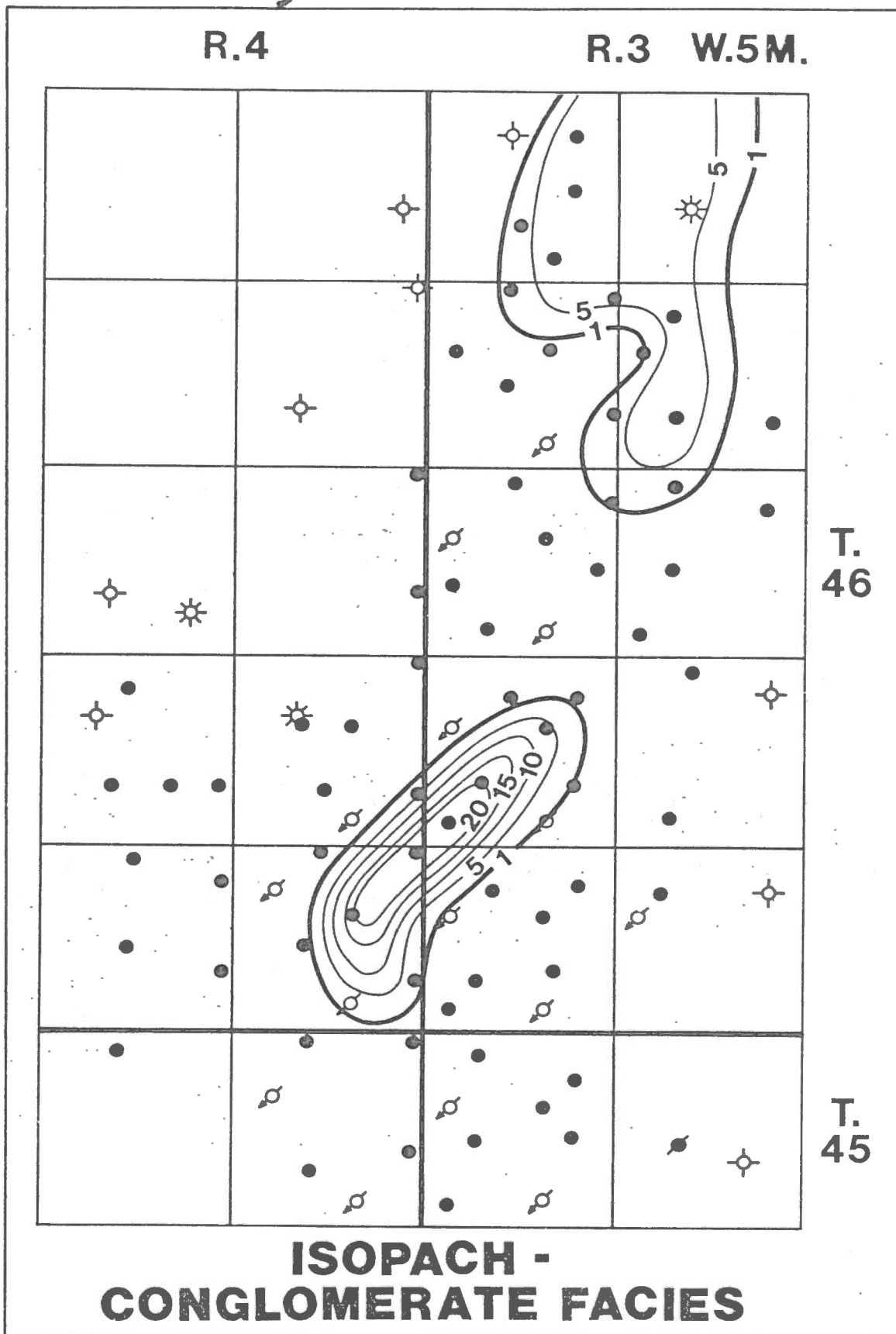


Figure 12. Isopach map of conglomerate facies. (Isopach line interval is 5 m, with the 1 m line also shown).

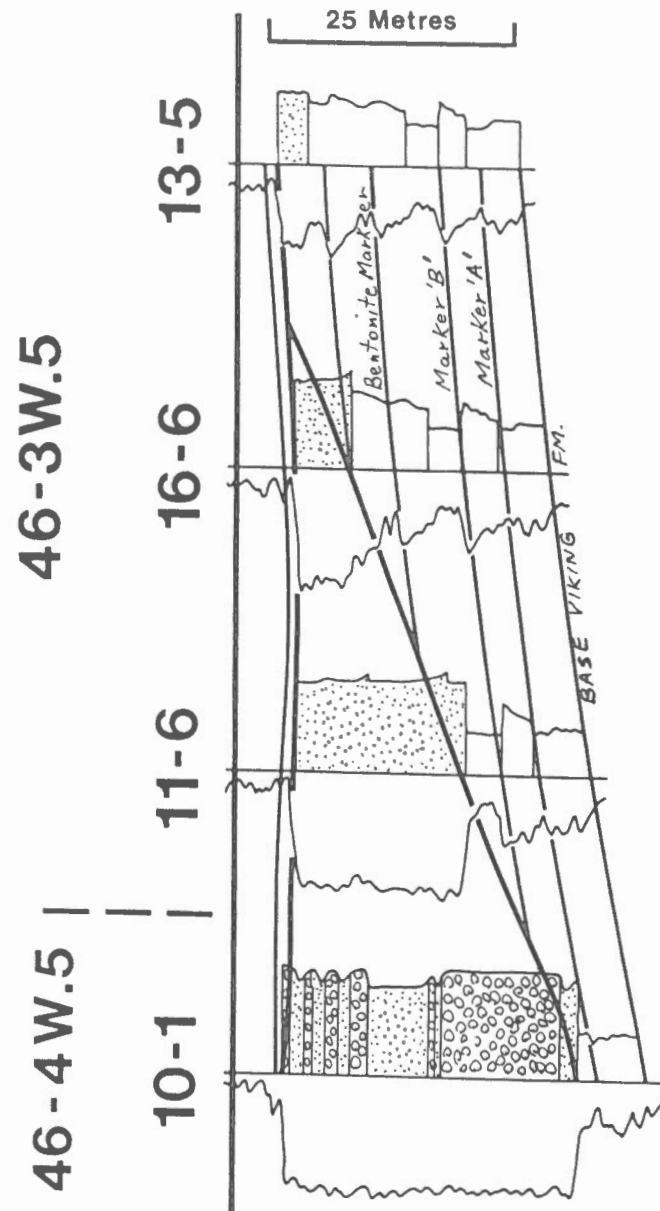


Figure 13. GR log-lithology cross-section from the eastern margin to the centre of the field, showing the unconformable relationship between the Crystal deposit and regional Viking facies. (Datum: Base of fish scales minus 30 m).

marginal-marine, subtidal channel affinities, but differentiation into discrete channel stages is difficult on the basis of core examination alone. Further variations in vertical facies succession occur on the western flanks of the sand body where the channel facies is characterized by sharply-based, fining-upward, progressively more shaly channel sandstone sequences, or by discrete shaly sandstones of the subtidal accreting channel margin interbedded with thick 'muddy' sequences of the estuary bay-fill facies, discussed in the next section.

Estuary bay-fill facies

This facies can be categorized into two broad groups, a lower estuarine 'muddy' subfacies and an upper shallow channel-bar sandstone subfacies. Subtidal estuarine 'muddy' deposits do not form any part of the reservoir body, whereas sandstones of the shallow channel-bar complex constitute the producing reservoir of the 'H' pool.

The muddy subfacies is characterized by thick units consisting of alternating, laminated to thin-bedded shale and sandstone (figs. 10, 11), which are often interbedded with bioturbated muddy sandstones similar to those occurring in the regional facies (Fig. 7). The estuarine 'muddy' subfacies, however, differs from the muddy sequences of the regional facies in both bedding aspect and trace-fossil assemblages. The difference between the two muddy facies is also clearly evident on gamma-ray well-log signatures (see cross-sections C-C', D-D', E-E', F-F'). Log signatures of the estuarine 'muddy' subfacies display an irregular, disordered deflection to the right, whereas the log signature of the regional facies displays a more ordered curve consisting of stacked funnel-shaped segments (Fig. 7).

The shallow channel-bar complex subfacies consists primarily of carbonaceous fine- to medium-grained sandstone, with root structures evident near the top of the subfacies in some cored sequences. This subfacies is sharply-based, displaying channel aspects at some localities, but in other areas only bar sandstones are present, often occurring in interbedding association with the estuarine muddy subfacies (Fig. 9).

The estuary bay-fill facies is present only on the western side of the Crystal field. Cored sequences in this region indicate that vertical successions of this facies vary substantially as follows. In the northern part of the field the estuary-bay facies consists only of the estuarine 'muddy' subfacies (Fig. 11). Towards the south sandstones of the shallow channel-bar subfacies are present, and separated from underlying channel facies by estuarine muddy subfacies (Fig. 10). Eastward toward the centre of the field estuarine 'muddy' subfacies thin and interbed with the shallow channel-bar subfacies (Fig. 9) which in turn becomes superimposed on top of reservoir channel facies. In the south part of the field sandstones of the shallow channel-bar complex amalgamate with sandstones of the channel facies and are virtually indistinguishable from the underlying channel sandstones on the basis of core examination alone.

Upper contact zone facies

Cored sequences through the upper contact of the Viking Formation indicate that all three major facies successions are overlain by a thin zone containing a similar sequence of facies (figs. 7-11). A very thin conglomeratic or granular layer invariably marks the top of each major facies, and this is interpreted to be a ravinement deposit formed during transgression by the lower Colorado sea. In the Crystal area, the thin conglomeratic lag is overlain either directly by lower Colorado shales, or by thin beds of two succeeding lithofacies, interlaminated sandstone-mudstone and coarse-grained to granular sandstone. The former lithofacies is thought to record deposition during the transition from shallow-marine to muddy shelf environments. The coarse-grained to granular sandstone lithofacies, which is trough crossbedded, is interpreted as a tidally-generated transgressive shelf-sand deposit.

Discussion

Lithofacies interpretations of cored sequences indicates that the Crystal Viking succession is characteristic of a marginal-marine depositional setting with the

combined association of facies representing some type of multistage estuarine tidal channel-bay complex. However, the stratigraphic relationships between the major facies, and the delineation of the equivalent channel stages within the channel complex, are not clearly evident from core examination alone. This is because of the superimposition of multiple channel-fill deposits, the lateral variation in lithofacies reflecting the various subenvironments within each channel deposit, and the interbedded association of successive channel-margin deposits with estuarine bay-fill facies to the west. The three-dimensional relationships of the facies and the delineation of equivalent channel events must be resolved through detailed correlative stratigraphy using well-log signatures supplemented by core lithofacies interpretations.

FACIES GEOMETRY AND DEPOSITIONAL RELATIONSHIPS

Stratigraphic relationships-regional Viking versus Crystal Viking

The log correlative section shown in Figure 13, and discussed previously, indicates that the eastern side of the Crystal Viking deposit is unconformable with underlying regional Viking deposits. The unconformable relationship of the Crystal Viking Channel facies with older regional facies is clearly evident in most cored sequences and mechanical log cross-sections. The east-west log stratigraphic cross-sections (B-B' to F-F') illustrate that this unconformity is not just local and due simply to channelization but more regional in nature, as elaborated upon below.

The lack of marker beds (particularly the bentonite marker) in the estuarine muddy subfacies, and the difference in gamma-ray log signature of this facies compared to the regional Viking facies, suggest that the estuary bay-fill facies is also unconformable with regional facies of the Viking Formation. Log correlations confirm this, with the bentonite marker, and markers A and B appearing in well-logs situated west of the Crystal field. The unconformity separates estuarine 'muddy' facies from regional 'muddy' facies on the western side, and channel facies from regional 'muddy'

facies on the eastern side (cross-sections C-C' to F-F'). In the centre of the field, the unconformable surface extends through the entire Viking Formation into the underlying Joli Fou Formation (cross-section C-C').

To summarize, based on log correlations supplemented by core examination, it can be demonstrated that: 1) the Crystal Viking deposits are younger than the regional Viking sequences, 2) estuarine bay-fill facies are laterally equivalent to the channel facies, and, 3) the estuary bay-fill and channel facies fill some pre-existing valley that was incised into older regional Viking deposits. Thus a major unconformity is present in the Viking Formation in the Crystal area.

Channel stages

A gamma-ray log mosaic of the entire field was constructed in order to delineate the major channel depositional events within the overall channel complex (Fig. 14). When the Crystal deposit is examined in this manner, the resolution and correlation of the channel facies into separate channel stages is possible (Fig. 15). The lateral relationship of each channel stage to the estuary bay-fill facies also becomes evident.

Four distinct units constitute the Crystal reservoir deposit. These are termed channel stage 'A', 'B' and 'C', and estuary-fill stage 'H'. Channel stages 'A', 'B' and 'C' correspond to three major estuarine channel-fill depositional events, and constitute the bulk of the reservoir, that is, the Crystal Viking 'A' pool. The sand body delineated as estuary-fill stage 'H', corresponds to the shallow channel-bar complex subfacies of the estuary bay-fill facies. It is given the term "stage 'H'" since it forms the reservoir for the Crystal Viking 'H' pool.

The deposits of the three channel stages exhibit a divergent pattern in the north, but throughout most of the field the channel-stage deposits are partially superimposed with a downcutting and scouring relationship clearly visible (Fig. 15, and GR cross-section mosaics). Southward, deposits of the three channel stages appear to amalgamate as one sand body, and separate channel stages are barely distinguishable either on logs or in core.

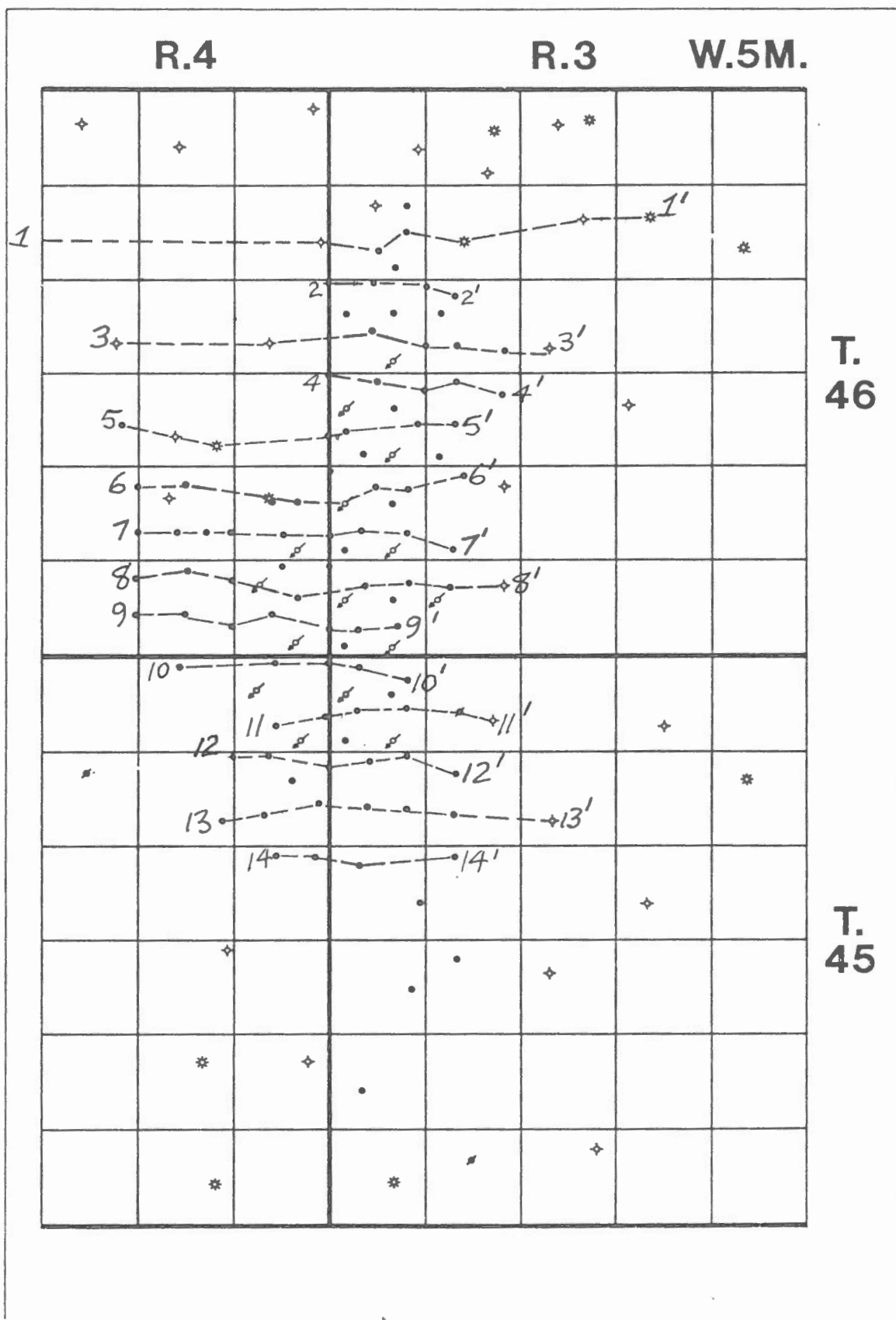


Figure 14. Location of GR log sections illustrated in the cross-section mosaics of North and South Crystal. (Cross-section mosaics are included as enclosures).

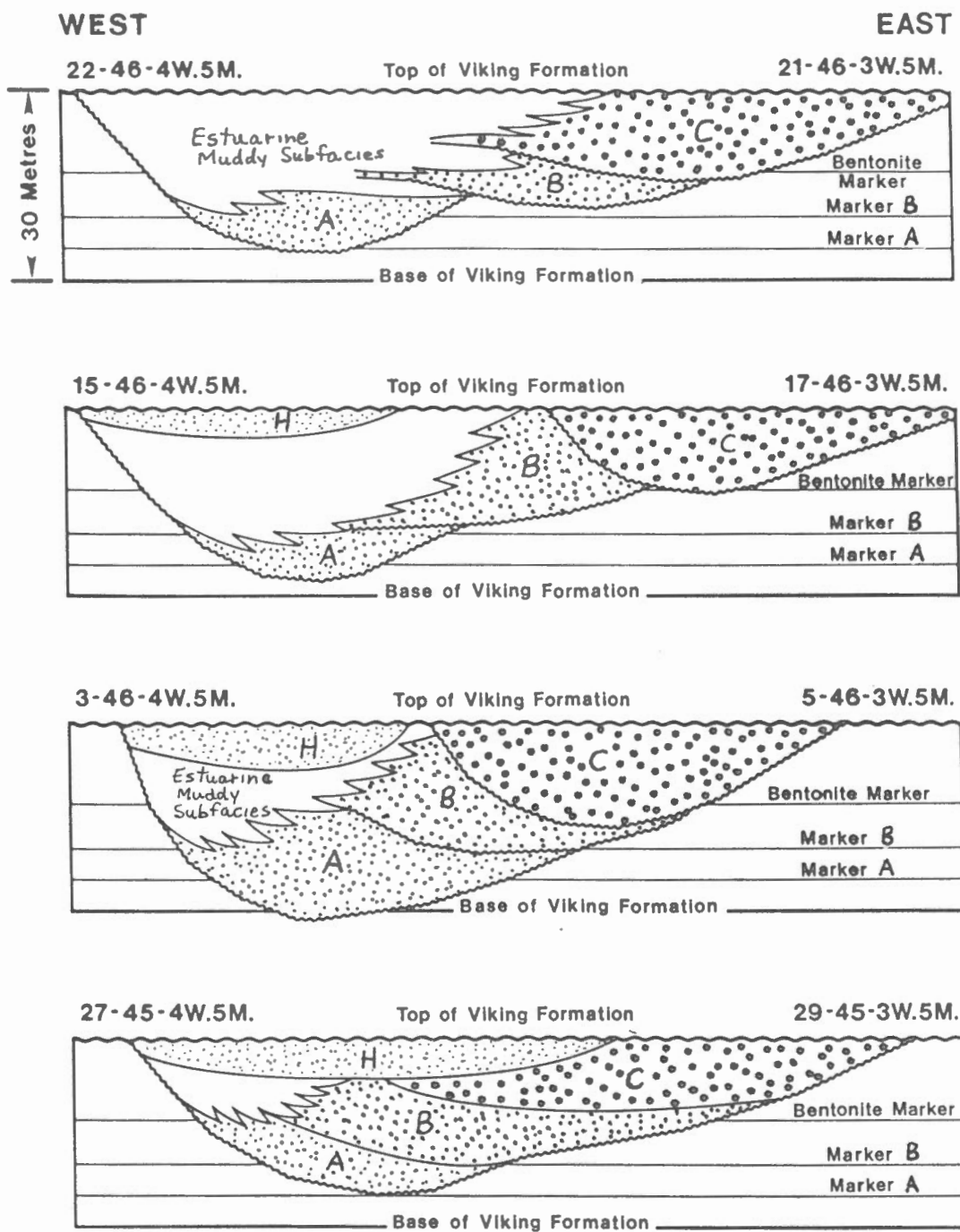


Figure 15. Schematic diagram interpreted from the GR cross-section mosaics, illustrating the varying relationship of the three channel depositional stages and the estuary bay-fill stage, between the north and south parts of the field.

An interbedding and gradational relationship is apparent on the western side of each channel deposit. This side would correspond to the laterally accreting margin of each channel stage, with the estuary bay-fill facies being the lateral facies equivalents of the channel sandstone-conglomerate deposits. The eastern side of each channel stage exhibits a sharp, truncated contact with adjacent facies, which may indicate that the concave or cutbank side of each channel stage was situated predominantly on the eastern side.

The regional distribution of the stage 'H' sand body (or shallow channel-bar complex) relative to the multistage estuarine channel deposits is clearly delineated in Figure 15. The stage 'H' sand is completely absent in the northern part of the field, but is present and thickens in a southward direction. As the stage 'H' sand thickens, it displays some channel characteristics, until it merges with estuarine channel deposits in the south part of the field, where it is difficult to differentiate from the underlying sandstone deposits.

DEPOSITIONAL MODEL

The Crystal Viking reservoir body is interpreted as a multistage tidal channel-fill complex deposited in a marginal-marine (estuarine) setting. The Crystal estuarine deposits are unconformable with underlying regional deposits of the Viking Formation, and the depositional model invoked here accounts for this unconformable relationship.

The Crystal Viking deposits are interpreted to have formed under the following sequence of events.

1. At the end of Joli Fou deposition a regressive stage began which corresponded to the initiation of Viking deposition. In the Crystal area this resulted in the deposition of a cyclic sequence of prograding shelf to shoreface sediment wedges, which have been referred to here as the "regional Viking facies".

2. Terminating this fluctuating but overall regressive event, was a major regional drop in sea level. This drop in sea level led to erosion and incisement of a

shallow but submarine linear valley into lower shoreface-inner shelf deposits of the regional Viking facies (Figs. 15, 16).

3. The resulting estuarine valley was then filled during a subsequent rise in sea level, with each of the channel depositional stages representing stillstands during an overall, and otherwise, continuously transgressive event. Each channel stage modified the estuary via erosion on the eastern margin, whereas the channel sand and conglomerate deposits intertongued laterally with estuary bay-fill sediments on the western side (figs. 15, 16).

4. The final estuary-fill episode is represented by the shallow channel-bar complex of estuary fill 'stage H'. It is possible this complex may be representative of secondary channel or tidal-deltaic deposits which are genetically related to uppermost channel stage 'C' deposition.

5. After the estuary filled, deposition may have continued across the area. This is difficult to ascertain because of an ensuing rapid transgression of the lower Colorado sea which eroded the uppermost strata, leaving a thin, conglomeratic lag deposit across the entire area.

The depositional model proposed here is similar to the model postulated by Weimer (1983, 1985) for the equivalent Muddy J sandstone in the Denver Basin. In the Weimer model, however, the depositional setting for the Muddy J is interpreted as alluvial plain, as opposed to the marginal-marine setting for the Crystal Viking deposits as postulated here.

DEPOSITIONAL CONTROLS ON RESERVOIR CHARACTERISTICS

The Crystal reservoir sand body has been shown to consist of four major sandstone-conglomerate units, designated as channel stages 'A', 'B' and 'C' and estuary-fill stage 'H'. The three-dimensional distributions of each of the units relative to one another appears to bear directly upon the reservoir continuity and performance trends

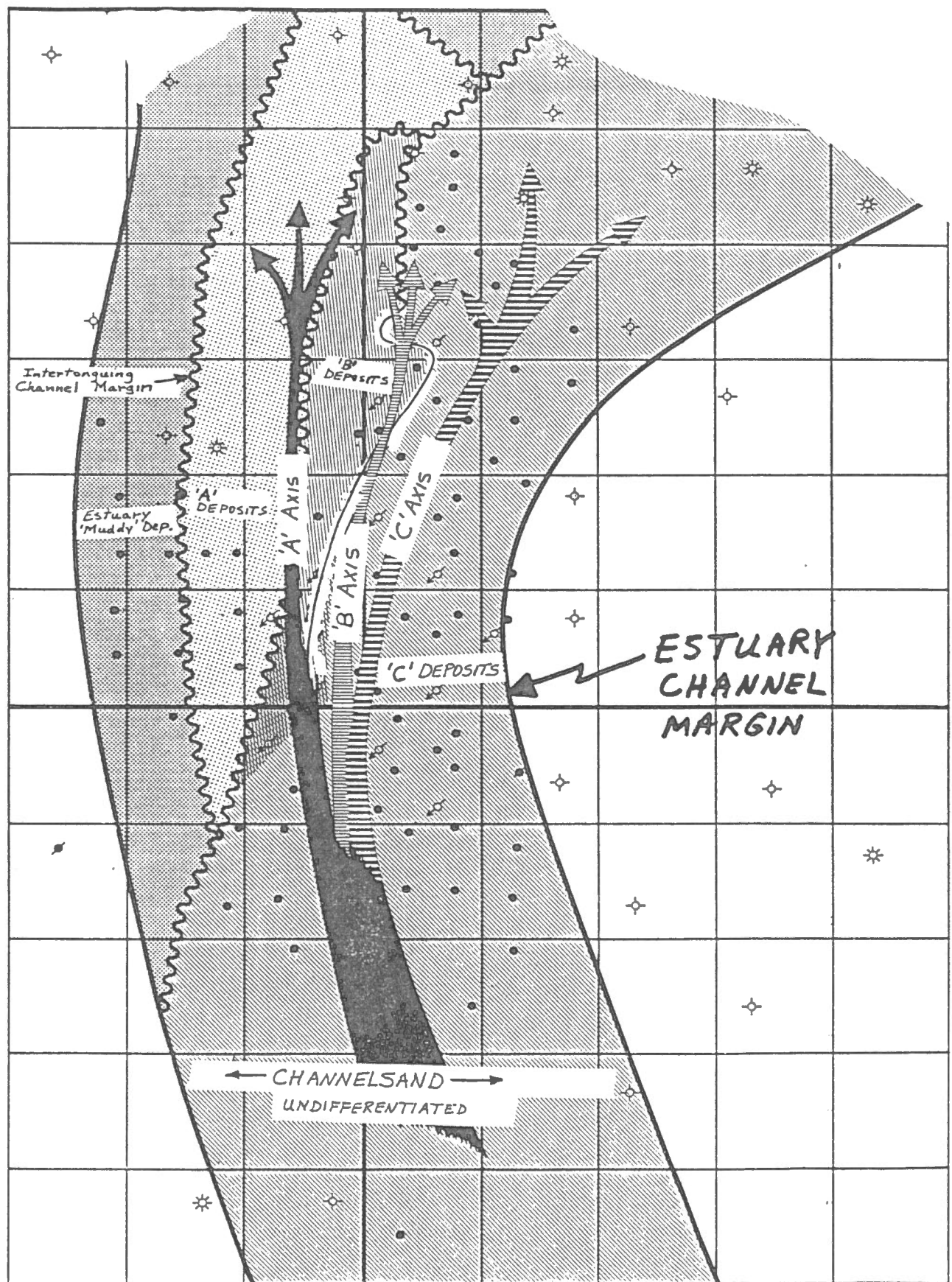


Figure 16. Schematic of the depositional model proposed for the Viking deposits in the Crystal area.

exhibited by the producing field. That is, the in-field variability in net-pay thicknesses, and performance trends of specific producing wells or groups of wells, and the occurrence of two hydrodynamically separated oil pools, is a function of the degree of amalgamation, superimposition and divergence of the four reservoir depositional units. When the deposits of specific channel stages are mapped separately, the relationships between the facies geometry and reservoir characteristics is readily apparent. Some of these relationships are elaborated upon below.

1. The most obvious example of depositional control on reservoir characteristics in the Crystal field, is the Crystal Viking 'H' pool. When mapped as a separate entity from the total reservoir sand body, the distribution of the shallow channel-bar complex subfacies (stage 'H' sand) corresponds to the distribution of the 'H' pool (figs. 5, 17). The line of separation of the stage 'H' sand from channel-stage deposits virtually marks the lower limit of water-free oil production in the 'H' pool. The divergence of stage 'H' sands from the main reservoir body by impermeable estuary muddy subfacies in a northward, or regionally updip direction, created favourable conditions for the occurrence of a secondary oil-pool that is isolated from the main oil-bearing reservoir.

2. The gross reservoir isopach (Fig. 3) indicates the occurrence of two linear thickening trends toward the north part of the field. The thickening trend in Tp. 46, Rg. 4W5 is a reflection of both the stage 'H' reservoir sand, and the channel stage 'A' deposit which diverges toward the north away from the main channel complex (Fig. 15). Fine-grained shaly sandstone and partially bioturbated shaly sandstone lithofacies, both of poor-reservoir quality, comprise the channel stage 'A' deposits in this area. These lithofacies reflect the intertonguing and "shaling-out" of channel stage 'A' sands toward the west and northwest margin of the estuarine valley, as shown in the cross-section mosaics (see enclosures). Such sands should not be expected to form part of the 'A' pool reservoir, and it is evident that they do not by the

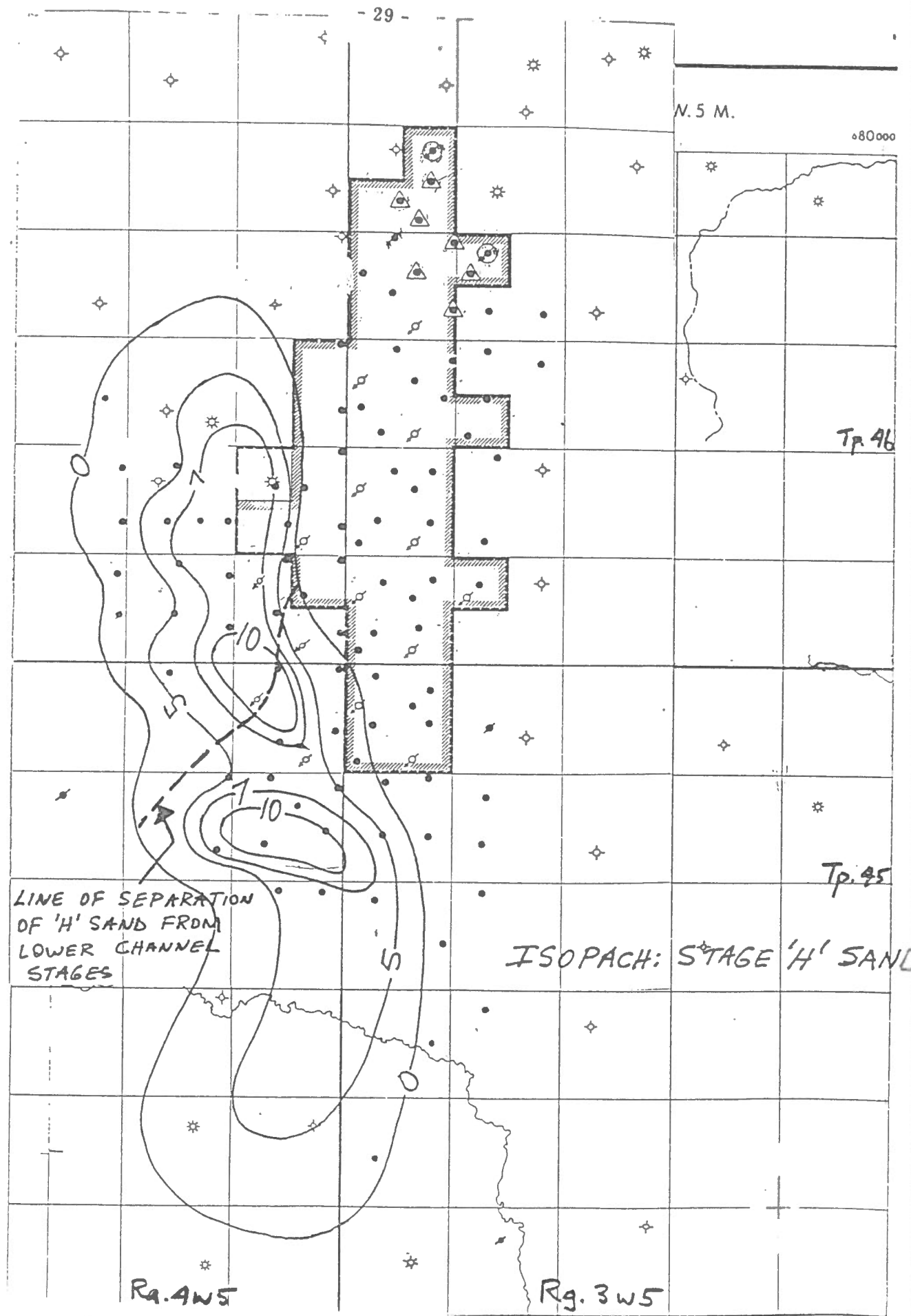


Figure 17. Isopach map of stage 'H' sandstone (shallow channel-bar complex subfacies of the estuary bay-fill facies). This sand deposit forms the reservoir of the 'H' pool. (The zero, 5, 7 and 10 m isopach lines are shown).

remarkable correspondence between the isopach of Channel 'B' and 'C' deposits and the limits of the 'A' pool (figs. 4, 18). Channel stage 'A' deposits, however, do contribute to the net-pay thickness of the 'A' pool in the central area of the field where they are extremely thick and partially superimposed by deposits of channel stages 'B' and 'C'.

3. The deposits of highest-reservoir quality appear to be those of channel stage 'C', both in core and on logs. When the channel stage 'C' deposit is isopached separately from the other units (Fig. 19), there is a definite correspondence between the distribution of the stage 'C' deposit, and the "sweet-zone" of the reservoir (Fig. 20). Thus, of the four distinct reservoir units, stage 'C' should be expected to have the highest productive capability.

4. Maximum reservoir continuity trends between producing wells of the 'A' pool should be aligned north-south, corresponding to the alignment of specific channel-stage deposits. Conversely, permeability barriers might be expected to occur between wells oriented in an east-west direction from each other. For example, in section 4-4' and 5-5' of the cross-section mosaic of North Crystal, the 16-13, 14-18, 8-13 and 5-18 wells penetrate shaly sandstone lithofacies or more shaly-upward (fining-upward) sequences situated at the accreting margins of channel stage 'B'. These wells penetrate poor-quality reservoir sands, in contrast to the 16-18 and 8-16 wells, which contain porous channel bar or axial channel facies of stage 'C'. Poor reservoir communication between the two sets of wells should be anticipated. Preliminary results from a water-injection well situated in the stage 'B' marginal channel deposits in section 18 confirm this. Wells situated in marginal channel facies of stage 'B' immediately flooded-out, while there was no response to the injection in the producing wells to the east which penetrate porous channel stage 'C' deposits.

It is obvious from the above examples that depositional controls on facies distributions and reservoir geometry govern, in large part, the reservoir continuity and performance trends of the Crystal Viking field. Thus, it is apparent that facies

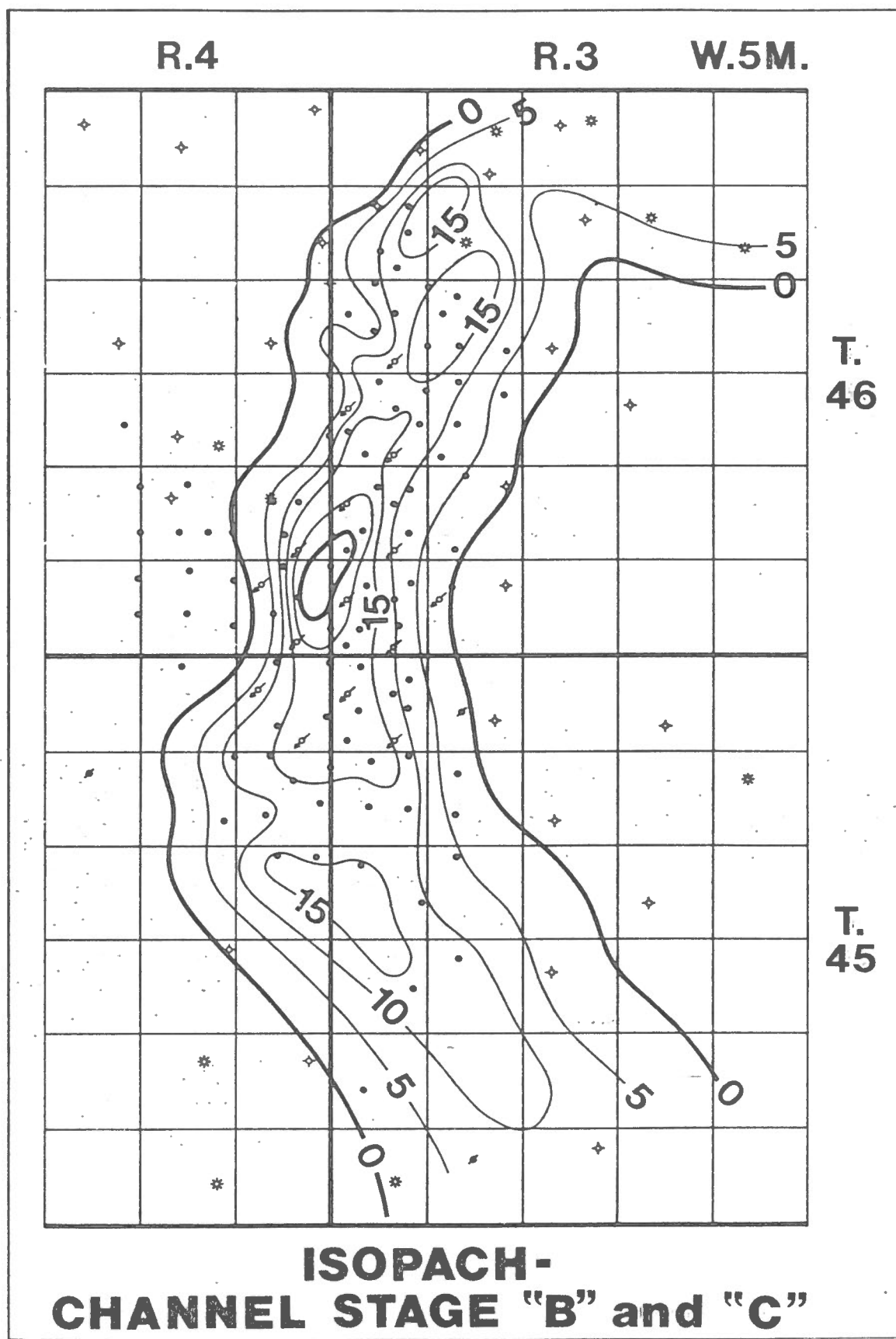


Figure 18. Isopach map of the total thickness of channel stage 'B' plus 'C' deposits (isopach line interval - 5 m).

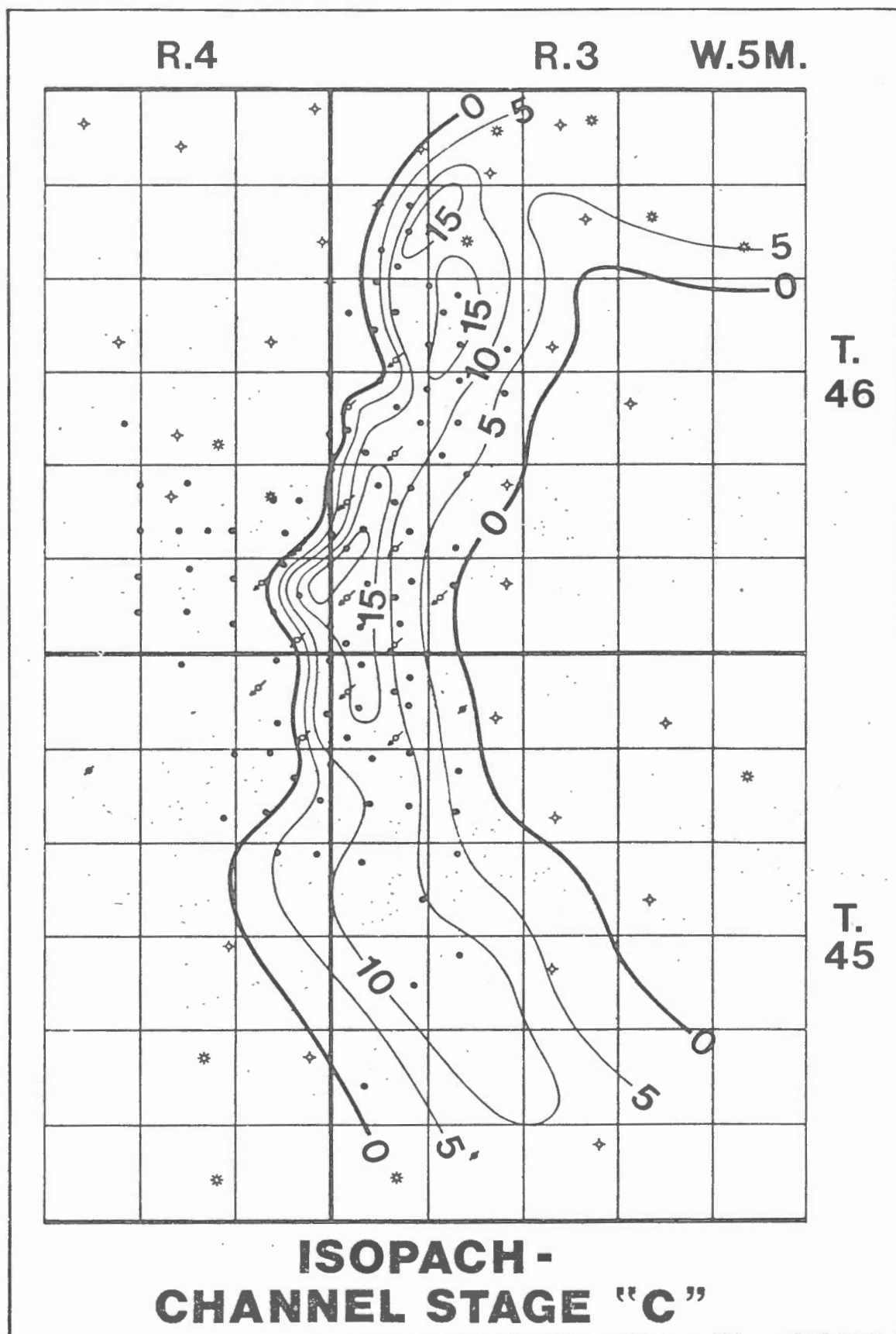


Figure 19. Isopach map of channel stage 'C' deposits (isopach line interval - 5ⁿ).

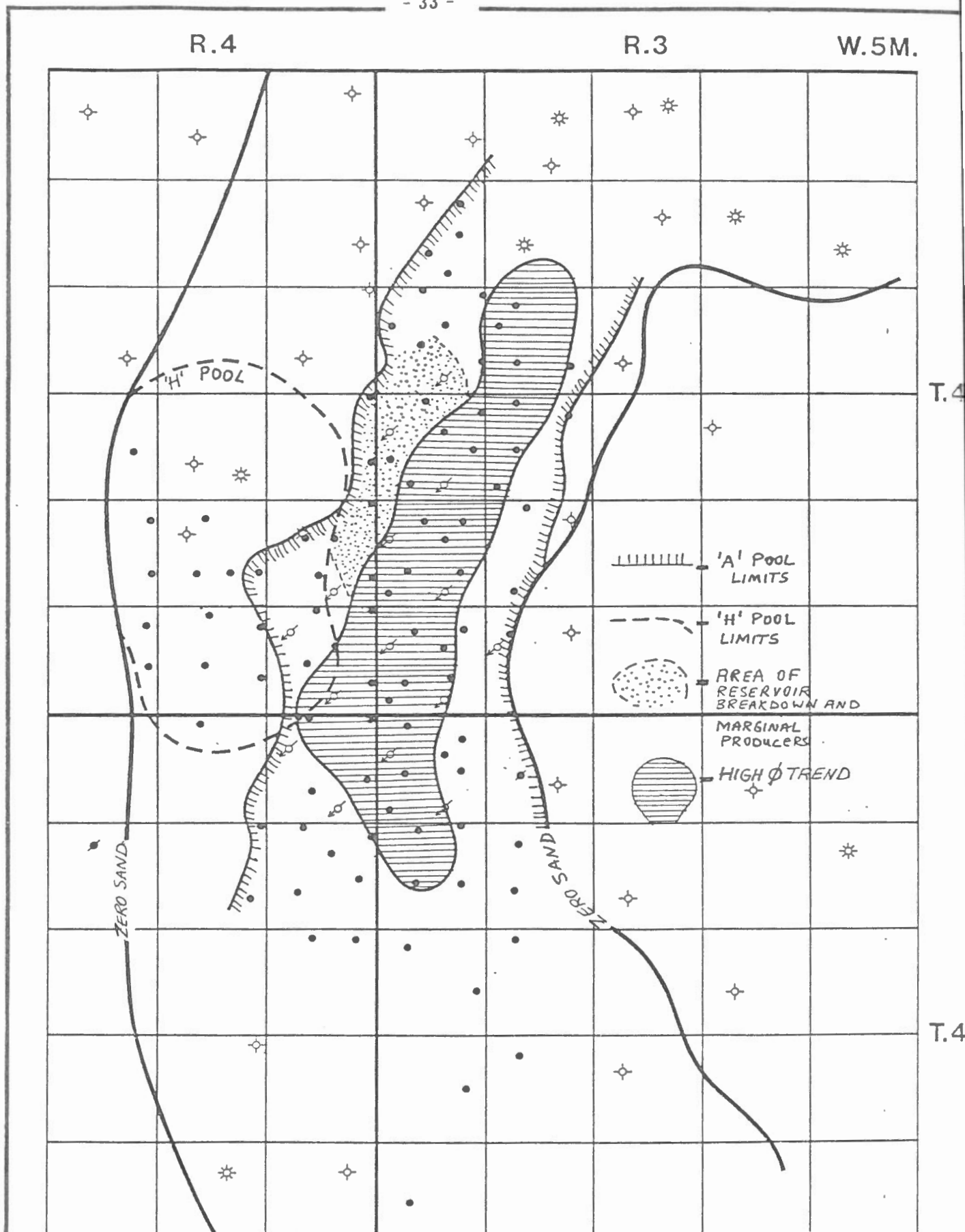


Figure 20. Schematic map highlighting the principal reservoir trends that are governed by depositional factors.

distributional trends and channel stage geometries should be taken into account during both the planning and evaluation phases of any secondary waterflood scheme.

SUMMARY AND CONCLUSIONS

1. The Viking Formation in the Crystal field is comprised of a linear, north-south trending, sandstone-conglomerate deposit ranging up to 30 m thick. This contrasts sharply with other producing Viking fields in south-central Alberta, which are generally elongated in northwest-southeast to north northwest-south southeast directions and have reservoir zones in the order of 2 to 10 m thick.

2. The Viking facies sequence situated at the margins of the Crystal field is typical of the regional Viking facies succession, which is characterized by a series of stacked, coarsening-upward sequences consisting of bioturbated sandy mudstone to bioturbated muddy sandstone. These stacked sequences are interpreted to represent cyclic progradation of the lower shoreface sediment wedge, with the sporadic occurrence of 'clean' sandstone at the top of the cyclic sequence being indicative of shoreface bar development.

3. Facies sequences within the Crystal field differ markedly from the regional Viking facies succession. Detailed core examination indicates that the Crystal deposits consist of two major facies, channel and estuary bay-fill, with the combined association of facies representing an estuarine tidal channel-bay complex. Multiple superimposed channel-fill deposits comprise the linear reservoir sand body, which is unconformable with underlying and adjacent regional Viking facies.

4. Log stratigraphic correlations clearly indicate that not only is the channel facies unconformable with underlying regional facies, but that estuary bay-fill facies and channel facies are lateral equivalents. Further, both facies fill some pre-existing valley that was incised into older regional Viking deposits. Thus a major unconformity occurs within the Viking Formation in the Crystal area.

5. Detailed 'in-field' correlations indicate that the reservoir sand body is comprised of four depositional units, corresponding to three successive and partially-superimposed channel-fill stages (A, B and C) and a final estuary-fill stage (H). Deposits of channel stages 'A', 'B' and 'C' constitute the bulk of the reservoir and form the Crystal Viking 'A' pool. The stage 'H' sand is the uppermost unit of the estuary bay-fill facies and forms the reservoir for the Crystal Viking 'H' pool.

6. The multistage channel depositional events are thought to be a record of progressive estuarine valley fill under conditions of rising sea level, with each channel depositional stage representing a stillstand during an overall transgressive event. Each channel stage modified the estuary on the eastern side while subtidal estuary bay-fill deposits accumulated, as facies equivalents to the channel-fill deposits, on the western side. The final estuary-fill episode is recorded in the form of shallow channel-intertidal bar deposits represented by the reservoir sandstones of the 'H' pool.

7. The occurrence of two separate pools ('A' and 'H' pools), and the variability in reservoir capacity, continuity and performance trends of the 'A' pool, can be shown to be directly controlled by depositional factors. The proposed depositional model readily accounts for the occurrence of the 'H' pool as a discrete reservoir separated from the main oil-bearing 'A' zone pool. The highly productive wells of the 'A' pool correspond to specific channel stage deposits, or are situated in the areas where channel deposits of successive stages are highly superimposed. In contrast, marginally productive wells and poor reservoir communication between producing wells, occur where the different channel-stage deposits are shown to diverge.

8. Since the facies distributional trends and channel stage geometries can be demonstrated to account for specific continuity and performance trends exhibited to date by the producing field, it is obvious that such depositional controls must be taken into account during both the planning and evaluation phases of any secondary recovery scheme.

REFERENCES

- Alho, L.O., Gray, F.F., and Kassube, J.R. 1977. The Provost Viking "C" oil pool, east-central Alberta. *Bulletin of Canadian Petroleum Geology*, v. 25, p. 396-409.
- Beaumont, E.A. 1984. Retrogradational shelf sedimentation: Lower Cretaceous Viking Formation, Central Alberta. *In*: Tillman, R.W. and Seimers, C.T. (Eds.), *Siliciclastic Shelf Sediments*. Tulsa, Society of Economic Paleontologists and Mineralogists, Special Publication No. 34, p. 163-178.
- Koldijk, W.S. 1976. Gilby Viking 'B': a storm deposit. *In*: Lerand, M.M. (ed.). *The Sedimentology of Selected Clastic Oil and Gas Reservoirs in Alberta*. Calgary, Canadian Society of Petroleum Geologists, p. 62-77.
- Lerand, M.M. and Thompson, D.K. 1976. Provost field - Hamilton Lake pool. *In*: Clack, W.J.F. and Huff, G. (Eds.), *Joint Convention on Enhanced Recovery, Core Conference*. Calgary, Canadian Society of Petroleum Geologists - Petroleum Society of Canadian Institute of Mining, p. B1-B34.
- Love, A.M. 1955. The Joffre oil field: geology and development. *Oil in Canada*, v. 7, no. 33, p. 20-24, 26.
- Love, A.M. 1960. Joffre field, Viking pool. *In*: *Gas Fields of Alberta*. Calgary, Alberta Society of Petroleum Geologists, Reference Volume, p. 140-141.
- Reinson, G.E. 1984. Variable facies sequences in cores of the Lower Cretaceous Viking Sandstone, south-central Alberta. *In*: *Research Symposium, Sedimentology of Shelf Sands and Sandstones, Program and Abstracts*. Calgary, Canadian Society of Petroleum Geologists, p. 87.
- Reinson, G.E., Foscolos, A.E., and Powell, T.G. 1983. Comparison of Viking sandstone sequences, Joffre and Caroline fields. *In*: McLean, J.R. and Reinson, G.E. (Eds.), *Sedimentology of Selected Mesozoic Clastic Sequences*. Calgary, Canadian Society of Petroleum Geologists, Corexpo '83, p. 101-118.
- Reinson, G.E. and Foscolos, A.E. (in press). Trends in sandstone diagenesis with depth of burial, Viking Formation, southern Alberta. *Bulletin of Canadian Petroleum Geology*, v. 34.
- Tizzard, M.B. and Lerbekmo, J.F. 1975. Depositional history of the Viking Formation, Suffield area, Alberta, Canada. *Bulletin of Canadian Petroleum Geology*, v. 23, p. 715-752.
- Weimer, R.J. 1983. Relation of unconformities, tectonics, and sea level changes, Cretaceous of the Denver Basin and adjacent areas. *In*: Reynolds, M.W. and Dolly, E.D. (Eds.), *Mesozoic Paleogeography of the west-central United States, Rocky Mountain Paleogeography Symposium 2*. Denver, The Rocky Mountain Section, Society of Economic Palaeontologists and Mineralogists, p. 359-376.
- Weimer, R.J. 1985. Relation of unconformities, tectonics, and sea level changes, Cretaceous of western interior, U.S.A. *In*: Schlee, J.S. (Ed.), *Interregional Unconformities and Hydrocarbon Accumulation*. Tulsa, American Association of Petroleum Geologists, Memoir 36, p. 7-36.

+

APPENDIX I







Core Lithologs

CORE LITHOLOG SYMBOLS







BEDDING STRUCTURES

No Symbol - MASSIVE; STRUCTURELESS





LAMINATIONS









	HORIZONTAL PARALLEL
	FAINT PARALLEL
	DISCONTINUOUS, WISPY
	INCLINED PARALLEL
	WAVY PARALLEL
	GENTLY CURVILINEAR

CROSS - STRATIFICATION

	CURRENT RIPPLES
	WAVE RIPPLES
	UNDIFFERENTIATED, COMBINATION RIPPLES
	RIPPLE - DRIFT
	TROUGH CROSS - BEDS
	PLANAR CROSS - BEDS

MISCELLANEOUS







	GRADED BEDDING
	INVERSE GRADED BEDDING
	LENSES, LENTICULAR BEDDING
	FLASER BEDDING

	CONTORTED, CONVOLUTE BEDDING (LAMINATIONS)
	DISRUPTED BEDDING; MICROFAULTS, FRACTURES, ETC.
	SLUMP, FLOW STRUCTURES
	SOLE MARKS; GROOVES, FLUTES, SCRATCHES, LOADCASTS.
	RIP - UP CLASTS
	MUD CRACKS
	STYLOLITES
	IMBRICATION

MISCELLANEOUS SYMBOLS

	BENTONITE LAYERS; THICKNESS
	FERRUGINOUS; NODULES, BANDS, CONCRETIONS
	PLANT, WOOD FRAGMENTS
	CARBONACEOUS PARTINGS PARTICLES
	ROOTLETS
	COAL, LENSES, STREAKS, PARTINGS
	BIOTURBATED
	EXTENSIVELY BIOTURBATED; CHURNED, MOTTLED
	BURROW; VERTICAL, HORIZONTAL
	SHELLS
	IDENTIFIABLE TRACE FOSSIL
	LAMINATED TO BIOTURBATED











LITHOLOGY

-  — CONGLOMERATE
-  — COARSE-GRAINED TO GRANULAR SANDSTONE
-  — VERY FINE TO MEDIUM-GRAINED SANDSTONE
-  — SILTSTONE
-  — SHALE
- xx — FERRUGINOUS NODULES, BANDS, CONCRETIONS
-  — CLAY CLAST

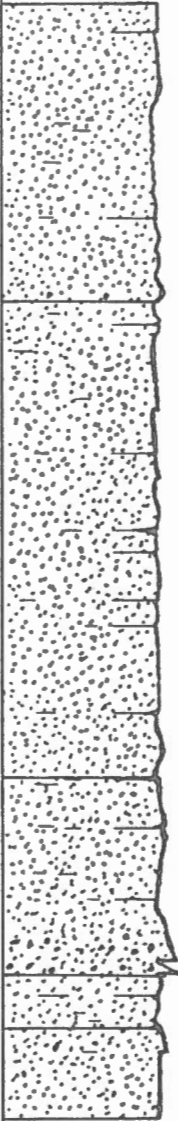


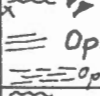
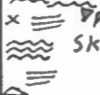



TRACE FOSSILS

- Te. — TERESELLINA Pl. — PLANOLITES
- Sk. — SKOLITHOS Pal. — PALEOPHYCUS
- Op. — OPHIOMORPHA Tc. — TEICHICHNUS

STRUCTURES

-  — LOW-ANGLE CROSSBEDDING
-  — TROUGH CROSSBEDDING
-  — PARALLEL LAMINAE
-  — WAVY, LENTICULAR LAMINAE
-  — WAVE RIPPLES
-  — CURRENT RIPPLES
-  — SOLE MARKS
-  — BIOTURBATED
-  — EXTENSIVELY BIOTURBATED, CHURNED
-  — VERTICAL BURROW

WELL NAME Westcoast et al Crystal (4" diameter unslotted)LOCATION 14-19-45-3 W5CORE INTERVAL 1768-1786 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1768						light olive-gray	Shallow Channel-Bar Complex
1771					 Op. Op.	irregular 2cm thick mudstone nodular layers	
1774					 Sk.	light olive-gray	Channel Margin Bar
1777					 cyclic fining-upward, laminated to rippled units (30 to 90 cm thick)		
1780					 Fe-mudst. nodular band (1cm thick) Fe-mudst. clasts		
1783					 light olive-gray wood fragments		Channel
1786						light olive-brown	STAGE 'B'



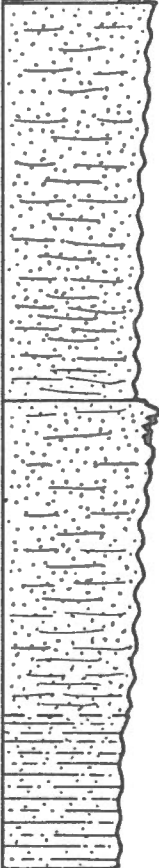

ESTUARY-FILL
STAGE 'H'

CHANNEL STAGE 'C'

(Rec 18.0m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1763							mud		dark gray interlam mudst.-sst. light gray	SHELF MUDSTONE	
1766									light gray Fe-mudst rip-up clasts		
1769									light gray light olive-gray series of fining-up x-lam. to rippled units with sh. partings at top		
1772									light gray 80% sst. mottled light and dark gray 45% sst. micro-mottled olive and dark gray		
1775											
1778											
1781									dark gray		

WELL NAME H.D. Hoadley (10cm diameter, unslotted)LOCATION 11-26-45-3W5 CORE INTERVAL 1726-1744

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE <div>v.f. f. m. c. g. d. mud</div>	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
1726						black	SHELF MUDSTONE (LOWER COLORADO)	
1729					X - - O Btr.	salt and pepper dark gray	Coarse-gr. to Gran. Sst. interlam. sst.-Mudst.	
1732					≈ ≈ Te. ≈ ≈ ≈	light olive-gray, mottled mottled medium to dark olive gray	Bioturbated 'Muddy' Sandstone	Coarsening-Upward Inner Shelf to LOWER SHOREFACE CYCLES
1735			≈ Te. ≈ Te. Te.		whitish-gray and olive-gray mottling, abundant large <u>Terebellina</u> near top	Bioturbated 'Muddy' Sandstone		
1738			≈ ≈ ≈		mottled light and dark gray			
1741			≈ ≈ ≈			Bioturb. 'Sandy' Mudst.		
1744								

WELL NAME Dumper Crystal (10cm diameter ; 5196622)

LOCATION 6-29-45-3W5 CORE INTERVAL 1771-1789.5 (Rec 18.5)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1771						dark gray	LOWER COLORADO SHALE
1774						n.s. Salt + pepper	C. gr. to gran. sst. interlem. sh.-sst.
1777						light olive-gray	Fine-to Medium-Grained Sst. Channel Margin
1780						light/dark gray micromottling	Bioturb. 'Sandy' Mudst. Inner Shelf
1783						mottled light and olive-gray	LOWER SHOREFACE
1786						60% sst.	
						45% sst.	
						mottled light and dark gray	
1789						55% sst.	Bioturbated 'Muddy' Sandst.
						40% sst.	

WELL NAME Bumper Crystal (10cm diameter; unslashed)LOCATION 14-29-45-3 W5

CORE INTERVAL

1775-1778 (Rec 2.3m)

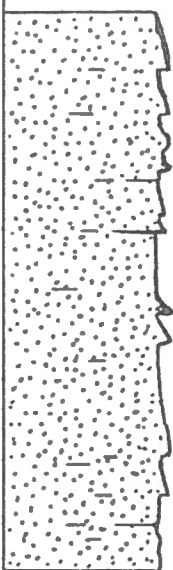
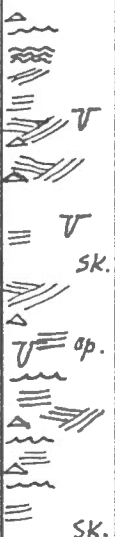
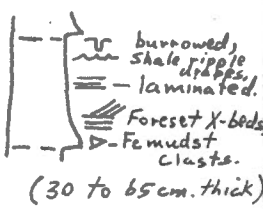
1778-1796 (Rec 18.0m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE mud v.f. v.l. E.C. v.g. d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1775							mud		dark gray	Shelf Mudstone	
									-----	Transition	
1778								x ≡ L	light olive-brown, high ϕ	CHANNEL STAGE 'C'	
								≡≡≡ Pal.	light olive-gray shaly partings	Shoreface Bar	
								≡≡≡ 4.5cm	-----	Transition	
1781								~ ~ ~	mottled light olive-gy. and dark gy.	Lower Shoreface	
								x ≡ T 5k.	light olive-gray 80% sd.	Bioturbated 'Muddy' Sandsstone	LOWER SHOREFACE
1784								~ ~ ~ Te.	mottled light and dark gray		
								~ ~ ~	40% sd.		
1787								~ ~ ~ 8 1.5cm	60% sd.		
								~ ~ ~ 8 1.5cm	-----		
1790								~ ~ ~	30% sd.		
								~ ~ ~	-----	Bioturb. 'Sandy' Mudst.	TRANSITION
1793								~ ~ ~	dark gray		
								~ ~ ~	mottled light and dark gray	Bioturb. 'Muddy' Sst.	LOWER SHOREFACE
1796								~ ~ ~			

WELL NAME WELL 61 41 CRYSIA 1 (100m diameter) JUNE 1960

LOCATION 6-30-45-3W5

CORE INTERVAL 1796-1805 (Rec 9.0m)

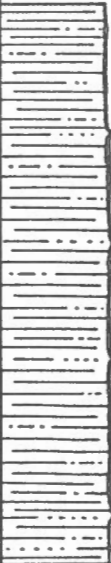
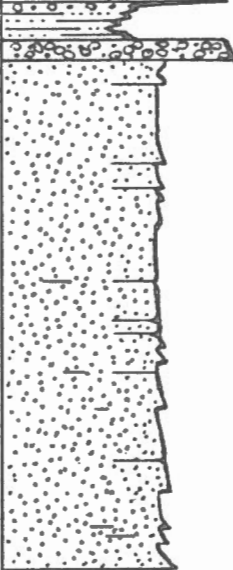
METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20 15 10 5	v.l. v.f. E c v.c. g. p. mud				
1796						light gray cycles as: 	FINE- TO MEDIUM-GRAINED SANDSTONE	CHANNEL STAGE 'C'
1799								
1802								
1805								

CORE INTERVAL 1785-1801.75

(Rec 15.95m)

METRES DEPTH FEET		OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE <div>v.f. E.C. v.g. d. mud</div>	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1785							light gray-brn	Accreting Channel Bar Deposits CHANNEL STAGE 'C'
1788							light gray-brown Seven cyclic units as 6-30 well, all marked by scoured base with Fe-clay clasts	
1791							light gray	
1794							light gray with salt & pepper layers, cyclic interlayers: light gray, salt & pepper, m. to c. gr.	
1797							N.S. micro- mottled dark and light gray, very f. gr. to silty	
1800							dark gray	Channel Base
1803								STAGE 'B'
								INNER SHELF TO LOWER SHOREFACE

WELL NAME Chietco et al Crystal (10cm diameter; unslabbed)LOCATION 16-30-45-3W5CORE INTERVAL 1781-1799.2 (Rec 18.2)

METRES DEPTH FEET	OIL STAIN CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud s. f. E. G. v. G. D.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
1781				D	dark gray	SHELF MUDSTONE LOWER COLORADO	
1784							
1787							
1790							
1790				tr. op. U	interlam. Sst.-Mudst. Congl.	Transition Trans. Lag?	Fine- to Medium-Grained Sandstone Channel Bar Depos. CHANNEL STAGE 'C'
1793					buff-gray		
1793					Cyclic units: fining-up x-bedded → ripple or planar laminated → bioturbated (30 to 100cm. thick)		
1796							
1799							

WELL NAME WES/COAST 1 el al crystal (10cm diameter; unslotted)LOCATION 2-31-45-3W5

CORE INTERVAL

1790-1799 (Rec 9.0m)
1799-1814 (Rec 15.0m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE mud v.f. E.C. v.c. g.p.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5						
1790										dark gray	conglomeratic lag FINE- TO MEDIUM-GRAINED SANDSTONE Accreting Channel Bar Deposits CHANNEL STAGE 'C'	
1793										light olive-gray		
1796									sk.			
1799									sk. Pal.	light olive-gray		
1802										Cyclic units: x-bedded to wavy and ripple -laminated.		
1805										Salt and pepper sst. light olive-gray, good	C.gr. - Grain Channel base Channel Stage 'B'	
1808										mottled light/dk.gr. 45% sd. 20% sd.	Bioturb. 'Muddy' Sst.	LOWER SHOREFACE
1811										dark gray	Bioturb. 'Sandy' Mudst.	OFFSHORE TRANS.
1814										mottled light and dark gray	Bioturb. 'Muddy' Sandst.	LOWER SHOREFACE

LOCATION 8-31-45-3 W5 CORE INTERVAL 1781-1786
1786-1804

METRES DEPTH	FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	SAMPLES
				20	15	10	5					
1781										Dark gray	LOWER COLORADO (SHELF MUDSTONE)	5A
1784										Laminated light and dark gray	interlam. sst.-Mudst.	5B
1787										Light olive-gray		5C
1790										50 to 150 cm. thick cyclic units of		5D
1793										Mottled light and dark gray		5E
1796										60% sand (f.g.)		5F
1799										50% sand		5G
1802										25% Sand		5H
										Micromottled dark gray Sandstone		5I
										Mottled light olive gray and medium gray		
										65% sand (u.f. to f.g.)		

WELL NAME Westcoast et al CrystalLOCATION 10-31-45-3W5CORE INTERVAL 1778-1796.2 (Rec 18.2)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1778				mud		dark gray	OFFSHORE SHELF
1781						altern. light/dk. gray	SHELF SAND TRANSITION TRANS. LAG
1784						light olive-gray	FINE- TO MEDIUM-GRAINED SANDSTONE CHANNEL STAGE 'C'
1787						stacked channel bar units	
1790							
1793							Stage 'B'
1796						N.S. mottled light/dk. gray.	LOWER SHOREFACE

WELL NAME WESTCOAST of a crystal (10cm diameter; unslabbed)

LOCATION 12-31-45-3w5

CORE INTERVAL

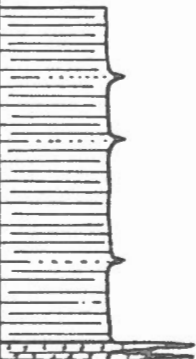
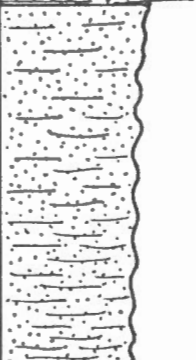
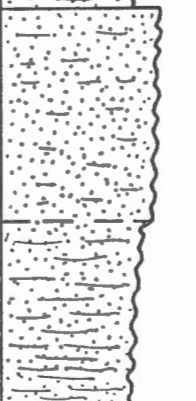
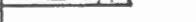
1792-1810 (Rec 17.25m)
1810-1820 (Rec 9.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
1792							mud			
1795									dark gray	SHELF MUDSTONE
1798									light olive-brown, high ϕ	Transgressive Lag?
1801									olive-brown, buff-weathered grains common high ϕ	Estuary- Fill Stage "H"
1804									light buff-gray	Channel Cycle #3
1807									Cyclic fining-up units with Fe-mudst. clasts at base of each.	Channel Cycle #2
1810									buff-gray	Channel Cycle #1
1813									light olive-brown, high ϕ	CHANNEL STAGE "B"
1816									Fe-mudst. clasts light olive-gray	
1819									dark gray	BIOTURBATED "SANDY" MUDSTONE OFFSHORE- TRANSITION

WELL NAME Westcoast et al Crystal (10cm. diameter; unslabbed)LOCATION 6-32-45-3W5CORE INTERVAL 1755-1773 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1755				mud			
1758					0	dark gray	OFFSHORE SHELF (MUDSTONE)
1761						interlam. sst.-mudst.	C. gr. - Gran. sst. transition
						light olive-gray	Channel Stage 6
1764					N.S. mottled light/dk. gray <35% sd. >45% sd.		Shoreface Bar
1767					8.5cm Sk. Te.		Bioturbated 'Muddy' Sandstone
1770						light gray 90% sd. mottled light/dark gray 75% sd.	LOWER SHOREFACE
1773					8.5cm	45% sd.	Bioturbated 'Muddy' Sandstone Prograding Shoreface

WELL NAME Wainoo Rembing (1 cm diameter juuslabbed)LOCATION 7-32-45-3W5 CORE INTERVAL 1750-1768 (Rec 18^m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. E c. v.g. d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
1750						dark gray	OFFSHORE SHELF MUDSTONE (LOWER COLORADO)	
1753					0			
1756					≈	interlam. sh. + c. gr. sst. medium olive-gray	Trans. Shelf sand	
					≈ Te.		BIOTURBATED 'MUDDY' SANDSTONE LOWER SHOREFACE	
					≈ Te.			
1759					≈ Te.	mottled dark and light olive-gray		
					≈ Te.			
1762					≈ Sk. V	Whitish-gray with few 5cm. thick sst. lam. beds.	BIOTURB. 'MUDDY' SANDSTONE INCIPIENT SHOREFACE BAR	
					≈ Te.	to		
					≈ Sk.	olive-gray		
1765					≈			
					≈	mottled olive-gray and dark gray	BIOTURB. 'MUDDY' SANDSTONE LOWER SHOREFACE	
1768					≈ Te.			

WELL NAME Focus et al Wintfield (10cm diameter; 5/96 bed)

LOCATION 6-34-45-3W5

CORE INTERVAL

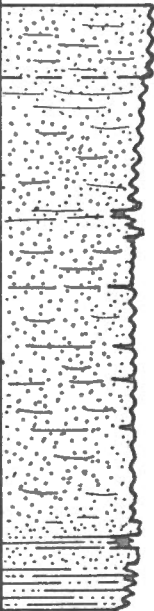





1730-1747 (rec 13.6m)

1748-1748.6 (Rec C.6-)

1750-1756.4 (Rec 6 Am)

[illegible]

WELL NAME Westcoast at al Minhik (10 cm diameter, partially slotted)LOCATION 16-14-45-4W5CORE INTERVAL 1775-1784.75 (Rec 9.75)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES INTERPRETATION
			20	15	10	5				
1775									light olive-gray	PARTIALLY-BIOTURBATED SHALY SANDSTONE Subtidal Channel-margin (bank) deposits ↓ CHANNEL STAGE 'A'
1778									light olive-gray, abundant shaly partings and layers	
1781										
1784										
1787										INTERBED. Sst.-Shale. Subtidal Estuary Bay

WELL NAME Chiefco et al Crystal (10cm diameter; partially sleebed)LOCATION 16-24-45-4W5

CORE INTERVAL

1-1785.5-1790

2-1790-1808

3-1808-1809.5

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	SAMPLES
			20	15	10	5						
							mud					
1785										NOTE: Core does not fit log. Core is not continuous. Some interval was not cored, probably between #2 and #3	LOWER COLORADO SHALE	7A
1788										light gray		7B
1791								base Core #1		dk. gray mudst. clasts		7C
1794									Sk. Fe-mudst. clasts cyclic to massive units as below		SHALLOW CHANNEL BAR COMPLEX	7D
1797									light gray Fe-mudst. clasts			7E
1800									burrowed laminated X-bedded		ESTUARINE CHANNEL FILL	7F
1803									light brown-gray 30 to 80cm. thick cyclic units: burrowed laminated massive		Estuarine Channel and Channel Margin Bar-Fill	7G
1806									light brown-gray			7H
1809								base Core #2		N.S. dark gray	Bioturbated Sandy Mudstone	7I

WELL NAME W. 14-25-45-4W5 LOCATION 14-25-45-4W5 CORE INTERVAL 1820-1838, 1838-1845.75 (Rec. 6-85)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
							mud			
1820									dark gray	LOWER COLORADO SHALE <i>shelf sand transition</i>
1823									light gray	
1826										FINE-TO MEDIUM GR. SST. SHALLOW CHANNEL- BAR COMPLEX ESTUARY-FILL STAGE 'H'
1829										
1832									light gray	FINE-GRAINED SHALY SST. CHANNEL MARGIN ACCRETING
1835										
1838									light. brn.-gray	FINE-TO MEDIUM GR. SST. Channel margin bar CHANNEL STAGE 'B'
1841										
1844									light. brn.-gray to ol. brn., high ϕ	Channel Stage 'A'

WELL NAME Dumper Crystal (10cm diameter junction box)LOCATION 16-25-45-4W5CORE INTERVAL 1792-1801 (Rec 9m)
1801-1819 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5						
1792								mud		light olive-gray high ϕ	SHALLOW CHANNEL- BAR COMPLEX	ESTUARY FILL STAGE 'H'
1795									massive to X			
1798									massive SK	light olive-gray		
1801									X-bedded \rightarrow or massive bedsets Fe-mudst. rip-up clasts common		Channel fill #2	CHANNEL STAGE 'C'
1804										Very high ϕ zone	Channel fill #1	
1807										light olive-gray		
1810												Channel Stage 'B'
1813									Scoured base dark gray		Prot. Sandy Mudst.	
1816										mottled olive gray and dark gray	Bioturbated 'Muddy' Sandstone	LOWER SHORE FACE
1819												

OFFSHORE
TRANS.

LOCATION 8-26-45-4 W5

CORE INTERVAL

1809-1827.25 (Rec. 18.5)

1827.25-1837.25 (Rec. 10.2)


METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	SAMPLES
			20	15	10	5					
							mud		dark gray	TRANS. LAG	
1814								NS.	light gray-brown good ϕ	Congl.	6A
1817									buff-gray	ESTUARY-FILL STAGE 'H'	6B
1820								Sk. V	buff-gray periodic shaly partings		
1823								Sk. Pa.	light to medium brown-gray	CHANNEL STAGE 'B'	
1826								Sk.	shaly partings and layers to 10%		
1829								Sk.	light gray		6C
1832								massive	large 4cm Fe-mudst. clast. light olive-brown, high ϕ		6D
1835								Te.	mottled light/dark gray 35-45% Sand.	Interbedded Sh.-Sst.	
1838								B ^{0.5cm}		Bi turb. 'Muddy' Sst.	LOWER Shoreface
										Bi turb. 'Sandy' Mudst.	OFFSHORE- TRANSITION

CORE INTERVAL 1803-1834.95m

METRES	DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
							dark gray	OFFSHORE SHELF
						N.S.	Trans. Lag	
1806						≡ ≡ ≡	buff-gray weathered buff chert grains common	SHALLOW CHANNEL- BAR COMPLEX
1809						Δ	large Fe-mud clasts	
1812						≡ Vsk.	buff-gray shale ripple drapes common	FINE-TO MEDIUM-GRAINED SANDSTONE
1815						≡ Pal.	light gray	CHANNEL BAR
1818						≡ Pi. Te.	shale-ripple drapes Fe-mudst. discoidal clasts	FINE-GRAINED SHALY SANDSTONE
1821						≡ - ~ V Pi.	shale-ripple drapes	CHANNEL MARGIN
1824						≡ ≡ ≡	light gray	Channel Bank
1827						Δ ○○○○	light brown-gray discordant red-mudst. clasts	Channel Fill (Fining-Upward)
1830						nassive	buff to light brown-gray abundant buff chert granules	
						≡ ≡ ≡		Subtidal Estuary

LOCATION 6-36-45-4 W 5 CORE INTERVAL 1803-1834.95

LOCATION 6-36-45-4 W 5 CORE INTERVAL 1803-1834.95

METRES		DEPTH		FEET		OIL STAIN		CEMENT		POROSITY		LITHOLOGY and GRAIN SIZE		SED. STRUCTURES					
										20 15 10 5		mud v.f. f. E. c. v. c. g. p.							
1830																			
1833														0 2 III 2 0 Tr. Te.		dark olive-gray		Bioherbated 'Sandy' Mudstone	
																		OFFSHORE-TRANSITION	

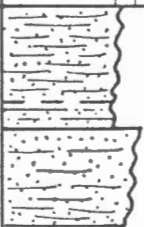
WELL NAME RETROCON Murphy Crystal (10cm diameter, core broken)LOCATION 8-36-45-4W5

CORE INTERVAL

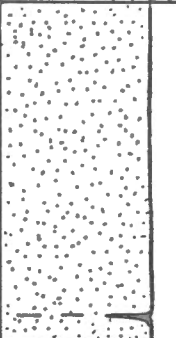



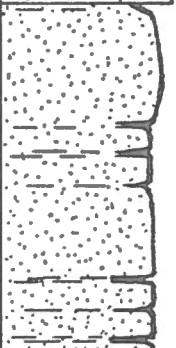


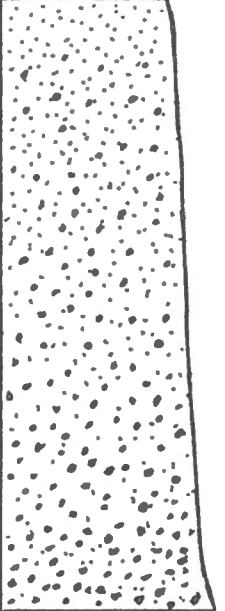

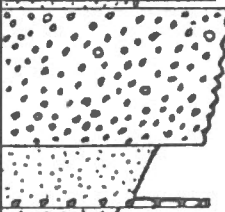



1795-1813
1813-1826 (Rec 12.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud s. l. E. C. G. D.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
1795					massive	light gray	BAR COMPLEX	STAGE 'H'
						buff-gray		
1798								
1801					massive	buff to olive-gray, abundant weathered buff clast grains micaceous shale parting	Fine to Medium-Gr. Sst. Fining-Upward Channel Cycle	CHANNEL STAGE 'C'
1804						high ϕ unit		
1807						buff-gray well-sorted, salt & pep. mixed, as two units above N.S.	Interbedded: 1) F. to M. gr. sst. 2) C. gr. to brn. sst. Channel Cycle	CHANNEL STAGE 'B'
1810					massive	light buff-gray	F. to M. gr. sst.	CHANNEL STAGE 'B'
						Fe-clay pebbles at base	C. gr. to brn. sst.	
1813						light olive-gray		
						buff-gray		
						buff-gray, clay-filled burrows good ϕ	F. to m. gr. sst.	
						inter/am. sd-mudst.		
1816								
						mottled light and dark gray	Bioturbated 'Muddy' Sandstone	LOWER SHOREFACE
1819								
1822								

WELL NAME RETROCON Murphy Crystal (Continued)LOCATION 8-36-45-4W5CORE INTERVAL 1795-1813
1813-1826

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.l. E.C. v.g. G.P.	SED. STRUCTURES		
1822					2020 tr.	mottled	Biot. 'Muddy' Sst. Coarsening slope -up L. side
1825					2020 Te.	dark brown-gray mottled light/dk. gy.	Biot. 'Sandy' Medst. Biot. 'Muddy' Sst. Lower Shoreface
1828							

WELL NAME Letrocon Murphy CrystalLOCATION 14-36-45-4W5CORE INTERVAL 1773-1791; 1791-1800

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES	
			20	15	10	5				INTERPRETATION	
1774									light gray to buff-gray	Shallow Channel-Bar Complex	Estuary-Fill Stage 'H'
1777									laminated to massive intervals		
1780									light olive-gray, high ϕ		
1783									light gray to buff-gray	Fine-grained Shaly Sst. Channel Margin Bar	Channel Stage 'B'
1786									1 to 2 cm. thick mudst. layers common		
1789									buff-brown to olive-brown massive.	FINING - UPWARD CHANNEL FILL	CHANNEL STAGE 'A'
1792									abundant buff-weathered chert grains, granules.		
1795									high ϕ		
1798									light-gray speckled, 'salt & pepper' sst.	Axial Channel	Subtidal Estuary
									n.s. light gray scoured base dark gray		
										Bioc. 'Sandy' Mudst.	Shelf Transition

WELL NAME Focus ET al Wintield (10cm diameter, slotted)LOCATION 13-5-46-3W5

CORE INTERVAL

1731-1749 (Rec 18m)

1749-1763 (Rec 4.75m)

1763-1771 (Rec 7.75m)

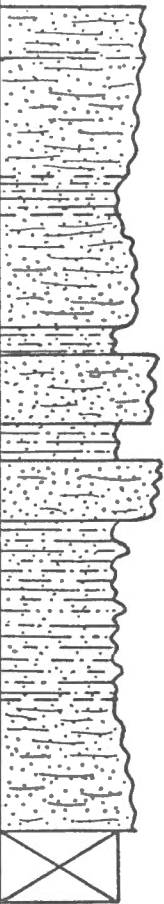
METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1743				mud			
1746						dark gray	SHELF (LOWER Colorado Shale)
1749						interlaminated sdst.-mudst.	Transition Trans. lap
1752						light-gray, (glaucousitic)	Coarsening-up Lower Shoreface to Shoreface Bar
1755						mottled medium and dark olive-gray	
1758						mottled whitish- gray and olive-gray (glaucousitic)	Bioturbated 'Sandy' Sandstone LOWER SHOREFACE
1761						mottled medium and dk. olive gray (glaucousitic)	
1764						Note: Core intervals are not properly labelled with respect to log depths. See Figure 7 for adjusted core depths.	
1767						dark olive-gray 'micromottling'	Bioturbated 'Sandy' Mudstone (OFFSHORE- TRANSITION)
1770						very shaly	
						mottled med. to dk. olive-gray to dark olive-gray to base	LOWER SHOREFACE TRANSITION

WELL NAME P.D. U. Gas Rending | 1cm diameter; unslabbed

LOCATION 16-5-46-3W5

CORE INTERVAL 1748.25-1762.75

Rec 13.4m

METRES DEPTH FEET		OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE <div><div>v. l. v. f. E. c. v. g. d.</div><div>mud</div></div>	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1748						~ ~	mottled white-olive gray and dark gray	Alternating sequence of bioturbated 'sandy' mudstones (offshore transition) and bioturbated 'muddy' sandstones (lower shoreface) 'REGIONAL' VIKING FACIES
1751				~ ~ Te.				
				~ ~		dark olive gray		
				~ ~		mottled dark/light gray		
				~ ~ Te.				
1754				~ ~		dark gray.		
				~ ~ tr.		light olive-gray with whitish mottles		
				~ ~		dark brown-gray		
				~ ~ Te.		light olive-gray to 'whitish' gray		
				~ ~ Te				
1757					~ ~	dark brown gray		
					~ ~			
1760					~ ~	mottled dark and light gray		
					~ ~ Te.			
1763					~ ~			

WELL NAME WESTCOAST CI 21. REMBING (2cm diameter; unslapped)LOCATION 6-6-46-3 W5

CORE INTERVAL

1735-1744 (REL 8.7-)
1745-1756 (REL 11.2)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5					
1735										light olive-gray	Channel Cycle #2
1738											
1741										light olive-brown abund. coal frags. on bedding planes.	
1744									massive	light. brn.-gray	Channel Cycle #1
1747										light brown-gray to olive-brn. high ϕ	
1750										c.gr. to Granular light gray	
1753										dark gray	Bioclastified 'Sandy' Mudstone
1756										mottled light/dk. gy.	Bioclastified 'Muddy' Sst.

CHANNEL STAGE 'C'

STAGE 'B'

OFFSHORE-
TRANSITIONLOWER
SHOREFACE

WELL NAME Pluesky et al PembinaLOCATION 11-6-46-3W5CORE INTERVAL 1739-1757 (Rec 17.4)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5					
1739								mud			
1742									massive	light olive-brown high ϕ , oil-staining	Channel Cycle #2
1745									massive	fining-upward cyclic units, buff-clast granules at base	
1748									massive	light olive-brown, high ϕ	Channel Cycle #1
1751										buff-grains of clast buff-clast granules bimodal	
1754										light gray brown. Fe-mudst. clasts and ool frags.	Channel Stage 'B'
1757											

CHANNEL STAGE 'C'

CORE INTERVAL 1742-1760 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5					
1742											
1745										dark gray	LOWER COLORADO
1748											SHELF MUDSTONE
1751											Tidal Shelf Sand?
1754										olive gray-brown	Transition
1757										Fe-mudst. rip-up clasts	CHANNEL STAGE 'C'
1760										alternat. lgt/dk. gray mottled buff-gray/ olive-gray 85% to 70% Sd. ↓	Channel Scour Dept. Laminated-Biot. Sst.-Sh. Bioturb. 'Muddy' Sst. LOWER SHOREFACE

WELL NAME WEST COAST et al Crystal 110cm diameter; partially slabbedLOCATION 2-7-46-3W5CORE INTERVAL 1734-1752 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1734				mud		dark gray	LOWER COLORADO
1737							
1740						'salt & pepper' sst	Tidal Shelf Sand
						interlam. sst.-mudst.	Transition
						Olive-gray, high ϕ - gray mudst. clasts	Secondary Channel
1743						light olive-gray, cyclic units (30cm. to 1m.) or massive \rightarrow to γ	Channel Bar Accretion
1746							
1749							
1752						mottled olive gray/dk. gy.	

CHANNEL STAGE 'C'

LOWER SHOREFACE

WELL NAME WEST COAST ET AL. Crystal (10cm. diameter, unslabbed)LOCATION 4-7-46-3 W5CORE INTERVAL 1717-1735,
1735-1753

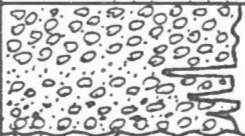




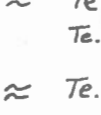




METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES INTERPRETATION
			20 15 10 5				
1718				mud		dark gray	SHELF MUDSTONE
					X	s. + P. type	C. gr - Gran. Sst. ^{Tidal}
1721					X	0.3 - 1cm clasts, clast support	Conglomerate
1724					X	clasts 0.5 - 1.5cm. D., clast-support	
1727					X	Granular to 4mm. clasts floating in f. to m. gr. sandst.	
1730					X	0.3 to 0.7 D. clasts, clast support, thin sst. interbeds	
1733					X	trough X-beds	
1736					X	Chaotic bedding	Interbedded Sandst. - Congl.
					X	0.3 to 0.7 clasts, clast-support, sd. matrix	
1739					X	bimodal	Sandy Congl. to Conglomeratic Sst.
					X		
1742					massive	olive-brown, high ϕ , bimodal	Gran. Sst.
1744					X		Interbedded Congl. none

Multiple - superimposed, used, and reworked Channel deposits

CHANNEL STAGE 'C'

Channel
— Stage 'B' —

LOCATION 4-7-46-3W5 (Continued) CORE INTERVAL 1735-1753

METRES DEPTH	FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES				
									20	15
1744							clasts 0.6 to 1 cm, clast-support, sd. matrix.	Congl.		
1747							dark gray	Boturb. 'Sandy' Mudst.		
1750							mottled whitish-gray and dark gray 60% sd.	Bioturbated 'MUDDY' SANDSTONE		
1753							35% sd.			
							25% sd.	LOWER SHOREFACE		

CORE INTERVAL 1719-1737 (Rec 18.2)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1719					massive	olive-brown, high ϕ	f. to m. gr sst.
1722					massive	bimodal	congl. sst.
					massive	0.2 to 0.7 cm. clasts, clast-support, sand matrix	congl.
					N.S.	as above	
1725					interlayered	interlayered light and dark gray	Lam. to Bioturb. Sst-Muds.
1728					Biocn	mottled buff/ 80% sd. lght. gry.	Bioturbated 'Muddy' Sst.
					Bi 1.5 cm	mottled light and 65% sd. dark gray	
					Te		
1731						30% sd. micromottling	
1734						dark gray	Bioturb. Sandy Mudst.
1737							

WELL NAME DUECKY et al crystal (8cm diameter; partially slabbed)LOCATION 14-7-46-3W5CORE INTERVAL 1691-1696 (Rec 5m)
1696-1711 (Rec 15m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES INTERPRETATION
			20	15	10	5				
							mud			
1691									dark gray	OFFSHORE Shelf
									N.S. 'salt+pepper' type	Trans. Shelf Sand
1694									bimodal; f. to m-gr. and gran. to congl.	Conglomeratic Sst. Channel Cycle #2
1697									Fe-clay clasts (to 2cm.) Congl. clasts 0.4 to 0.8cm.	
1700									light olive-gray	Fine- to Medium-Grained Sst. Channel Cycle #1
1703									Layers and laminæ rich in buff-weathered chert granules	
1706									Fe mudst. clasts	
1709									N.S. micromottled light and dk. gray	Bi turb. 'Muddy' Sst.
1712										Bi turb. Sandy Mudst.

CHANNEL STAGE 'C'

LOWER SHOREFACE
OFFSHORE-TRANSITION

CORE INTERVAL 1690-1708 (Rec 18 m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. f.c. m.c. g.c. g.d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1690						dark gray	OFFSHORE SHELF
1693						olive-brown, high ϕ	TRANS. REWORKING
1696						Thick cyclic units:	Accreting Channel Margin CHANNEL STAGE 'C'
1699						mod. ϕ in lower $\frac{2}{3}$	
1702						interlayered light gray and dk. gray 70% sd. layers	
1705						mottled dark and light gray 65% sd.	LOWER SHOREFACE
1708						45% sd.	
1711							
1714							

CORE INTERVAL 1723-1741.25 (Rec 18.25)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1723						dk. gray 'salt & pepper' type	Transgressive lag?
1726						lght. olive-brown, high ϕ	CHANNEL STAGE 1' C
						floating buff chert granules	
1729						Coarse-grain to Granular	
						lght. olive-brn, high ϕ interbedded lght gray and dark gray	Incipient Shoreface Bar
1732						mottled	
						lght olive gray, 10% shale layers.	BIOTURBATED 'MUDDY' SANDSTONE LOWER SHOREFACE
1735						mottled light and dark gray	
1738							
1741						dark gray	BIOTURB. 'SANDY' Mudstone OFFSHORE- TRANSITION

LOCATION 16-17-46-3W5

CORE INTERVAL 1730-1739.8 (Rec 9.1m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1730						dark gray	LOWER COLORADO
1733					massive	light olive-brown, good ϕ	Channel Stage 'C'
					ns. Vsk	light gray, abundant shaly layers	Shore face Bar
1736					sk	mottled lgt/dk.gy.	Bioturbated 'Muddy' Sandstone
					50% sd.		
1739					sk	olive-gray/light.gry mottling 70% sd.	LOWER SHOREFACE
					sk		

WELL NAME WESTCOAST ET al Crystal (10cm diameter ; unslotted)LOCATION 2-18-46-3W5CORE INTERVAL 1702-1705 (REC 3.0m)
1705-1721.5 (REC 16.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5					
								mud			
1702										dark gray	OFFSHORE SHELF
1705											Transgressive Lag
1708									Sk. massive	light olive gray-brown	CHANNEL STAGE 'C'
1711										high ϕ throughout	
1714										buff-weathered chert granules	
1717										interlayered light and dark gray	
1720										mottled light and dark gray	Lower Shoreface
1723											LOWER SHOREFACE

CaCO₃ CaCO₃
11 11Bioturbated
'Muddy'
Sandstone

WELL NAME WEST COAST CRUI. CRISTAL (O.C.M.) UNSHODD, MANY CORE
 LOCATION 3-18-46-3W5 CORE INTERVAL 1685-1689.5 (Rec. 4.15)
1689.5-1707.5 (Rec. 10.23)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE v.f. v.c. v.g. d. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	SAMPLES
			20	15	10	5						
1685										lgt. brown-gray foreset bedding	Cycle #2	3A
1688										lgt. gray, high ϕ	Channel Cycle #1 FINING-UPWARD CHANNEL FILL	3B
1691										lgt. brown-gray		3C
1694										large (4cm) rounded Fe-clay clasts		3D
1697									massive	lgt. olive-brown, high ϕ granular buff grains		3E
1700										lgt. gray 0.3 to 0.7cm. clasts	Fine-M.gr. Sst. CHANNEL CYCLE	3F
1703										lgt. brn.-gray	Fine-grained Shaly Sandstone CHANNEL CYCLE	3G
1706										salt + pepper dk. gray	C. gr. to Gran. Sst. Bioturbated Sandy Mudstone	3H
										mottled whitish/dk. gry	Bioturbated Muddy Sst.	3I
										medium to dk. gry.	Bioturbated Sandy Mudstone	3J
										mottled whitish/dk. gry, Spreiten burrows	Bioturbated Muddy Sandstone	3K

↑ CHANNEL STAGE 'C'
↓ CHANNEL STAGE 'B'
Cyclic Prograding Inner Shelf-Shoreface

WELL NAME Westcoast et al Crystal (10cm diameter, partially slabbled)LOCATION 10-18-46-3W5

CORE INTERVAL

1707-1725 (Rec 18m)

1725-1728.6 (Rec 3.1m)

1728.6-1740 (Rec 11.4m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE v.f. E.C. v.g.d. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20 15 10 5					
1713						dark gray	SHELF MUDSTONE	
1716						light olive-gray high ϕ	Transgressive Lag Marginal Channel Bar	CHANNEL STAGE 'C' CHANNEL STAGE 'B'
1719						Cyclic units: X-bedded to laminated to burrowed		
1722						light olive-gray Good ϕ Fe-mudst. and shale pebble clasts at base of most units	Accreting Channel Margin Deposits with scoured base	
1725						lgt gray, abundant shale partings		
1728						c.g. to granular		
1731						mottled light and dark gray	LOWER SHOREFACE	
1734						dark gray	OFFSHORE TRANSITION	
1737						mottled light and dark gray	LOWER SHOREFACE	
1740								

WELL NAME West Coast et al Crystal (10 cm diameter; unslabbed)LOCATION 12-18-46-3 W5CORE INTERVAL 1708-1725.8 (Re 17.6)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
							mud				
1708									dk. gray	Shelf Mudstone	
								X	N.S. 'soft + pepper' type	Transgressive Sd.	
								≈ Te.	N.S. alternating light and dk. gray.	Interbedded Sst.-Mudst.	
1711								≡ - ~			
								≈ - ~			
								≡ - ~			
								X	C. gr. to Granular.	Stage 'C' Edge	
1714								x ≡ - ~	alternating light and dark gray	Interbedded Sandst.-Mudst.	
								≡ - ~			
								≈ - ~			
								≡ - ~			
1717								≈ - ~			
								≡ - ~			
								Δ X	N.S. light. olive-gray, high φ	Chn. Bar	
1720								≡	light gray	Accretion Margin	
								≡ V Sk	abundant dk. gray shale rip-up clasts		
1723								~	dark gray	Biot. 'Sandy' Mudst.	
								≈ SK	mottled light and dark gray	Bioturb. 'Muddy' Sandst.	
1726								~			

ESTUARINE BAY FILL

STAGE 'B'

OFFSHORE TRANS.

LOWER SHOREFACE

WELL NAME Westcoast et al Crystal (10 cm diameter; partially slumped)LOCATION 16-18-46-3W5CORE INTERVAL 1726-1744 (Rec 18m)






















METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE v. l. E c v. g. d. mud	SED. STRUCTURES	REMARKS	FACIES INTERPRETATION	
			20	15	10	5						
1726										clasts 0.4 to 0.9 cm, clast supp.	CONG.	CHANNEL STAGE 'C'
1729										light gray-brown, floating congl. clasts throughout	Gonglomeratic Sst. Channel Cycle #2	
1732												
1735										lght. olive gray floating buff chert grains and granules	CONGLOMERATIC Sst. Channel Cycle #1	
1738												LOWER SHOREFACE
1741										mottled light gray/ 65% sd. olive gray	Bi turb. 'Muddy' Sandstone	
1744										mottled light and dark gray 35% sd.	Bi turb. 'Sandy' Mudst.	
										dark gray		OFFSHORE TRANSITION

WELL NAME WESTCOAST et al Crystal (8cm diameter; partially sieved)LOCATION 2-19-46-3W5

CORE INTERVAL

1732.6-1743.4 (Rec 10.3)

1743.4-1761.4 (Rec 17.3)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE mud v.l. E.C. v.c. v.g. d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
1732								 T	lgt gray with abund shaly layers	Partially Bioturb Shaly Sst.
1735								 2	lgt gray to olive-gy	Fine- to Medium-grained Sst.
									good ϕ	
1738								 T	cyclic units 0.9-1m thick:	
								 T	 - shaly ripple drapes	
1741								 T	lgt. olive-gray	Fine- to Medium-grained Sst.
								 T		
								sk.		Fine- to Medium-grained Sst.
								 T		
1744								 T		C. gr. to gran. Sst.
								 T	N.S.	
									dark gray 'micromottling'	Bioturbated 'Sandy' Mudstone
1747										
										Bioturbated 'Muddy' SANDSTONE
1750								 Te.	70% Sd. mottled olive-gray	
										Bioturbated 'Muddy' SANDSTONE
1753								 Te.	mottled dk. 35% Sd. and lgt. gy	
								 B. 5cm		
1756									45% Sd.	
										Bioturbated 'Muddy' SANDSTONE
1759									dark gray	

CHANNEL STAGE 'B'

OFFSHORE-
TRANSITION

LOWER SHOREFACE

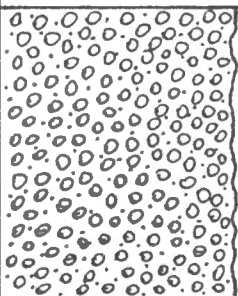





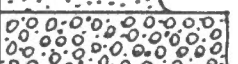




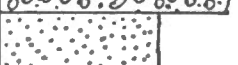


















CORE INTERVAL 1729-1747

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE <div><div>l. E. C. G. S.</div><div>mud</div></div>	SED. STRUCTURES	REMARKS	FACIES		
							INTERPRETATION		
1729						lght. olive-gray, floating buff- granules - layered	Cycle #2	CHANNEL STAGE 'C'	
1732						light olive-gray			
1735						cyclic units: → mass. → with shaly layers at top light brn.-gray, high ϕ	Cycle #1		
1738						olive-brown gray, floating buff-chert granules			Channel Stage 'B'
1741						dark gray			Channel Stage 'A'
1744					mottled dark and light gray		Channel Stage 'A'	Channel Stage 'A'	
1747					Biorturb. 'Muddy' Sst.		Channel Stage 'A'	Channel Stage 'A'	

WELL NAME Westcoast at al Crystal (4" diameter; partially sleebed)LOCATION 12-19-46-3W5CORE INTERVAL 1732.5-1750.5

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE v. l. E. c. v. g. d. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1733						dark gray	SHELF
					~ x ~ Te. ~ ~ ~	mottled lgt/dkgy. approaches interlayered	Channel Stage 'C' Equivs. →
1736					2 ~ Te. 2 - ~ ~ - 0	interlayered light gray u.f. to f-gr sd, and mudst.	
1739					2 - ~ 0 - 2 ~ - 0		
					~ - 0		
1742					Sk. T massive	lgt. olive-gray shaly partings and layers	Channel 'C' margin Accreting Channel Margin
1745						dark gray	Channel Stage 'B' ←
					~ ~		OFFSHORE TRANSITION
1748					~ Te. ~ ~ ~	mottled olive/red-gry. mottled lgt. and dark gray.	LOWER SHOREFACE
1751							

WELL NAME Dumper ci. al crystal (10cm diameter, unslabbed)LOCATION 6-20-46-3W5 CORE INTERVAL 1720-1738.25 (Rec. 1775)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE v.f. v.c. v.g. d. mud	SED. STRUCTURES			SAMPLES
			20	15	10	5					
1720											
1723								  	clasts 0.3 to 0.8cm, mod. sorting, clast-support, sd. matrix	CONGLOMERATE	
1726									olive-brown, good ϕ		2A
1729								 	as above, well-sorted, 0.3 to 0.6cm. clasts. trough to high-angle planar beds	CONGL.	2B 2C 2D
1732									olive-brown, high ϕ floating buff-granules	F. to M. Gr. Sst.	2E
1735									Gran. to 0.4cm clasts		2F
1738								  	olive-brown, high ϕ buff-clast granules floating	F. to M. gr. Sst.	2G
								           	BIOTURBATED 'MUDDY' SANDSTONE	LOWER SHOREFACE	2H 2I

CHANNEL STAGE 'C'

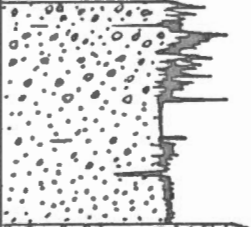

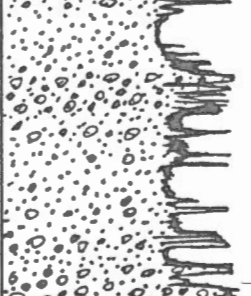
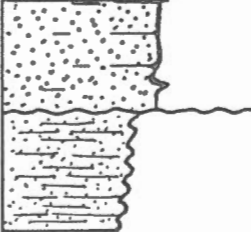
WELL NAME Dumper Crystal (4" diameter; partially slotted)LOCATION 8-20-46-3W5CORE INTERVAL 1711-1729.5 (Rec 18.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud s. c. g. d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1711				mud		dark gray	SHELF MUDSTONE (LOWER COLORADO)
1714						1.5 cm. thick congl.	
1717					Op.?	lght. Olive-brown, high ϕ	CHANNEL BAR
1720						Fe mudst. clasts and nodules common, also coal clasts.	
1723						Fe-mudst. rip-up clasts	CHANNEL BASE
1726						mottled dark /olive-gray	Bioturbated 'Muddy' Sandstone
1729						mottled lght. gray, and dark gray 85% sd. 50% sand 65% sand 40 sand	

CHANNEL
STAGE 'C'

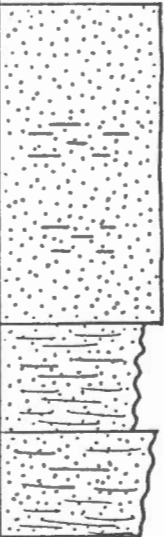

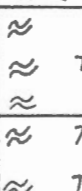
LOWER SHOREFACE

WELL NAME Westcoast et al Crystal (10cm diameter; partially slabbed)LOCATION 14-20-46-3W5CORE INTERVAL 1692-1710.2 (Rec 17.6m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES			
			20	15	10	5					
							mud				
1692								x v	olive-brown, high ϕ buff-chert gran. common	F. to M. gr. sst.	
1695								x v			
1698								L x	bimodal, 1) gr. to 0.4mm clasts 2) f. to m. gr. sst. high ϕ	Conglomeratic Sst.	Channel Cycle #2
1701								L L L v			
1704								L L L v	olive-brown, floating buff granules	CONGLOMERATIC Sst.	Channel Cycle #1
1707								x L L v			
1710								x L L v	f. to m. gr. sst with floating gran. + clasts	Channel Transition	
								x L L v	light olive-gray	f. to m. gr. Sst.	Channel Margin
								x L L v	mottled light and dark gray	Biocarb. 'Muddy' Sst.	LOWER SHOREFACE

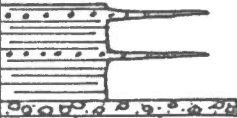
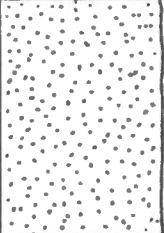
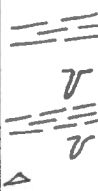
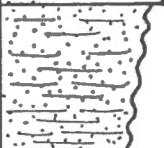

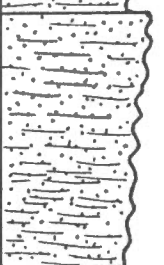
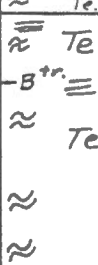

CHANNEL STAGE 'C'

WELL NAME Focus Pembina (10 cm diameter; unsheathed)LOCATION 11-27-46-3W5 CORE INTERVAL 5403-5432 (Rec 285)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. E.C. v.g. D.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
5400						light gray	Channel Marginal Bar Channel Stage 'C' Equivalent
5410							
5420							
5430						mottled light and dark gray	Bioturbated 'Muddy' Sandstone LOWER SHOREFACE
						light olive-gray to 'whitish' gray large <i>Terebellina</i>	

WELL NAME _____ (1 cm diameter, unslotted)

LOCATION 10-28-46-3 W5 CORE INTERVAL 5459-5499 ft.

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. Ec v.c. g. d.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
5460						dk. gray	LOWER COLORADO transgressive Lag
5470						light gray rare Fe-mudst. pebble clasts	Channel Marginal Bar Channel Stage 'C'
5480						mottled olive and dark gray	Coarsening-upward LOWER SHOREFACE CYCLIC DEPTS.
5490						light olive-gray, 'whitish' mottles, few 1 to 5 cm. thick sst. laminae in upper part; large <u>Terrebellina</u>	
5500						mottled dark and light gray	

WELL NAME Westcoast ET 91 Crystal (10cm diameter; partially slabbbed)LOCATION 2-30-46-3W5CORE INTERVAL 1687-1705.4 (Rec 18.4m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1687				mud	x x		
1690					x x	0.2 to 0.7mm clasts, moderate sorting, clast support, m. gr. sd matrix	CONGLOMERATIC CHANNEL Cycle #2
1693					x x	moderat to high ϕ	
1696					x x	- Fe mudst. pebble clasts	
1699					x x	- Fe nodule	
1702					x x	light olive gray, high ϕ	Channel Lag
1705					x x	light olive gray, high ϕ	
					x x	light gray, abund. shale interlayers	Incipient Bar Sst.
					x x	interlayered light v.f. to f-gr sst. and mudst.	Lam. to Bioturb. Sst.-Mudst.
					x x	N.S. mottled olive-gray and dark gray	Bioturb. 'Muddy' Sst.

CHANNEL STAGE 'C'

Cycle #1

PROGRADING
LOWER TO MIDDLE SHOREFACE

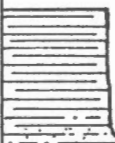
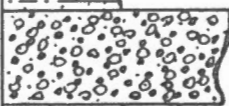
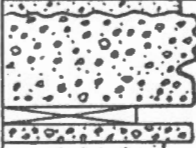
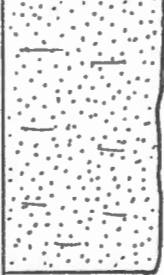
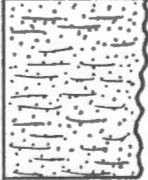
WELL NAME ULL WES/COAST 47 Crystal (8cm. diameter; unslabbbed)LOCATION 16-30-46-3w5CORE INTERVAL 1675 - 1693.15

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
							mud			
1675									dk. gray	Shelf Mudstone
1677								Te.	mottled dark and light gray with discontinuous sd. layers	Subtidal Estuarine Bay - Mouth Fill
1678									alternating light and dark gray	
1681										
1684									clast size 0.5 to 1.0 cm., clast- support, low matrix sd. content.	Channel Fill CHANNEL STAGE 'C'
1687										
1690										
									congl. interlayers with interlayered to mottled dark/light gray.	Subtidal Estuary margin to Channel
									congl. as above, large wood frags.	Channel Base
									steel-gray	STAGE 'B'
1693									mottled dark and light gray	LOWER SHOREFACE

WELL NAME Lego Tenn. Wintfield (1cm diameter; unslabbed)

LOCATION 2-32-46-3W5

CORE INTERVAL 5385-5404 (REL 18')
5404-5429 (REL 20')

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE v.f. E. C. v.c. v.g. p. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
5390									black	SHELF MUDSTONE
5400		SiO ₂						~ X X	gran. to 1cm. clasts, chert and mudst.	CONGL. Sst. Channel/Cyrt#2 ↓ CHANNEL STAGE 'C' ↓
5410		SiO ₂						X Δ X Δ X Δ	Granular to v.c.gr with buff-weathering chert grains near top	
5420		SiO ₂ CaCO ₃						~ sk ~ sk ~ sk	buff to light gry. well-sorted	
5430								≈ Te. ≈ ≈	Medium to dark olive-gray downward	LOWER SHOREFACE

WELL NAME Retrocon Murphy CrystalLOCATION 6-1-46-4W5CORE INTERVAL 1752-1770 (Rec 18m)
1770-1779.75 (Rec 9.45m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERP.
			20	15	10	5					
							mud				
1755										dark gray	SHELF MUDSTONE
1758										'salt + pepper' type	Shelf sand Transition Lag
1761								Pa. SK.		light gray	Fine-gr. 'shaly' Sst.
1764								massive		Olive-brown, high ϕ	F. to m. gr. Sst.
1767								massive		light gray	f. gr. 'shaly' Sst.
1770								interbeds: 1) lgt. olive-gray Sst. 2) interlam. - interbed. Sst - mudst.		Subtidal channel Margin Sands interfingering with estuarine muddy facies	CHANNEL 'B'
1773								massive		olive-gray	Channel base
1776								massive		light gray	Accreting Channel Bar #2
1779								massive		olive-gray	Channel Bar #1
								U _{SK} . AST.		light gray large <u>Skolithos</u> (?) burrows	CHANNEL STAGE 'A'

WELL NAME ARCTIC PEKULON CRYSTAL (10 cm diameter; unslotted)LOCATION 8-1-46-4W5CORE INTERVAL 1737-1755 (Rec 18.2m)
1755-1762 (Rec 7.0m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5					
							mud	v.f. v.E. v.C. v.G. v.D.			
1737									== - 0	interlam. sst.-mudst.	Transition Trans. Lag?
1740									massive	olive-brown, high ϕ	Cycle #2
1743										buff-chert granules	
1746										lght. gray-brn.	Cycle #1
1749										lght. brown-gray, high ϕ	
1752										lght. olive-brown, bimodal, with floating granules and granular layers	CHANNEL STAGE 'C'
1755										lght. gray granular 's. & p.' type	
1758										Granular Sandst., conglomeratic	CHANNEL STAGE 'B'
1761										dk. gray	
										dk. gray	OFFSHORE- TRANSITION
										dk. gray	LOWER SHOREFACE
										dk. gray	OFFSHORE- TRANSITION

WELL NAME WCD 104921 41 crystal (10cm diameter; unslabbed)LOCATION 10-1-46-4W5

CORE INTERVAL

1700-1714.25 (Rec 14.25m)

1714.25-1732.25 (Rec 18m)

1732.25-1739.75 (Rec 17.4m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	SAMPLES
			20 15 10 5					
1700				mud				
1703						dark gray	SHELF MUDSTONE (LOWER COLORADO)	4A
1706					X	N.S. salt + pepper sst.	Tidal Shelf Sand	4B
					≡ - O	interlam. sst./mudst.		4C
					x X	clasts 0.2 to 0.75 cm, clast-supp.		4D
1709					x X	light olive brown, bimodal		4E
					x X	10-20 cm. thick x-bed sets.		4F
1712					X	light olive-brown, medium-gr. sst., with scattered granules/pebble layers		4G
1715					X	Periodic 1-2 cm. thick Fe-mudst. nodular layers		4H
1718					X	light olive brown, high ϕ		4I
					X	20-40 cm. x-bed set thickness		4J
1721					X	large (2-3 cm.) disoidal mudst. clasts common.		4K
					X	0.75 cm. clasts.		4L
					X	0.75-1.2 cm clasts, fgr. sd. matrix, clast-support		4M
1724					X	Well-sorted granular congl., 2 mm to 5 mm. clasts, clast-supported, m. gr. sst. matrix		4N
1727					X			

CHANNEL STAGE 'C'

WELL NAME Westcoast et al Crystal (10 cm diameter; unslabbed)LOCATION 10-1-46-4W5 Continued CORE INTERVAL _____

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES			SAMPLES
			20	15	10	5					
							mud				
1727											40
1730											4P
1733											4Q
											4R
											4S
1736											4T
											4U
1739											
1742											4V
1745											4W

Gran. to congl.
0.2 to 0.6 cm,
clasts, m. gr.
sst. matrix,
clast-support,
occas. f. to m. gr.
sandst. laminae

faint low-angle
to trough
x-beds throughout

lgt. brown-gray,
well-sorted,
with rare floating
gran. > to base.

N.S.
dark olive-gray
faintly
mottled

dark gray to
dark olive-
gray

Bioturbated
'Sandy'
Mudstone

CHANNEL STAGE 'B'

STAGE 'A'

OFFSHORE-TRANSITION

WELL NAME REICOON Flurpay CrystalLOCATION 14-1-46-4W5CORE INTERVAL 1709-1727 (Rec 16m)
1727-1739 (Rec 12m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.l. E.C. v.c. v.g. g.p.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
1709						dark gray	LOWER COLORADO	
					X	Salt + pepper	Trans. Tidal Sand?	
1712					h p massive	light gray	intertidal sand bar	
					o w	shale interlayers		
1715					x	light gray 1cm. Fe. mudst. layer	Sand bar	
					o pl. o pa. o	alternating light and dark gray	Subtidal bay	
					o	light olive-gray, high ϕ	Sand Bar	
1718					o o o	70% mudst. N.S.	Subtidal Bay	Estuary-Fill Stage 'H'
1721					to massive - w - Sk.	light gray to buff-gray		
					o o o	periodic Fe-mudst. clast-nodular zones		
1724					to massive			
					o o	light gray, few shale partings		
1727					o o o	light gray		
1730					o o o			
1733					o o o	flattened discoidal Fe-mudst. clasts		
					o o o	light buff-gray high ϕ		
1736					o o o			

Accreting Channel-Bars

CHANNEL STAGE 'A'

CHANNEL STAGE 'B'

WELL NAME WESTCOAST ET AL Crystal (0.9m diameter; 5160m)

LOCATION 16-1-46-4W5

CORE INTERVAL 1705-1719.5 (Rec 13.9m)
1719.5-1737.75 (Rec 17.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1705				mud			
1708						Clasts, 0.3 to 1cm. pebble-size, clast-support, with variously sandy f. to m. gr. layers and thin beds	
1711						Bedded Conglomerates	
1714						Chaotic conglomerates vertical pebble layers, random oriented, disrupted, etc.	
1717						Bedded	
1720						0.2 to 0.8cm. size clasts, clast support	
1723						buff-gray, high ϕ bedded buff-gray	
1726						chaotic N.S. chaotic Fe-mudst. pebble-clast zone buff-gray, high ϕ	
1729						Clasts 0.3 to 2cm in size, clast supp. bedded to chaotic near base	
1732							

CONGLOMERATE

Interbedded f. to m. g. sst. - Congl.

F. to M. g. sst.

CONGLOMERATE

HIGH-ENERGY CHANNEL DEPOSITS
(Tidal channel or Estuary Inlet Throat?)

CHANNEL STAGE

CHANNEL STAGE 'C'

'B'



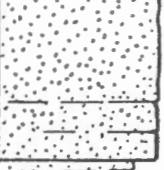



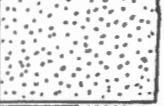
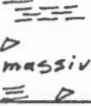
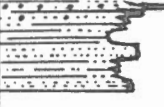

WELL NAME Petrocon Murphy CrystallLOCATION 14-1-46-4W5 (continued) CORE INTERVAL 1727-1739 (Rec 12m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. v.l. E c v.g. d.	SED. STRUCTURES		
1736					massive	light gray, rounded Fe-mudst. clasts	Fining- Upward Channel Cycle Channel Floor STAGE 'A'
1739					massive	light olive-brown, very high ϕ clasts 0.2 to 0.7 cm, clast-supported	
1742							

WELL NAME West coast et al CrystalLOCATION 16-1-46-4 W5 (Continued) CORE INTERVAL 1719.5-1737.75 (Rec 175)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.l. E.C. v.c. g.p.	SED. STRUCTURES		
1732					///	N.S. dark gray	STAGE 'B'
1735					≈	N.S. 'micro'mottled light/dk. gray	LOWER SHOREFACE
1738					≈	dark gray	OFFSHORE- TRANSITION

WELL NAME UCB10T 41 LRYST91LOCATION 6-2-46-4W5CORE INTERVAL 1764-1772.5

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1764							Transition
1767						light olive-gray - Fe-clay zone	F. to Mgr. Sst.
						N.S. light gray, partially bioturbated	Partially- Bioturb. Shaly Sst.
1770						light olive-brown, high ϕ - Fe-mudst. discorded clasts	F. to M. Gr. Sst.
1773						light gray, with abund. shale interlayers	Estuary Unconformity Incipient Shoreface Bar deposits

ESTUARY FILL
STAGE 'H'

WELL NAME O.I.L. CrystalLOCATION 14-2-46-4W5CORE INTERVAL 1723.5-1733.25 (Rec 9.75m)
1733.25-1740.75 (Rec 7.5m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1723											
1726									dark gray	SHELF MUDSTONE	
1729									'salt and pepper' type interlam. sst-mudst	Trans. shelf sand Transition	
1732									light gray abundant shale - ripple drapes	Fine-grained 'Shaly' Sandstone	Estuary-Fill STAGE 'H'
1735									light olive-gray	F. to M.gr. Sst.	
1738									light gray, 5-15% shaly partings	Partially- Biocarb. 'Shaly' Sst.	
1741									alternating light & dark gray	Interbedded Sst.-Mudst.	SUBTIDAL ESTUARINE BAY FILL

WELL NAME U.L.L. Crystal (8cm diameter, unslabbed)LOCATION 16-2-46-4W5

CORE INTERVAL

1728-1745.25 (Rec 16.8)

1745.25-1746.75 (Rec 1.12)

1752-1760 (Rec 9.0)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE mud v.f. E v.c. v.g. 	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1728									dark gray	SHELF MUDSTONE	
								X	'salt and pepper' type	Tidal Shelf Sand	
1731								SK.	light olive-gray	Transition	
1734								to massive	light olive brown	SHALLOW CHANNEL - BAR COMPLEX	ESTUARY-FILL STAGE 'H'
1737								to massive	high ϕ		
1740									high ϕ		
1743								to massive	N.S. interlayered light and dark gray to mottled light/dk. gy.	SUBTIDAL ESTUARINE BAY	
1746											
1749											
1752									light gray abundant shaly partings	CHANNEL STAGE 'A'	

LOCATION 16-2-46-4W5 (continued) CORE INTERVAL

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.l. E c v.c. g. d.	SED. STRUCTURES		
1754					V 40 sk. V Ast. Pa. 20 massive 10	lght. gray Fe-mudst. pebble clasts common in basal part	Channel Stage 'A'
1757							
1760							

WELL NAME U.L.L. 41 Crystal (8.8 cm diameter; unslotted)LOCATION 8-3-46-4W5

CORE INTERVAL

1744 - 1749
1748 - 1748.5
1748.5 - 1752.5

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1744						dark gray	LOWER COLORADO
1747					inter/am. sst.-mudst.	light gray, abund shale interlayers	Transition Estuary-Fill STAGE 'H' EQUIV.
1750					C. gr. to Granular homogeneous to interlayered sd. and shale mottled.		LOWER TO MIDDLE SHOREFACE
1753							

WELL NAME U.L.L. 41 CrystalLOCATION 16-3-46-4W5CORE INTERVAL 1735-1753 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20	15	10	5				
							mud			
1736								≡ - 0	mudstone to interlam. sst. - mudst	Estuary-Fill Stage 'H'
1739								x ≡ ≡ ≡ x ≡ ~ - ≡ 0 - ≡ ≡ Sk. ~ Te. - Pi. ≡ - ~ 0 - ≡	olive-gray, good light gray, shale partings, 85% sd to 65% sd with abundant shaly layers	
1742								≡ - ~ ~ to Te. Pi. ~ Sp.	Interlayered light gray, u.f. to f.gr. sst and dk. gy. mudst	Accreting Incipient shoreface bar
1745								≡ - 0 ~ - ≡ x ≡	Laminated to Bioturbated Sandst. - Mudst	Middle Shoreface
1748								~ ≡ ~ - ≡ to Sp.	mottled light and dark gray spreiten burrows	Lower Shoreface
1751								~	dark gray	OFFSHORE TRANS.
1754								~ R R ~ Sk.	'whitish' gray and dark gray	LOWER STOREFACE

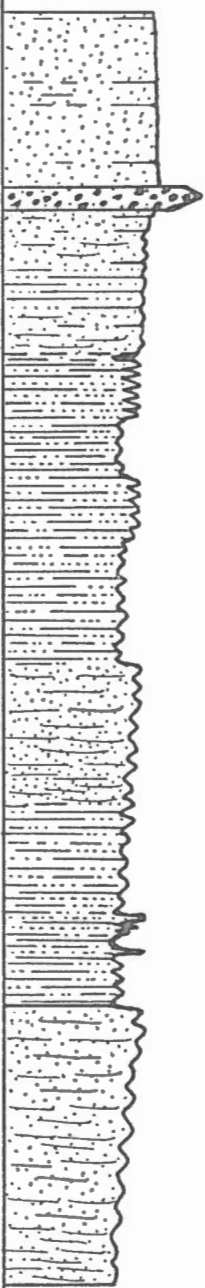
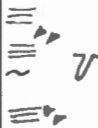
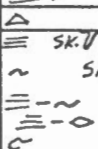
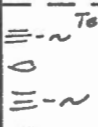
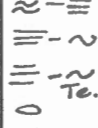
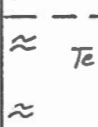
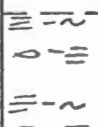
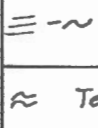
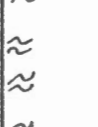
WELL NAME O.I.L. 20 Crystal (8cm diameter, unslabbed)LOCATION 8-10-46-4W5

CORE INTERVAL

1711-1711.5 (Rec 0.5m)

1711.5-1713.75 (Rec 2.25m)

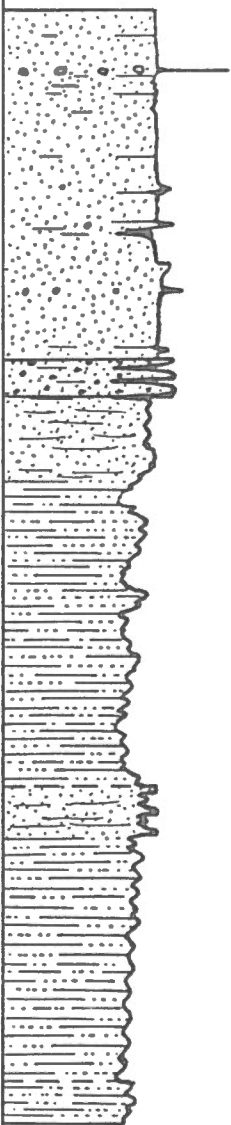
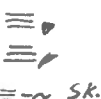

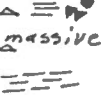
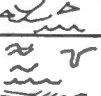
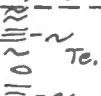

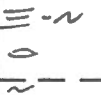
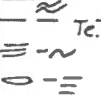
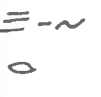
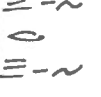
1713.75-1731.5 (Rec 17.75m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. Eo C. G. G.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1711						light olive-gray shaly carbonaceous partings	ESTUARY- FILL STAGE 'H'
1714						N.S. to granular light gray, partially-bioturb. with shaly partings	
1717						interlayered of f. to m. gr. sst and dk. gray shale	INCIPIENT SHOREFACE BAR
1720						Laminated to Bioturbated Sst.-Mudst	
1723						mottled olive/dk. gray	
1726						interlayered, 30% sst. layers	
1729						mottled dark and light gray	
1732						Bioturbated 'Muddy' Sandstone	CYCLIC LOWER SHOREFACE UNITS

WELL NAME U.L.L. et al. 41 CrystalLOCATION 16-10-46-4W5CORE INTERVAL 1697-1705 (RCC 8m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1697									olive-gray	Estuary-Fill Stage 'H'	
								~ -20	interlayered Sh/sst with c.gr. to gr. layers	Subtidal Estuarine-Bay Fill	
								x ~	light gray, partially bioturb.	Incipient Shoreface Bar	
1700								~			
								~			
								~	mottled lgt and dk. gray, occasional sst. laminate bed.	Bioturbated 'Muddy' Sandstone.	LOWER SHOREFACE
								~			
								~			
1703								~			
								~			
1706								~			

CORE INTERVAL 1717-1735 (Rec 18m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE v.f. f. Ec. v.g. g.d. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1717					 sk.	light olive-gray, good ϕ	SHALLOW CHANNEL-BAR COMPLEX ESTUARY-FILL STAGE 'H'
1720					 occasional shaly partings		
					 massive Fe-mudst. pebble rip-ups		
1723					 interlayered c.gr. to gran. N.S.	Channel Base	
					 mottled olive/lgt. gry. 80% sd	Biot. 'Muddy' Sst.	
1726					 Te. interlayered lgt. gry sst and dark gry. shale	Interbedded Sst.-Shale	SUBTIDAL ESTUARINE BAY FILL
1729					 Te. mottled	Biot. 'Muddy' Sst.	
					 Te. interlayered	Interbedded Sl.-Sst.	
1732					 Te.		
1735					 Te.		

WELL NAME Westcoast Bluesky Crystal (10cm diameter, unslabbed)

1698-1698.25 (Rec 0.25m)

LOCATION 14-11-46-4W5

CORE INTERVAL

1698.25-1716.5 (Rec 17.6m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1698				mud			
1701						dark gray	
1704							
1707							
1710							
1713							
1716							

CORE INTERVAL

1712-1730.2 (Rec 18.2m)
1730.2-1731.05 (Rec 0.85m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1712					X	Interlam Edst. - mudst.	Tidal Shelf Sand
1715					massive	light olive-gray to light gray	Trans. lag?
1718					coaly partings		SHALLOW CHANNEL-BAR COMPLEX
1721					very high ϕ light. olive-brn.		
1724					N.S.	mottled light. olive gray/dk. gray to alternating light. olive-gray and dark gray	CHANNEL STAGE 'B' and 'C' Equivalents
1727					N.S.	light gray, shaly partings	
1730							STAGE 'A'
1733							

WELL NAME Westcoast et al. Ramberg (8 cm diameter; Slabbed)LOCATION 8-12-46-4W5CORE INTERVAL 1721-1734 (Rec 12.7m)
1734-1752 (Rec 17.35m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION			
			20	15	10	5							
1721							mud		bimodal; clasts to 0.6 cm, f. to m. gr. sst.	CHANNEL BAR	CHANNEL STAGE 'C'		
									light gray				
1724									floating buff-weather chert pebs.				
									light gray				
									light olive-brown, good ϕ				
1727								massive	buff-gray	Channel Cycle #2	CHANNEL STAGE 'B'		
								massive	high ϕ				
1730													
1733									light to med. gray	Fining Upward Channel Cycle #1			
									c. gr. to granular				
1736								massive	light olive-brown, highly porous.				
1739									buff-chert, granules increase \downarrow				
									clasts 0.3 to 0.7, clast-support, sd. matrix				
1742									light olive-brown high ϕ	Channel Stage Transition	CHANNEL STAGE 'A'		
									olive-brown, periodic granule to fine pebble layers. Rounded Fe-mudst and coal clasts				
1745								massive	clasts 0.2 to 0.7 cm, clast-support, sand matrix				
									N.S.				
1748									dark gray	OFFSHORE-TRANS.			

WELL NAME Focus ET 91. Wintield (10cm diameter; slotted)LOCATION 11-12-46-4W5

CORE INTERVAL

5565-5585 (Rec 20')

5585-5586 (Rec 0.7')

5596-5616 (Rec 30')

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. E.C. v.g. D.	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
5570					0	black	SHELF MUDSTONE
5580					x 6" ~	lgt. gray	Trans. Lag? Fine-gr. 'shaly' Sst.
5590						lgt. olive brown high ϕ	F. to M. gr. Sst.
5600						lgt. buff-gray, shale partings common	Fine-gr. 'shaly' Sst.
5610						lgt. brown-gray high ϕ	F. to M. g. Sst.
						mottled light and dark gy. to interlayered	Subtidal Estuary Bay

Estuary Fill Stage 'H'

WELL NAME WESTCOAST CT at Crystal (10cm diameter, unslabbed)

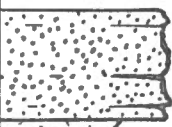

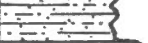

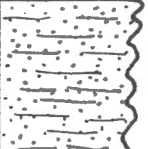
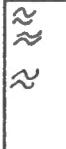
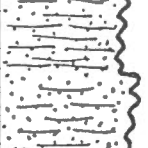

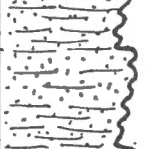

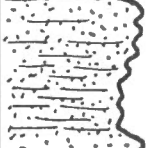

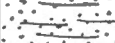

LOCATION 8-13-46-4W5

CORE INTERVAL

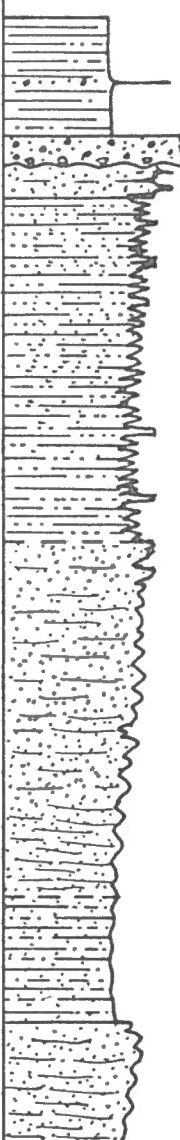
1692 - 1699.25 (Rec 6.2m)
1699.25 - 1701 (Rec 1.75m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
			20 15 10 5				
1692						interlayered light s.f. to f-gr sst. and dk. gry. mudst.	Subtidal Estuarine Muddy Facies
1695							
1698						N.S. light gray c. gr. to granular, with several 0.5-2cm. size mudst. rip-up clasts	Channel Edge CHANNEL STAGE 'B'
1701						light gray, numerous shaly partings	
							Channel marginal bank depts.

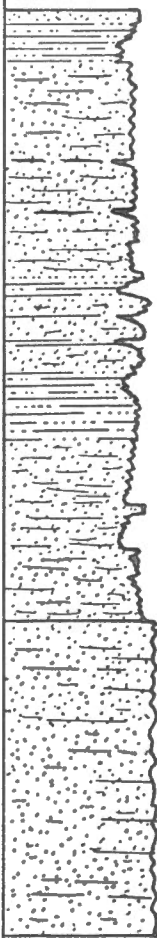
WELL NAME Westcoast ET at CrystalLOCATION 16-13-46-4W5CORE INTERVAL 1732-1750 (Rec 17.1m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE f. s. c. g. d. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1732						light olive-gray shaly partings and rip-ups N.S.	Fine-Grained 'shaly' sst. STAGE 'B'
1735						dark gray	OFFSHORE-TRANS.
1738						mottled olive gray/ 70% sd. med. gry Te. 45% sd 60% sd.	CYCLIC BIODTURBATED 'MUDDY' SANDSTONE DEPTS. LOWER SHOREFACE
1741						mottled olive gray/ dk gray	
1744						70% sd 40% sd 65% sd	
1747						25% sd. dark gray	
1750							Base Viking Fm.

WELL NAME Ducsky et al Crystal (8cm diameter; unslotted)LOCATION 8-15-46-4 W5 CORE INTERVAL 1704-1722.2 (Rec 18)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION	
			20	15	10	5					
1704									dark gray	SHELF	
1707								X	buff-gray, high ϕ	Transpressive Lag STAGE 'H' Sand	
1710								0 - Te - V 0 - Te. - 0 - - ~	interlayered light gray sst and dk. gry mudst. 80% sd. layers in top to 45% in base	Laminated To Bioturbated Sandstone-Mudst.	
1713								~ Te ~ Te ~ ~ ~	80% sd. mottled olive-gry/ med. gry	Bioturbated 'Muddy' Sandstone	LOWER SHOREFACE
1716								~ ~ ~ ~ ~ ~ ~	mottled dark/light gry.		
1719								~	dark gray	Biot. 'Sandy' Mudst.	OFFSHORE- TRANSITION
1722								~ Te. ~	mottled dark and light. gray.	Biot. 'Muddy' Sst.	

WELL NAME vesicuaqi ci al. crystal (10cm diameter; unslabbed)LOCATION 6-24-46-4W5CORE INTERVAL 1708.75-1723.75

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE v.f. v.l. E. v.c. v.g. p. mud	SED. STRUCTURES	REMARKS	FACIES AND INTERPRETATION
1708					~	Interbeds: 1) Bioturbated 'Muddy' Sandstone 2) Interbedded Sst.-Mudst.	SUBTIDAL ESTUARINE MUDDY FACIES
1711					~ ~		
					~ ~		
					~		
1714					~		
					~ ~		
1717					~ ~		
					~		
1720					~	Partially- Bioturbated 'shaly' Sandstone	SUBTIDAL ACCRETIONARY Channel Margin CHANNEL STAGE 'A' →
1723					~		

APPENDIX II

Depth plots of core-analysis data
from selected well cores

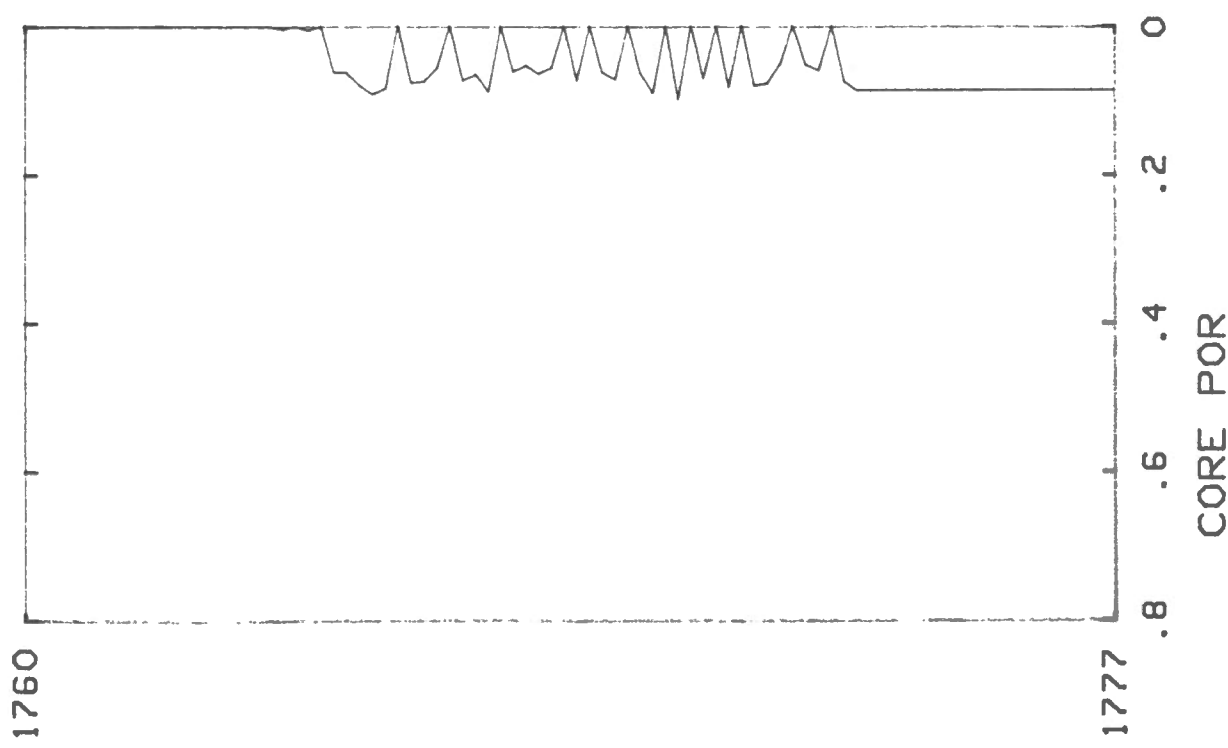
WELL NAME Decalta et al Crystal (4" diameter jumbo bed)

LOCATION 14-20-45-3W5

CORE INTERVAL 1763.25-1781.25 (Rec 18.0m)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. E.C. v.g. D.	SED. STRUCTURES	FACIES		
1763								
1766								
1769								
1772								
1775								
1778								
1781								

14-20-45-3W5

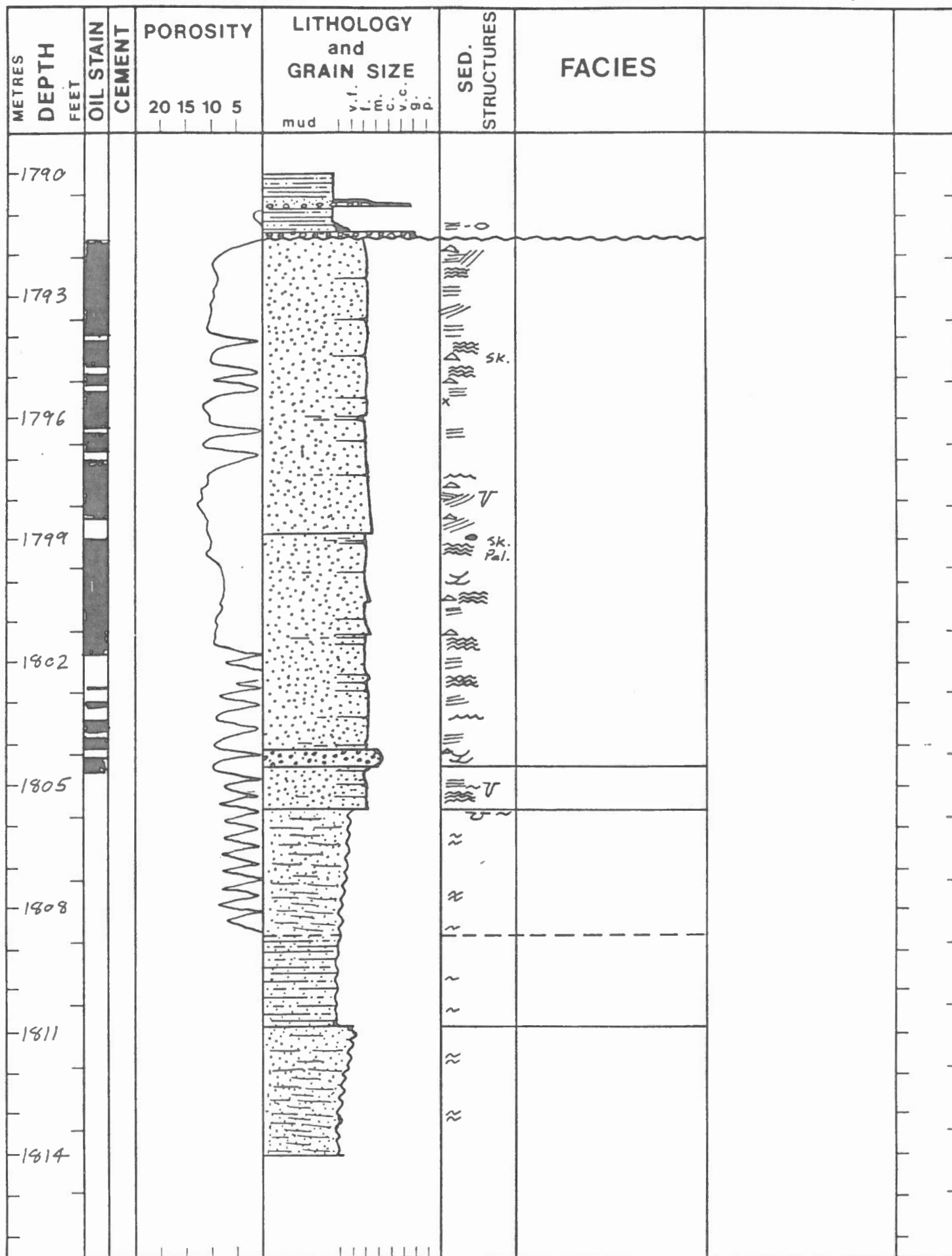


DEPTH

WELL NAME WESICOASI 21 91 crystal 17 diameter; UNSIA 2000

LOCATION 2-31-45-3W5

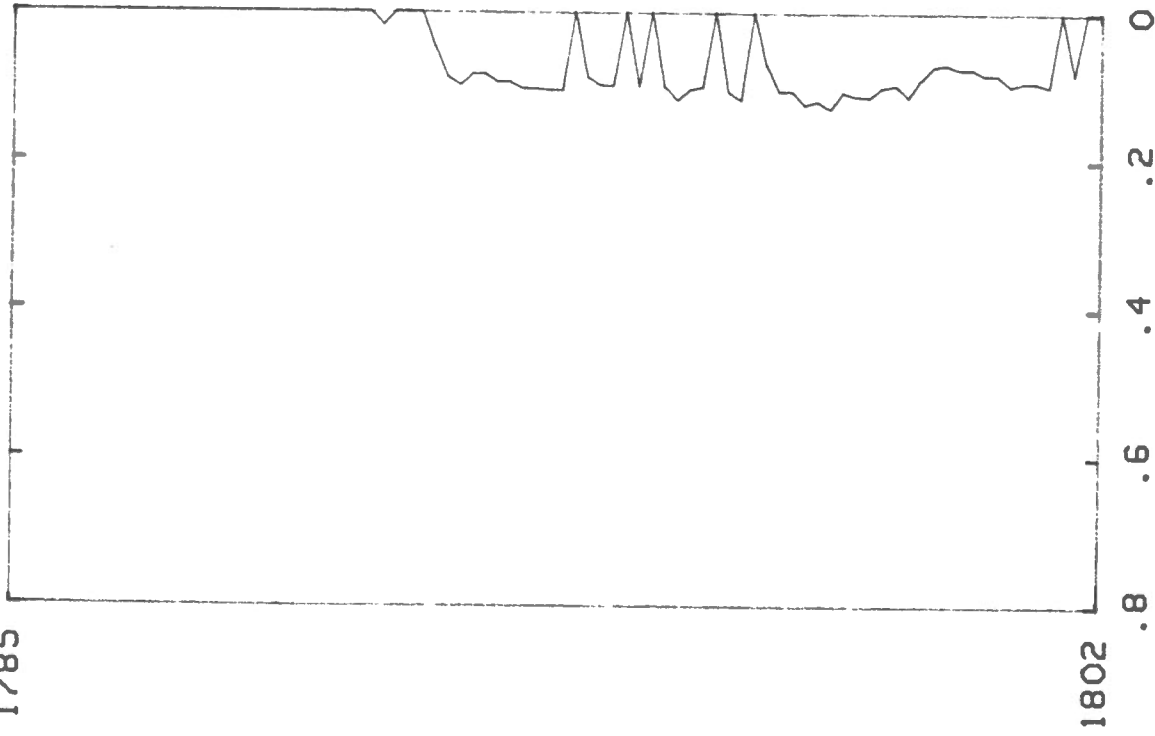
CORE INTERVAL 1790-1799 (Rec 9.0m)
1799-1814 (Rec 15.0m)



2-31-45-4W5

1785

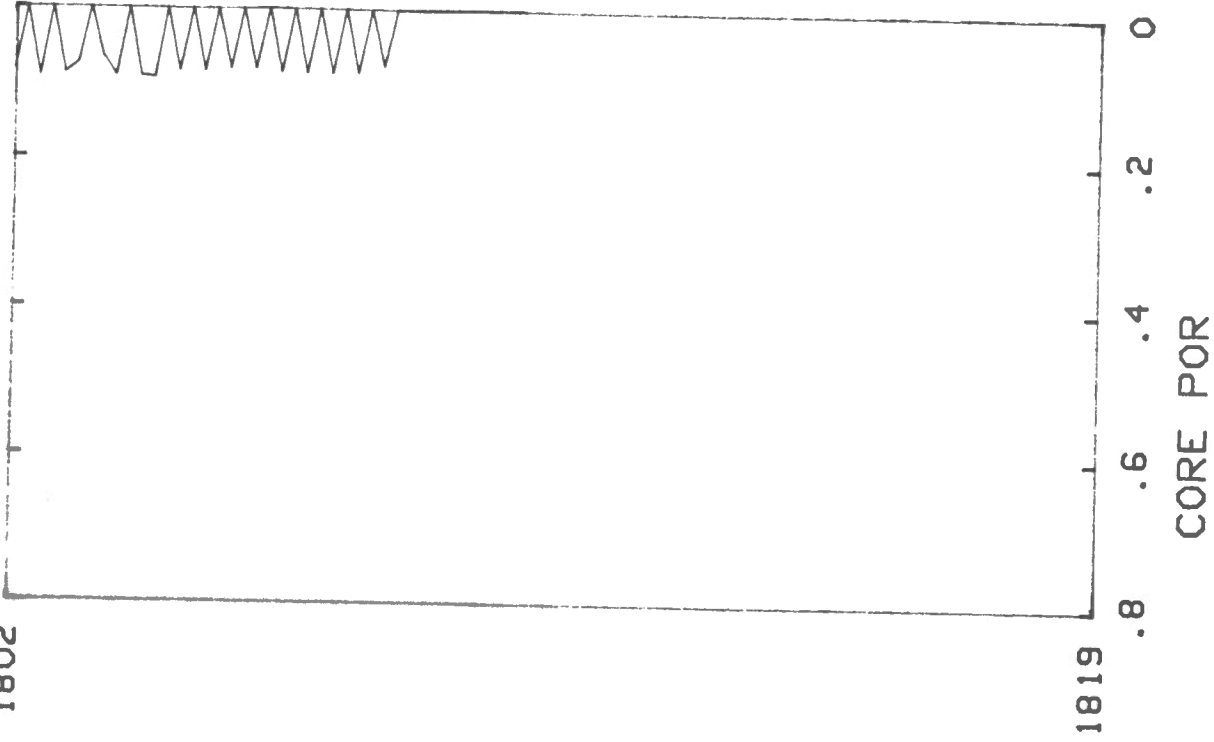
DEPTH



2-31-45-4W5

1802

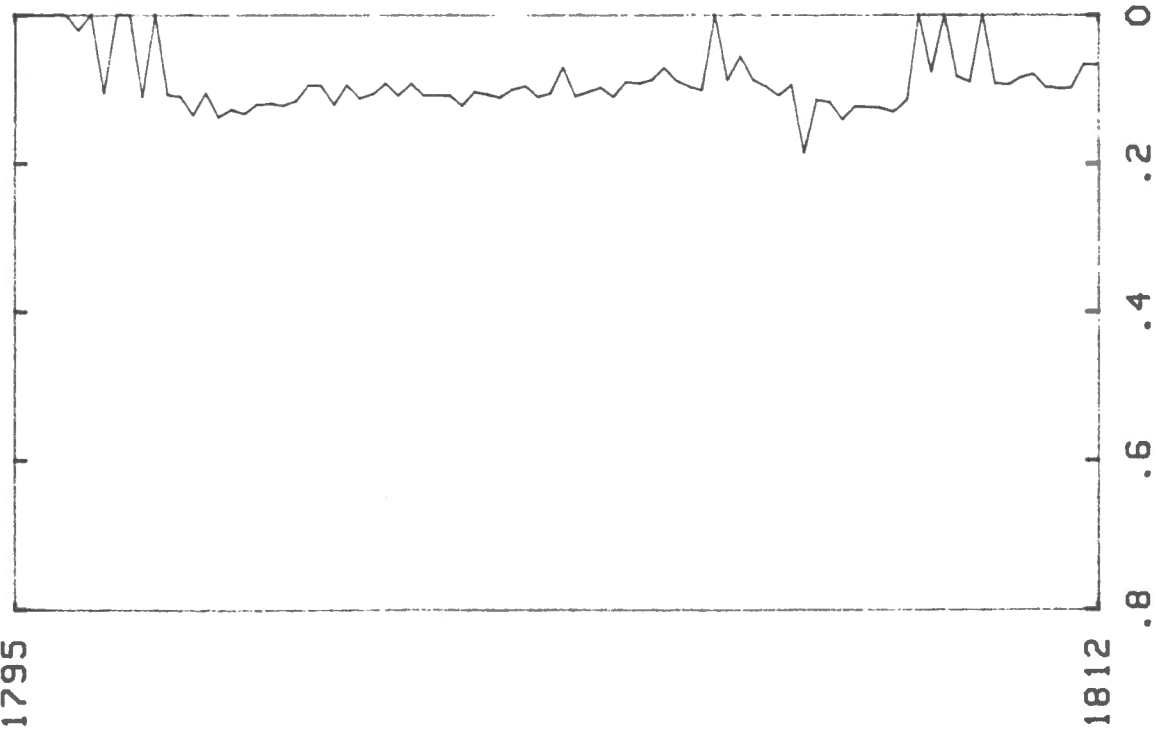
DEPTH



12-31-45-4W5

1795

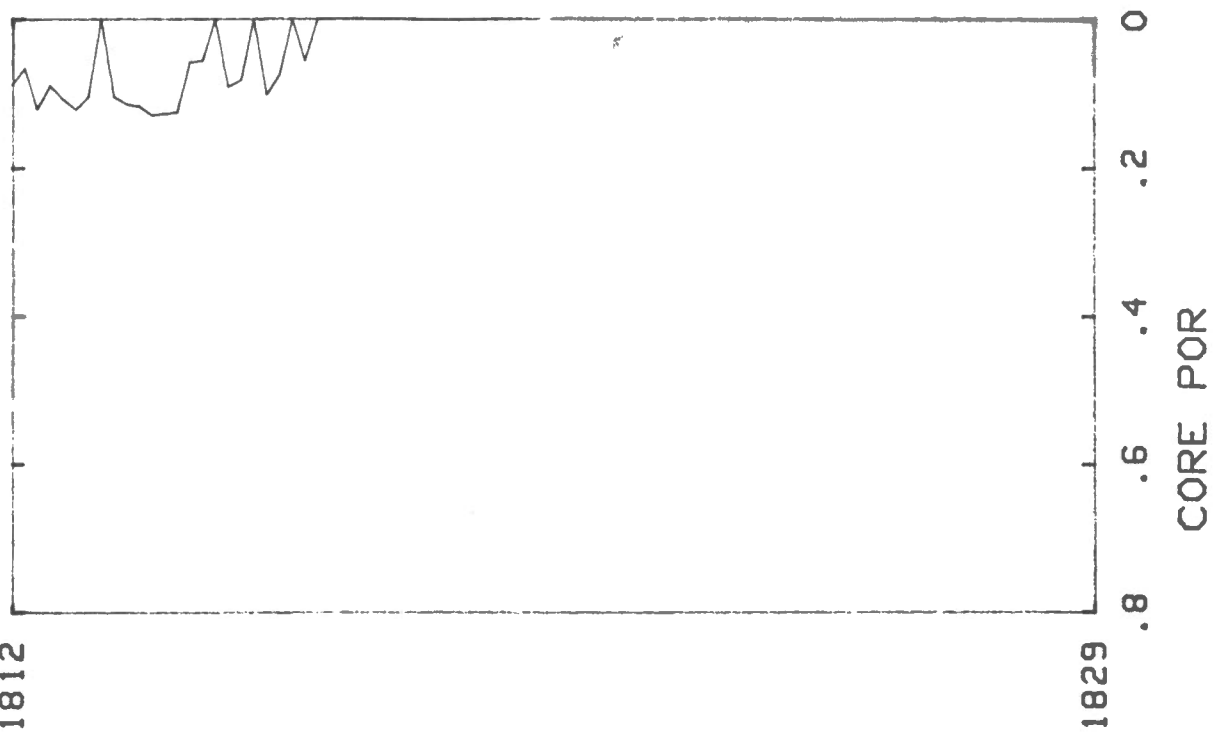
DEPTH



12-31-45-4W5

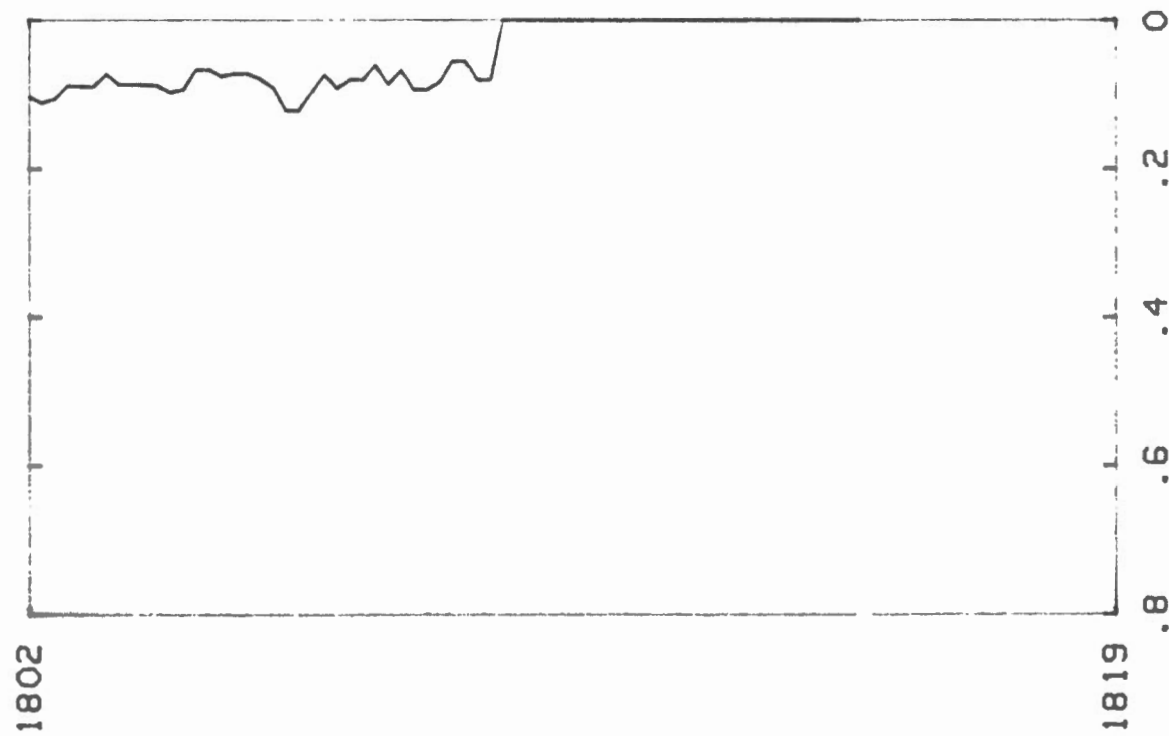
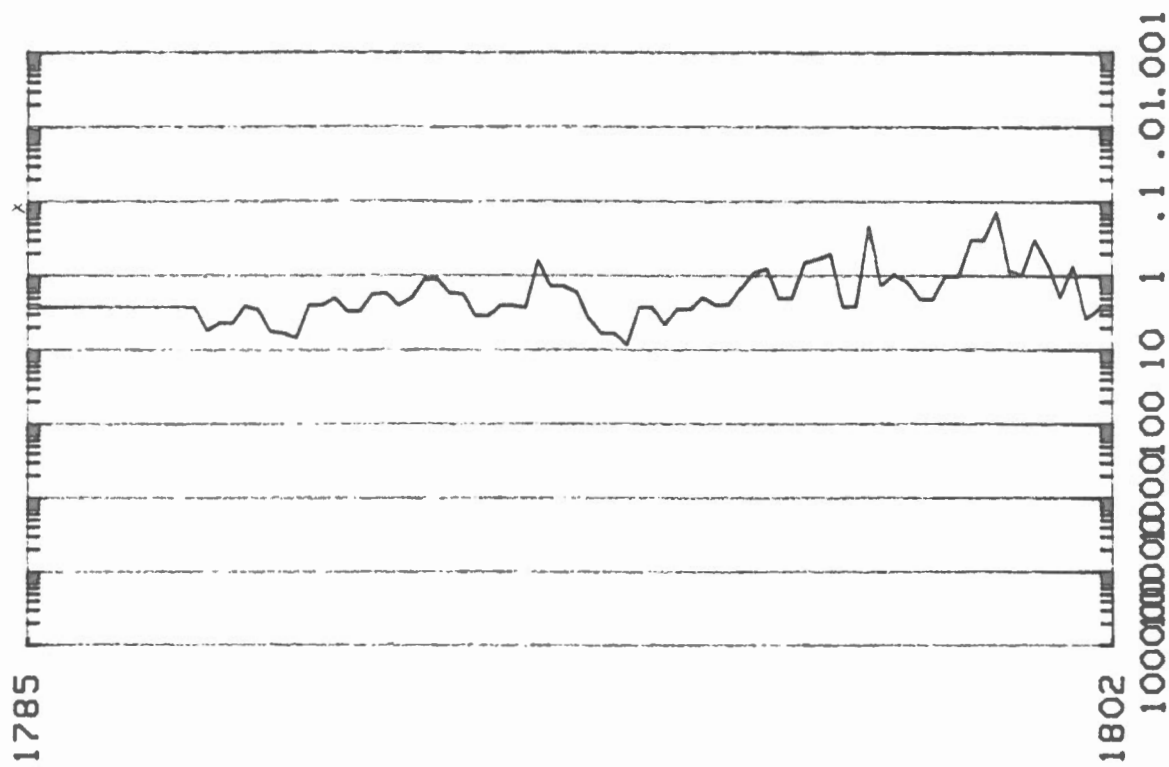
1812

DEPTH



$$\begin{array}{r} 1785.5 - 1790 \\ 1790 - 1808 \\ \hline 1808 - 1809.5 \end{array}$$
[illegible]

16-24-45-4W5



WELL NAME Retrocon Murphy Crystal

LOCATION 14-36-45-4W5

CORE INTERVAL 1773-1791; 1791-180

METRES DEPTH	FEET	OIL STAIN	CEMENT	POROSITY	LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	FACIES
				20 15 10 5	mud		
1774							
1777							
1780							
1783							
1786							
1789							
1792							
1795							
1798							

14-36-45-4W5

1770

DEPTH

1787

.8 .6 .4 .2 0

CORE POR

14-36-45-4W5

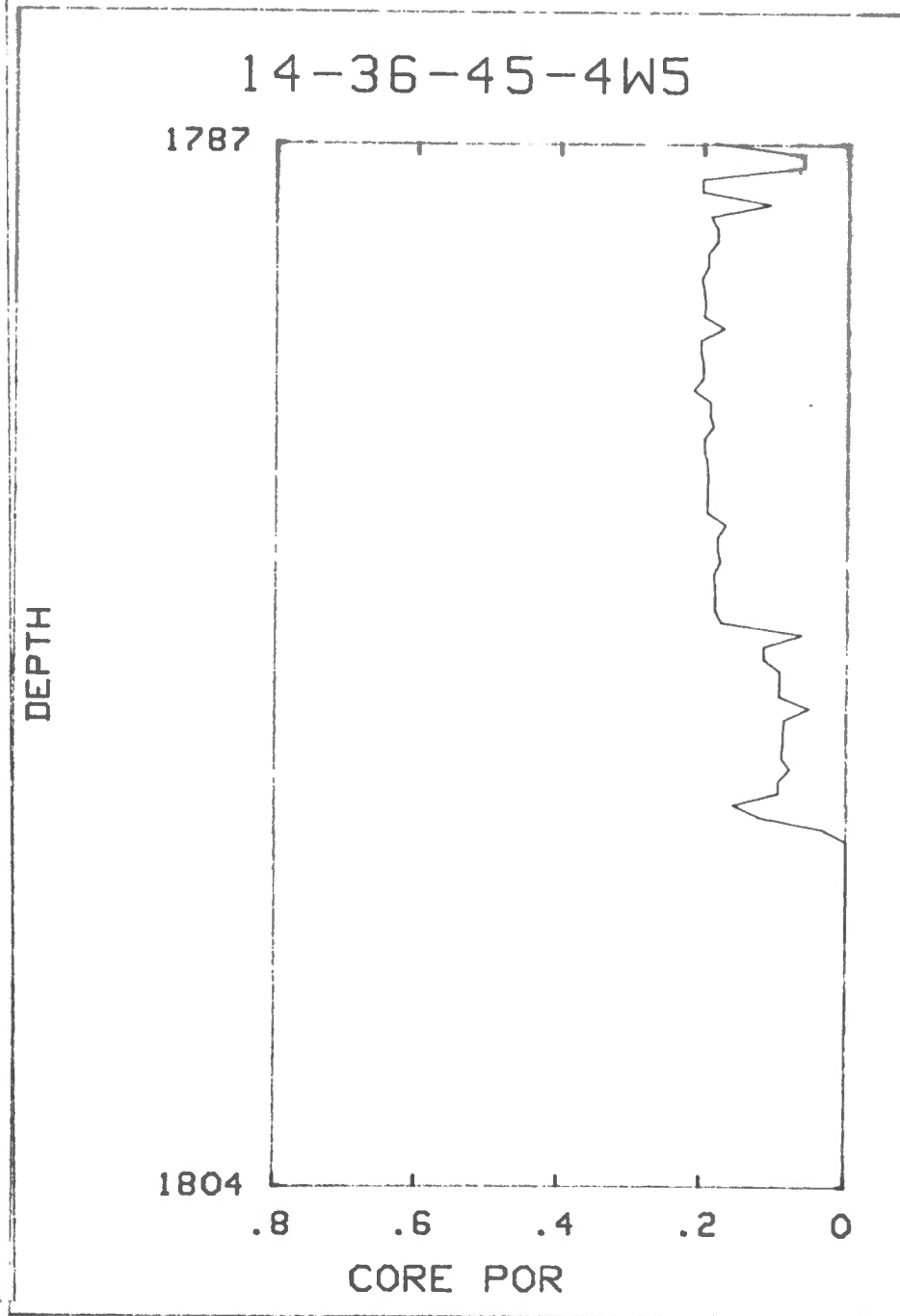
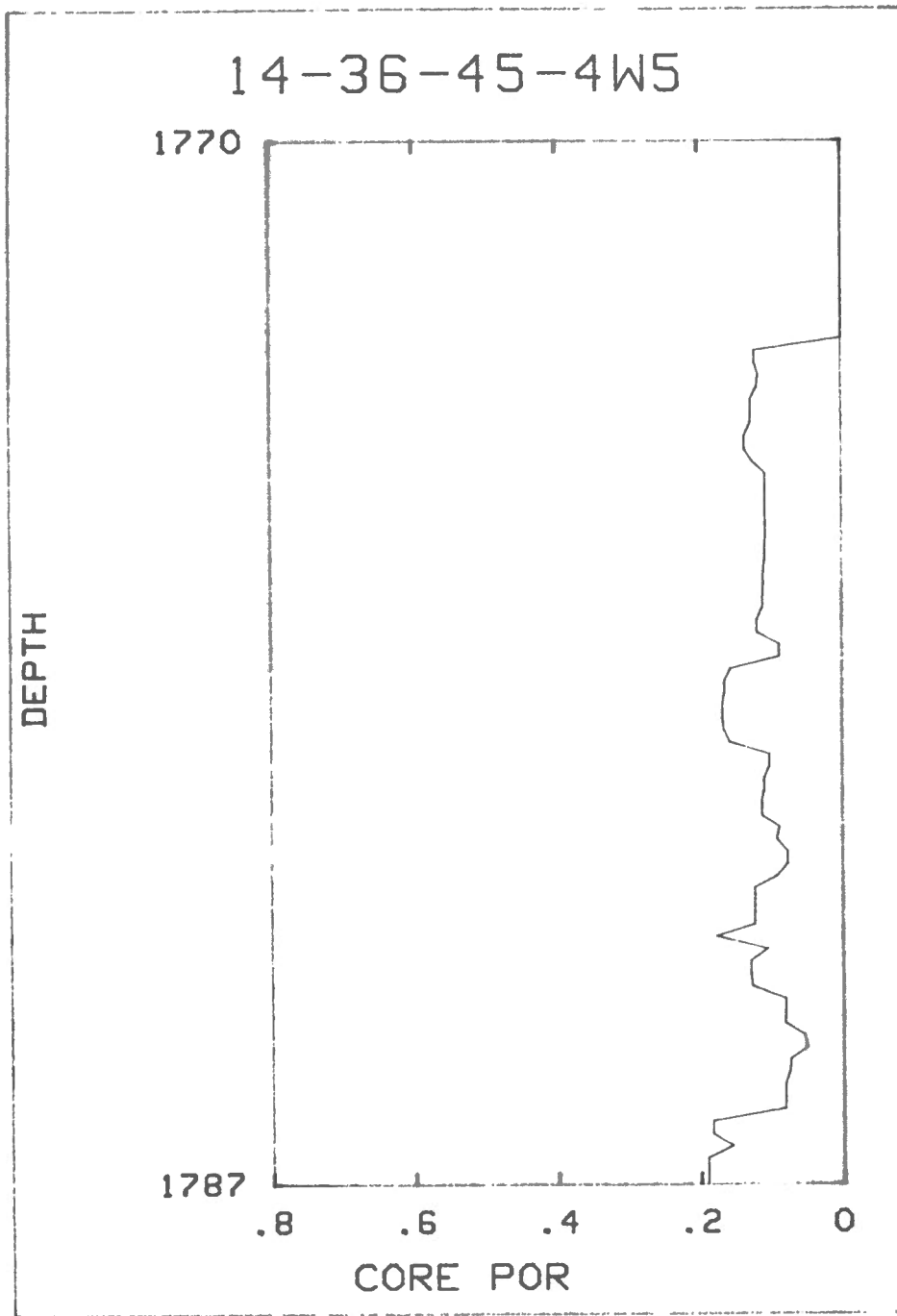
1787

DEPTH

1804

.8 .6 .4 .2 0

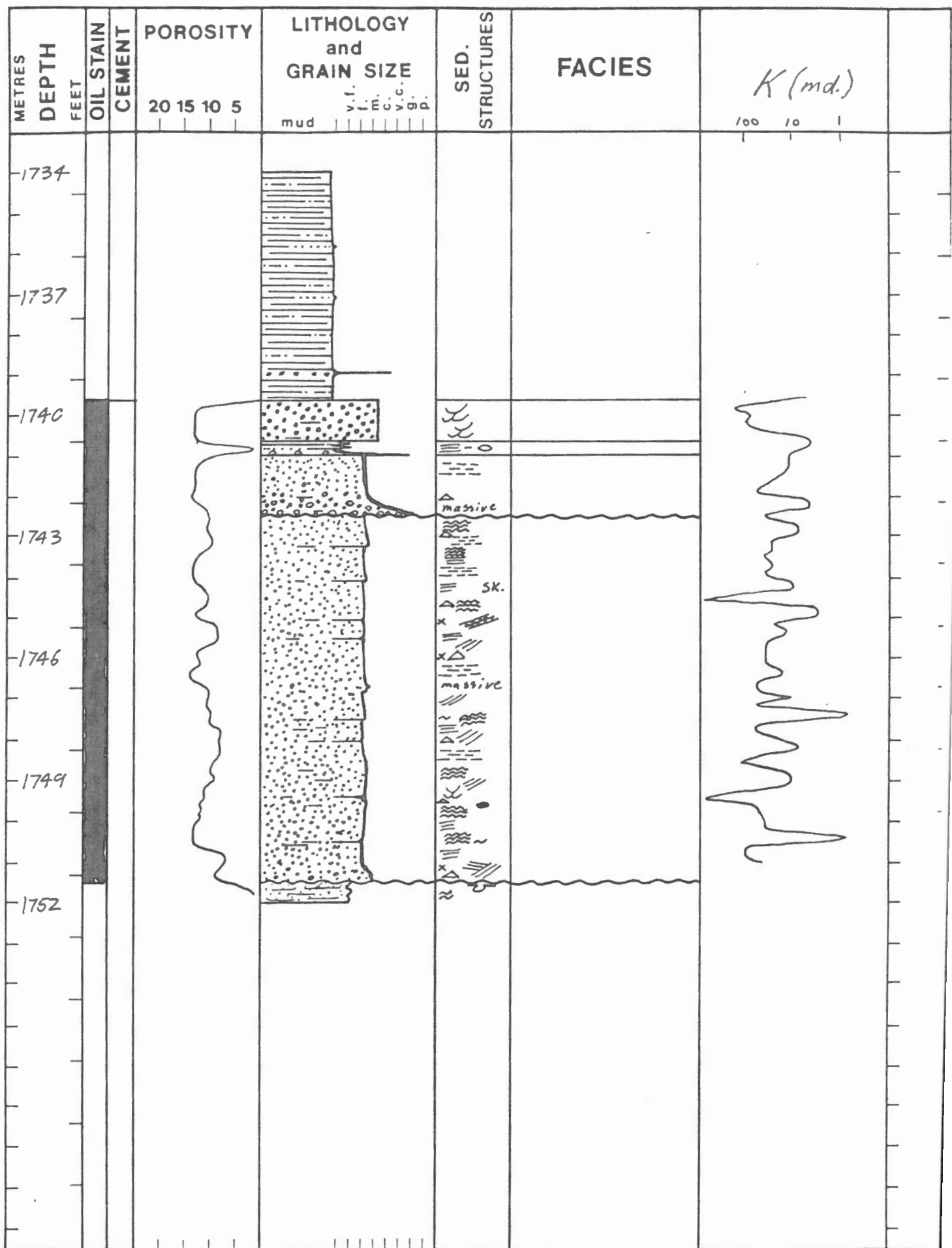
CORE POR



WELL NAME Westcoast et al Crystal (10cm diameter; partially slabbbed)

LOCATION 2-7-46-3W5

CORE INTERVAL 1734-1752 (Rec 18)

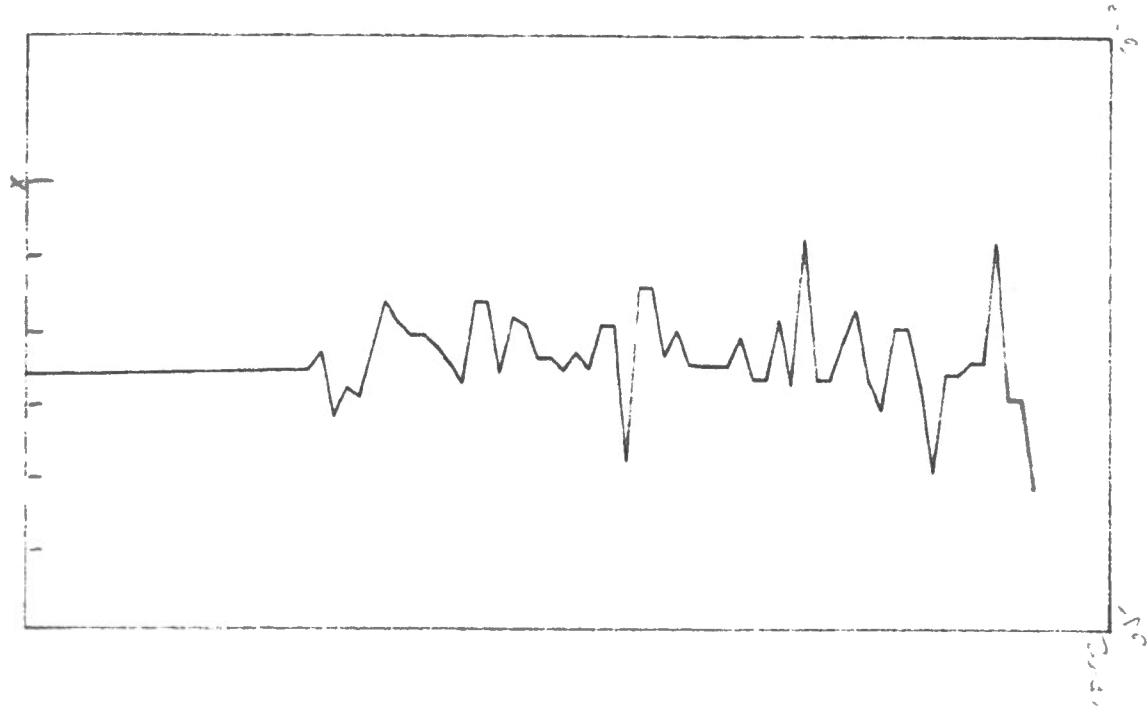
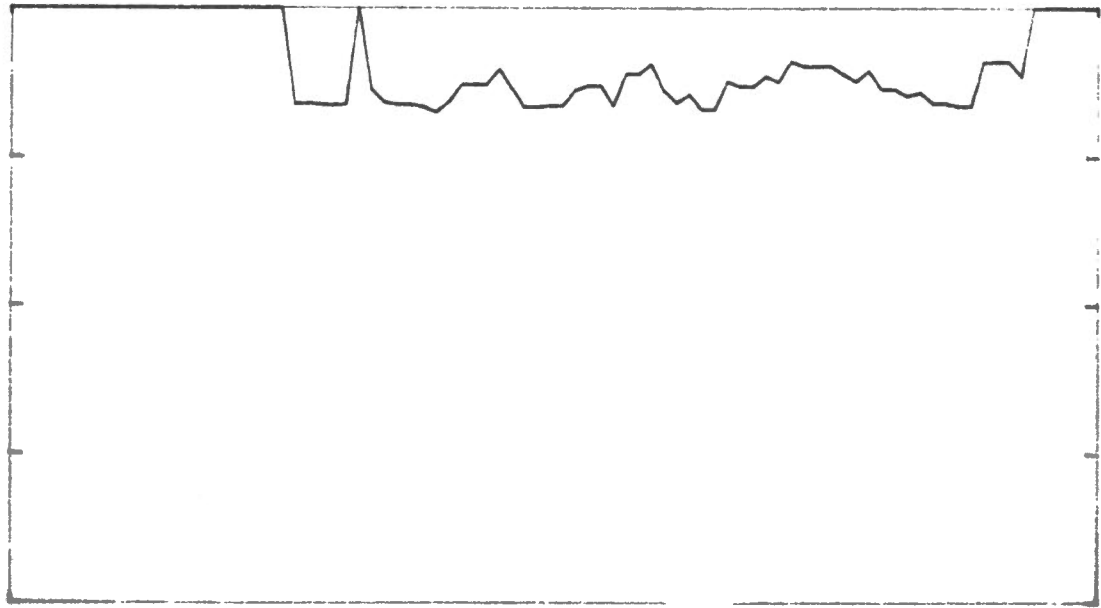


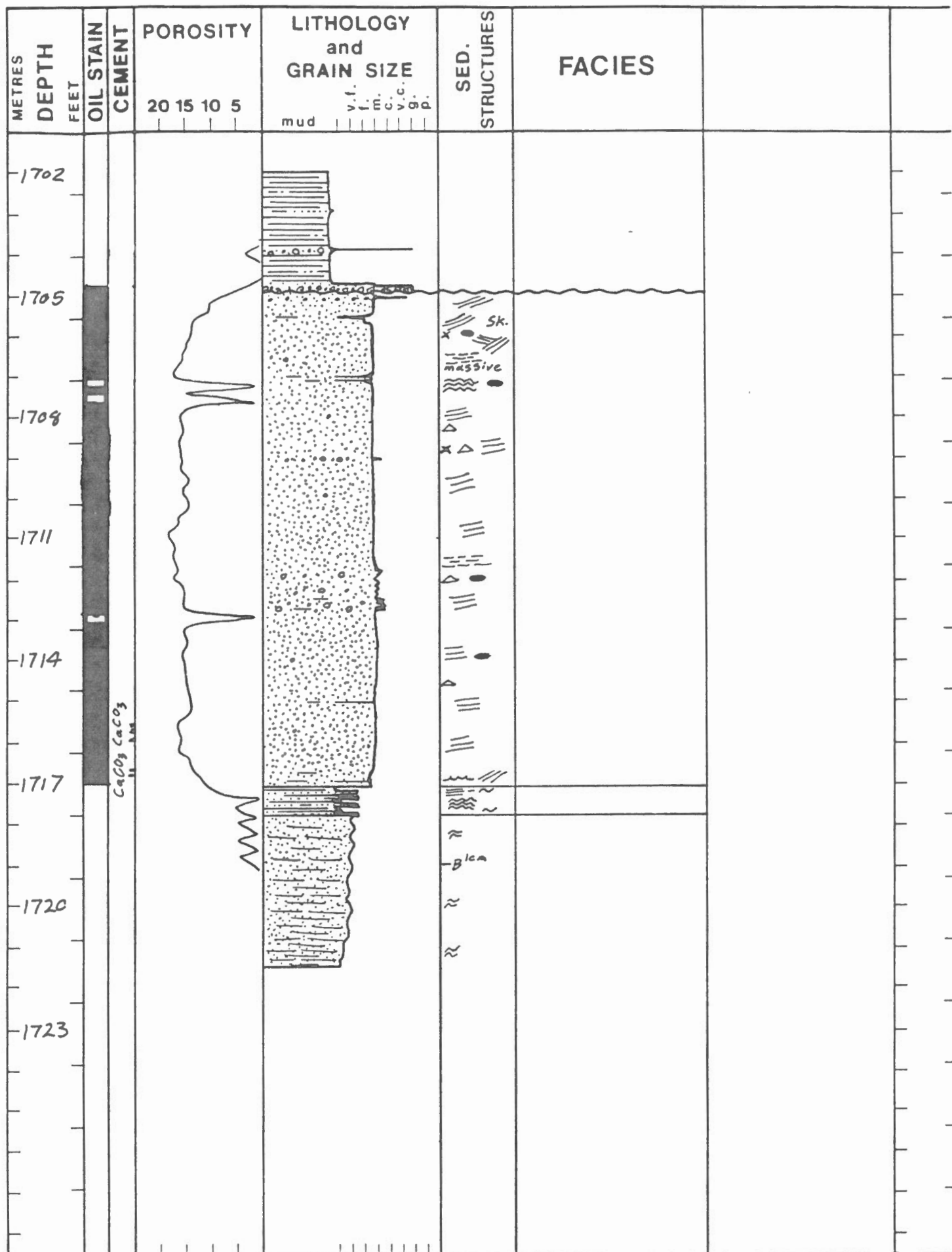
2-7-46-W5

1735

1752

.8 .6 .4 .2 0



WELL NAME Westcoast et al Crystal (10 cm diameter; unslotted)LOCATION 2-18-46-3W5CORE INTERVAL 1702-1705 (Rec 3.0m)
1705-1721.5 (Rec 16.5m)

2-18-46-3W5-12

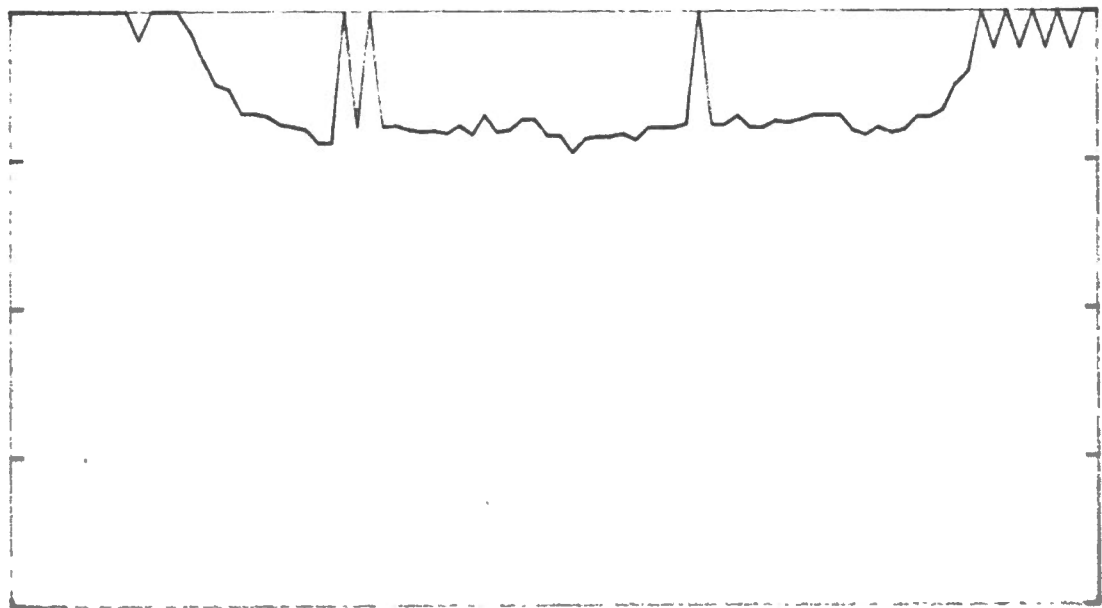
1702

DEPTH

1719

0
.2
.4
.6
.8

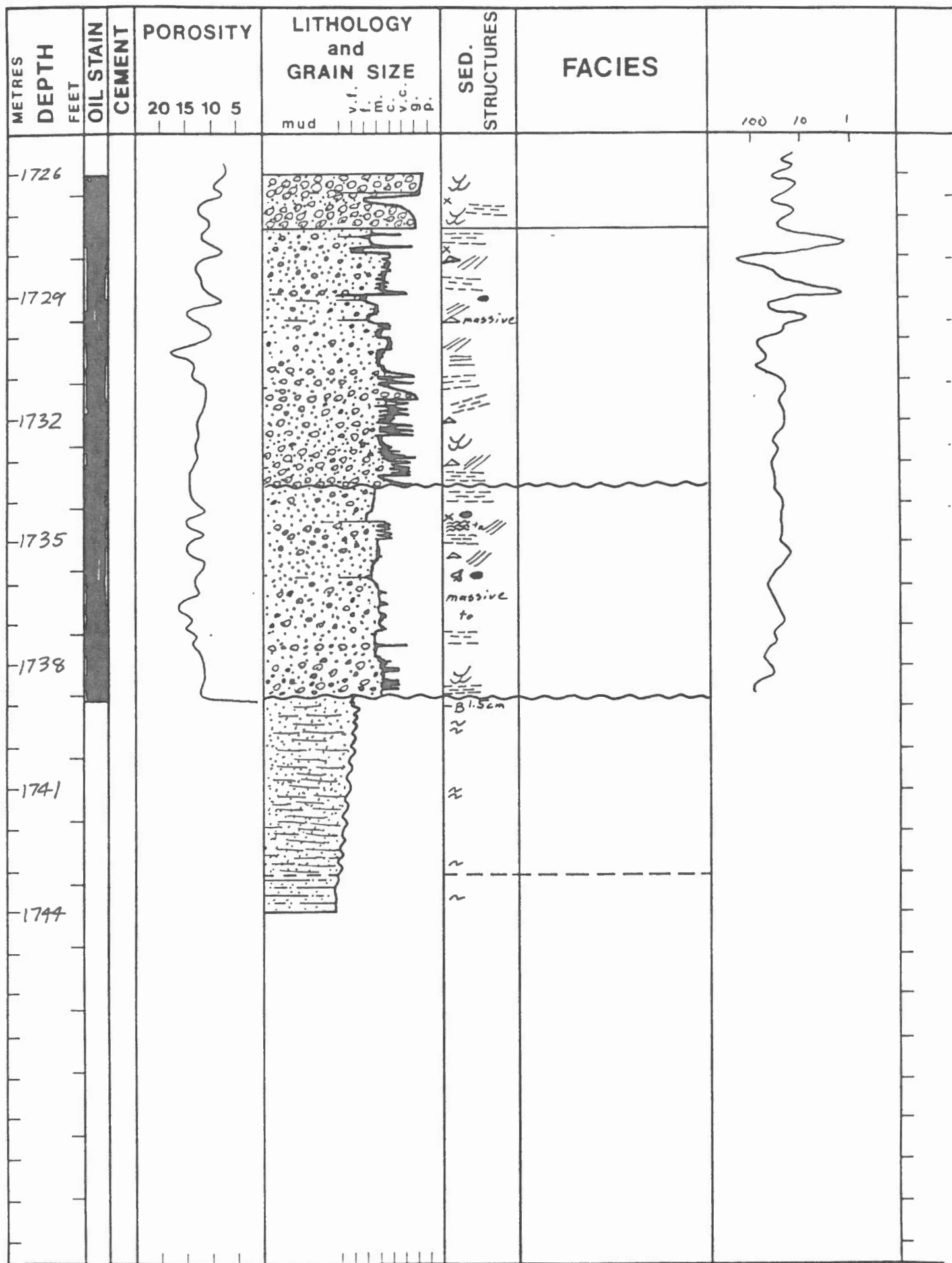
CORE POR

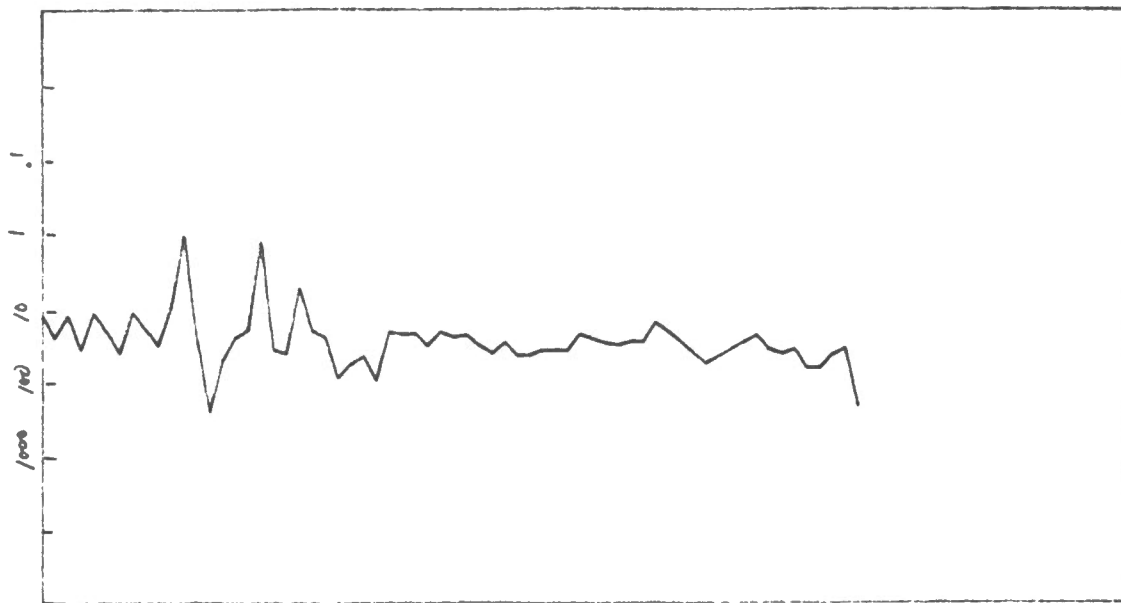
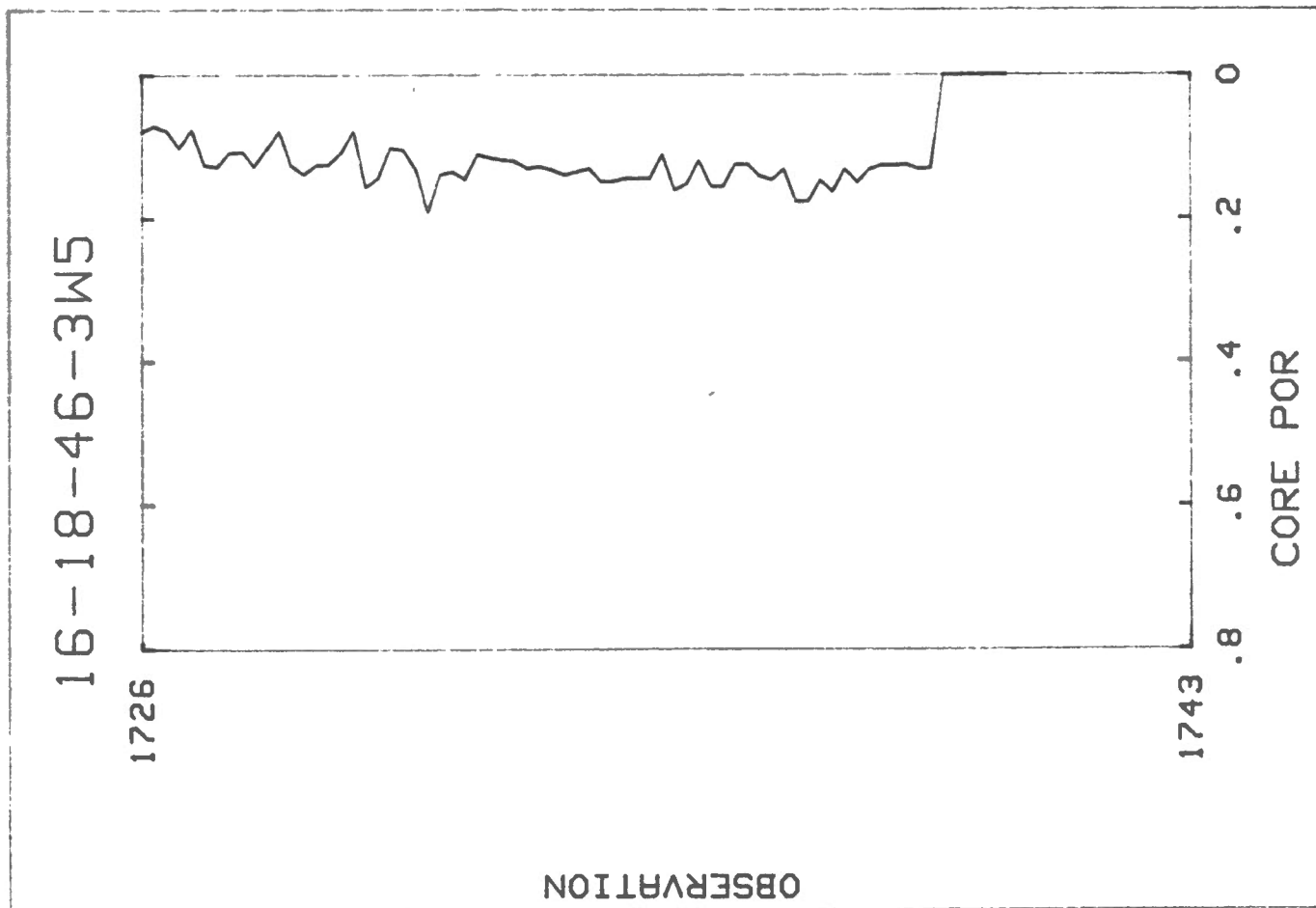


WELL NAME Westcoast et al Crystal (10 cm diameter; partially globbed)

LOCATION 16-18-46-3W5

CORE INTERVAL 1726-1744 (Rec 18m)

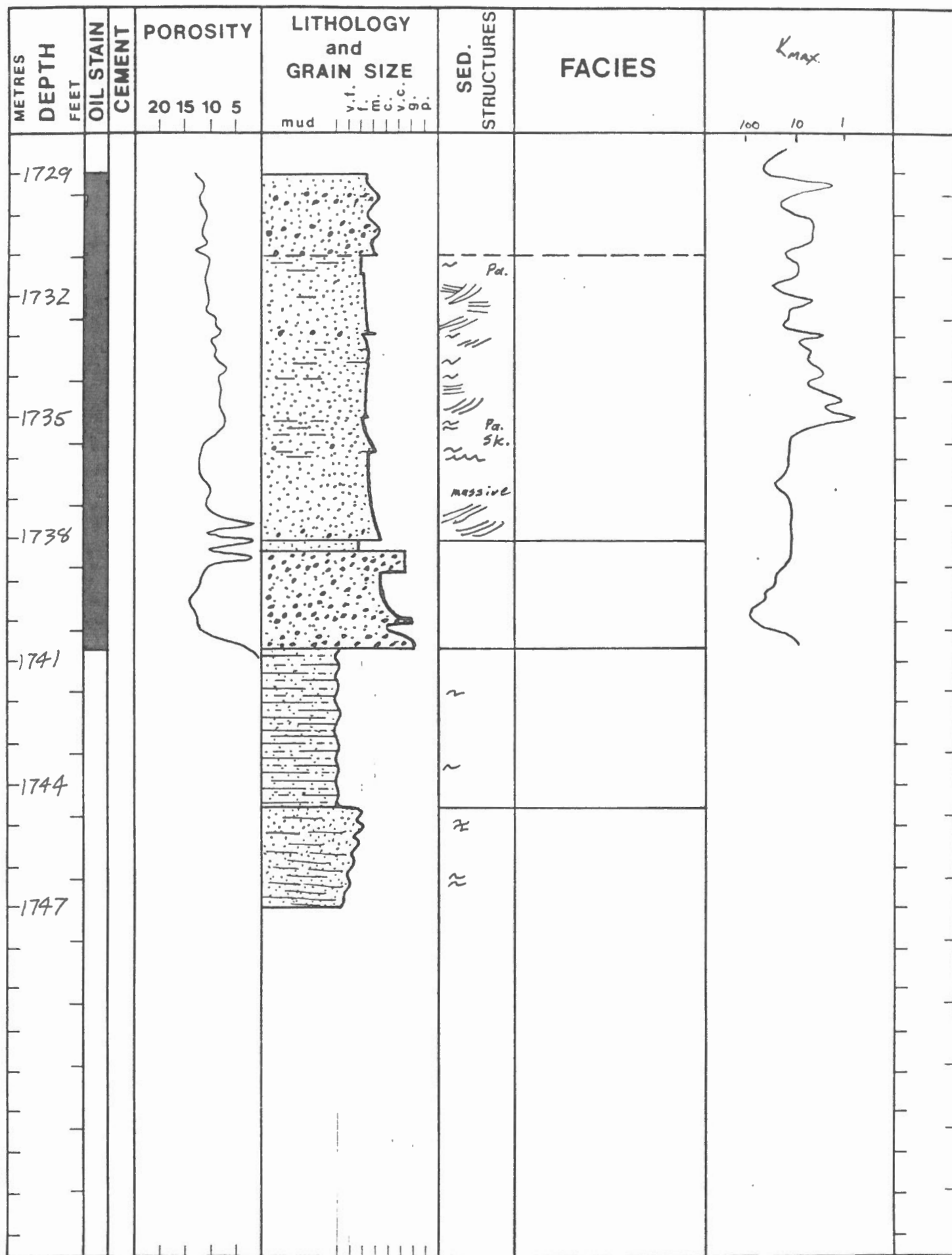




WELL NAME Westcoast OIL Crystal

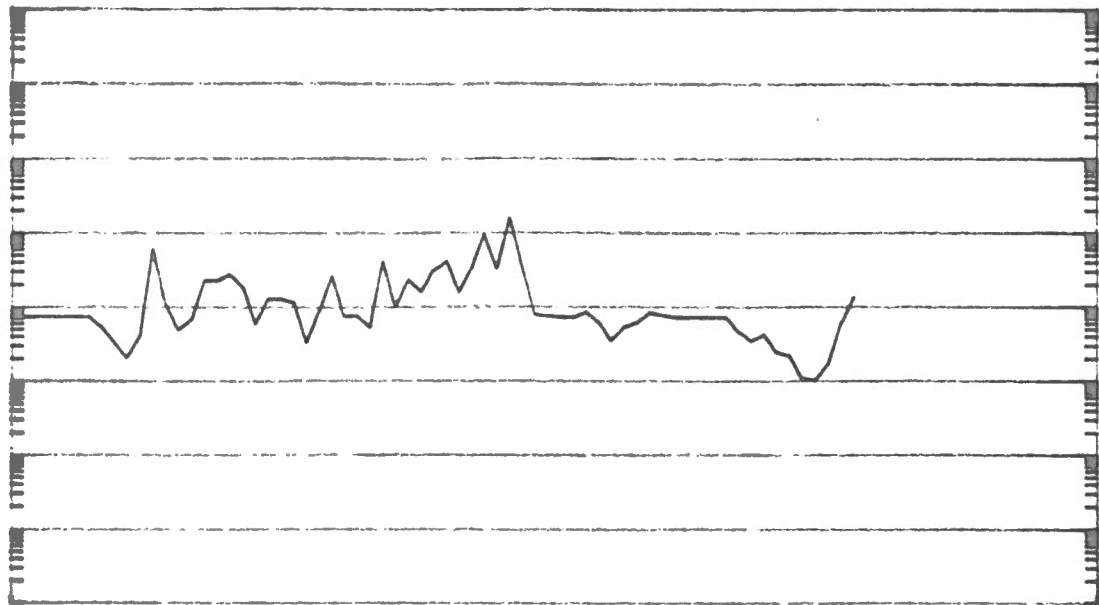
LOCATION 8-19-46-3W5

CORE INTERVAL 1729-1747



8-19-46-3W5

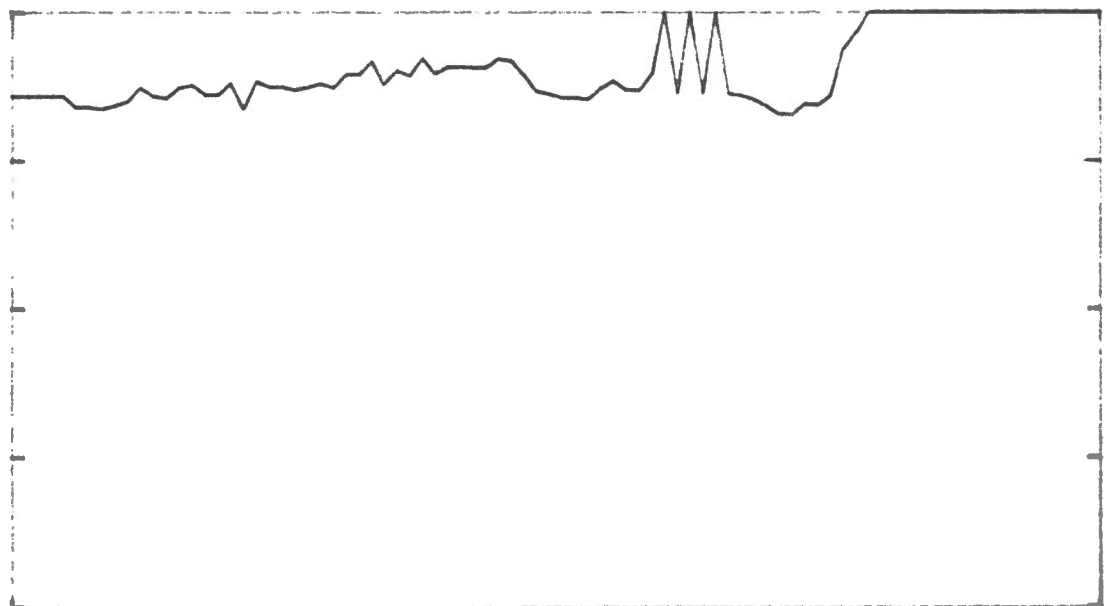
1728



1745

100 10 1 .1 .01 .001

1728

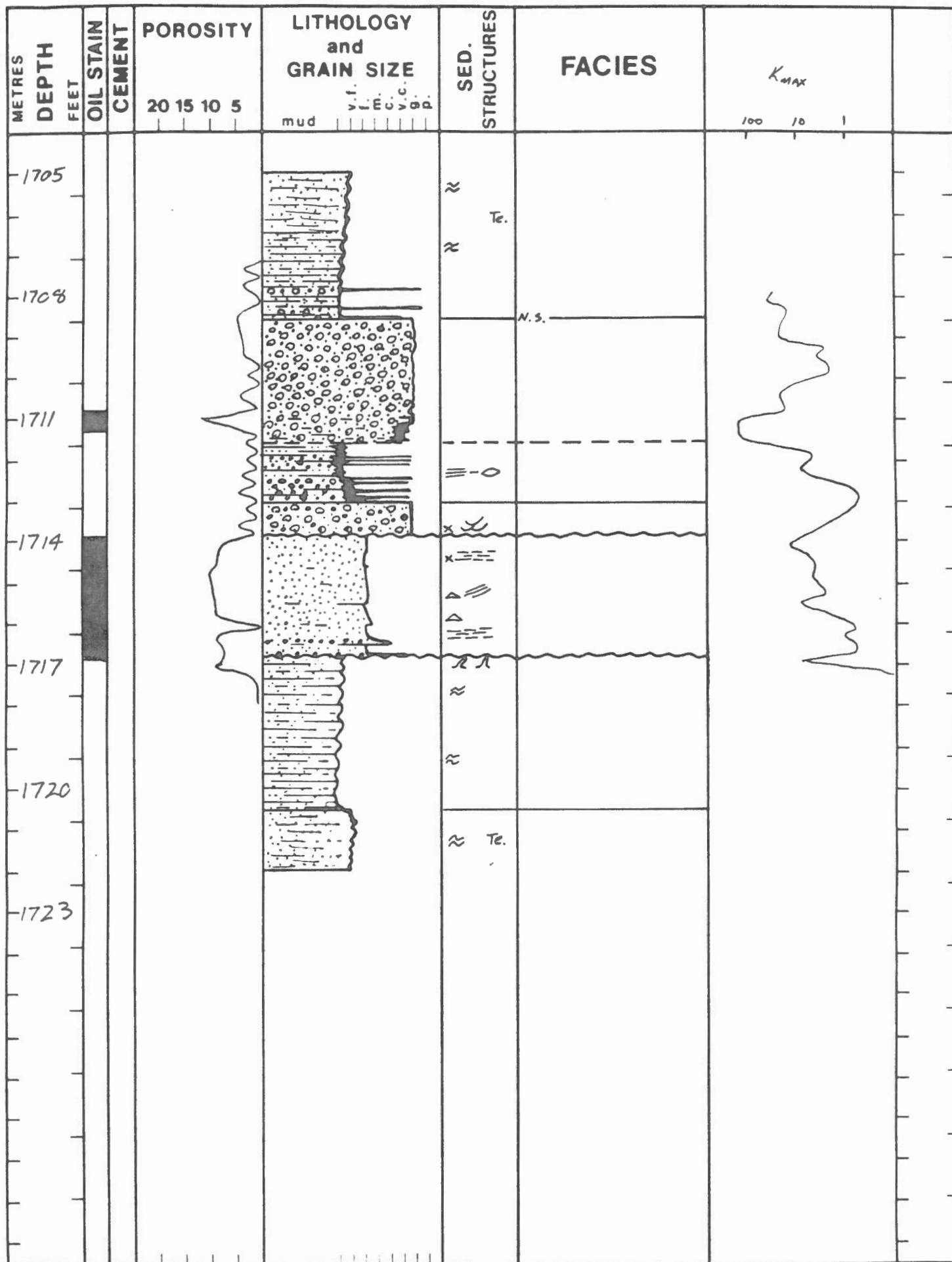


1745

.8 .6 .4 .2 0

WELL NAME WEST CORN 61 91 18/3141 17 11200000 142190000

LOCATION 14-19-46-3W5 CORE INTERVAL 1705-1721.9 (Rec 16.9)



6-20-46-3W5

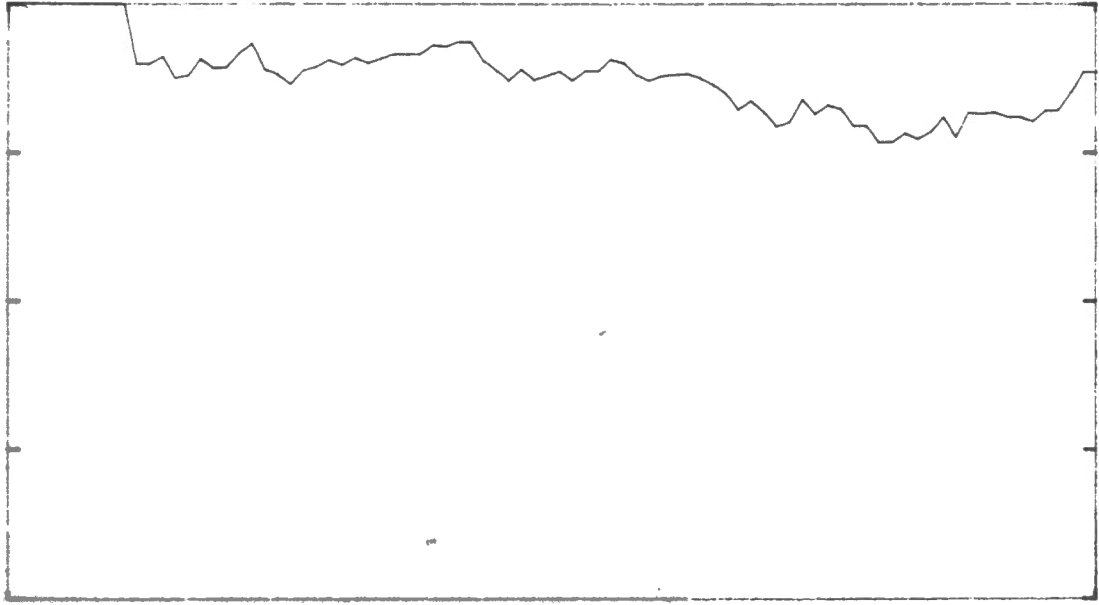
1718

DEPTH

1735

.8 .6 .4 .2 0

CORE POR



8-20-46-3W5

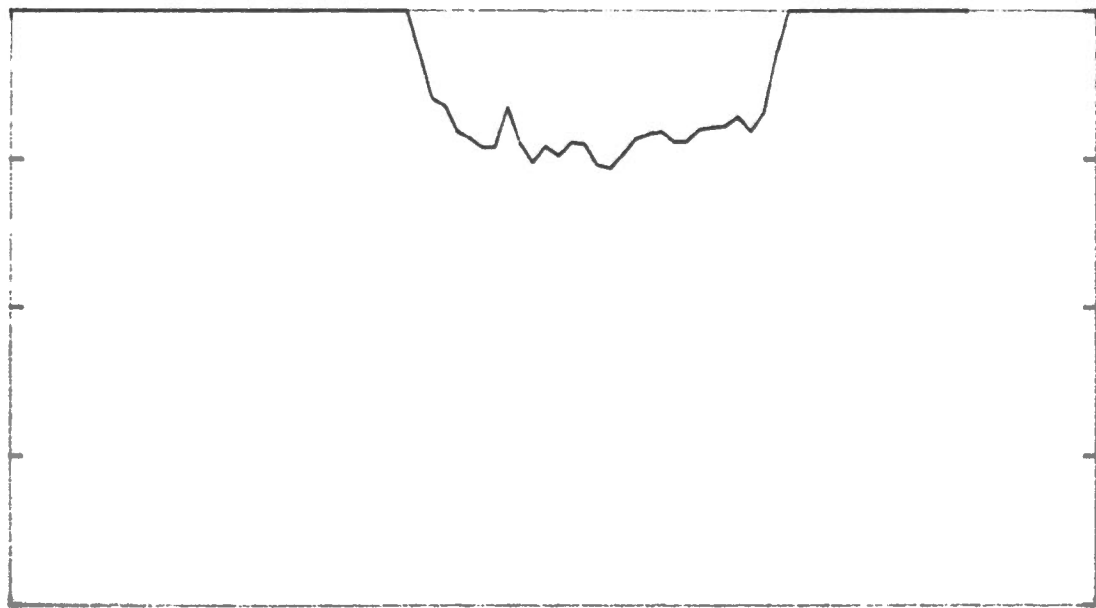
1710

DEPTH

1727

.8 .6 .4 .2 0

CORE POR

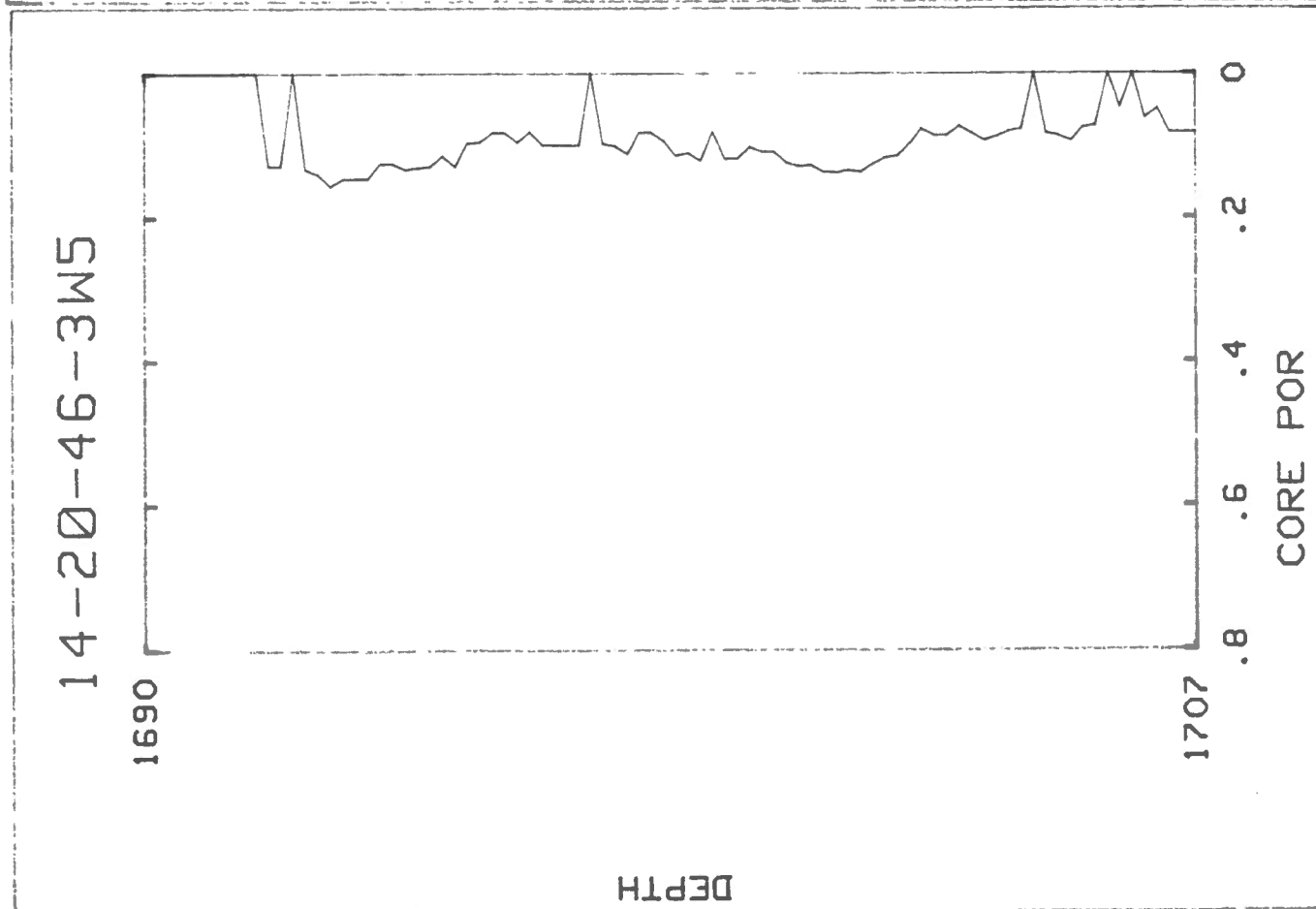
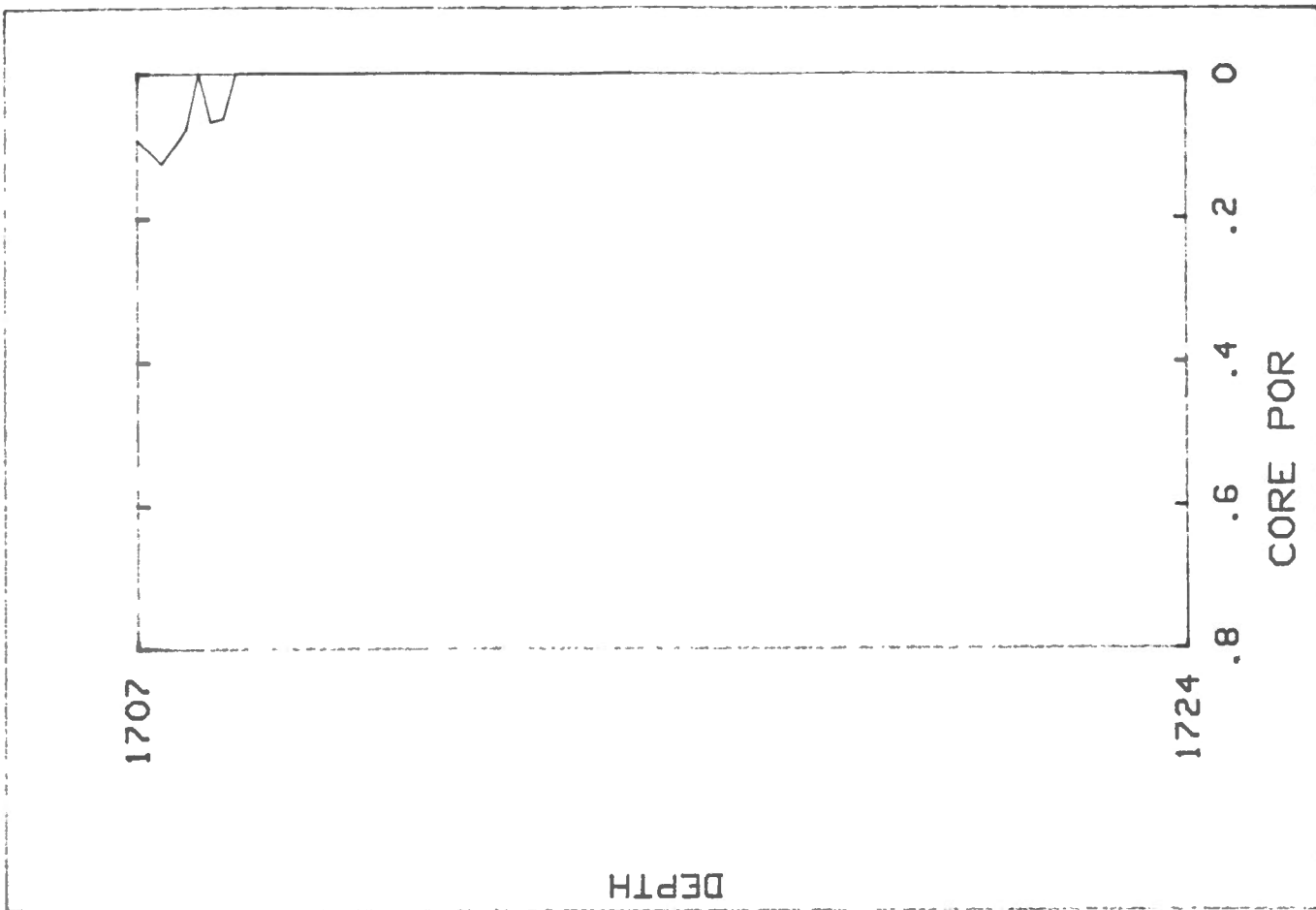


WELL NAME Westcoast et al Crystal (10cm diameter; partially slobbered)

LOCATION 14-20-46-3W5

CORE INTERVAL 1692-1710.2 (Rec 176)

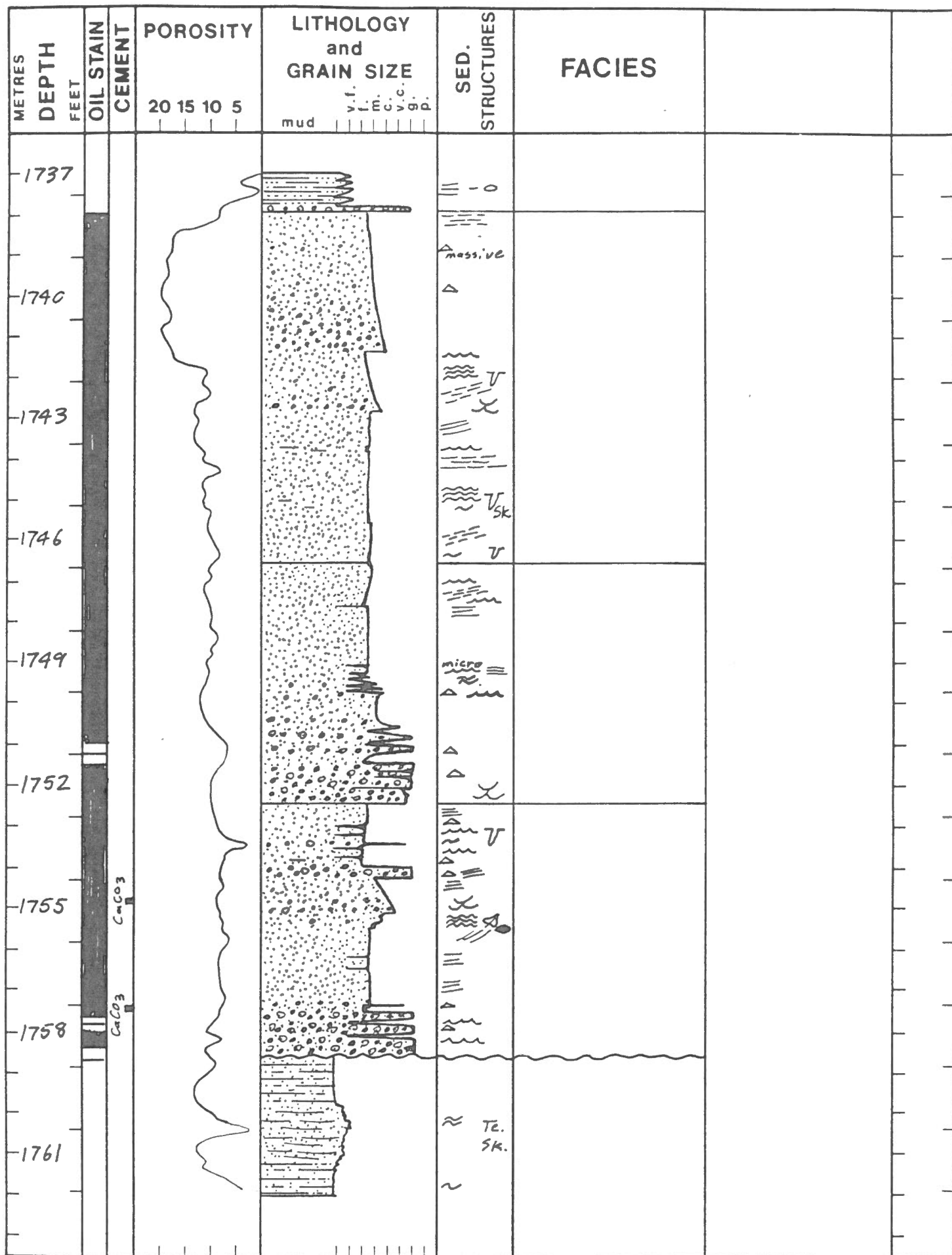
METRES DEPTH FEET	OIL STAIN CEMENT	POROSITY				LITHOLOGY and GRAIN SIZE mud	SED. STRUCTURES	FACIES		
		20	15	10	5					
1692							x v			
1695							x v			
1698							x v			
1701							x v			
1704							x v			
1707							x v			
1710							x v			

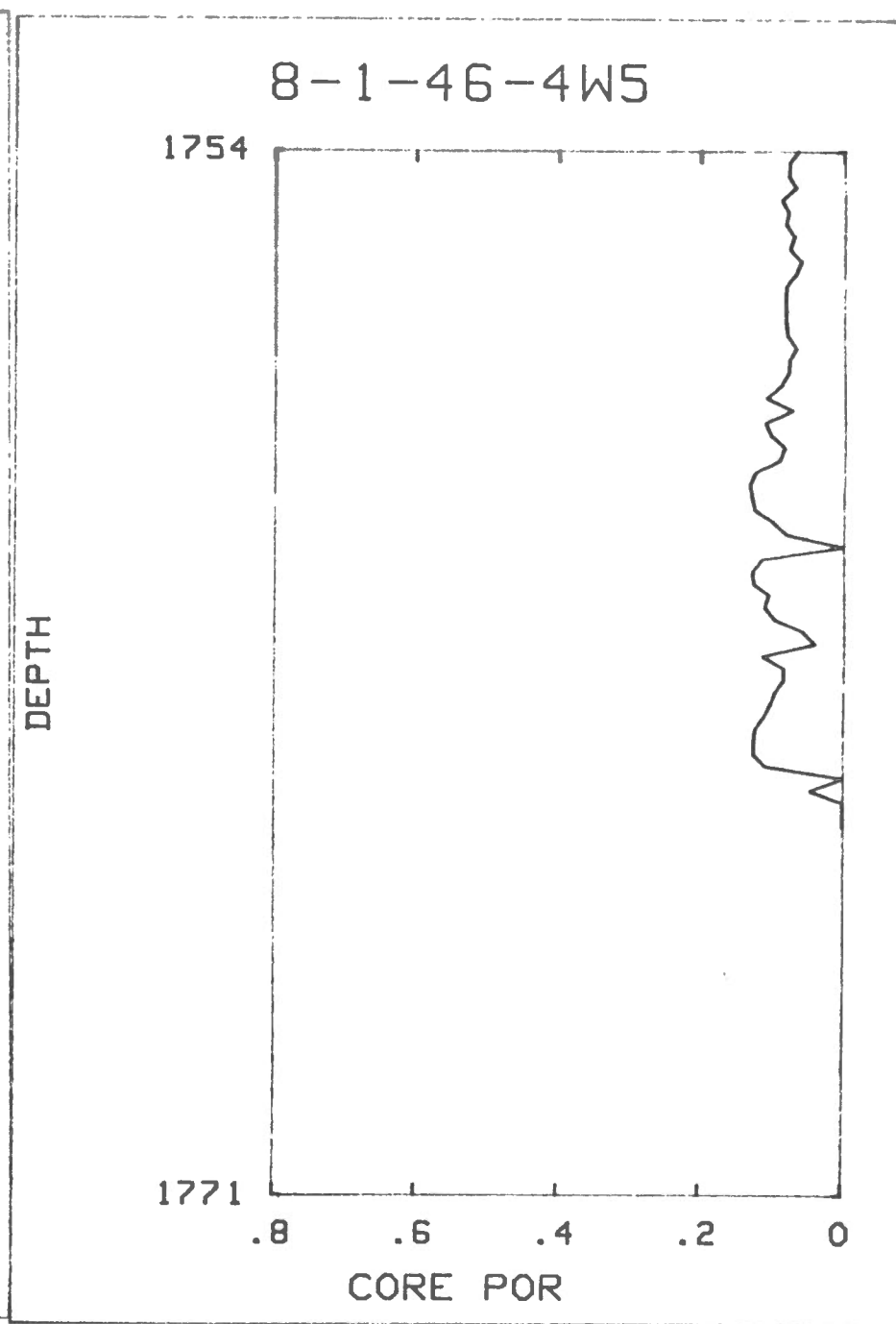
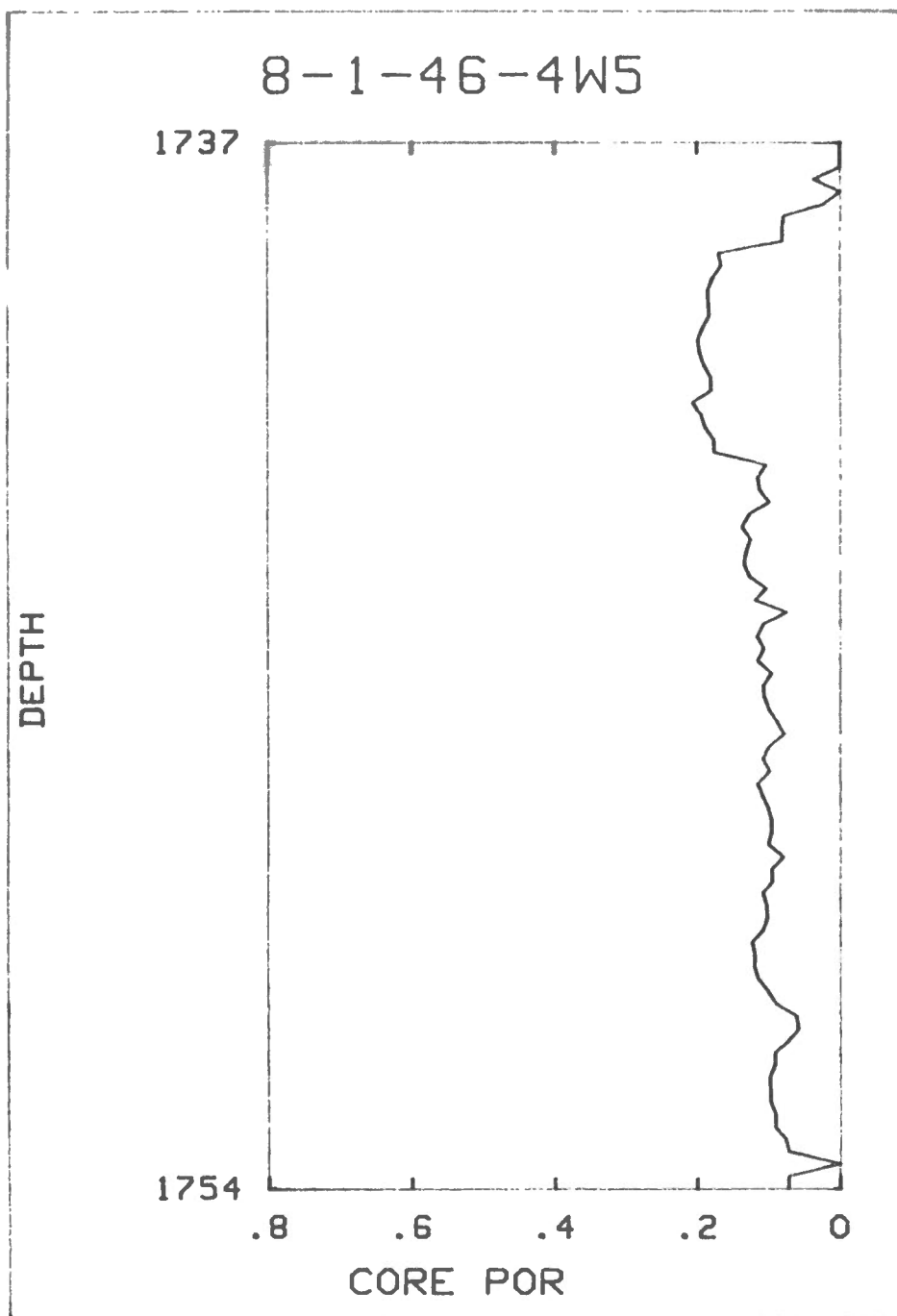


WELL NAME ARLIE PETROCON CRYSTAL (10 cm diameter; unglebed)

LOCATION 8-1-46-4W5

CORE INTERVAL 1737-1755 (Rec 18.2)
1755-1762 (Rec 7.0m)





WELL NAME Westcoast et al Crystal (10cm diameter; unslabbed)

1700-1714.25 (Rec 14.25)

LOCATION 10-1-46-4W5

CORE INTERVAL

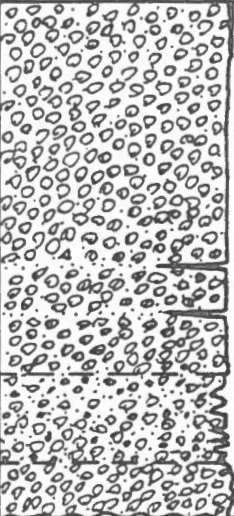

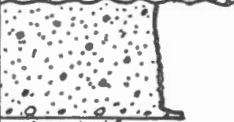





1714.25-1732.25 (Rec 18)

1732.25-1734.75 (1734.75-1737.75)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.l. v.f. E. C. v.g. d.	SED. STRUCTURES	FACIES	SAMPLES
1700							
1703							4A
1706						N.S.	4B
							4C
							4D
1709							4E
							4F
1712							4G
							4H
1715							4I
							4J
1718							4K
							4L
1721							4M
1724							4N
1727							

WELL NAME Westcoast et al Crystal (10cm diameter; unslotted)

LOCATION 10-1-46-4W5 Continued CORE INTERVAL _____

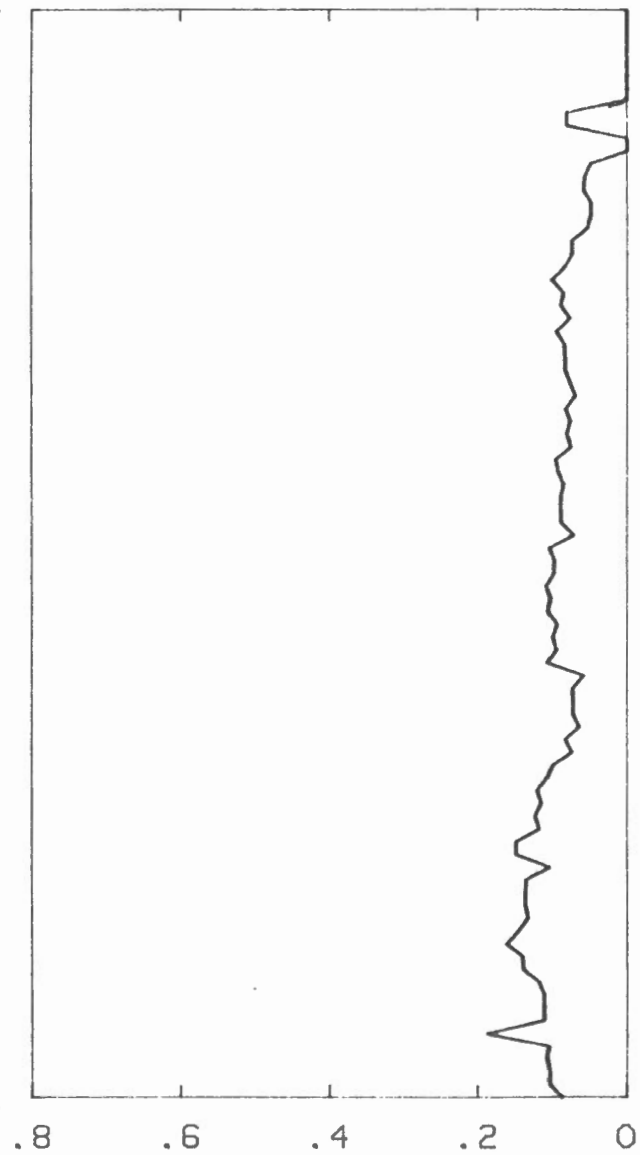
METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. l.E. c.v. g.p.	SED. STRUCTURES	FACIES		SAMPLES
1727								40
								4P
1730								4Q
								4R
1733								4S
								4T
1736					N.S.			4U
					~			
1739					~			
1742					~			4V
1745								4W

10-1-46-4W5

1704

DEPTH

1721

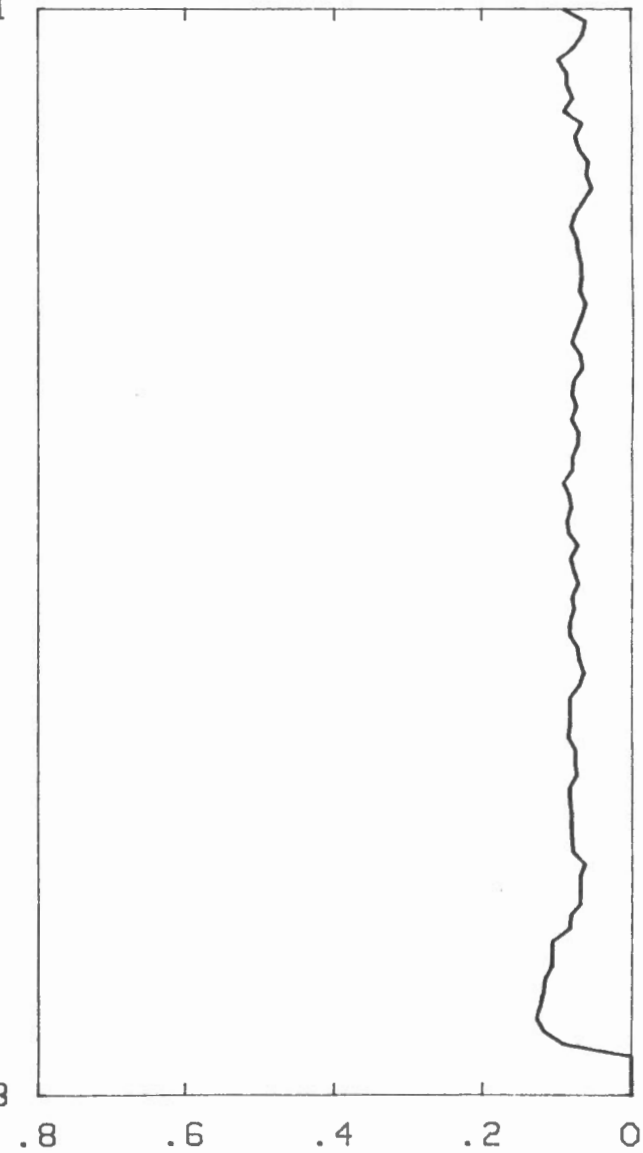


CORE POR

1721

DEPTH

1738



CORE POR

WELL NAME WESTCOAST 21 CRYSTAL (0.9m diameter) 210000

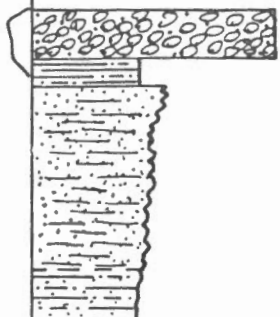
LOCATION 16-1-46-4W5

CORE INTERVAL 1705-1719.5 (Rec 13)
1719.5-1737.75 (Rec 17.5)

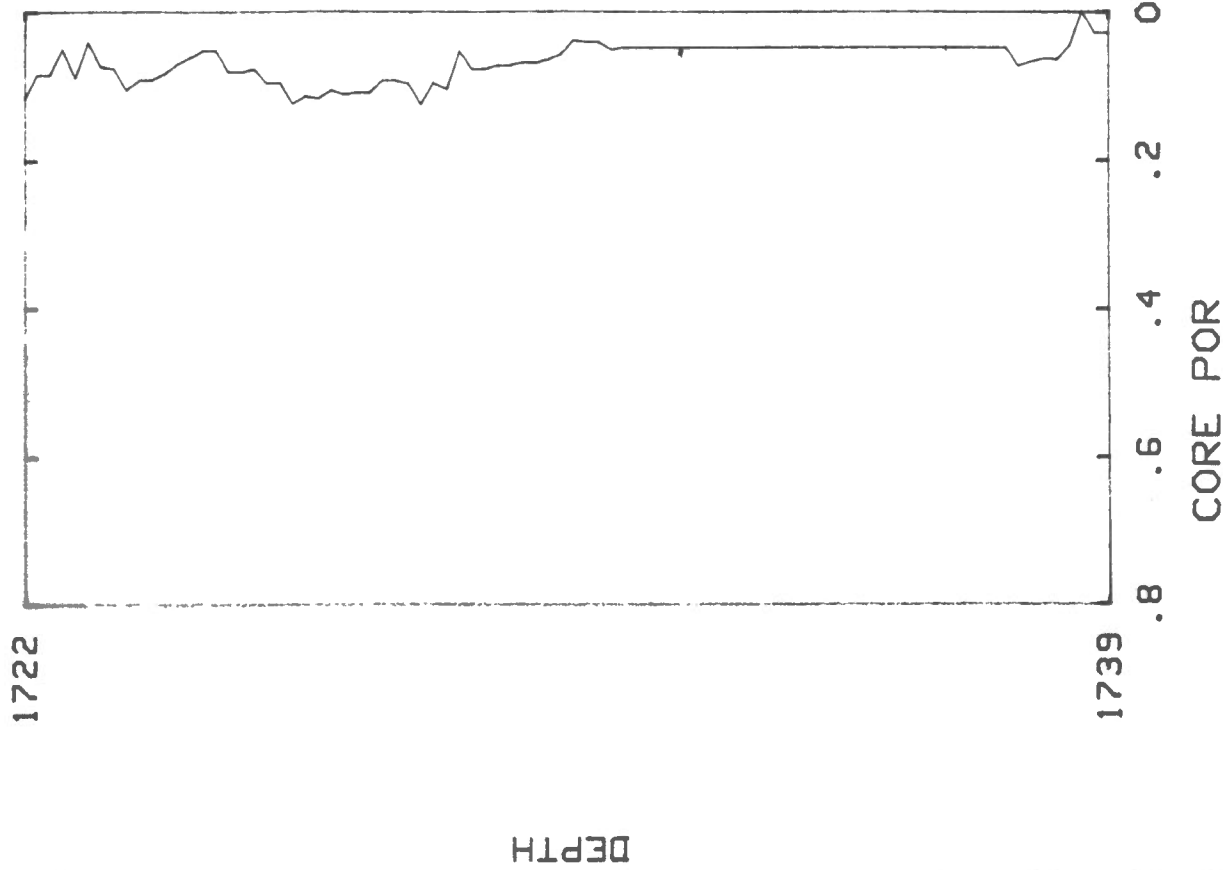
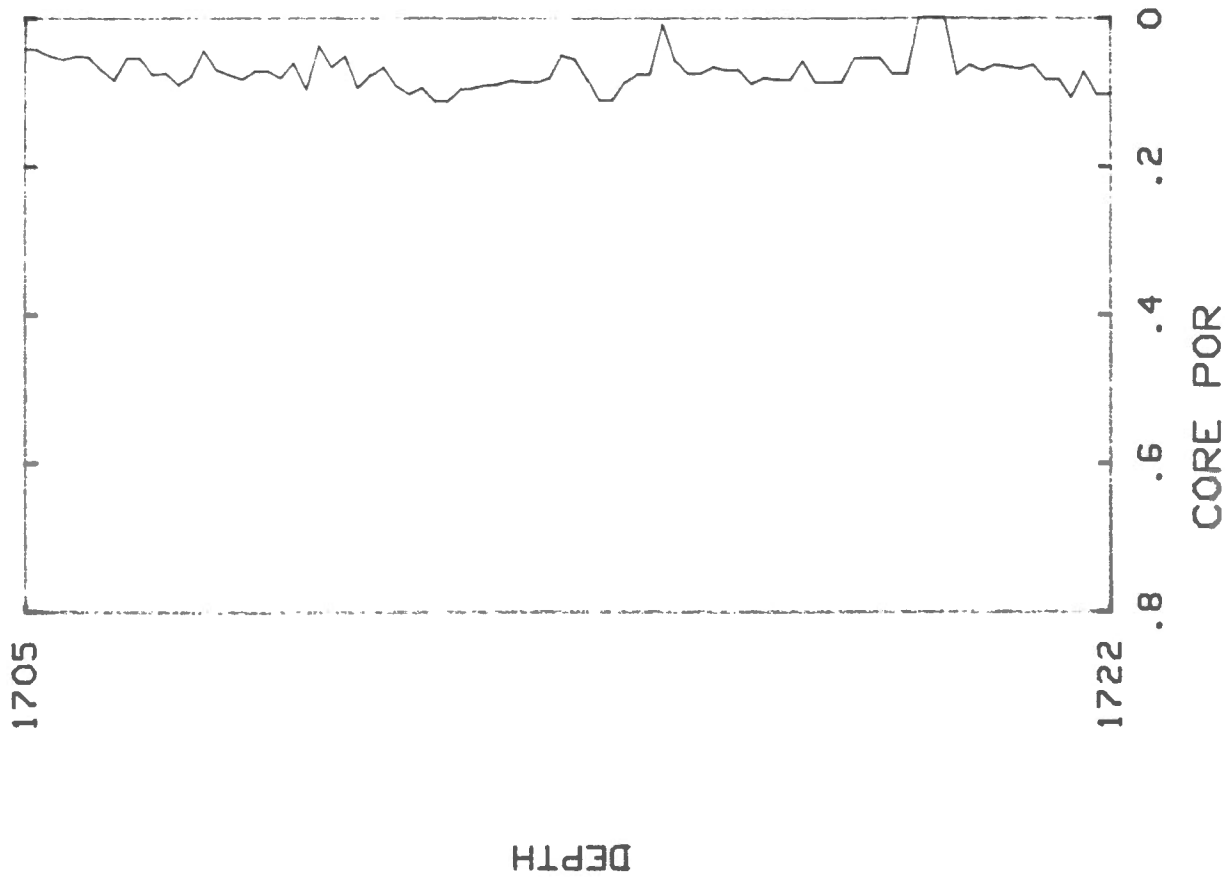
METRES DEPTH FEET	OIL STAIN CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE mud v.f. v.c. v.g. p.	SED. STRUCTURES	FACIES		
1705							
1708							
1711							
1714							
1717							
1720							
1723							
1726							
1729							
1732							

WELL NAME West coast et al Crystal

LOCATION 16-1-46-4 W5 (Continued) CORE INTERVAL 1719.5-1737.75 (Rec 17)

METRES DEPTH FEET	OIL STAIN	CEMENT	POROSITY 20 15 10 5	LITHOLOGY and GRAIN SIZE v. l. E. c. v. g. d. mud	SED. STRUCTURES	FACIES		
1732						N.S.		
					≈	N.S.		
1735								
1738								

16-1-46-4W5

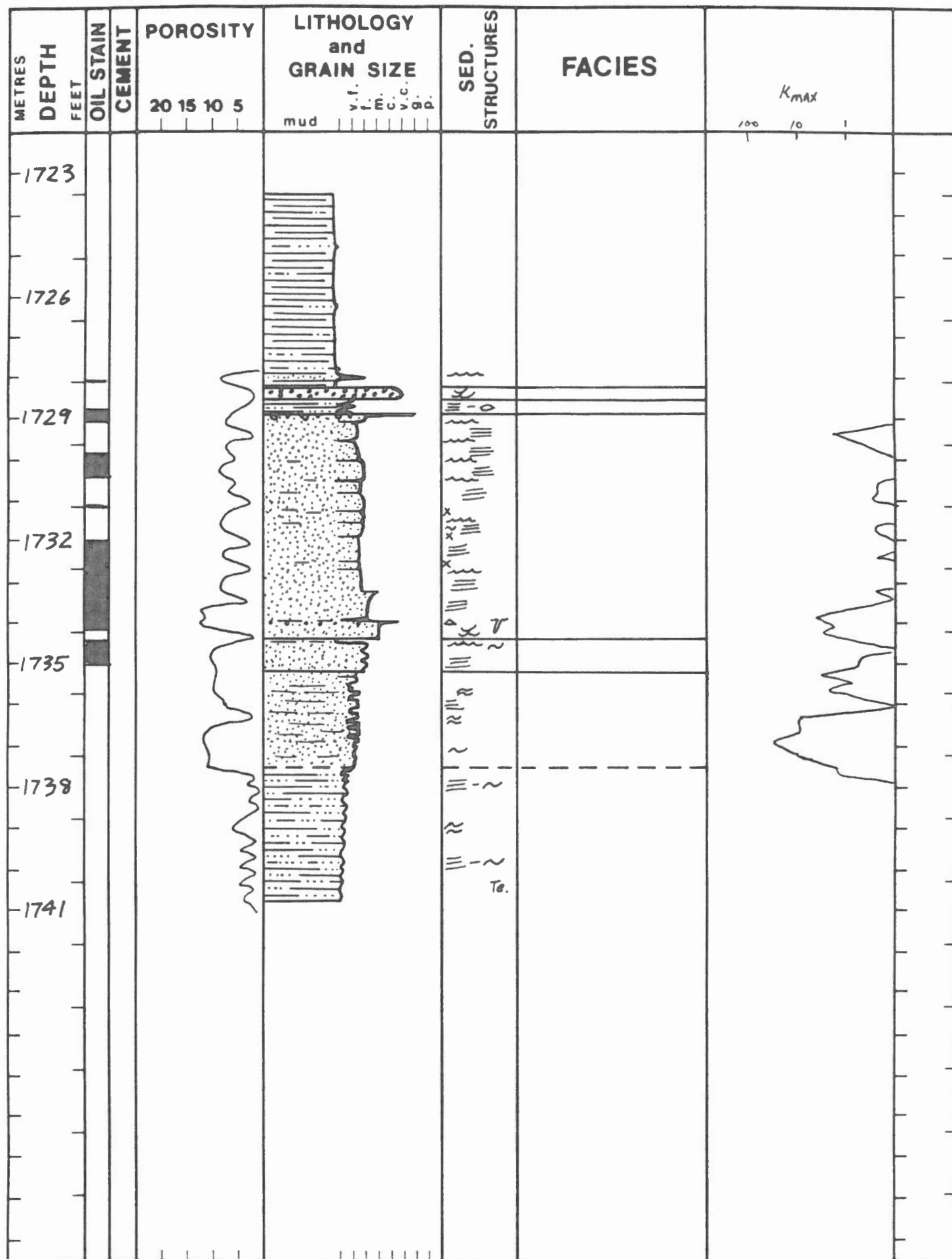


WELL NAME 14-2-46-4W5LOCATION 14-2-46-4W5

CORE INTERVAL

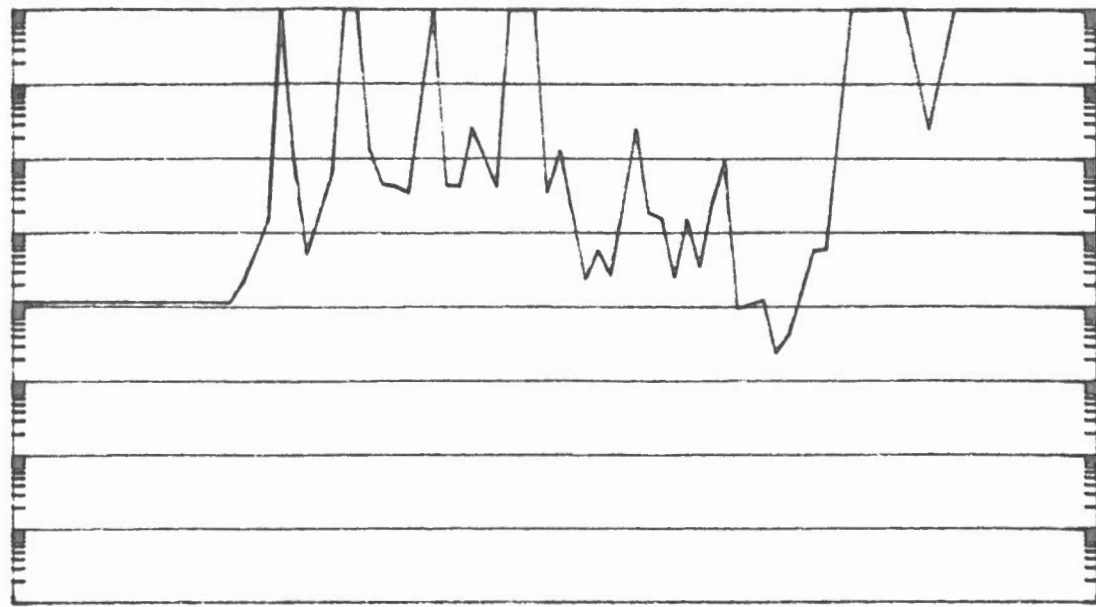
1723.5-1733.25 (Rec 9.75)

1733.25-1740.75 (Rec 7.5)



14-2-46-4W5

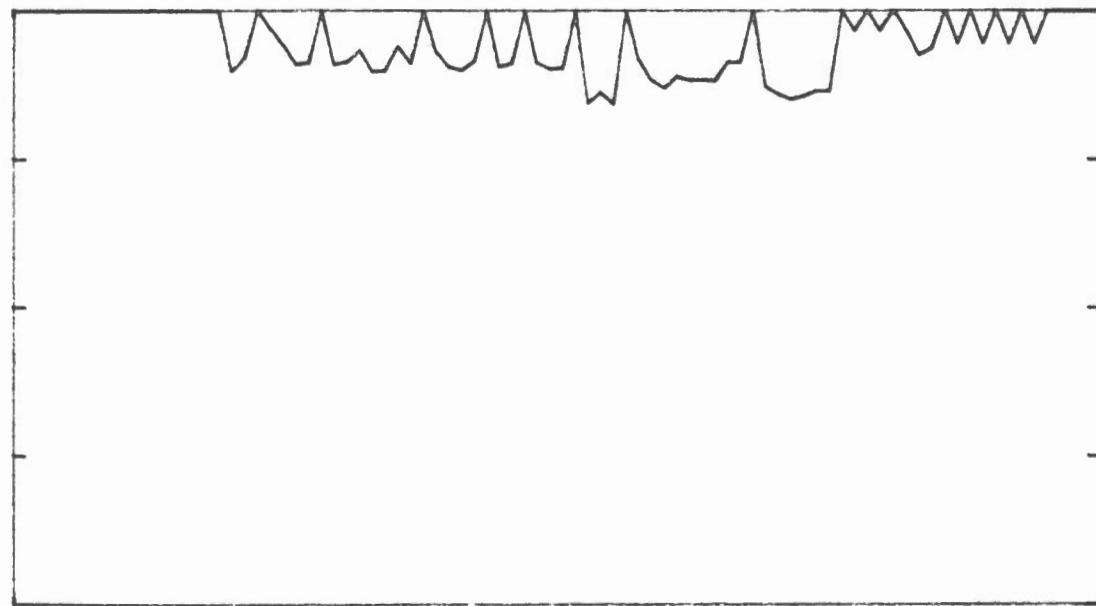
1725



1742

100 10 1 .1 .01 .001

1725



1742

.8 .6 .4 .2 0

WELL NAME WestCoast Bluesky CrystalLOCATION 8-11-46-4W5

CORE INTERVAL

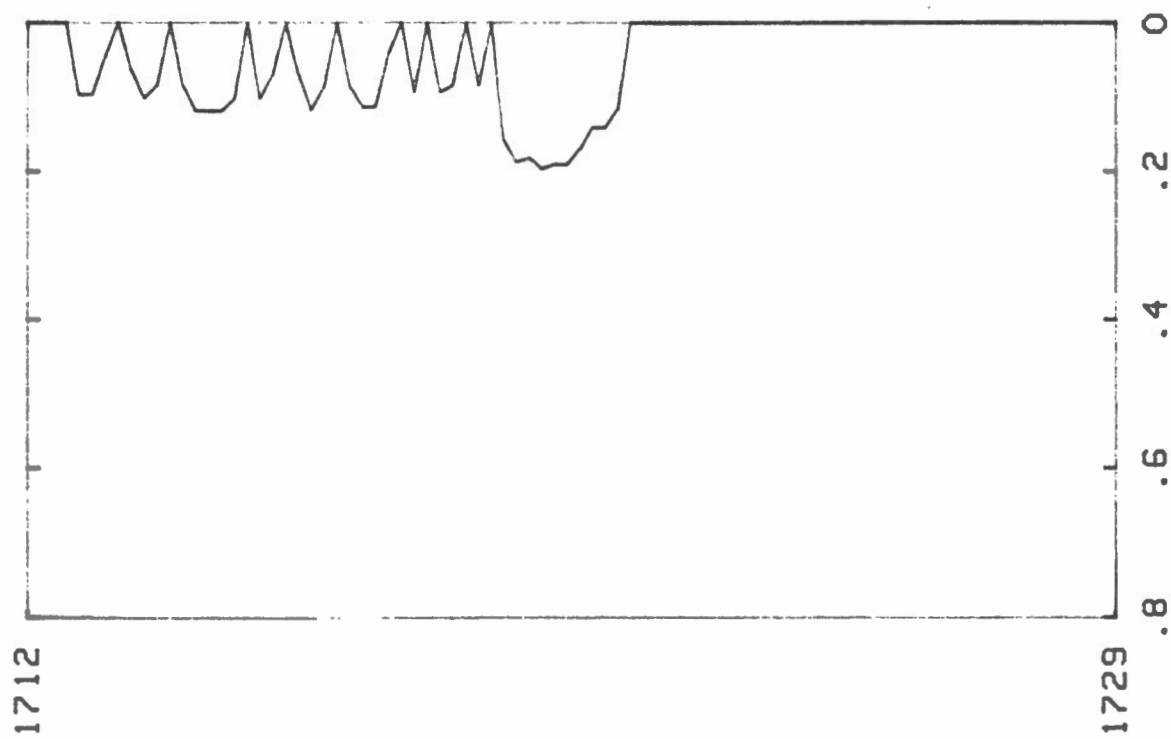
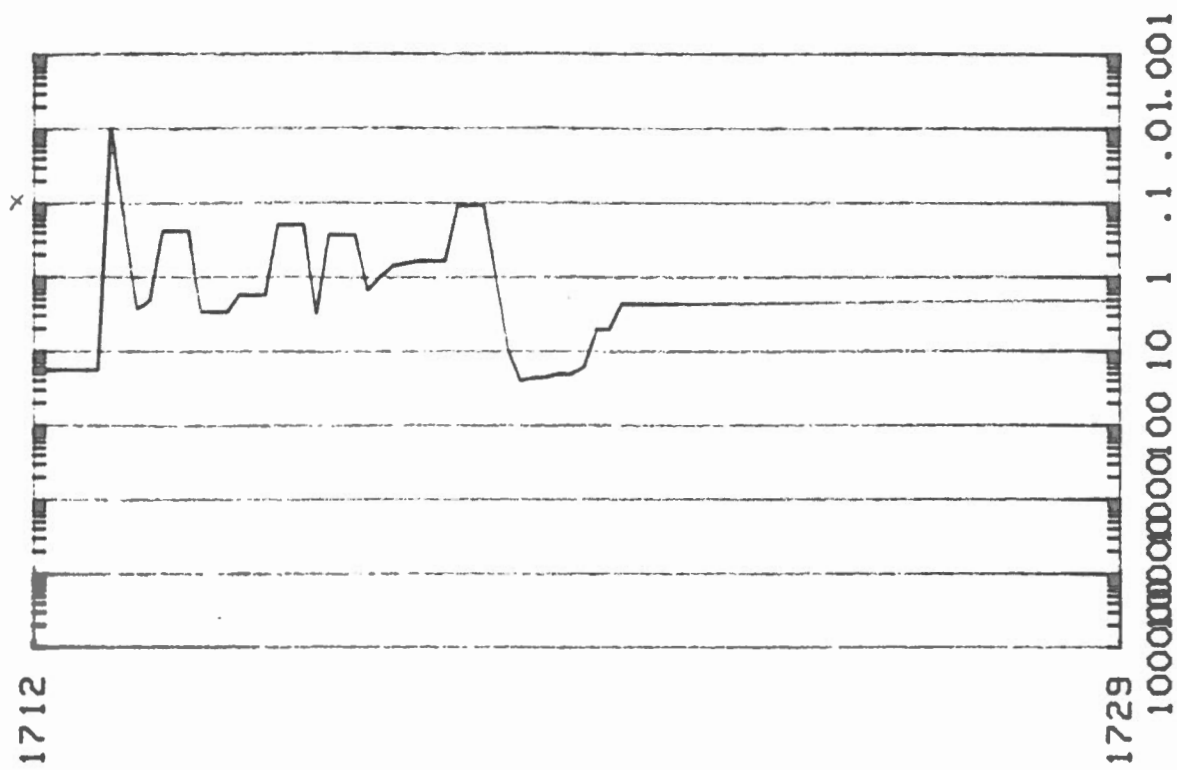
1712-1730.2 (Rec 18.2)

1730.2-1731.05 (Rec 0.9)

METRES DEPTH FEET	OIL STAIN CEMENT	POROSITY					LITHOLOGY and GRAIN SIZE	SED. STRUCTURES	LITHOFACIES	K _{max}		
		20	15	10	5					100	10	1
1712							mud		c.g. to granular Sandstone medium-grained sandstone			
1715								massive	FINE TO MEDIUM-GRAINED SANDSTONE			
1718								SK.				
								massive				
1721								Te.	INTERBEDS:			
									1) Bioturbated Muddy Sandstone			
1724									2) Interbedded Sandstone-Mudstone Shale			
1727								SK.				
1730									PARTIALLY BIOTURB. FINE-GRAINED SANDSTONE			
1733												

SHALLOW
CHANNEL-BAR
COMPLEXSUBTIDAL
ESTUARINE
BAYCHANNEL
MARGIN
BARESTUARY FILL-STAGE 'H'
CHANNEL STAGE 'B' AND 'C' EQUIVALENT
CHANNEL STAGE 'A'

8-11-46-4W5



APPENDIX III

**List of core samples
submitted with this report**

SAMPLE NO.	WELL	DEPTH	LITHOLOGY
1A	16-30-46-3W5	1675.3	Shale
1B	"	1675.9	Sandstone
1C	"	1676.4	Bioturbated muddy sst
1D	"	1679.8	Interbedded Mdst/sst
1E	"	1681.8	Conglomerate
1F	"	1684.4	Conglomerate
1G	"	1688.9	Interbedded Mdst/sst
1H	"	1689.2	Sandstone
1I	"	1690.5	Conglomerate
1J	"	1693.0	Mudstone
2A	6-20-46-3W5	1723.2	Conglomerate
2B	"	1725.2	Sandstone
2C	"	1725.3	Sandstone
2D	"	1726.9	Conglomerate
2E	"	1728.9	Sandstone
2F	"	1731.9	Sandstone
2G	"	1733.7	Sandstone
2H	"	1734.6	Bioturbated Muddy sst
2I	"	1737.3	Bioturbated Muddy sst
3A	3-18-46-3W5	1685.5	Sandstone
3B	"	1689.0	Sandstone
3C	"	1692.4	Sandstone
3D	"	1693.8	Sandstone
3E	"	1696.6	Sandstone
3F	"	1699.8	Sandstone
3G	"	1701.0	Sandstone
3H	"	1703.2	Mudstone
3I	"	1706.7	Mudstone
4A	10-1-46-4W5	1703.5	Shale
4B	"	1705.7	Sandstone
4C	"	1706.8	Conglomerate
4D	"	1708.2	Conglomerate sst
4E	"	1710.3	Conglomerate
4F	"	1711.4	Conglomeratic sst
4G	"	1713.8	Sandstone
4H	"	1715.3	Conglomerate
4I	"	1717.0	Sandstone
4J	"	1717.3	Sandstone
4K	"	1719.3	Sandstone
4L	"	1721.1	Conglomerate
4M	"	1721.5	Conglomerate
4N	"	1724.8	Conglomerate
4O	"	1727.1	Conglomerate
4P	"	1729.3	Conglomerate
4Q	"	1731.9	Conglomerate
4R	"	1732.7	Conglomerate

SAMPLE NO.	WELL	DEPTH	LITHOLOGY
4S	"	1734.1	Conglomerate
4T	"	1735.9	Sandstone
4U	"	1736.2	Sandstone
4V	"	1742.0	Mudstone
4W	"	1744.3	Mudstone
5A	8-31-45-3W5	1782.0	Shale
5B	"	1784.2	Shale
5C	"	1785.9	Sandstone
5D	"	1788.4	Sandstone
5E	"	1791.5	Sandstone
5F	"	1792.6	Sandstone
5G	"	1796.4	Bioturbated Muddy sst
5H	"	1800.5	Mudstone
5I	"	1802.8	Mudstone
6A	8-26-45-4W5	1813.8	Sandstone
6B	"	1817.0	Sandstone
6C	"	1828.5	Sandstone
6D	"	1831.5	Sandstone
7A	16-24-45-4W5	1785.7	Shale
7B	"	1787.9	Sandstone
7C	"	1790.25	Sandstone
7D	"	1792.7	Sandstone
7E	"	1796.51	Sandstone
7F	"	1800.9	Sandstone
7G	"	1805.4	Sandstone
7H	"	1807.9	Sandstone
7I	"	1809.5	Mudstone