Evolution of the Geological Model, Lobster Field (Ewing Bank 873)

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Throughout the life of a field an accurate and evolving geological model is needed to make certain critical decisions. These include the decision to drill the prospect, determining commerciality if successful, facility type and size, the number and placement of development wells and identifying bypassed reserves for infill drilling .Vast amounts of new data are added as wells are drilled and produced and as new seismic is shot and reprocessed . New ideas in interpretation also come about over time and need to be incorporated. We have had four phases of model building and rebuilding at Lobster. These are Prediscovery, Predevelopment, Development and Infill/stepout and Exploitation.

Lobster Field (figure 1) is located approximately 130 miles southwest of New Orleans in 775' of water. It was discovered in 1991 and a conventional 30 slot platform was installed in the summer of 1994. Figure 2 is a production graph for the field. Oil production from ten wells peaked initially at platform limits of 48,000 BOPD. Simple payout on the platform and development wells was achieved in April, 1996. After declining to 29,000 BOPD a series of recompletions and acidization work targeting zeolite cement problems stopped the decline. In 1997, two infill wells were drilled in the main reservoir and then two successful wells were drilled to a deeper horizon identified by the modeling work. In early 1998, the Arnold subsea tieback with 2 wells producing 25,000BOPD and the Oyster subsea tieback with one well producing at 12,000BOPD were brought on line.

Figure 3 is the current structure map showing key structural elements. Figure 4 is the log from the EW 873#1, the discovery well. The well was side tracked down dip to a thicker pay sand section of 150 net feet. The main producing reservoir at Lobster Field is a Pliocene-age sand designated the Bul. 1. It is contained in a sequence that began with a marl at the 3.8 My Sphen Abies ‘B’ sequence boundary on which were deposited basin floor fans. The Bul 1 is at the top of this facies. Overlying it are slope fans capped by hemipelagic shale and the 1.9 to 3.2 my sequence boundaries. This well confirmed the predrill model of

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ponded basin floor fans deposited in a salt withdrawal minibasin capped by a predominantly shale section which contained occasional slope fans and channel overbank deposits. An important consideration in the decision to drill the Lobster prospect was the necessity for continuos, homogeneous sands so that the field could be developed by a minimal number of well. The first major reconstruction of the model occurred as data from the discovery & delineation wells came in along with a new 3-D seismic survey. The first generation reservoir simulation model was build at that time. The reserve estimate from that work confirmed the estimate predicted by the predrill model. A thirty slot platform with waterflood capabilities was designed and the decision was make to go forward on the project.

After the platform was set early development drilling and production resulted in the next major reconstruction. Log and seismic character and two whole cores indicated that two different facies were present in the reservoir zone (figure 5). On the west side are basin floor fans these are blocky to fining upward, have clean gamma ray and high resistivity log responses. They were correlative and laterally continuos. Their seismic response is highly reflective, continuous and divergent or onlapping. In contrast the east side channel/overbank facies has suppressed log characteristics due to numerous shale laminations, is irregular to fining upward and is more difficult to correlate. The channel/overbank seismic signature is a weaker reflection, and appears more chaotic, discontinuous and mounded. The two compartments also show different reservoir properties, with the west side being composed of three stacked more chaotic, discontinuous and mounded. The two compartments also show different reservoir properties, with the west side being composed of three stacked fan lobes that are almost 100 percent net sand with uniform character and permeabilities of over a darcy. The east side has permeabilities in the 300 to 600 millidarcy range.

A 3-D geological model was built at this time using Stratamodel software and gridded up to an Eclipse model. These were continually updated during the development drilling phase. Turn-around time of only 24 to 36 hours was required to load the new data and rerun the reservoir model each time a well finished drilling. It also has become apparent as the field has produced that these are separate reservoir compartments based on reservoir pressure data, pvt data, geochemical finger printing of produced oil and different oil/water contacts identified on the seismic. Figure 6 is the pressure history we have seen in the field .

We are now in another stage of model updating. New information includes constraint geometry from an inverted, prestack-time migrated 3-D seismic data set. Further understanding of sand body and salt geometries based on a reconstruction of the basin formation from extensive regional mapping of salt and sequence boundaries has been added. Recent work by Paul Weimer, Mark Rowan and their students in this area has been freely incorporated into these interpretations. This information is being integrated to guide a current infill drilling program and has pointed the way to two discoveries in deeper fan packages. The next series of figures, showing a map at specific geological time horizons and a NW to SE cross-section, represents our current picture of the 873 basin formation and depositional history.

Figure 7 shows a portion of a massive salt canopy emplaced at approximately the end of the Miocene. Onto this canopy large basin floor fans were deposited during the early Pliocene. The major sand source appears to have been to the northwest based on correlative thick sands seen in wells in that direction. The Orion basin to the northeast was receiving very little sand during this time. There are also indications that fill and spill was going on to the Arnold basin to the southeast and the Morpeth Field reservoirs were being deposited during this time.

During the middle Pliocene (figures 7), basin floor fan deposition into the Lobster basin continued including the west Bul.1 side reservoirs. Loading of the basin resulted in the development of salt highs around its margin blocking sand flow to the Arnold basin. Also, there are indications a “depo shadow” is an area of nondeposition due to the blocking of sediment influx due to an obstruction, in this case the salt high. Extensive basin rimming faulting was also beginning to be developed. As the basin filled during this time the final stage of deposition was an extensive channel/overbank complex that forms the east side Bul.1` reservoirs. During the late Pliocene(figures 8) the amount of sand being deposited into the basin dwindled with isolated channel/overbank systems being prevalent. The salt highs became more pronounced, faulting continued to develop and basin touch down may have occurred during this time. At the end of this period was a major depositional hiatus, when the sand source shifted further west and foram rich marls were deposited. This hiatus at the Pliocene/Pleistocene boundary occurs an 200' of marl that accumulated over a period of approximately 1.9 million years.

At the end of the hiatus (figures 8), small basin floor fans in a fairly narrow fairway were deposited on top of the marls. The Lobster basin appears to have been at least partially blocked by a depositional shadow. These sands form the Oyster and Arnold reservoirs. During the Pleistocene (figure 8) a major change in the depositional style occurred. A large canyon system, in places several thousand feet thick, was carrying the majority of the sediment load beyond this area. Sea level rises led to sporadic backfilling of these canyons with very discontinuous channel/overbank complexes. The main sediment source had apparently shifted form the northwest to the northeast. Graben fault systems that continue to be active today formed in association with the salt highs during this time.

Table 1 summarizes the 4 major phases of model building, the data available as the project progressed and the results at each stage. As noted in the introduction, an evolving geological and reservoir model that has been continually updated with new data and interpretations has proven to be a successful exploration and field management tool from the initial concept on which the block was acquired to the present day infill drilling program.

Table 1 Summary of Lobster Model Evolution

Phase	Data Available	Results
Pre-discovery	Regional Wells, 2D and Spec 3D Seismic	Predicted reserves of 80 MMBOE vs. current reserves of 110 MMBOE
Pre-development	Discovery & 3 delineation well information, including logs, cores, dst	Decision to proceed with project made after confirmation of reserve estimate.
Refinement During Development	Additional logs, new 3D Seismic Survey, geochemistry, construction of Strata-model	Definition of reservoir compartments, optimal placement of development wells. Initial production of 48,000 BOPD vs. 35,000 BOPD planned.
Infill and Exploitation	Well performance, reprocessed seismic, new geological ideas, possible time lapse seismic.	4 infill/stepout wells and 2 exploitation wells in a deeper horizon producing 35,000 + BOPD.


TEXAS
LOUISIANA
MISS.
HOUSTON
NEW ORLEANS
Ewing Bank Block 873
Ewing Bank
Block 873
Index Map
AREA SHOWN

Figure 1

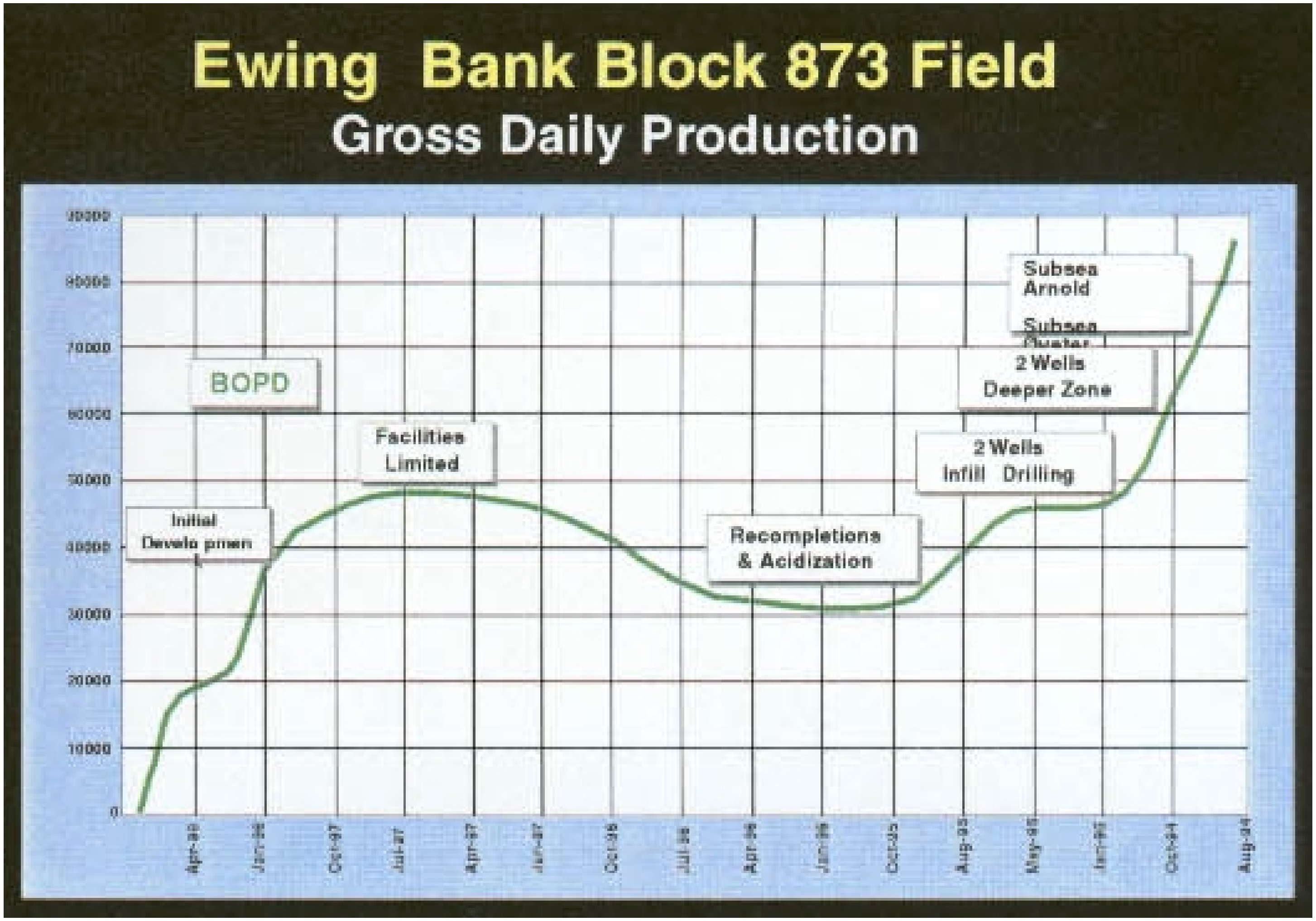
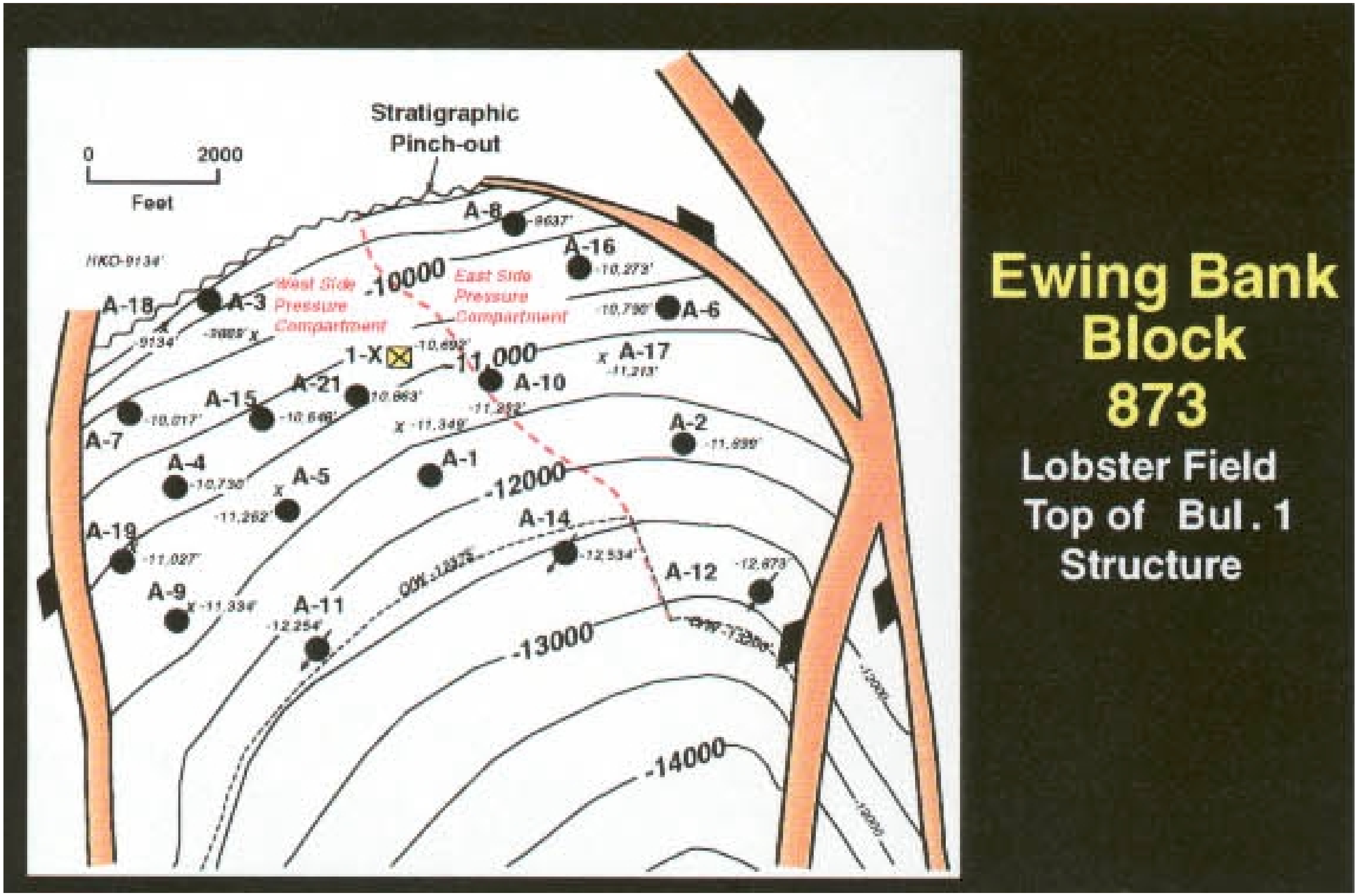

Ewing Bank Block 873 Field
Gross Daily Production
BOPD
Facilities
Limited
Initial
Develo pmen
Recompletions
& Acidization
2 Wells
Infill Drilling
2 Wells
Deeper Zone
Subsea
Arnold
10000
20000
30000
40000
50000
60000
70000
80000
0

Figure 2



Stratigraphic
Pinch-out
0
2000
Feet
A-8
A-16
A-6
A-17
A-18
A-3
1-X
A-10
A-21
A-15
A-7
A-2
A-4
A-5
A-1
A-19
A-14
A-9
A-11
A-12
West Side
Pressure
Compartment
East Side
Pressure
Compartment
-10000
-11,000
-12000
-13000
-14000
Ewing Bank
Block
873
Lobster Field
Top of Bul. 1
Structure

Figure 3

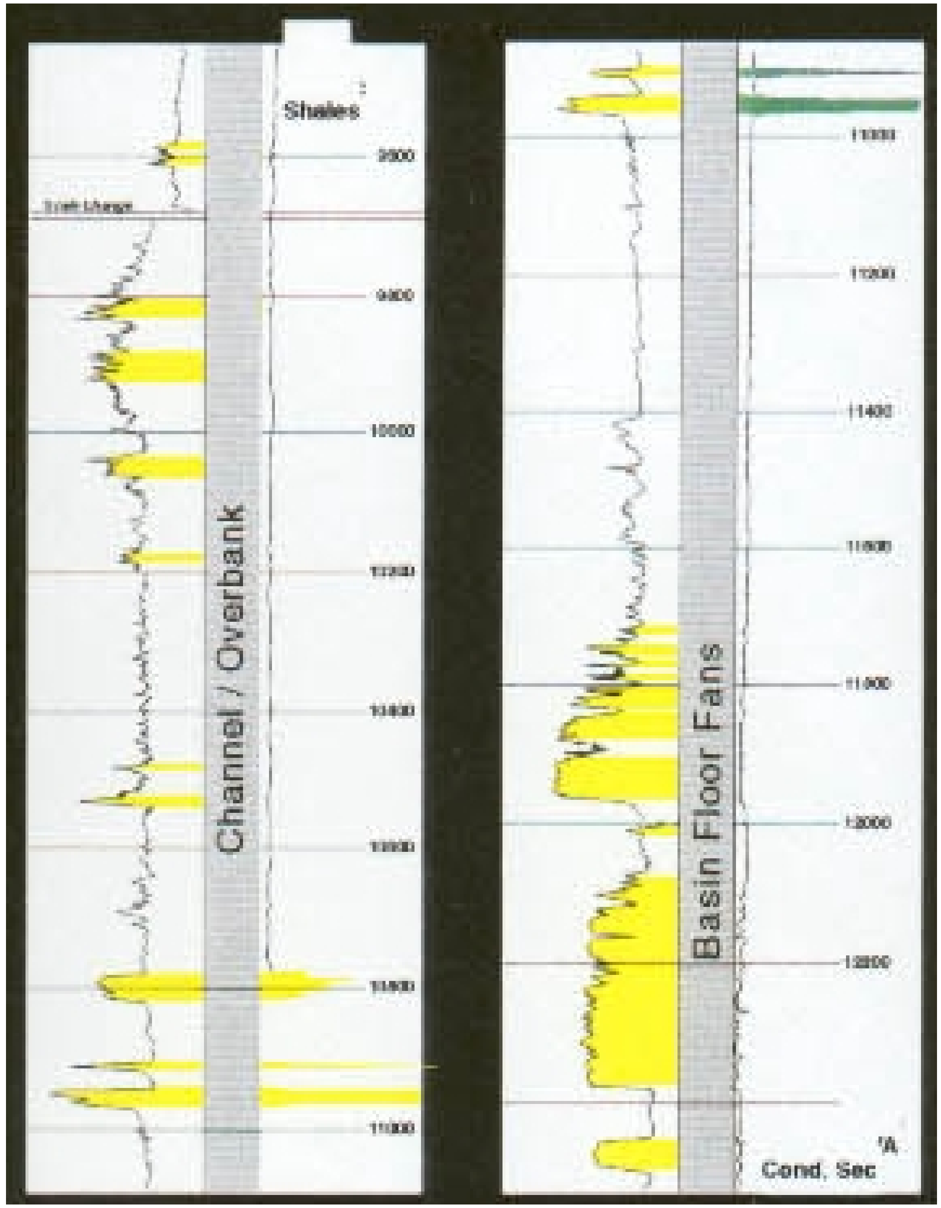


Figure4

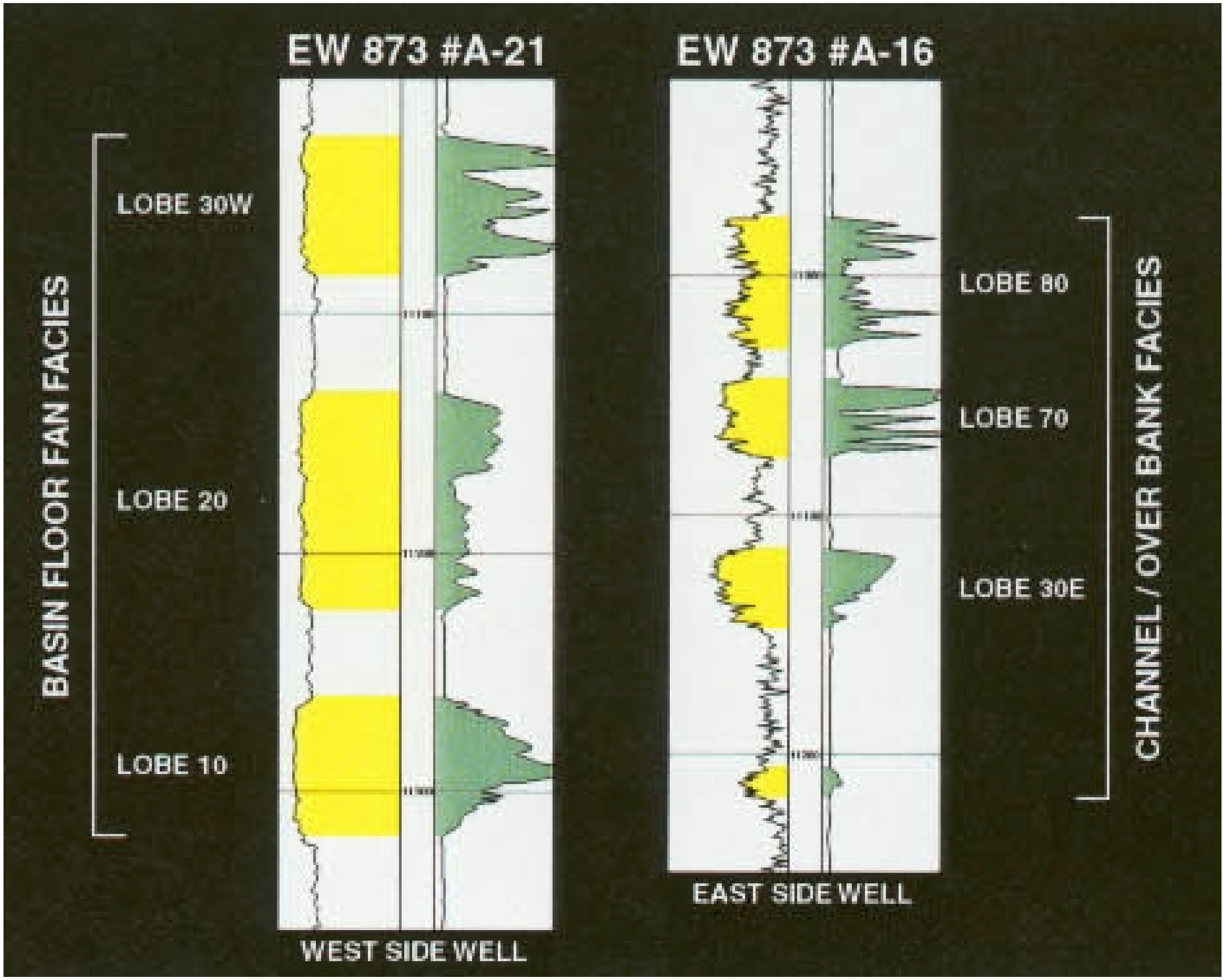

EW 873 #A-21
EW 873 #A-16
BASIN FLOOR FAN FACIES
LOBE 30W
LOBE 20
LOBE 10
WEST SIDE WELL
LOBE 80
LOBE 70
LOBE 30E
EAST SIDE WELL
CHANNEL / OVER BANK FACIES

Figure 5

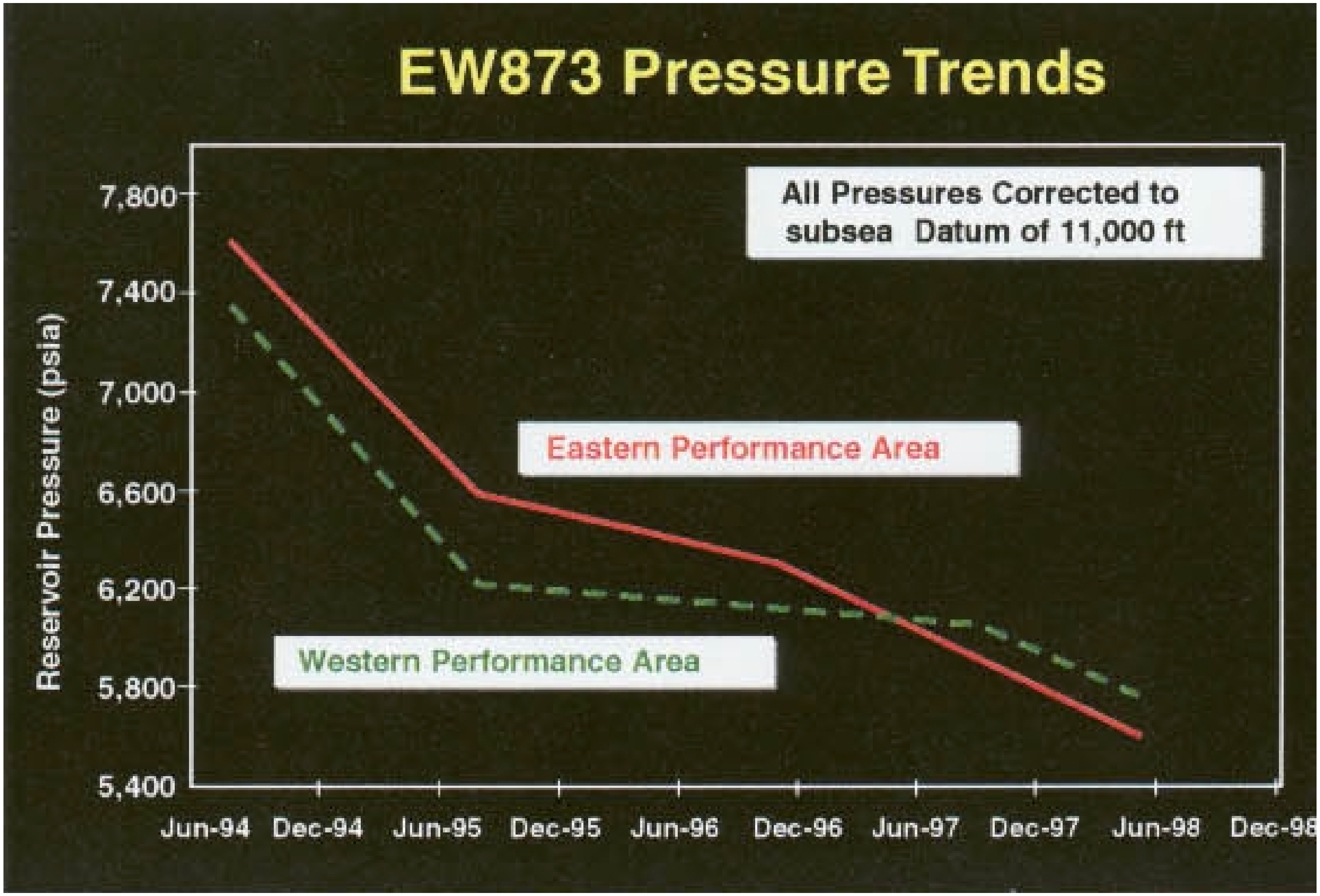
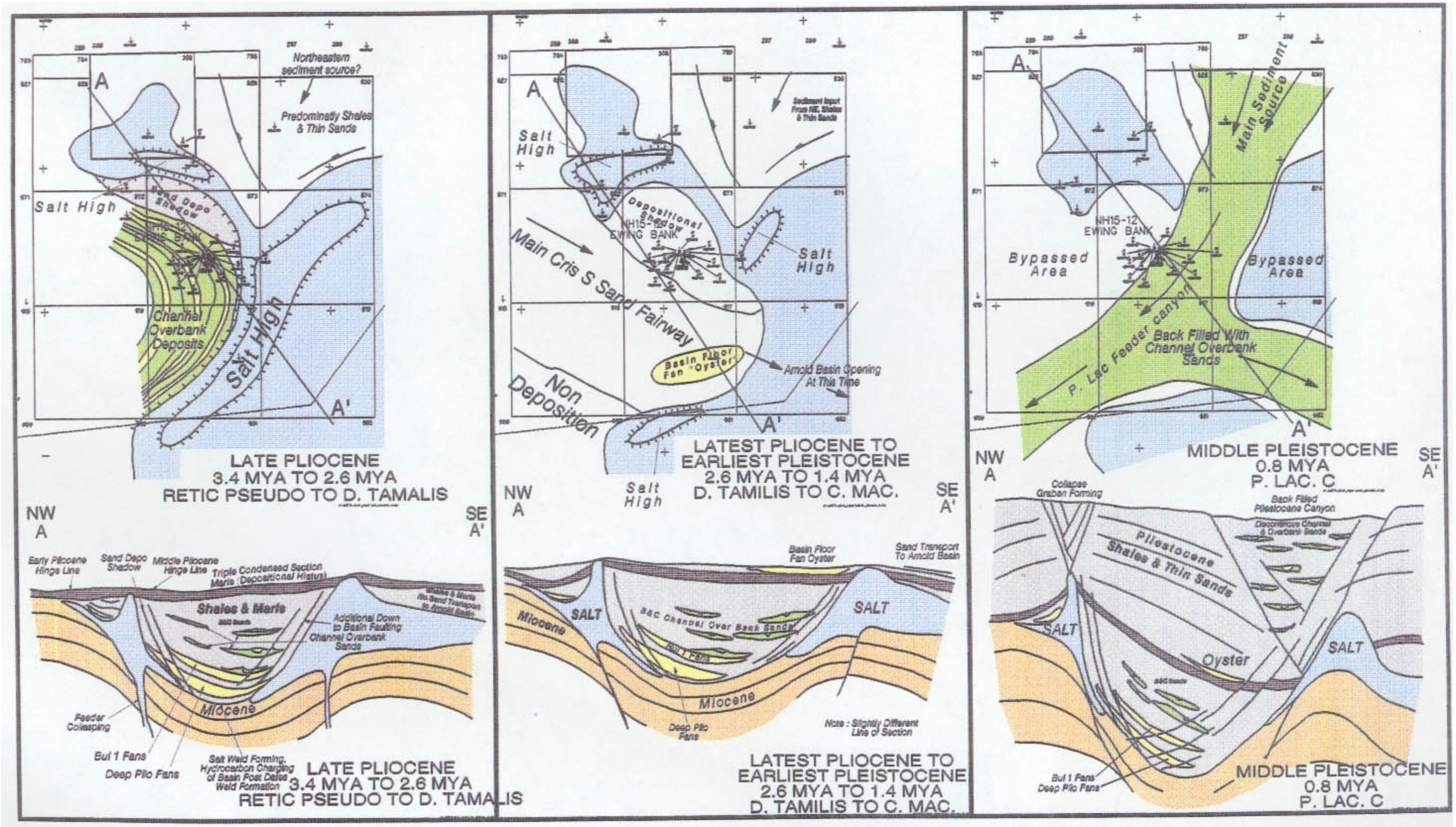

EW873 Pressure Trends
All Pressures Corrected to
subsea Datum of 11,000 ft
Eastern Performance Area
Western Performance Area
Reservoir Pressure (psia)
7,800
7,400
7,000
6,600
6,200
5,800
5,400
Jun-94
Dec-94
Jun-95
Dec-95
Jun-96
Dec-96
Jun-97
Dec-97
Jun-98
Dec-98

Figure 6



Northeastern sediment source?
Predominatly Shales & Thin Sands
Salt High
Sand Depo Shadow
Channel Overbank Deposits
Salt High
LATE PLIOCENE
3.4 MYA TO 2.6 MYA
RETIC PSEUDO TO D. TAMALIS
NW A
SE A'
Early Pliocene Hinge Line
Sand Depo Shadow
Middle Pliocene Hinge Line
Triple Condensed Section Marls (Depositional Hiatus)
Shales & Marls
Additional Down to Basin Faulting Channel Overbank Sands
Miocene
Feeder Collasping
Bul 1 Fans
Deep Plio Fans
Salt Weld Forming, Hydrocarbon Charging of Basin Post Delta Weld Formation
LATE PLIOCENE
3.4 MYA TO 2.6 MYA
RETIC PSEUDO TO D. TAMALIS
Salt High
Depositional Shadow
NH15-12 EWING BANK
Main Cris S Sand Fairway
Salt High
Basin Floor Fan "Oyster"
Arnold Basin Opening At This Time
Non Deposition
LATEST PLIOCENE TO EARLIEST PLEISTOCENE
2.6 MYA TO 1.4 MYA
D. TAMILIS TO C. MAC.
NW A
Salt High
SE A'
Basin Floor Fan Oyster
Sand Transport To Arnold Basin
Miocene
SALT
SALT
Bul 1 Fans
Miocene
Deep Plio Fans
Note : Slightly Different Line of Section
LATEST PLIOCENE TO EARLIEST PLEISTOCENE
2.6 MYA TO 1.4 MYA
D. TAMILIS TO C. MAC.
Main Sediment Source
NH15-12 EWING BANK
Bypassed Area
Bypassed Area
P. Lac Feeder canyon
Back Filled With Channel Overbank Sands
MIDDLE PLEISTOCENE
0.8 MYA
P. LAC. C
NW A
SE A'
Collapse Graben Forming
Back Filled Pleistocene Canyon
Pleistocene Shales & Thin Sands
SALT
Oyster
SALT
Bul 1 Fans
Deep Plio Fans
MIDDLE PLEISTOCENE
0.8 MYA
P. LAC. C

Figure 7

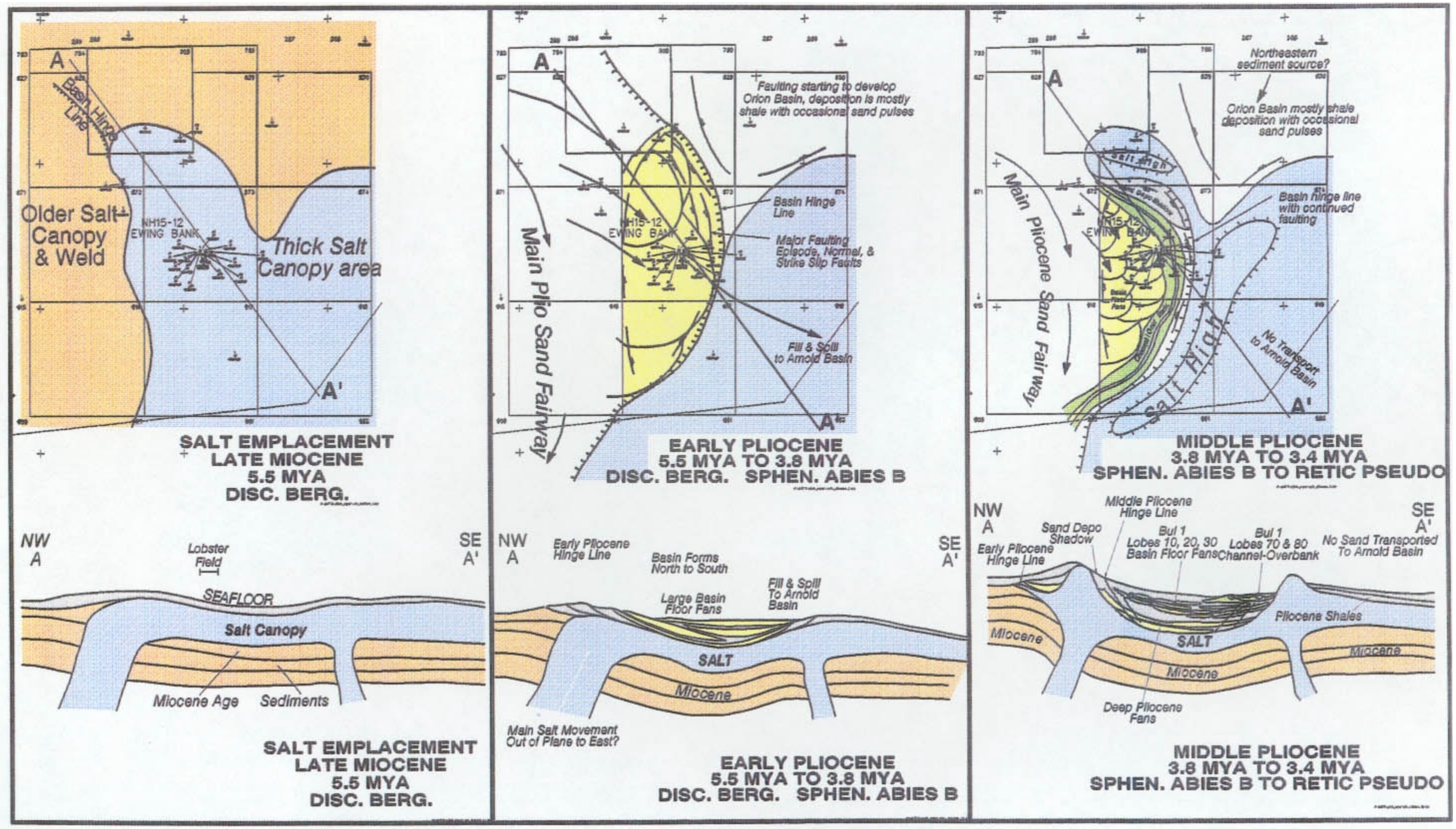

SALT EMPLACEMENT
LATE MIOCENE
5.5 MYA
DISC. BERG.
Older Salt Canopy & Weld
Thick Salt Canopy area
Basin Hinge Line
NH15-12 EWING BANK
NW A
SE A'
Lobster Field
SEAFLOOR
Salt Canopy
Miocene Age Sediments
EARLY PLIOCENE
5.5 MYA TO 3.8 MYA
DISC. BERG. SPHEN. ABIES B
Main Plio Sand Fairway
Faulting starting to develop Orion Basin, deposition is mostly shale with occasional sand pulses
Basin Hinge Line
Major Faulting Episode, Normal, & Strike Slip Faults
Fill & Spill to Arnold Basin
Early Pliocene Hinge Line
Basin Forms North to South
Large Basin Floor Fans
Fill & Spill To Arnold Basin
SALT
Miocene
Main Salt Movement Out of Plane to East?
MIDDLE PLIOCENE
3.8 MYA TO 3.4 MYA
SPHEN. ABIES B TO RETIC PSEUDO
Northeastern sediment source?
Orion Basin mostly shale deposition with occasional sand pulses
Main Pliocene Sand Fairway
Salt High
Basin hinge line with continued faulting
No Transport to Arnold Basin
Middle Pliocene Hinge Line
Sand Depo Shadow
Early Pliocene Hinge Line
Bul 1 Lobes 10, 20, 30 Basin Floor Fans
Bul 1 Lobes 70 & 80 Channel-Overbank
No Sand Transported To Arnold Basin
Pliocene Shales
Deep Pliocene Fans

Figure 8