Petroleum Systems

(Part Two)

Trap and Reservoir

GEOL 4233 Class
January 2008

Petroleum System Summary

- **Source (Material and Rocks)**
- **Generation (Maturation)**
- **Migration**
- **Trap**
- **Reservoir**

Trap Types

(A Question of Seal)

- Structural
- Stratigraphic
- Other

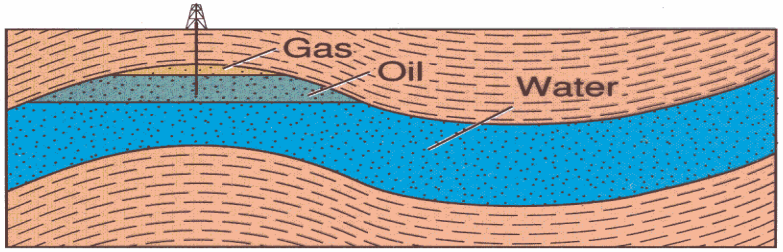
Traps

- **Anticlinal** - Rock layers folded into a dome

- **Stratigraphic** - Rock layers changing from a good reservoir to non-reservoir due to change in rock type (pinch-out), reservoir quality (diagenesis), or removal (erosional unconformity)

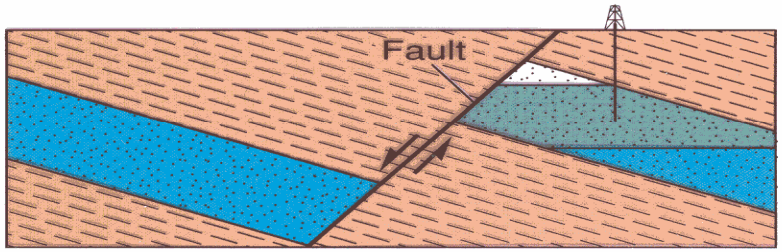
- **Fault** - Offset of rocks such that oil and gas accumulates in reservoir rock

Structural



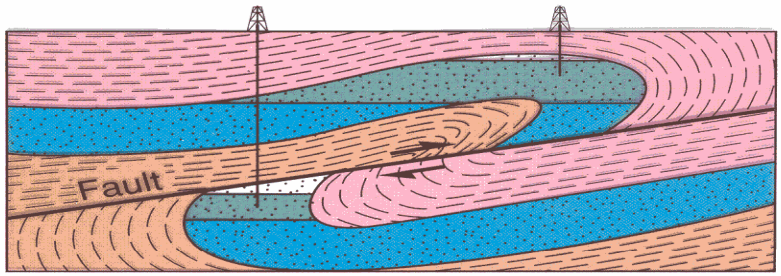
A Anticline

Structural



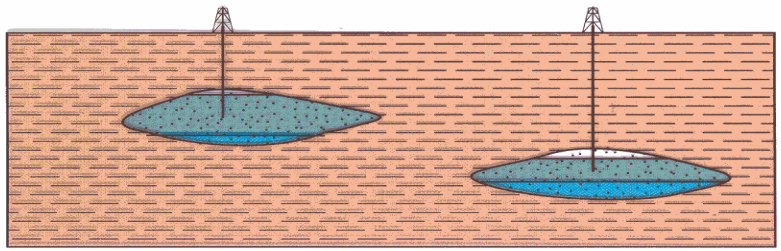
B Normal fault

Structural



C Thrust fault

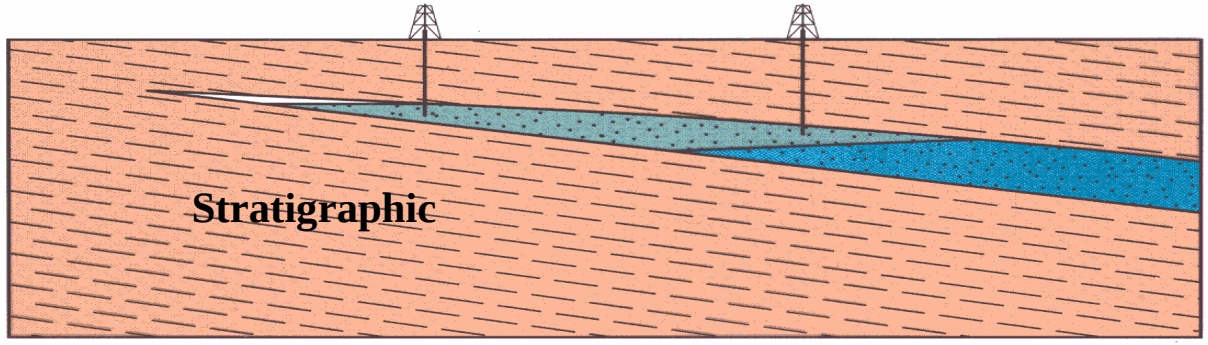
Stratigraphic



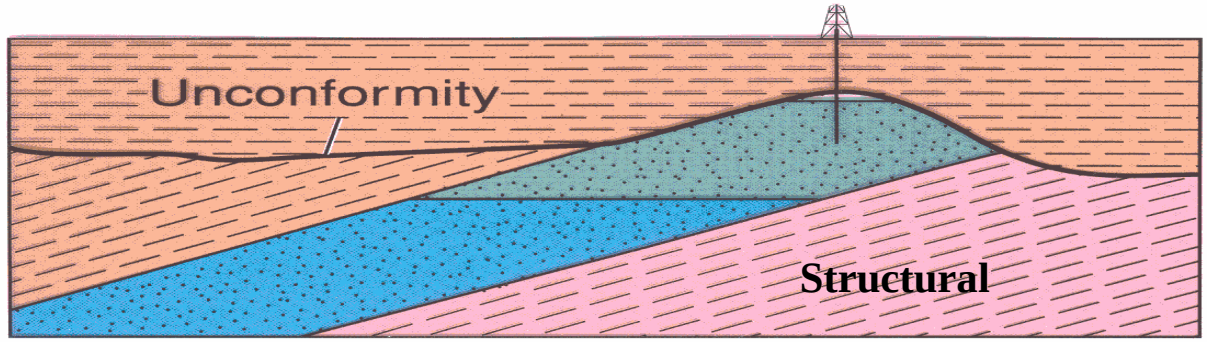
D Sandstone lenses

217 Traps for Oil and Gas
Figure 21.3A-D

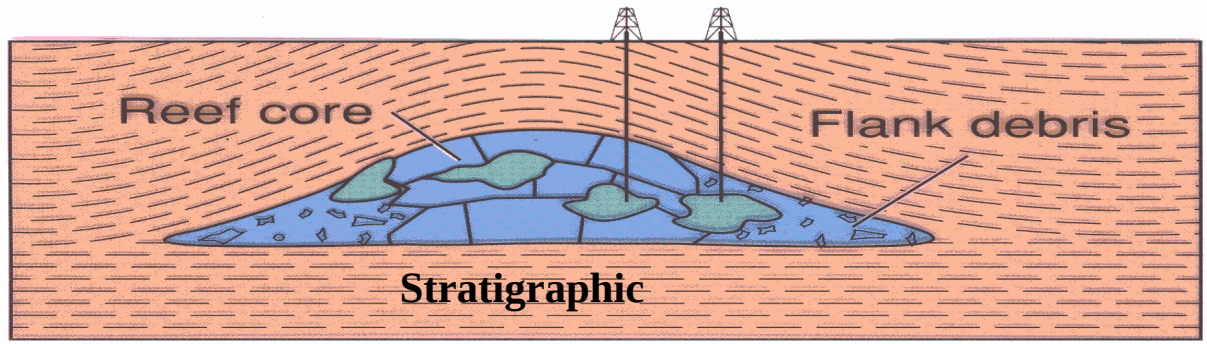
Typical Hydrocarbon Traps



E Sandstone pinchout



F Unconformity

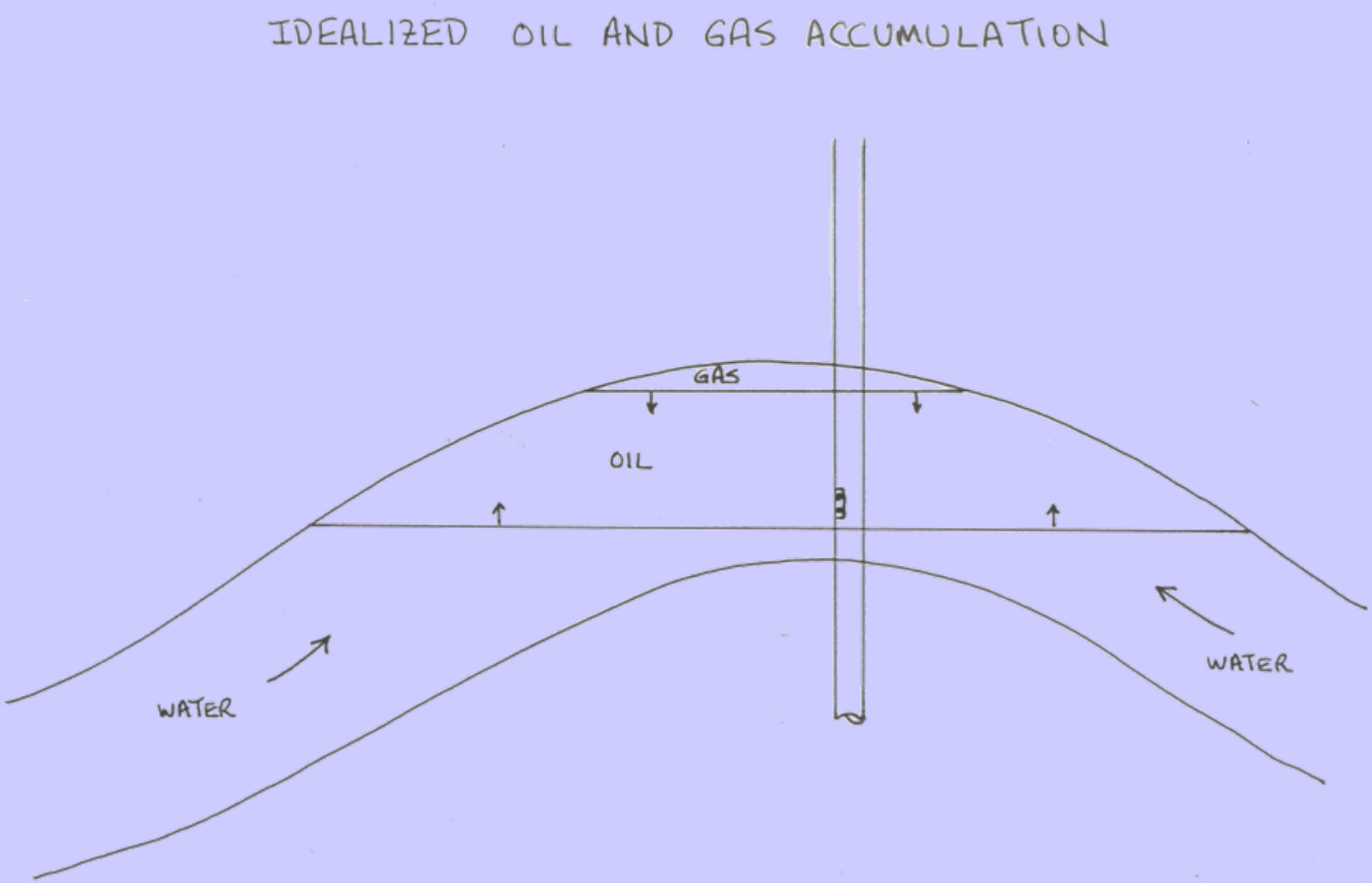


G Reef (a small "patch" reef)

Typical Hydrocarbon Traps

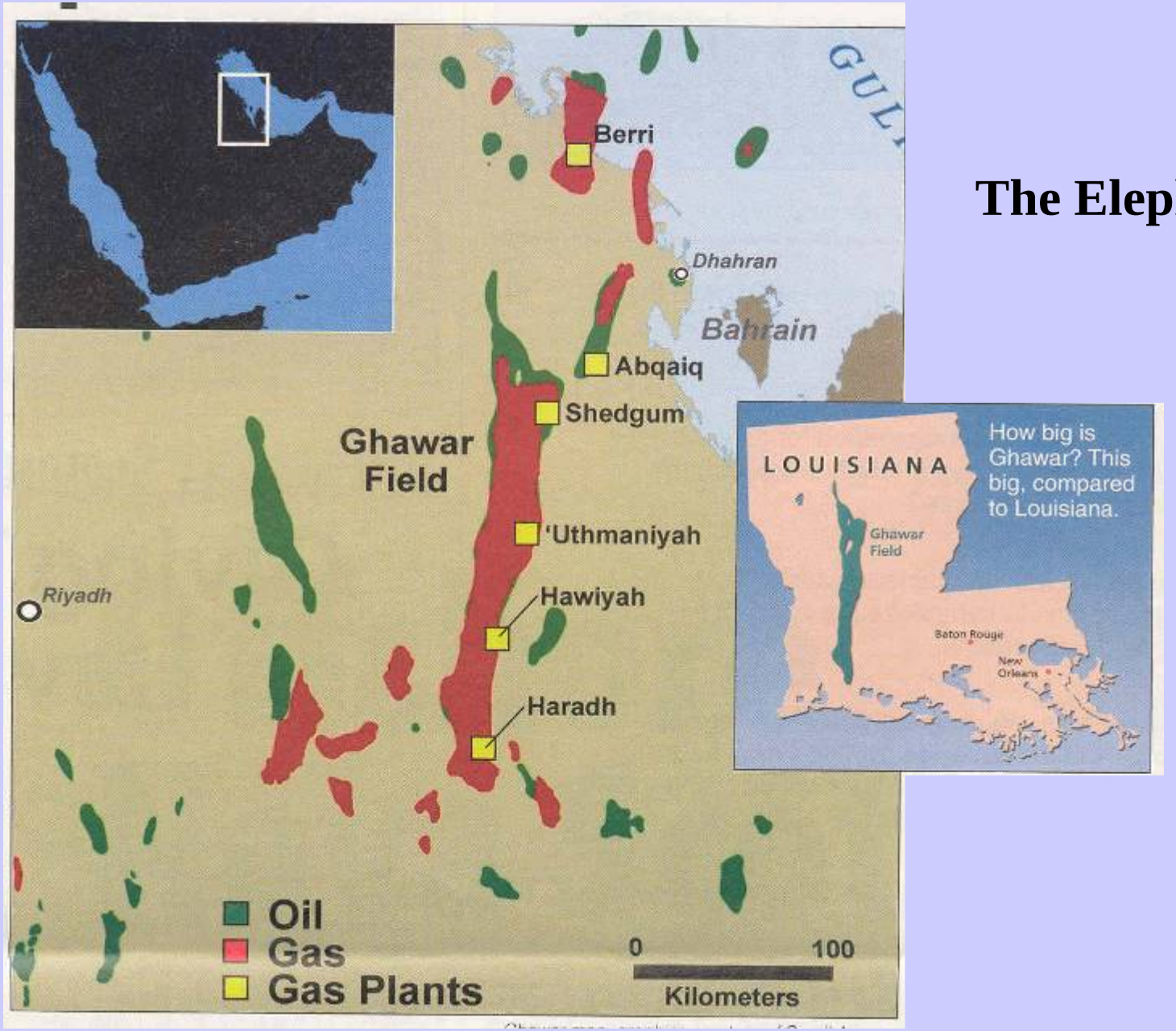
Structural Traps

Simple Anticline

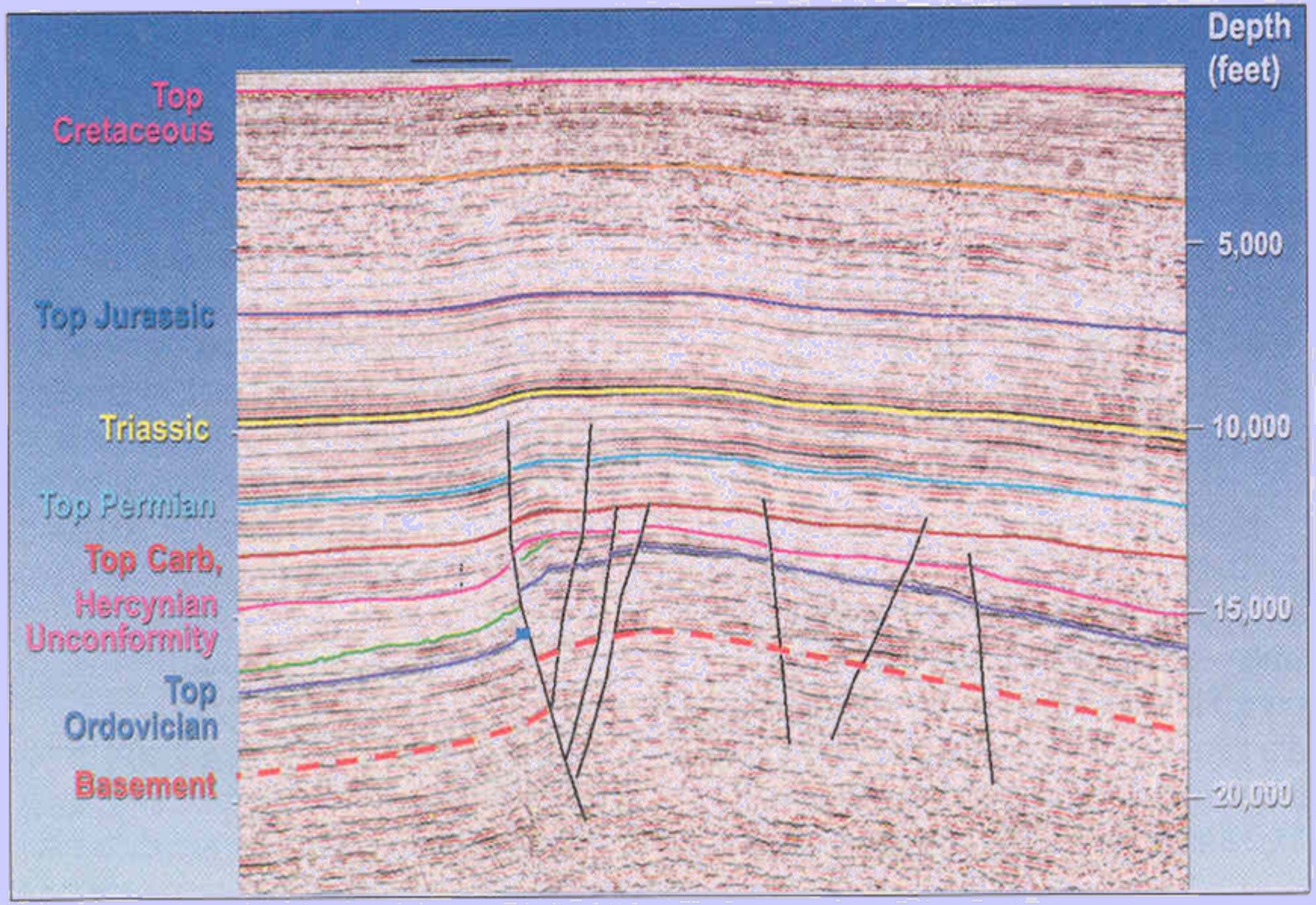


Surface Anticline
Hunton Limestone (Oklahoma)

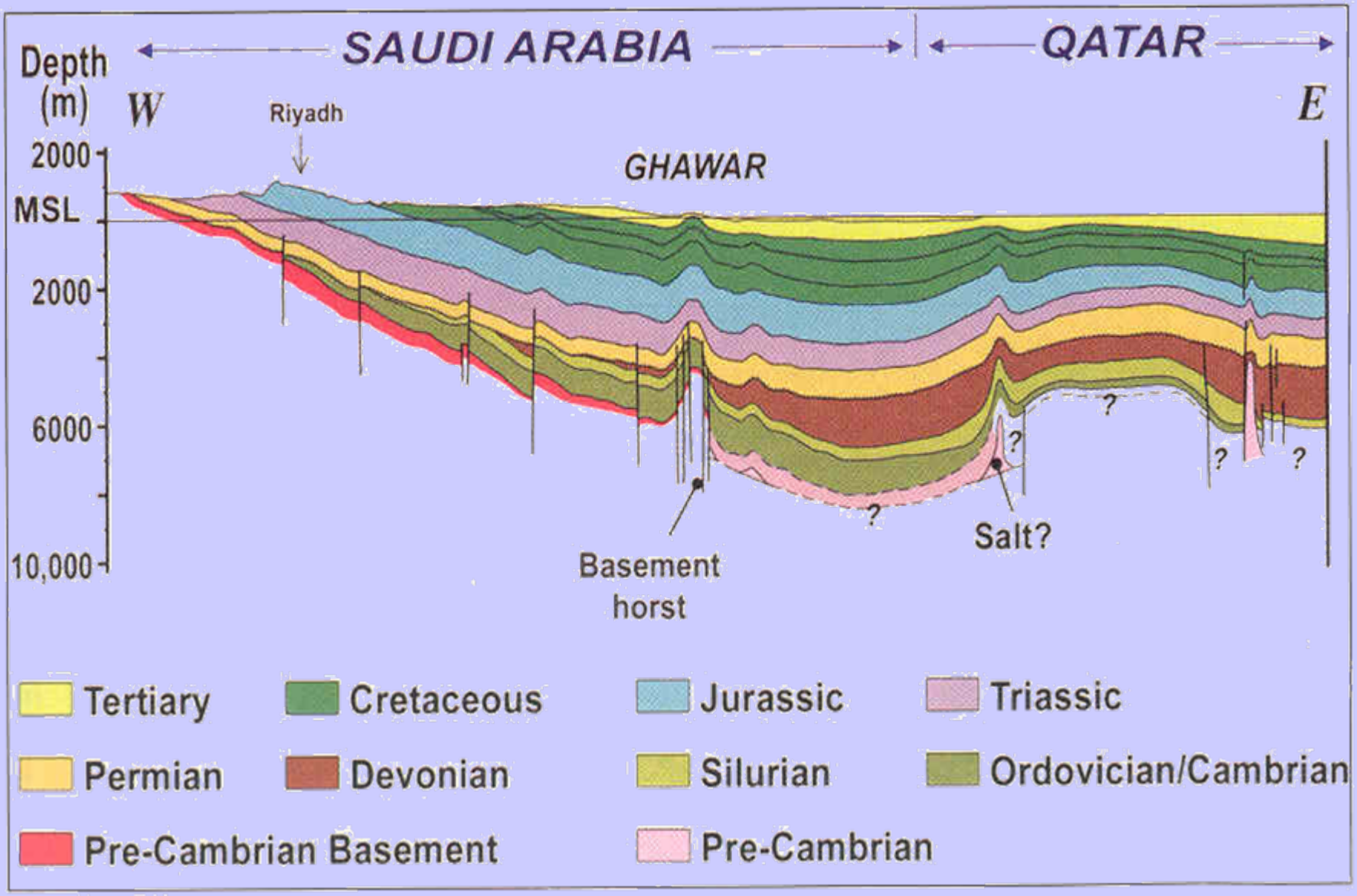
The Elephant



East-west seismic depth section, south Ghawar.



Regional east-west cross section.



A Structural 'Football'

(As Simple as it Gets)

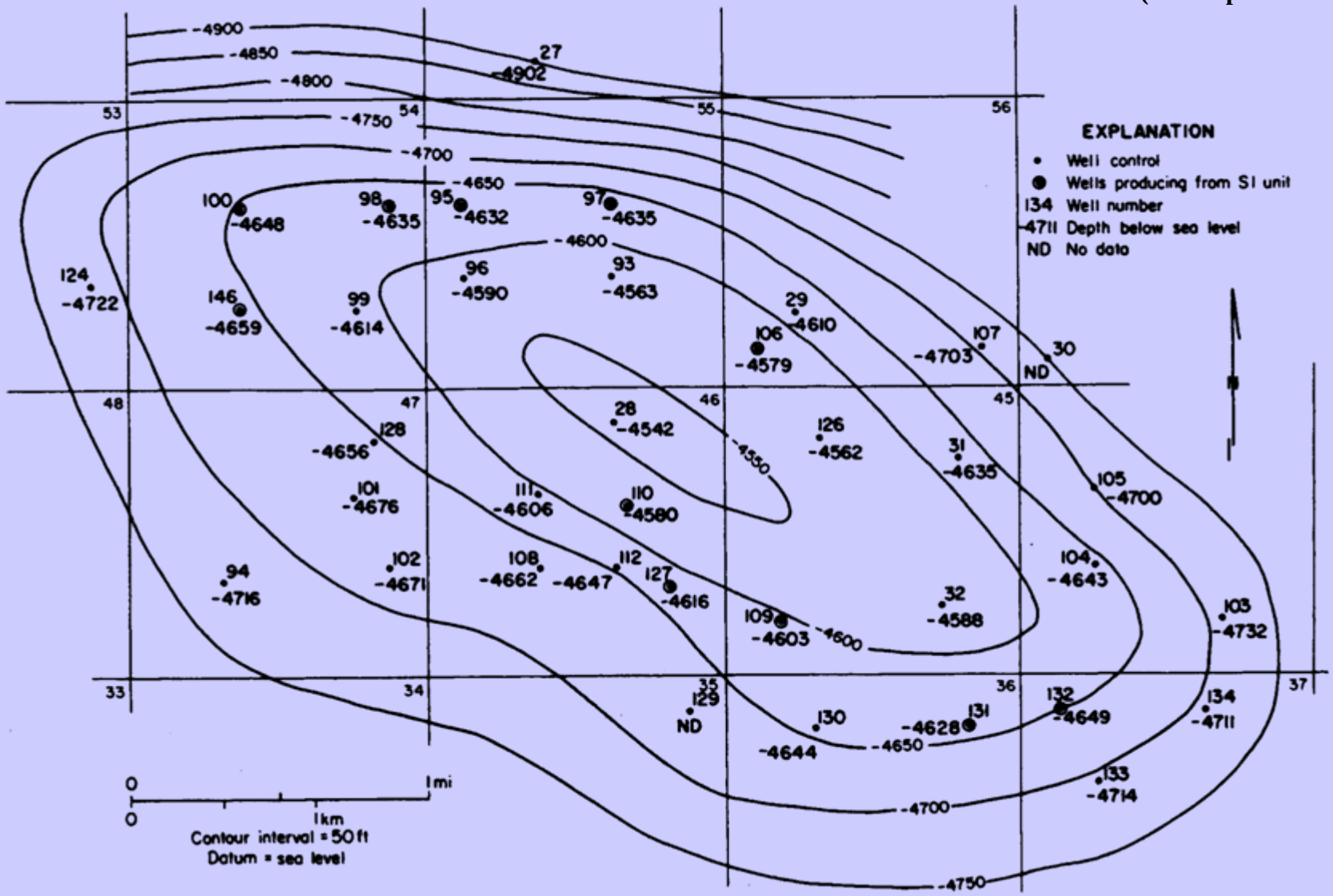


Fig. 214. Missourian sandstone structure map, Mobeetie field. From Dutton, 1982. Permission to publish by AAPG.

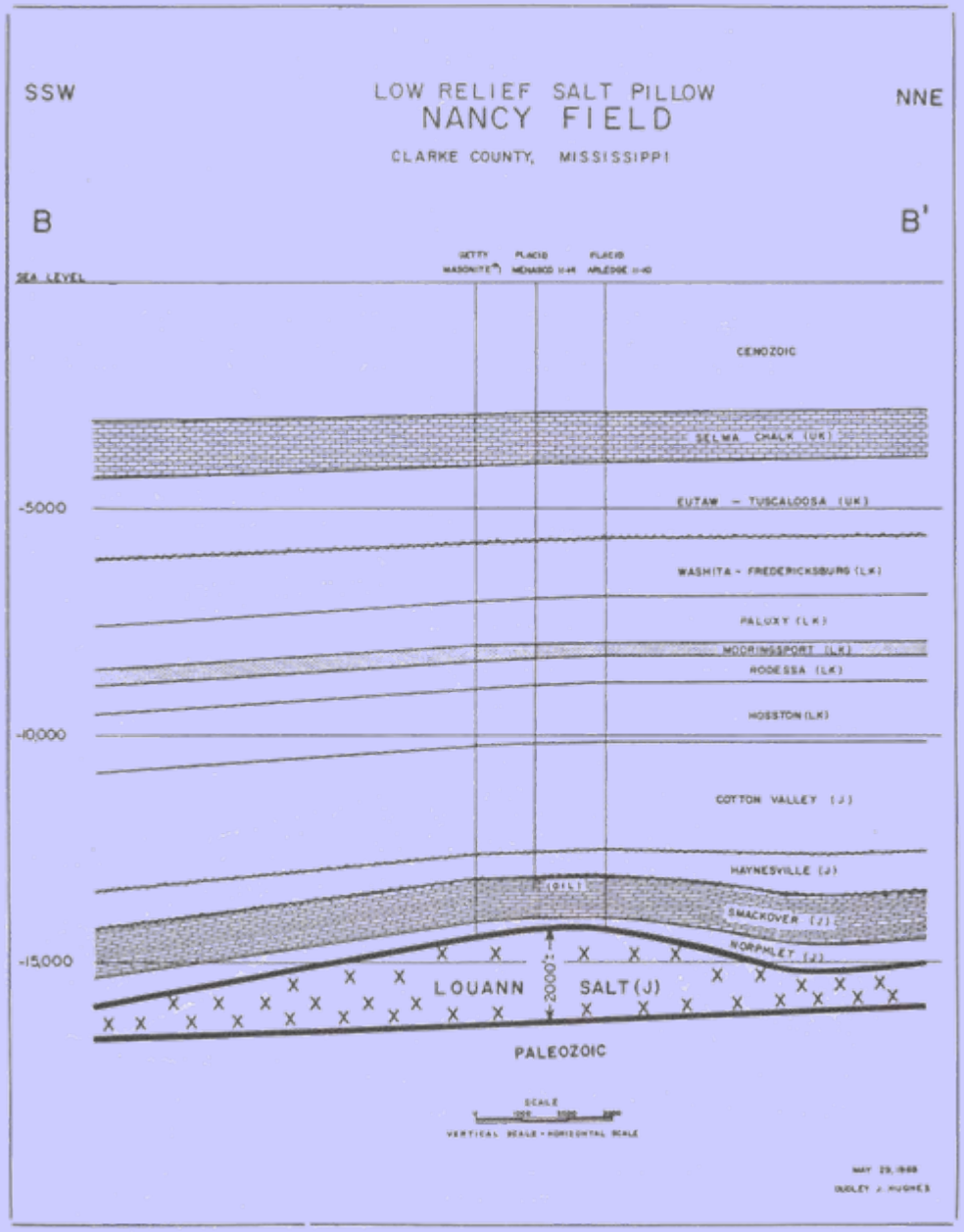


Fig. 314. Nancy Field, low relief salt pillow, Mississippi. From Hughes, 1968. Permission to publish by the Gulf Coast Association of Geological Societies.

Salt-Induced Structural Trap

(Gentle)

A Minor Fault Complication

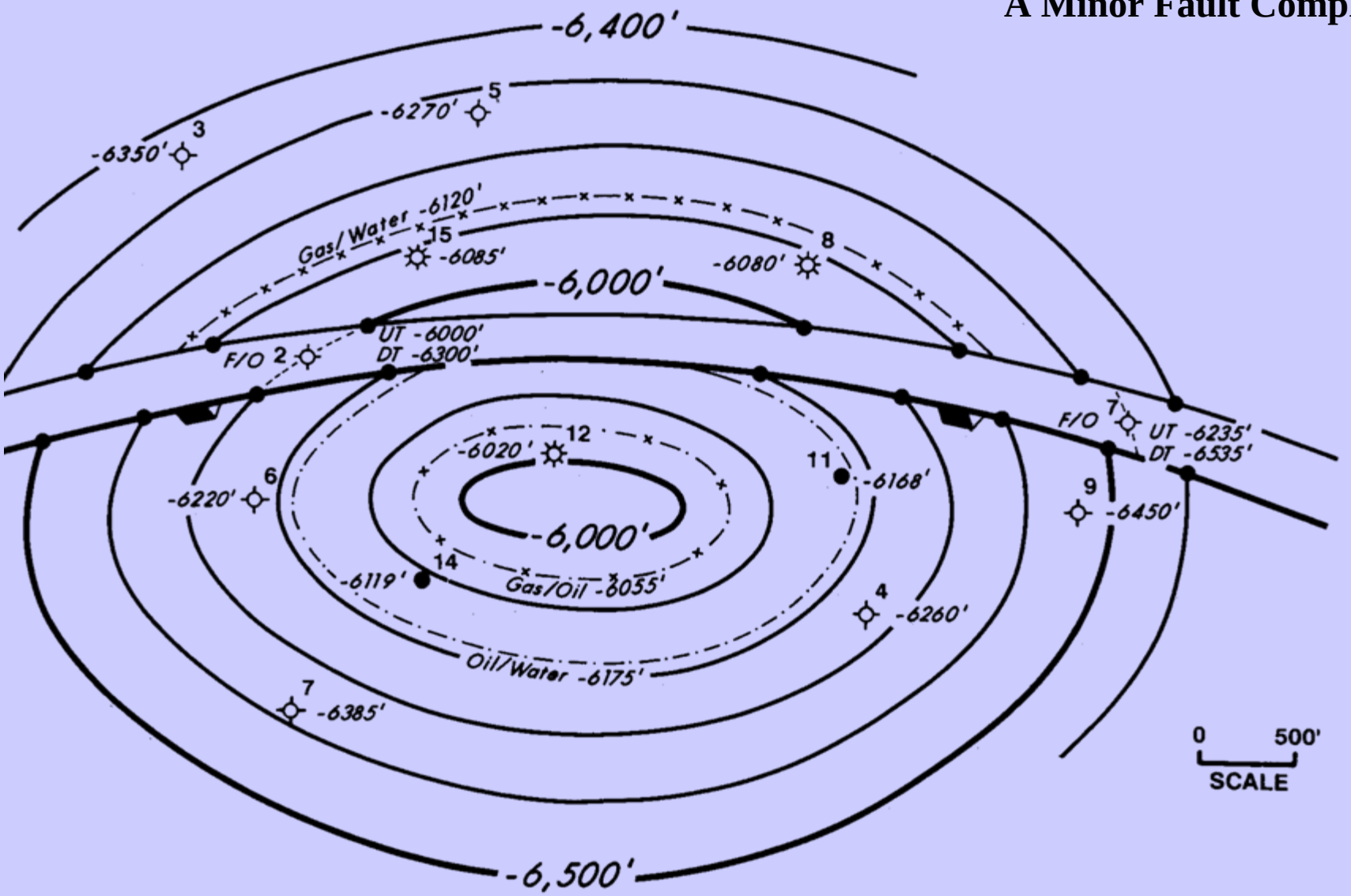


Figure 8-10 Integrated fault and structure map for the 6000-ft Horizon. The darkened circles delineate the intersection of each structure contour with the fault contour of the same elevation.

A Major Fault Complication

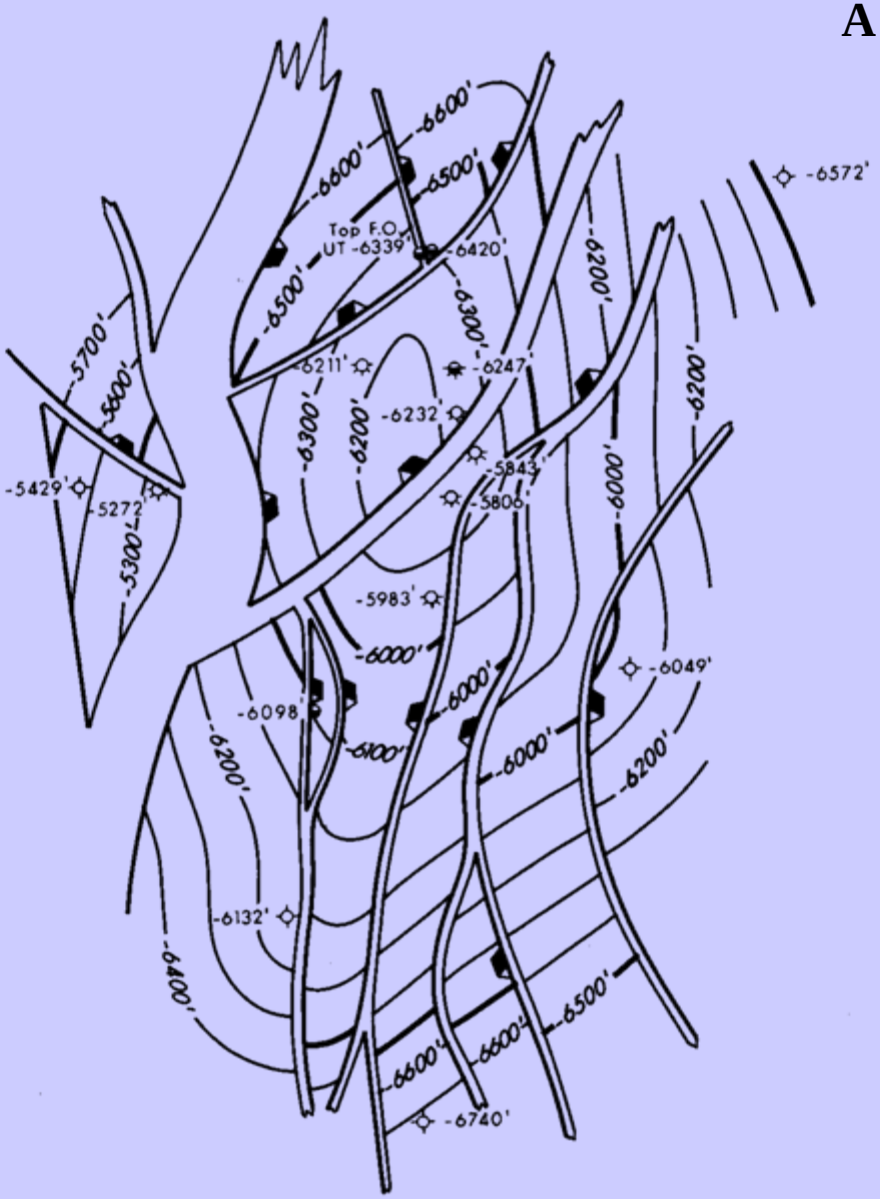


Figure 8-22 An integrated structure map of a very complexly faulted anticlinal structure. Each fault was integrated with the structural interpretation as shown in Fig. 8-21.

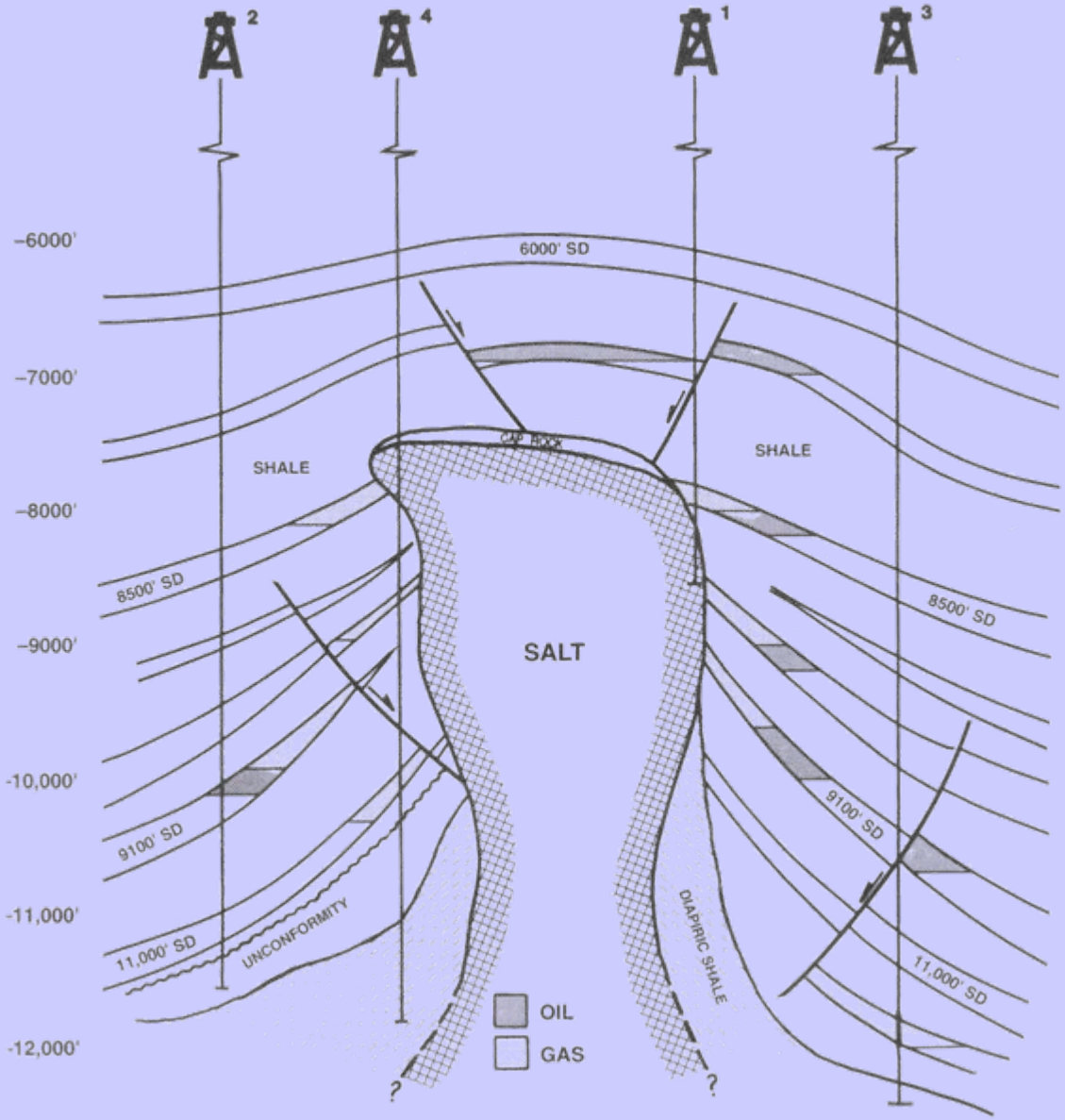
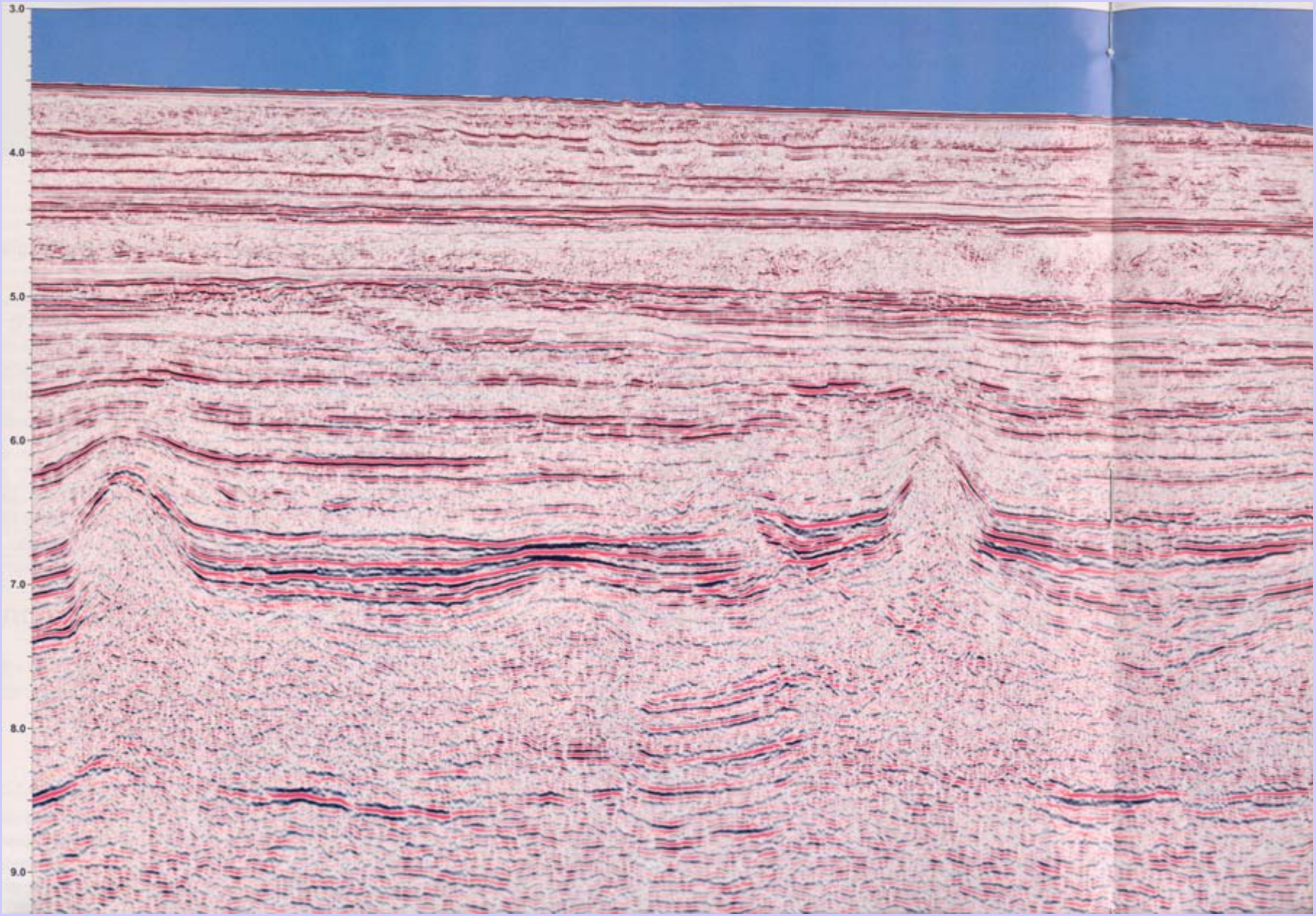


Figure 4-6 A cross section through a complex diapiric salt structure, penetrated by four vertical wells.

Salt-Cored Structure

(Greatly Simplified)

Deepwater Seismic Line (Showing Affects of Diapirs)



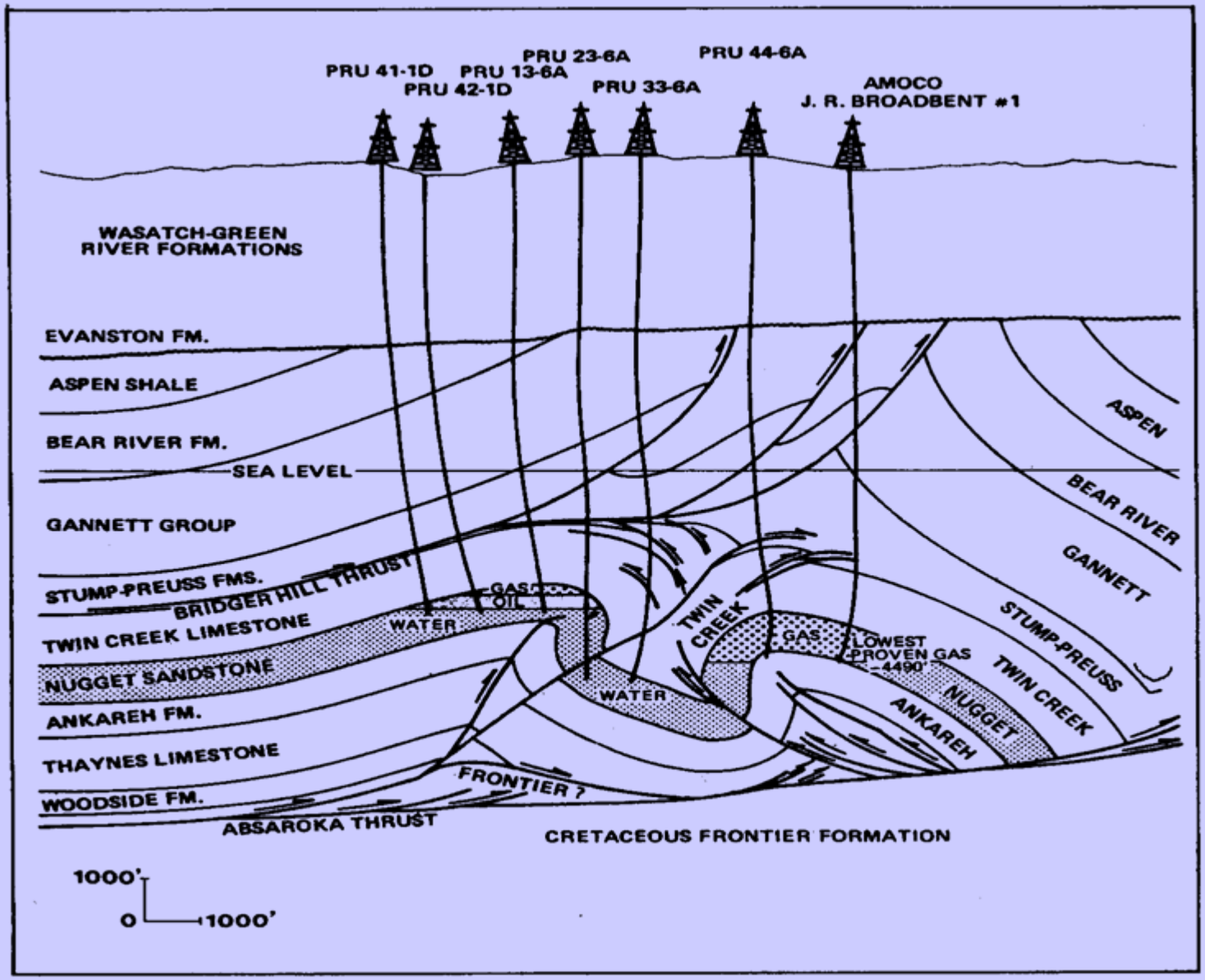


Fig. 219. Structure section, Painter Reservoir, Wyoming. Permission to publish by Chevron.

Structural Traps in a Compressional Terrain

Groningen Field (Largest Gas Field in Europe)

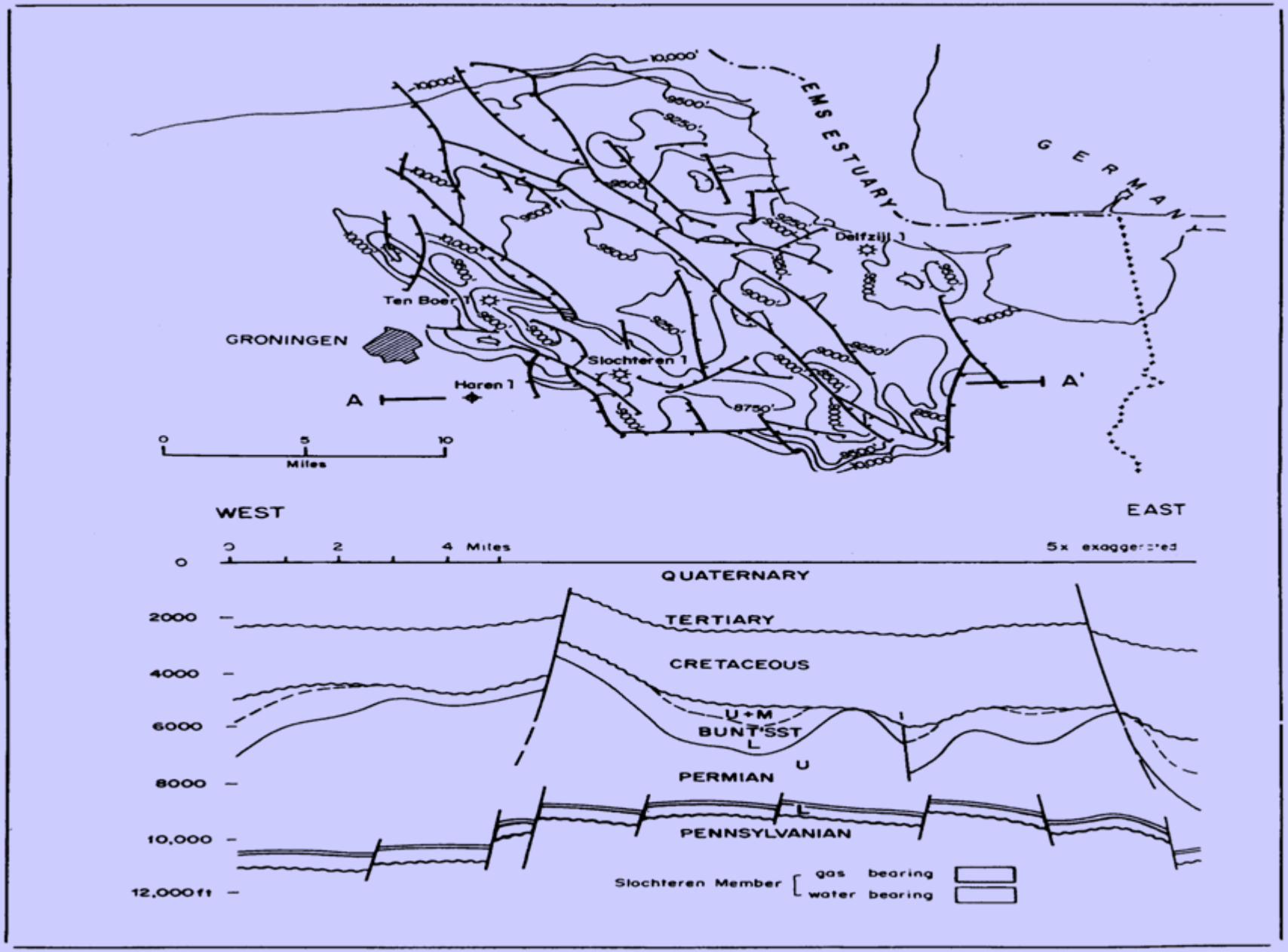


Fig. 217. Cross-section and structure map, Groningen field. From Stauble and Milius, 1970. Permission to publish by AAPG.

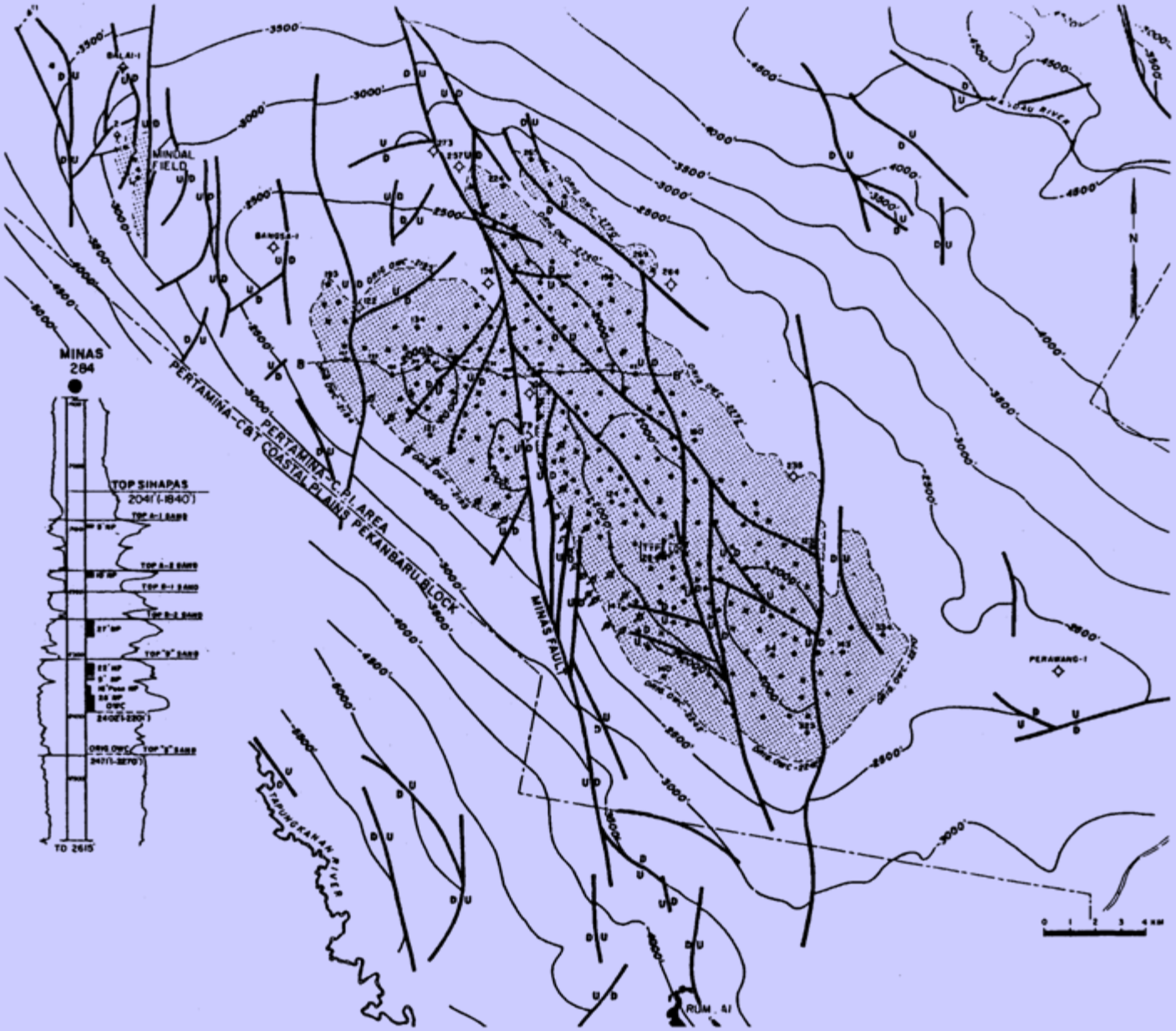


Fig. 31. Minas Field structure map. From Hasan, et al., 1977. Permission to publish by PT Caltex Pacific Indonesia.

Minas Field (Largest Oil Field in Indonesia)

Unconformity Trap

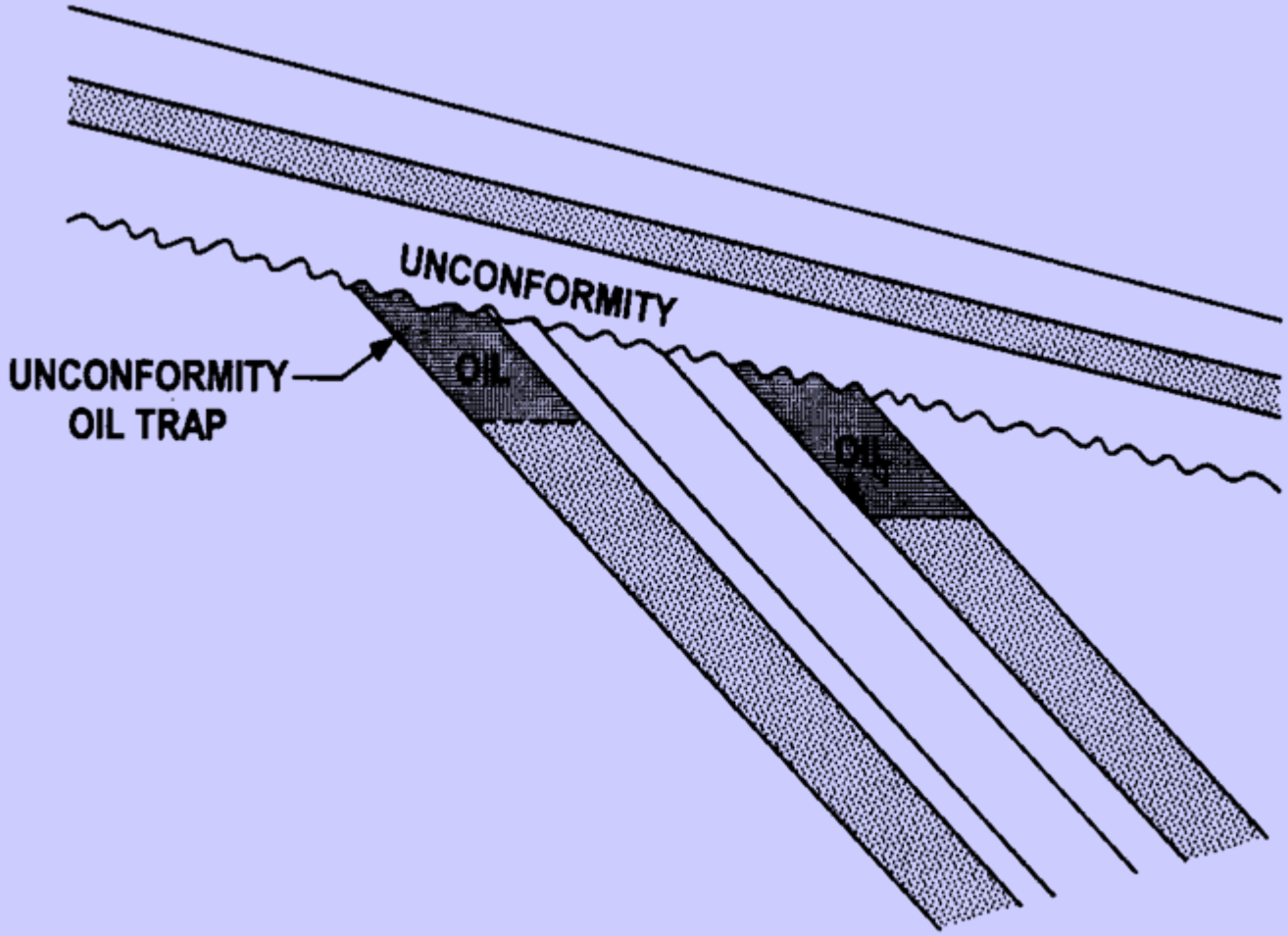


Figure 8-41 Typical hydrocarbon trap beneath an angular unconformity.

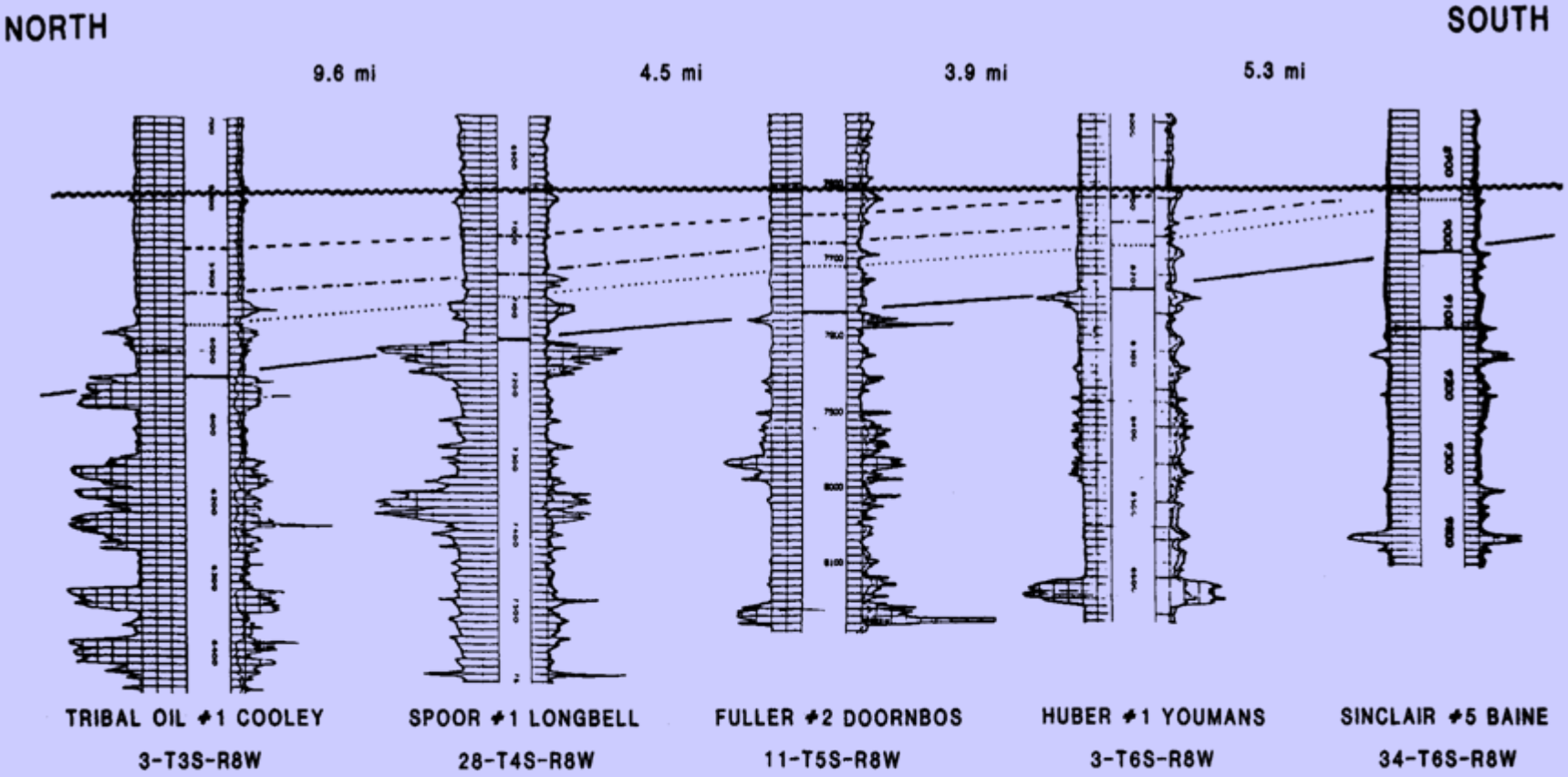


Figure 8-42 Example of an angular unconformity recognized by electric log correlation. (From Lock and Voorhies 1988. Published by permission of the Gulf Coast Association of Geological Societies.)

East Texas Field

(E.U.R. ~ 5 BBO)

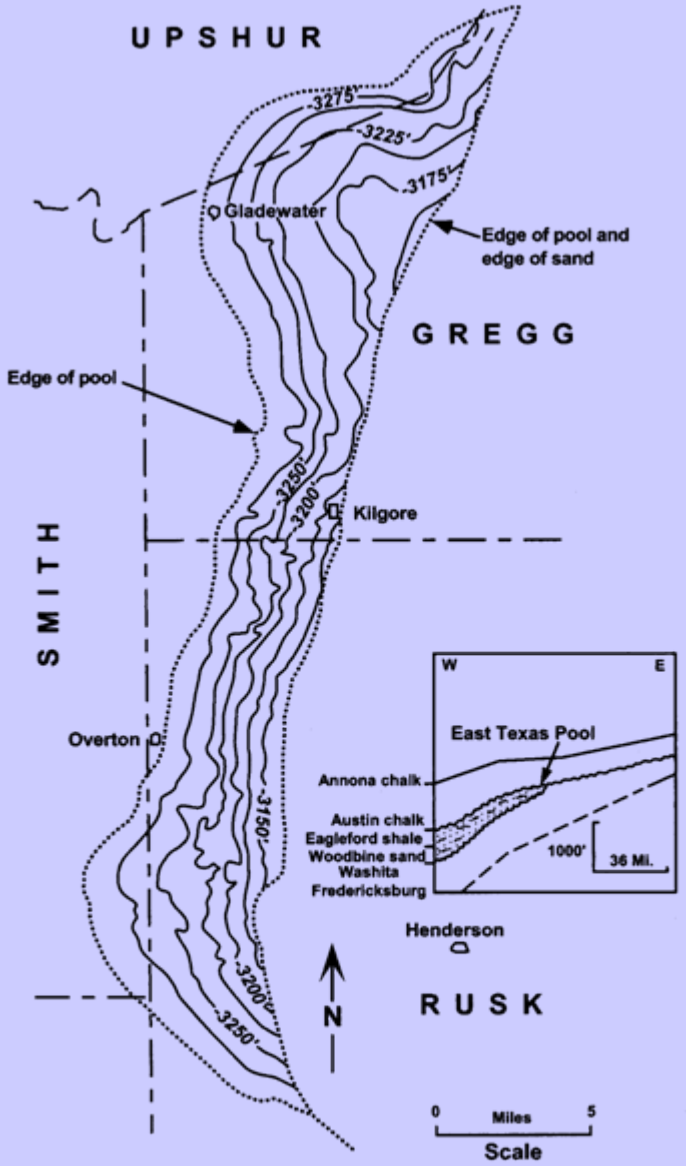
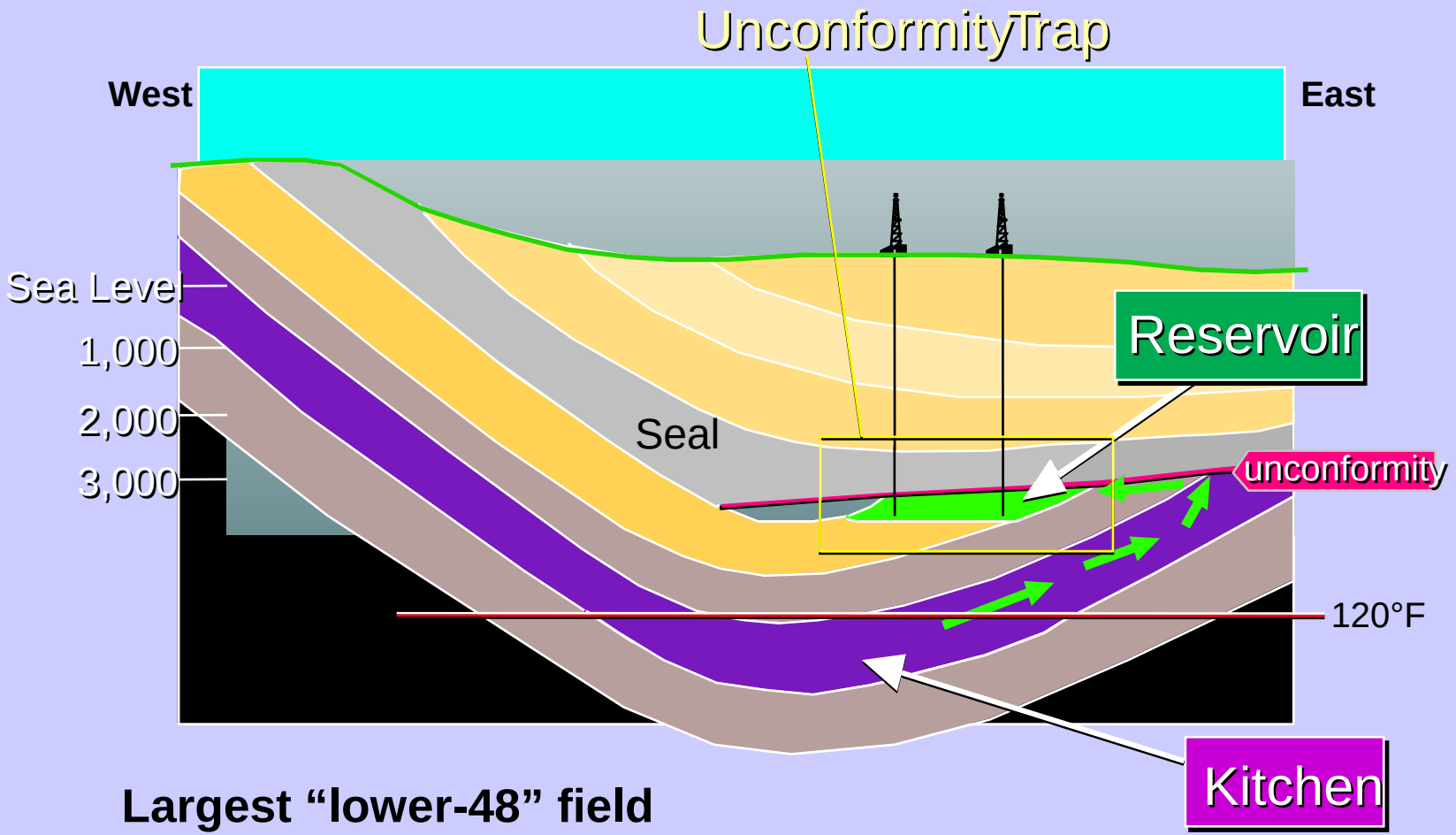


Figure 8-43 Structure map on top of the Woodbine Sand in the East Texas pool. As shown in the cross section insert, the intersection of two unconformity surfaces marks the eastern boundary of this unconformity trap. (From Geology of Petroleum, first ed. By A. I. Levorsen, Copyright 1954 by W. H. Freeman and Company. Reprinted by permission.)

East Texas Oil Field (1930)

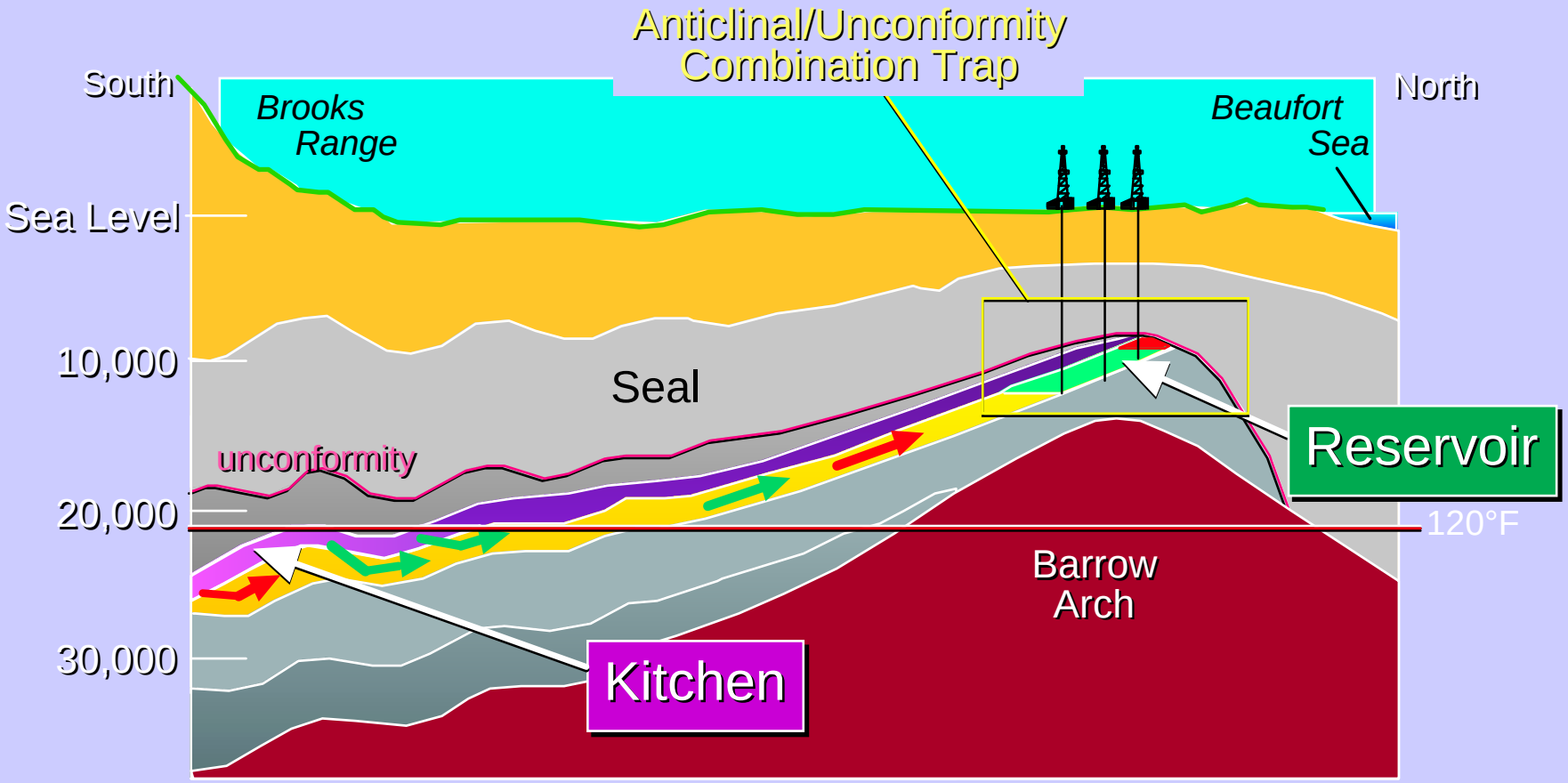


Largest “lower-48” field

More than 5 billion barrels recoverable

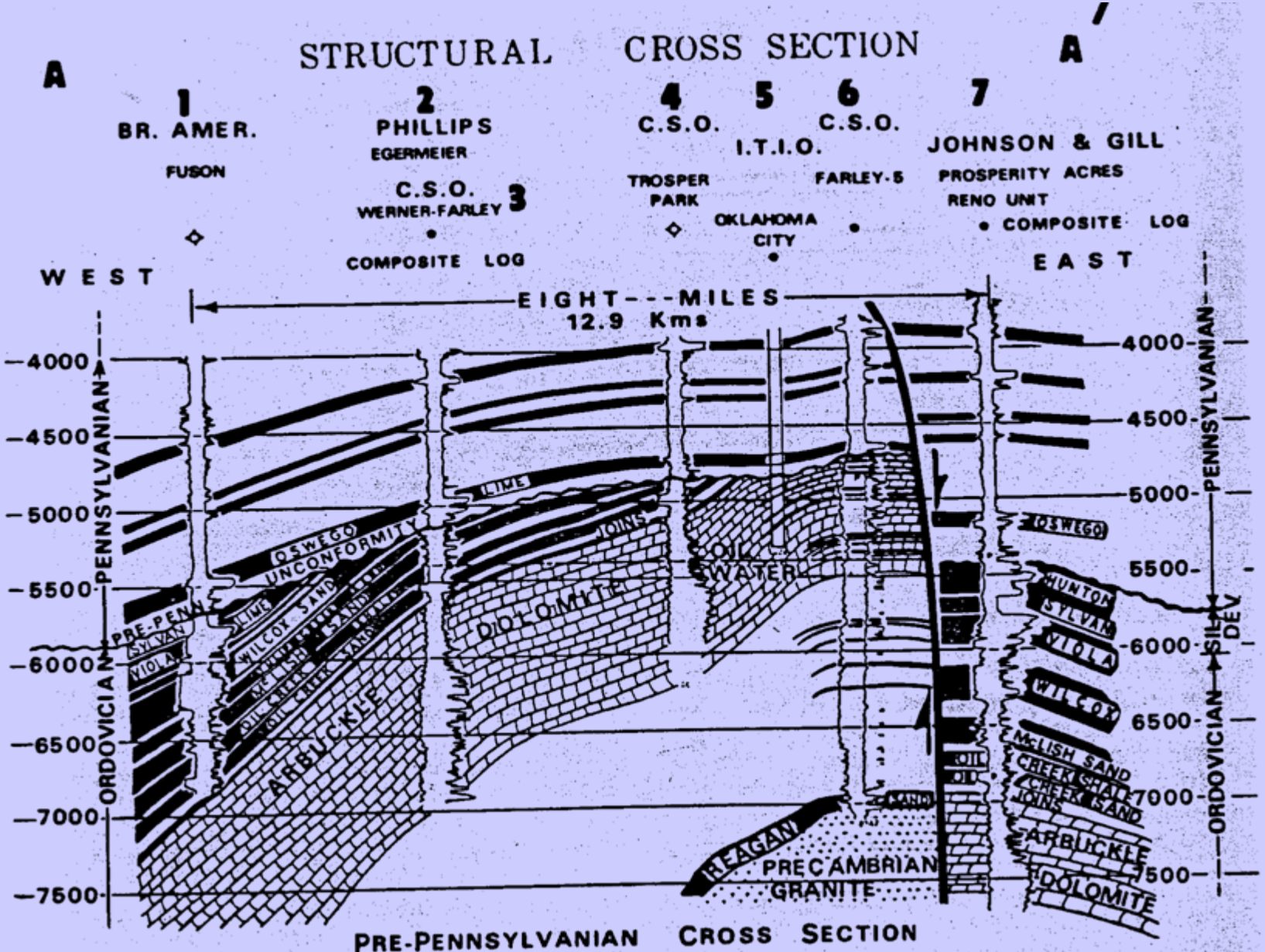
American Association of Petroleum Geologists, 1990

Prudhoe Bay Oil Field (1968)



- Largest NorthAmerican field
- More than 8 billion barrels recoverable

American Association of Petroleum Geologists, 1990



Oklahoma City Field (Largest in Oklahoma)

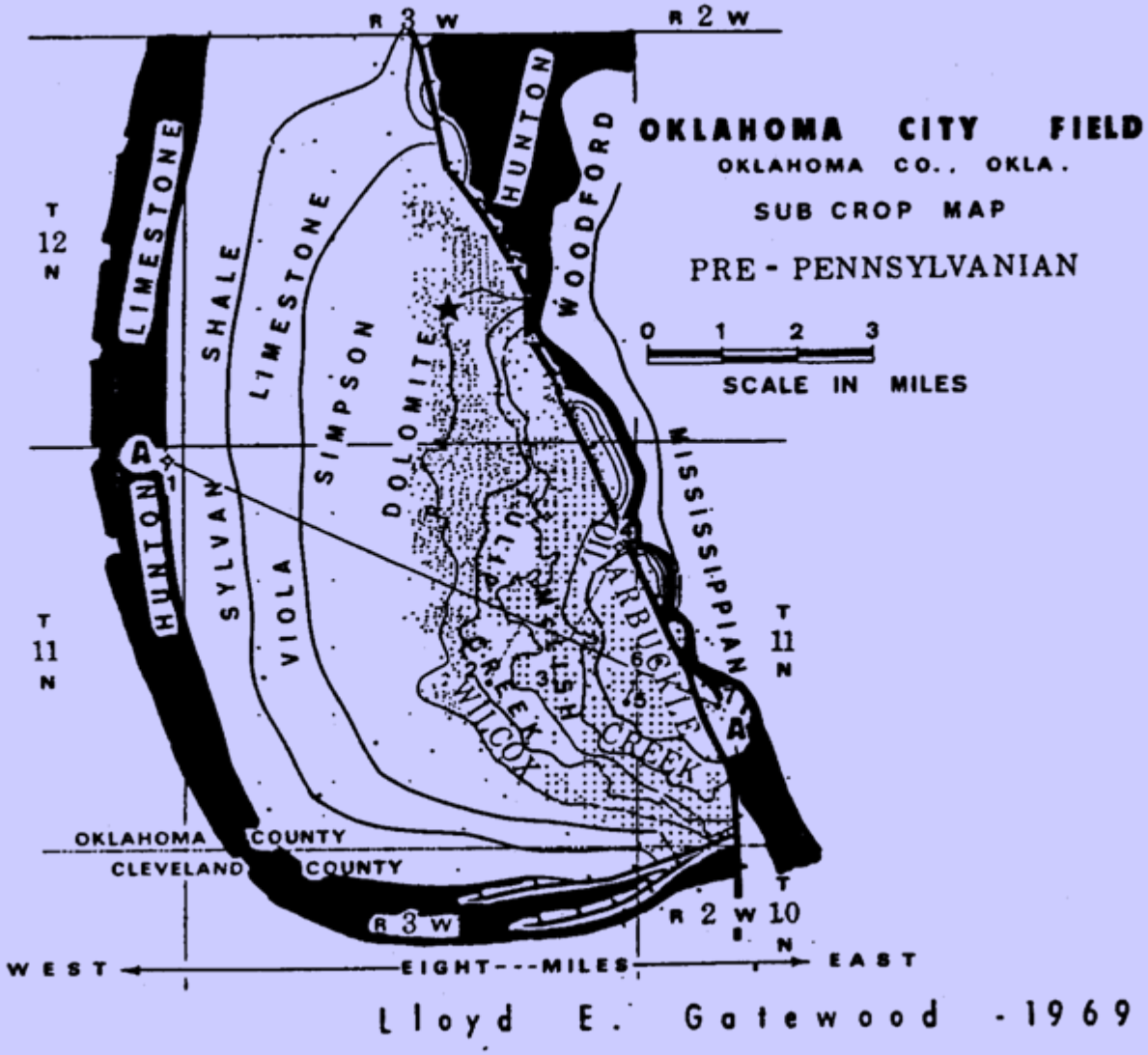
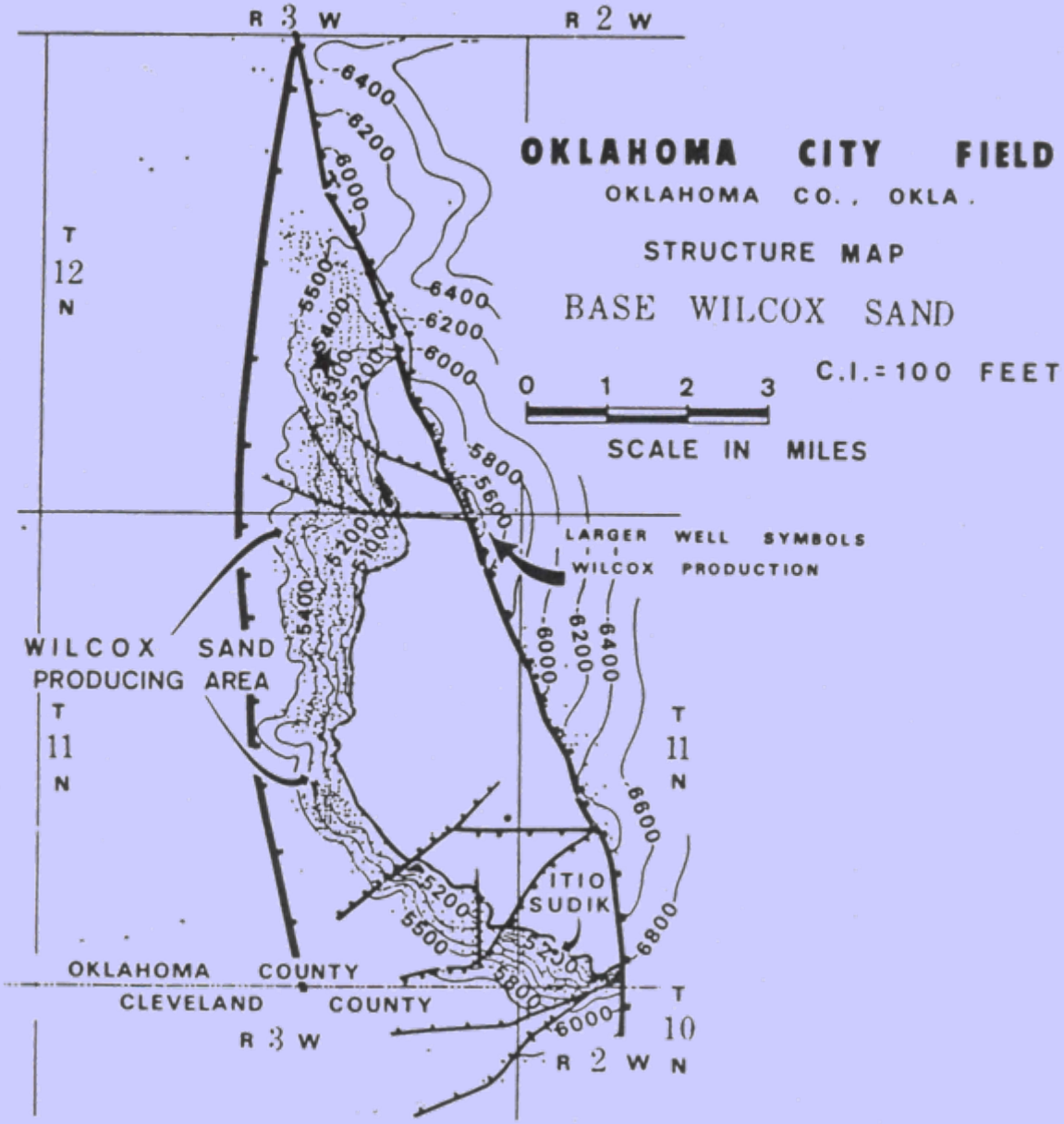
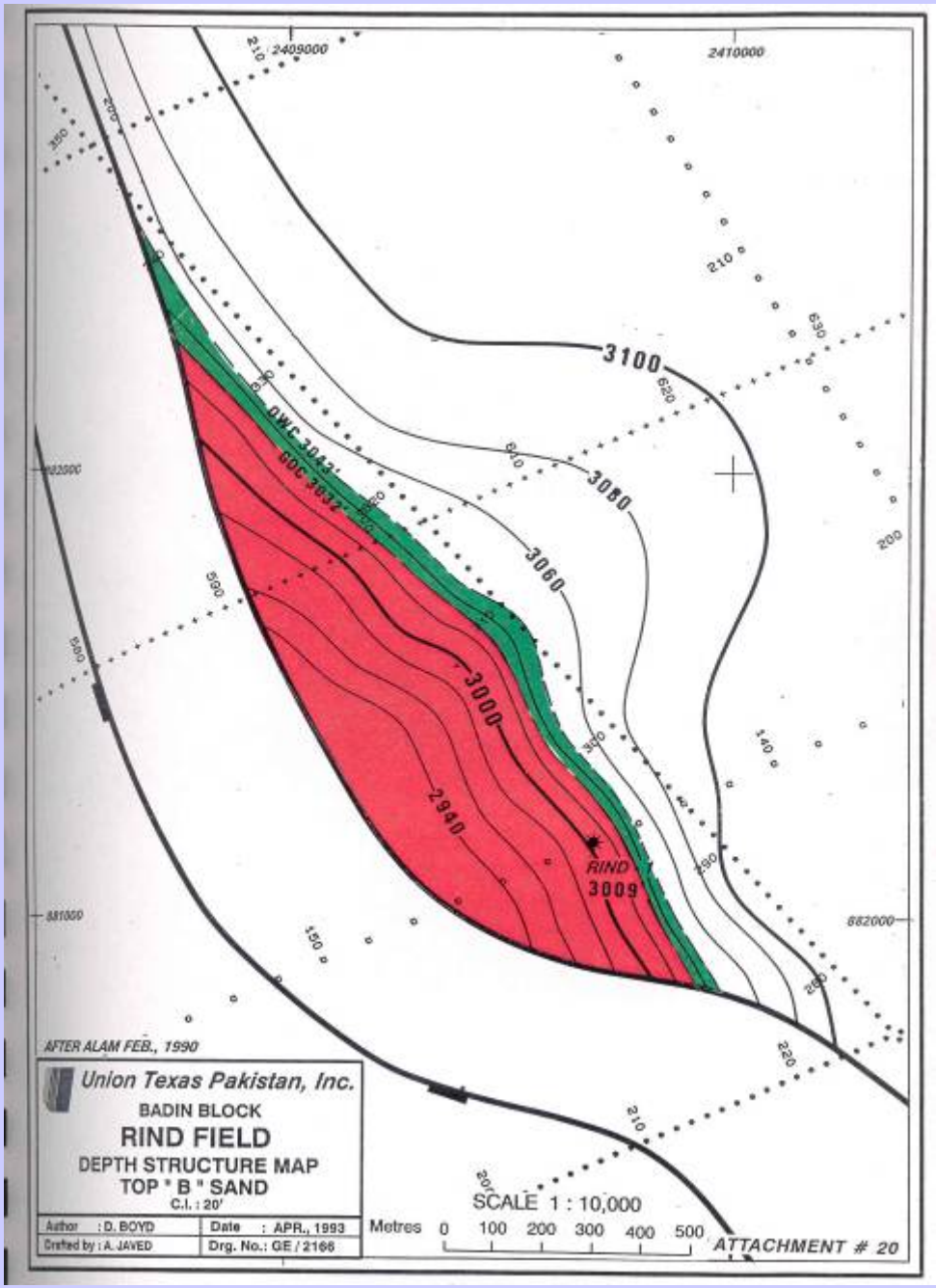


FIG. 7.—Pre-Pennsylvanian subcrop map illustrating large areal extent of erosion and truncated shape Ordovician Simpson and Arbuckle preserved at unconformity surface. A-A′ is line of sections in Figures 6 and

Oklahoma City Field Sub-Crop Map (Pre-Penn Unconformity)



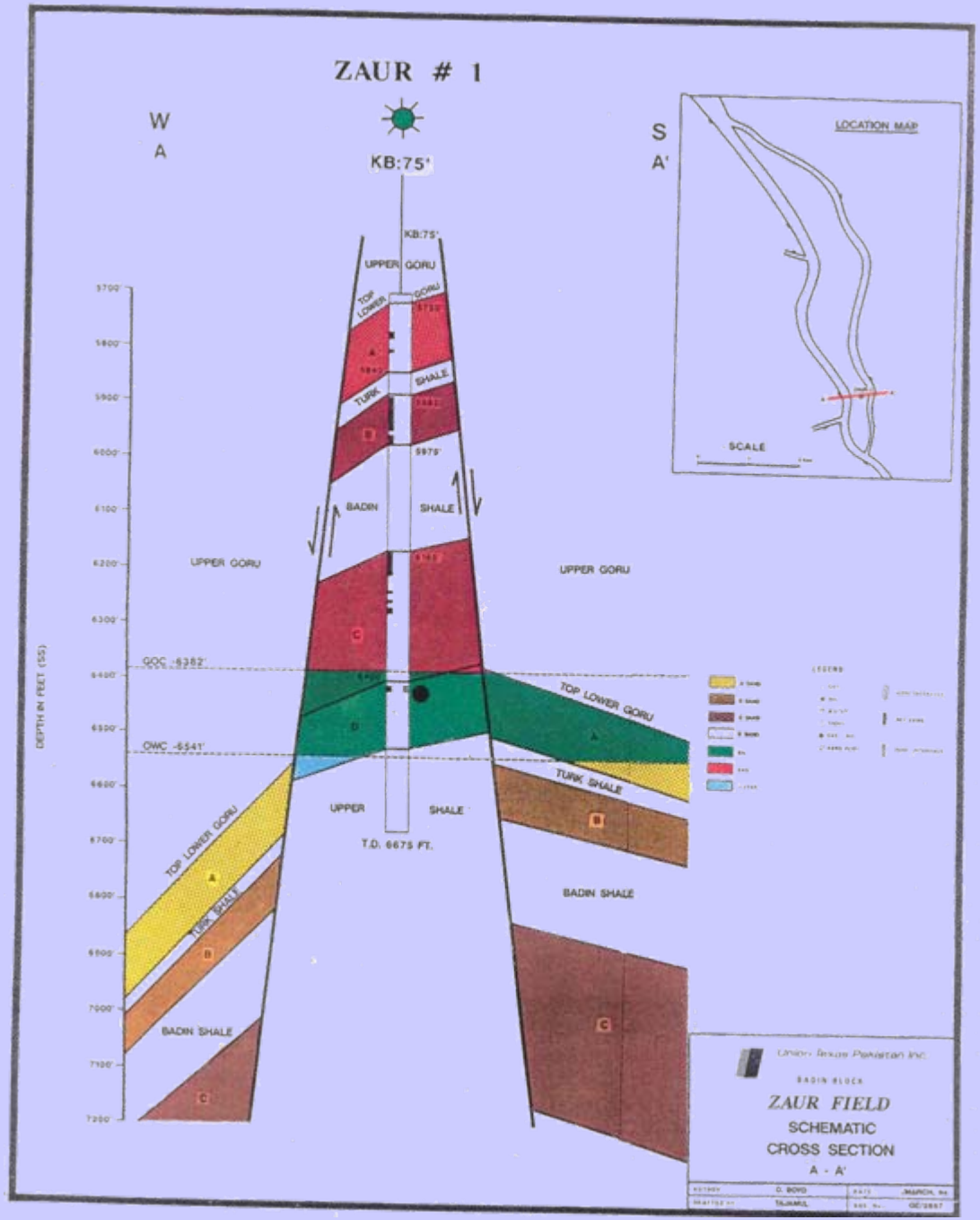
Oklahoma City Field (Wilcox Reservoir)



Simple Fault Trap

(Upthrown Normal Fault)

Extensional



Simple Fault Trap

(Narrow Horst)

Extensional

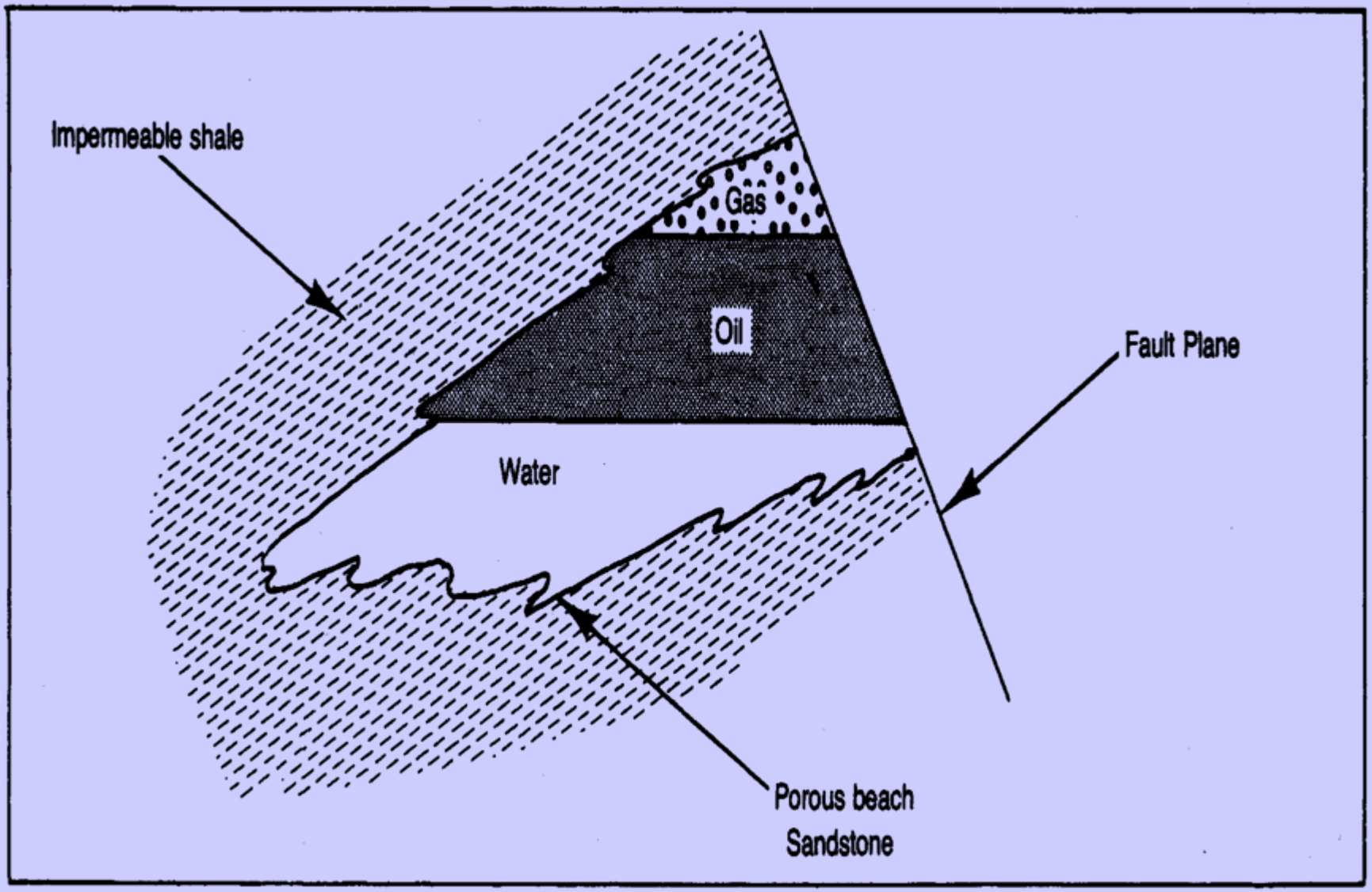
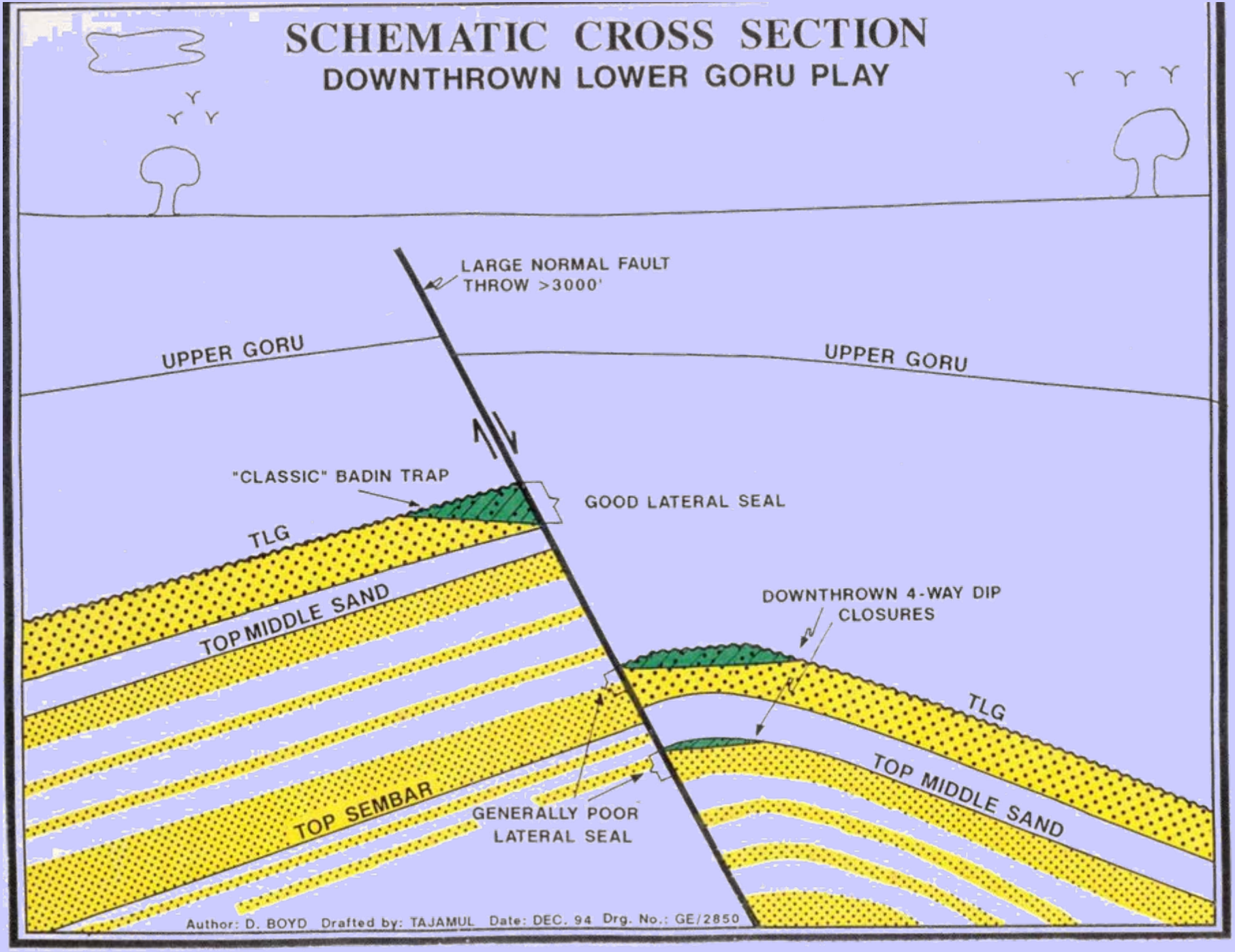
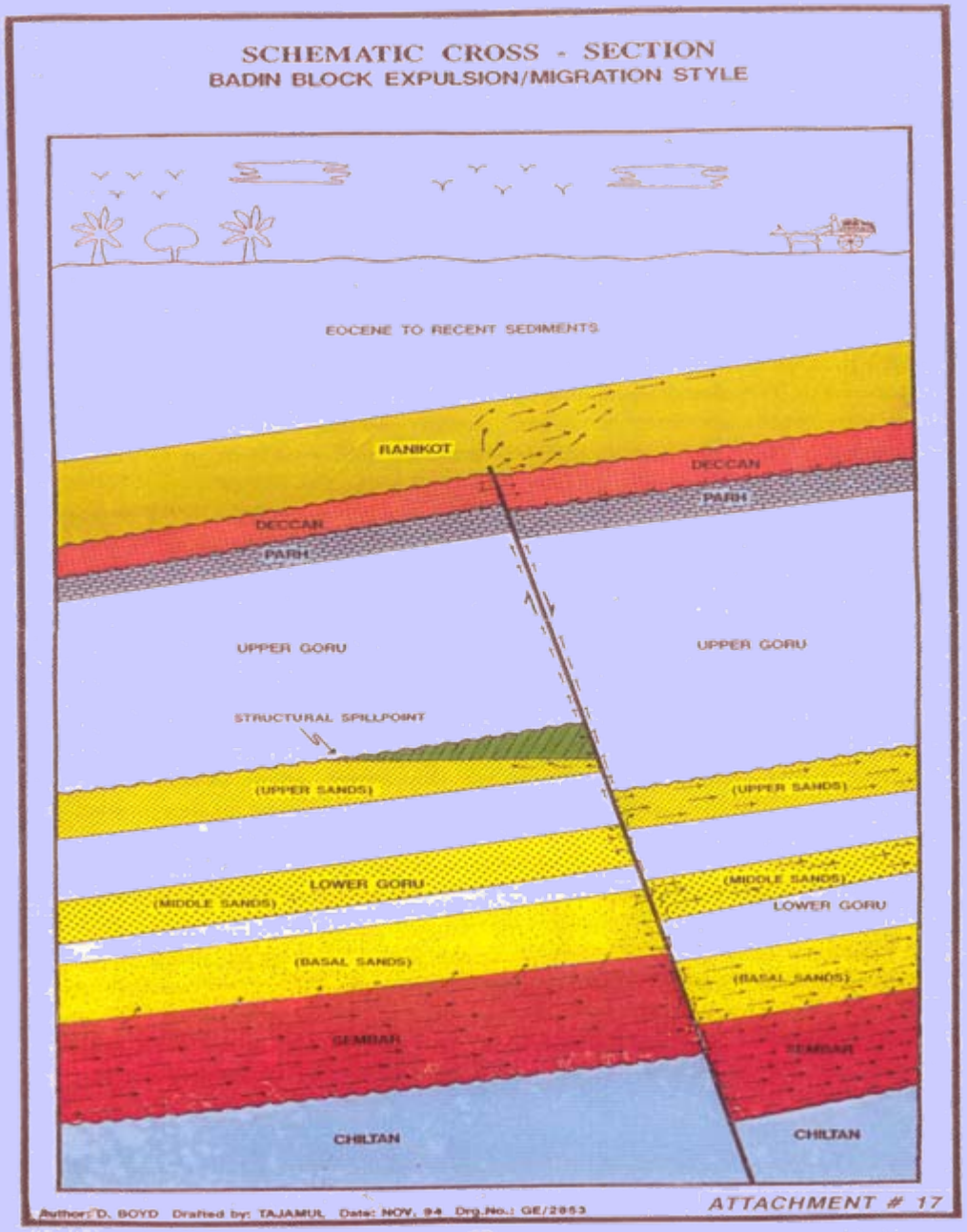


Fig. 410. Combination stratigraphic/structural trap

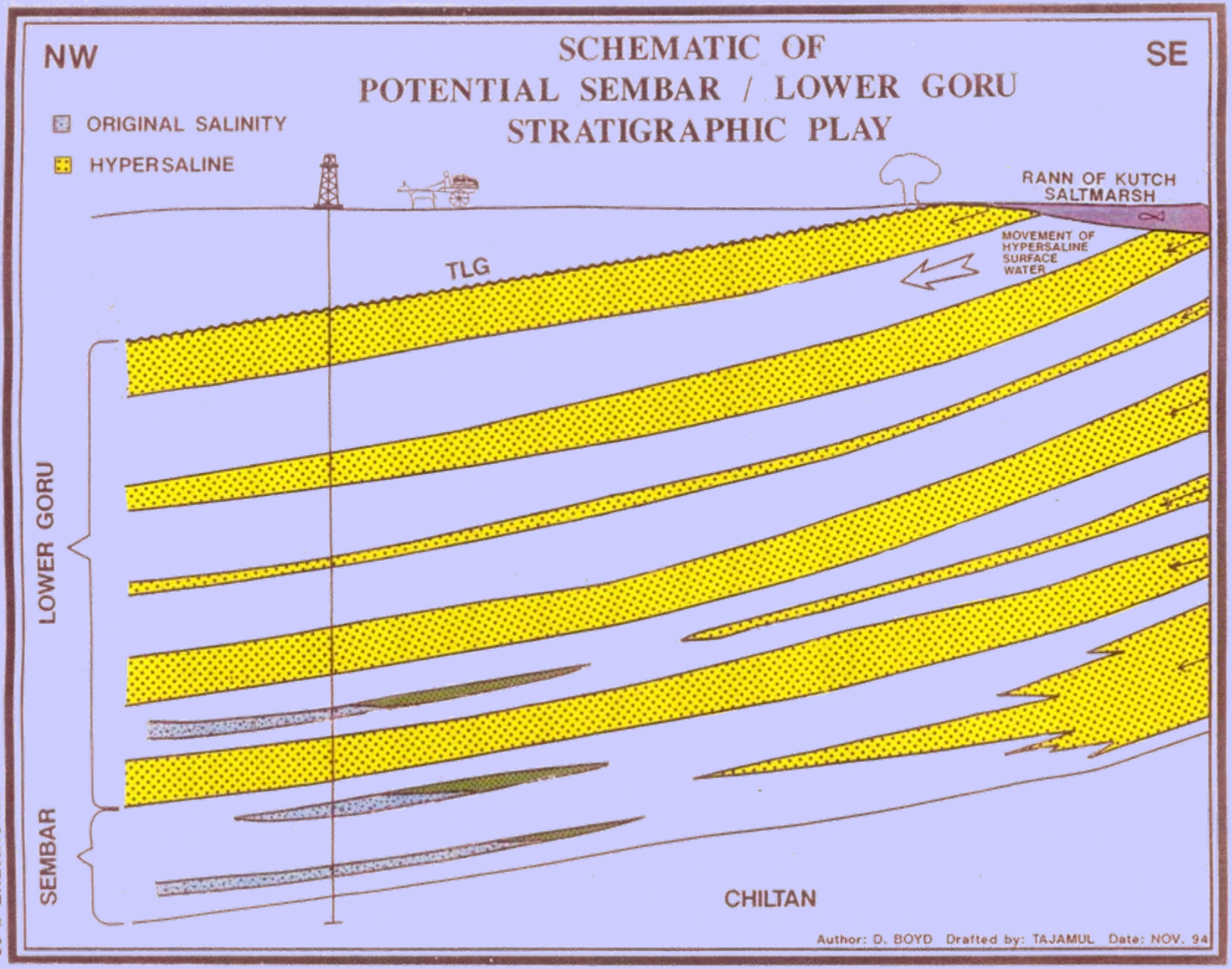
SCHEMATIC CROSS SECTION
DOWNTHROWN LOWER GORU PLAY



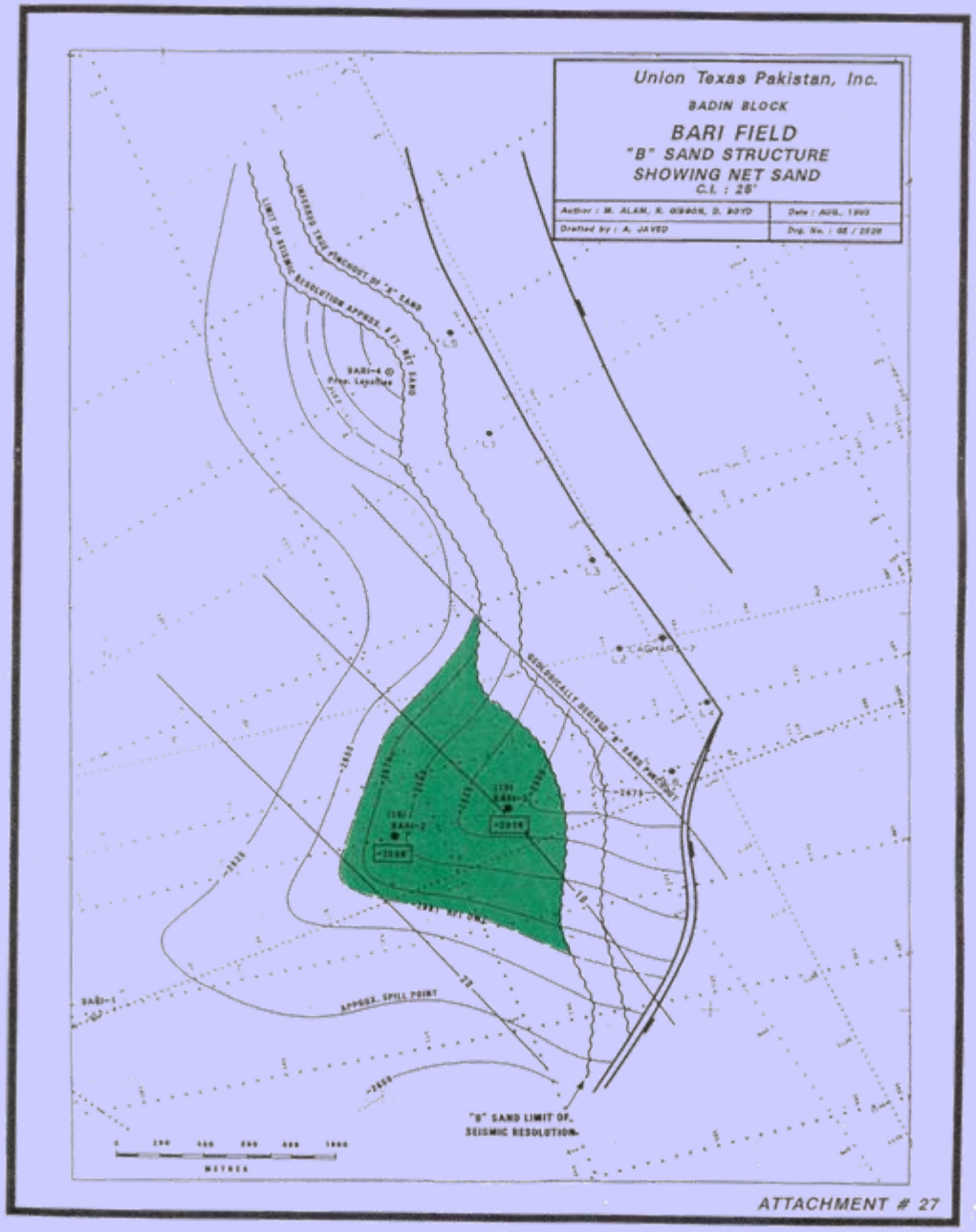


Variably Sealing Fault

Stratigraphic Traps



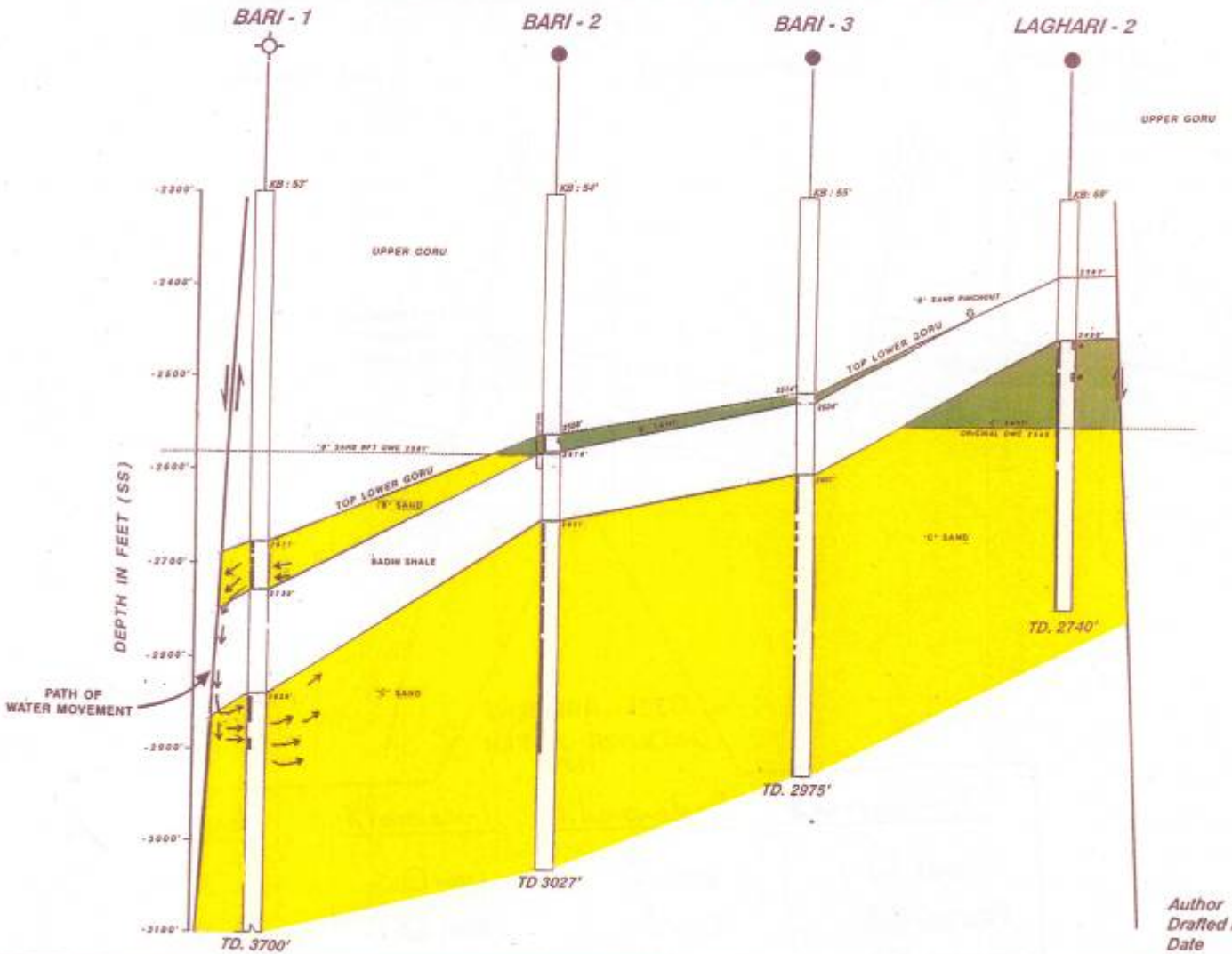
ATTACHMENT # 38



Truncation Trap on Flank Of Fault Closure

BARI FIELD

SCHEMATIC CROSS SECTION



Author : D. BOYD
Drafted by : A. JAVED
Date : AUGUST, 1993

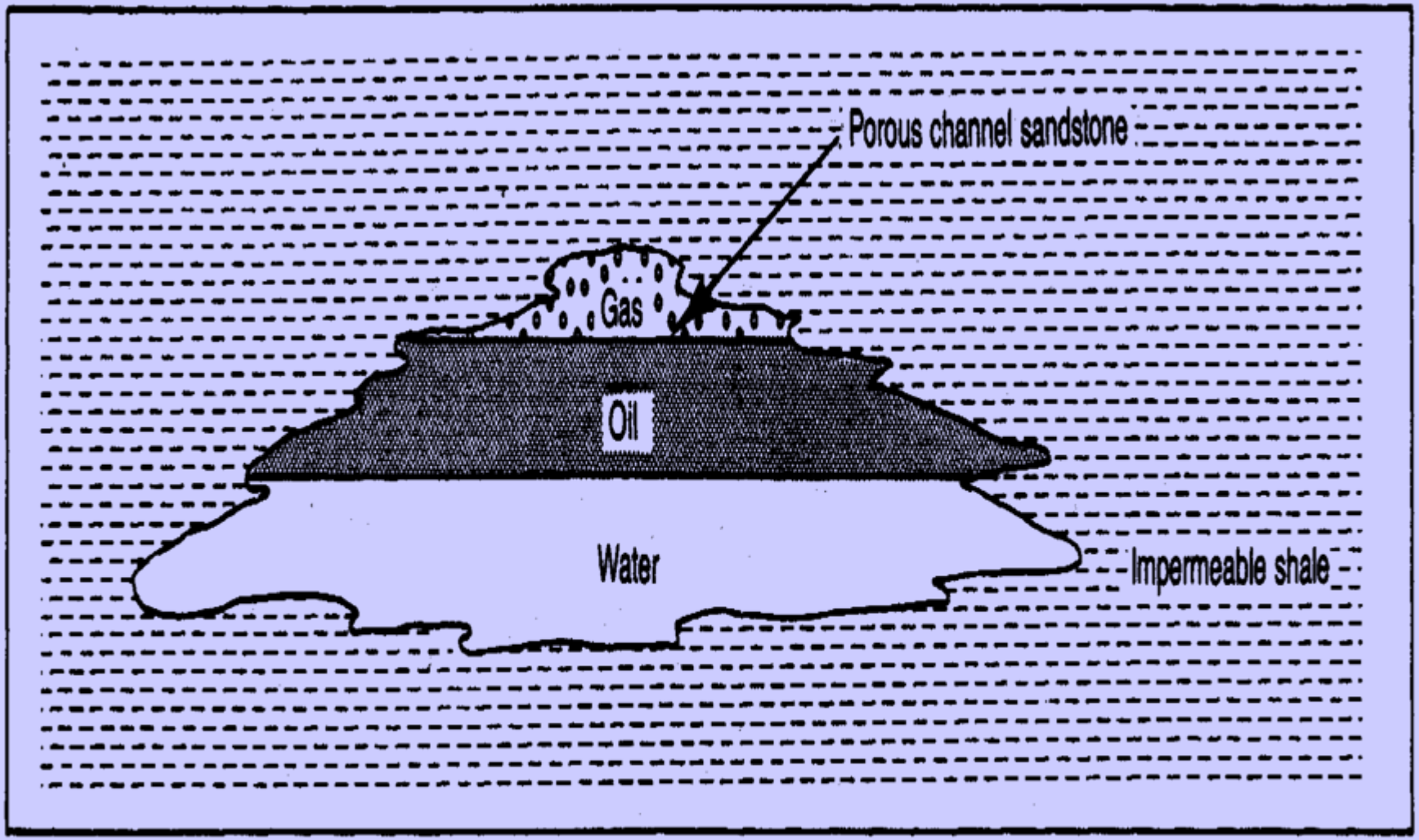


Fig. 409. Stratigraphic trap

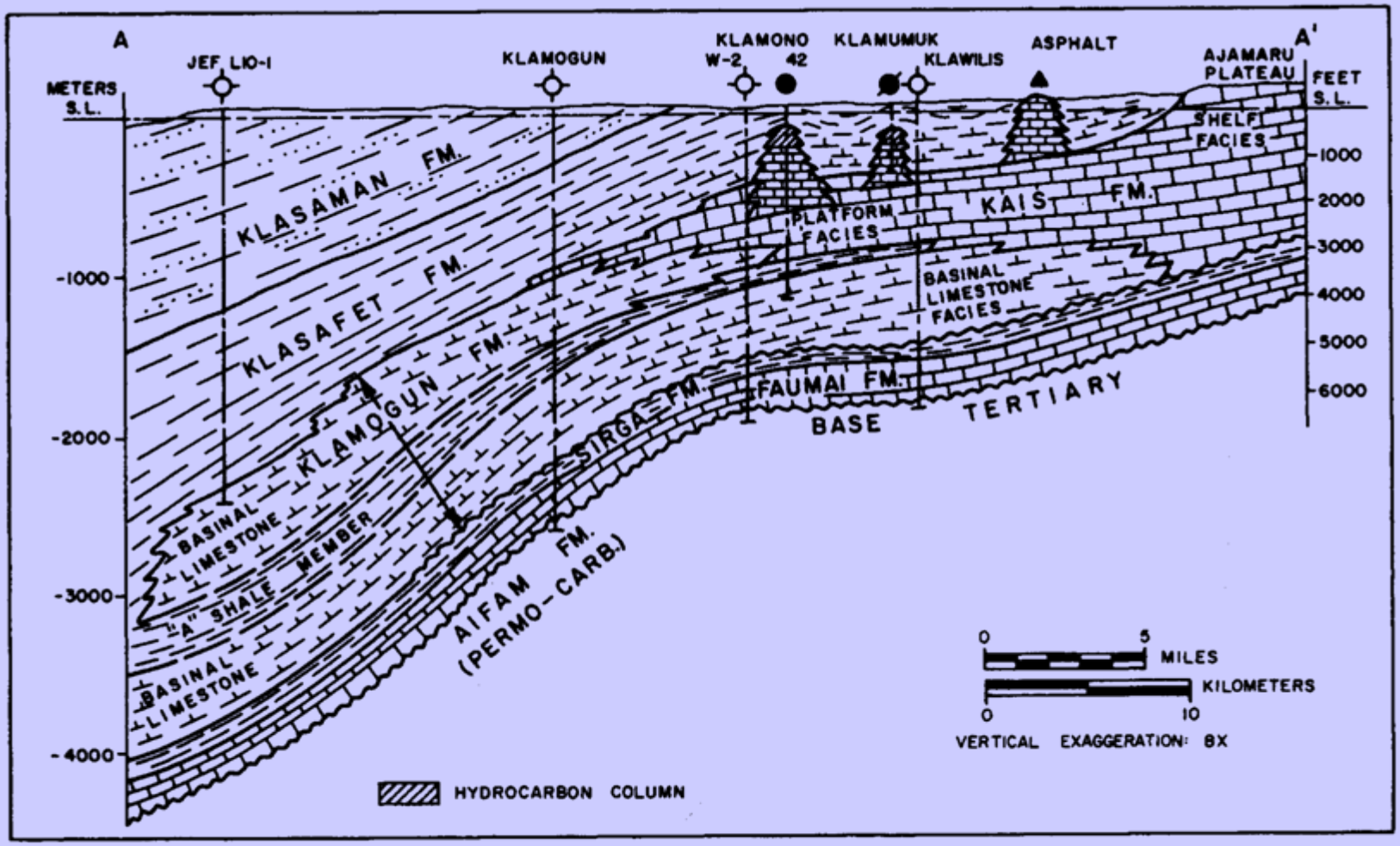


Fig. 169. Cross-section of reef production, Indonesia. From Vincelette and Soeparjadi, 1976. Permission to publish by AAPG. See Figure 165.

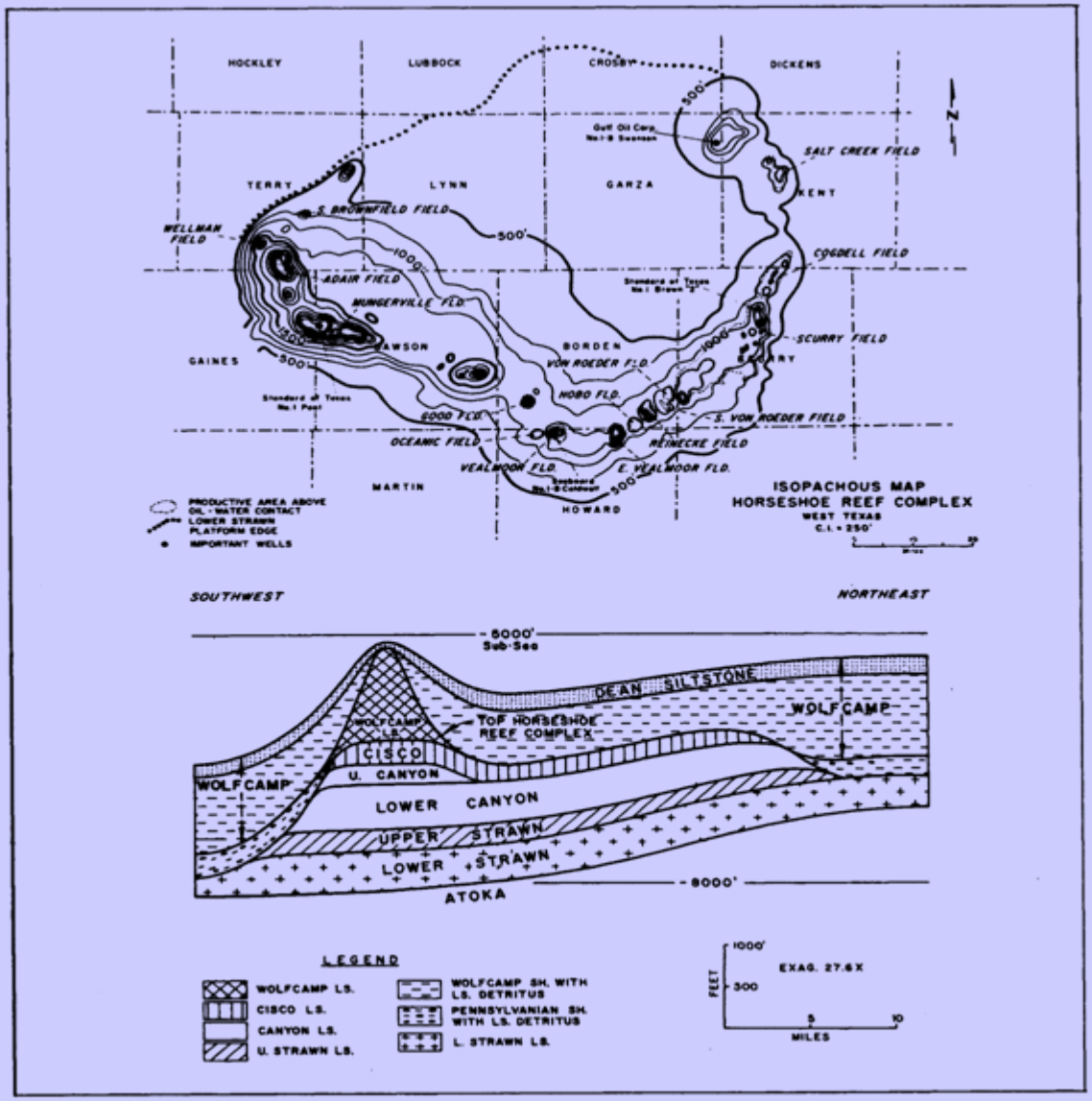


Fig. 174. Above: Isopach map of Horseshoe reef field, West Texas, showing location of significant production from reef limestone along crest of atoll. Below: Southwest-northeast schematic cross-section through thickest known part of Horseshoe atoll. From Vest, 1970. Permission to publish by AAPG.

Horseshoe Atoll Complex
Midland Basin (W. Tx)

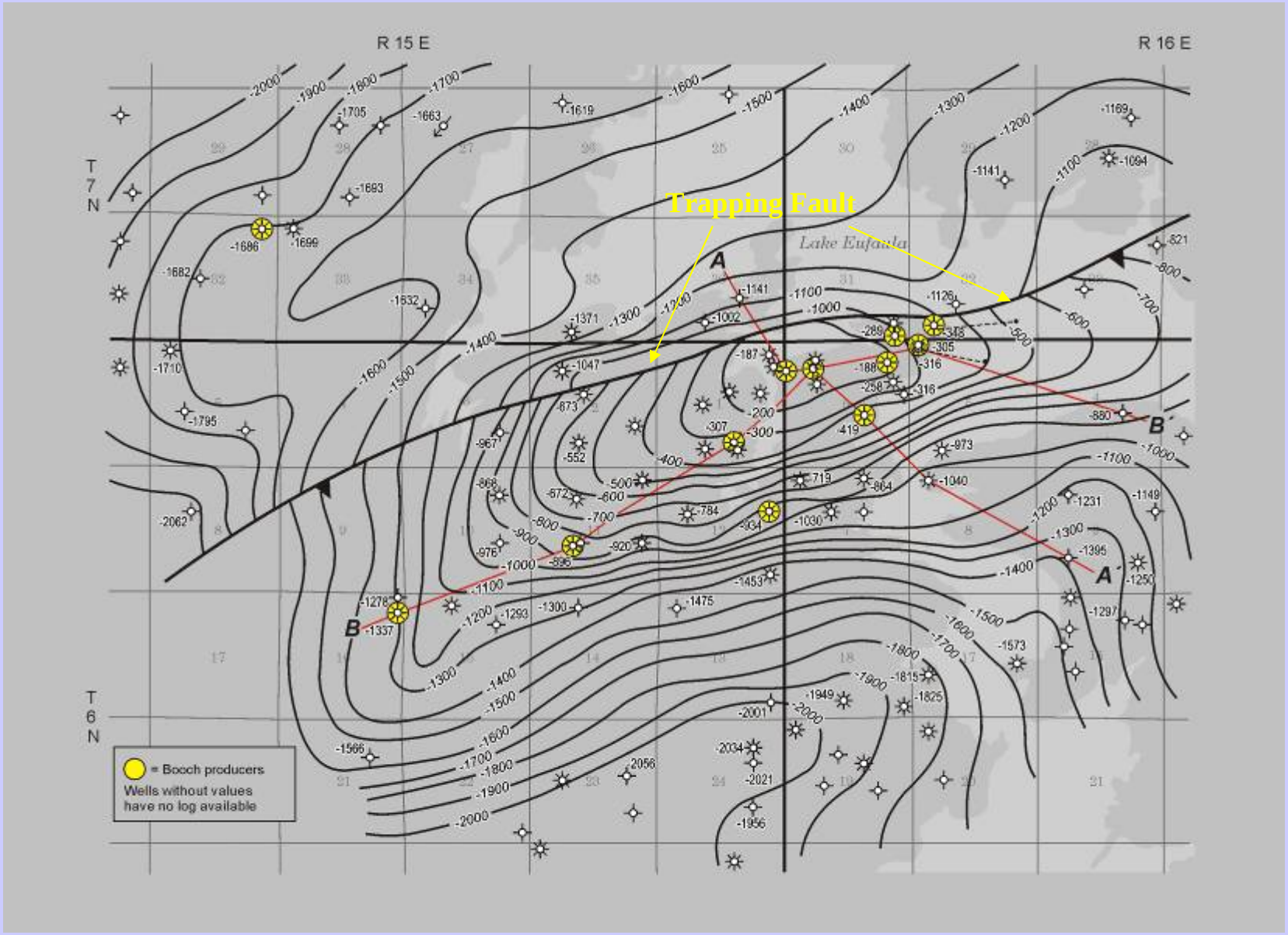
Other Traps

Combination

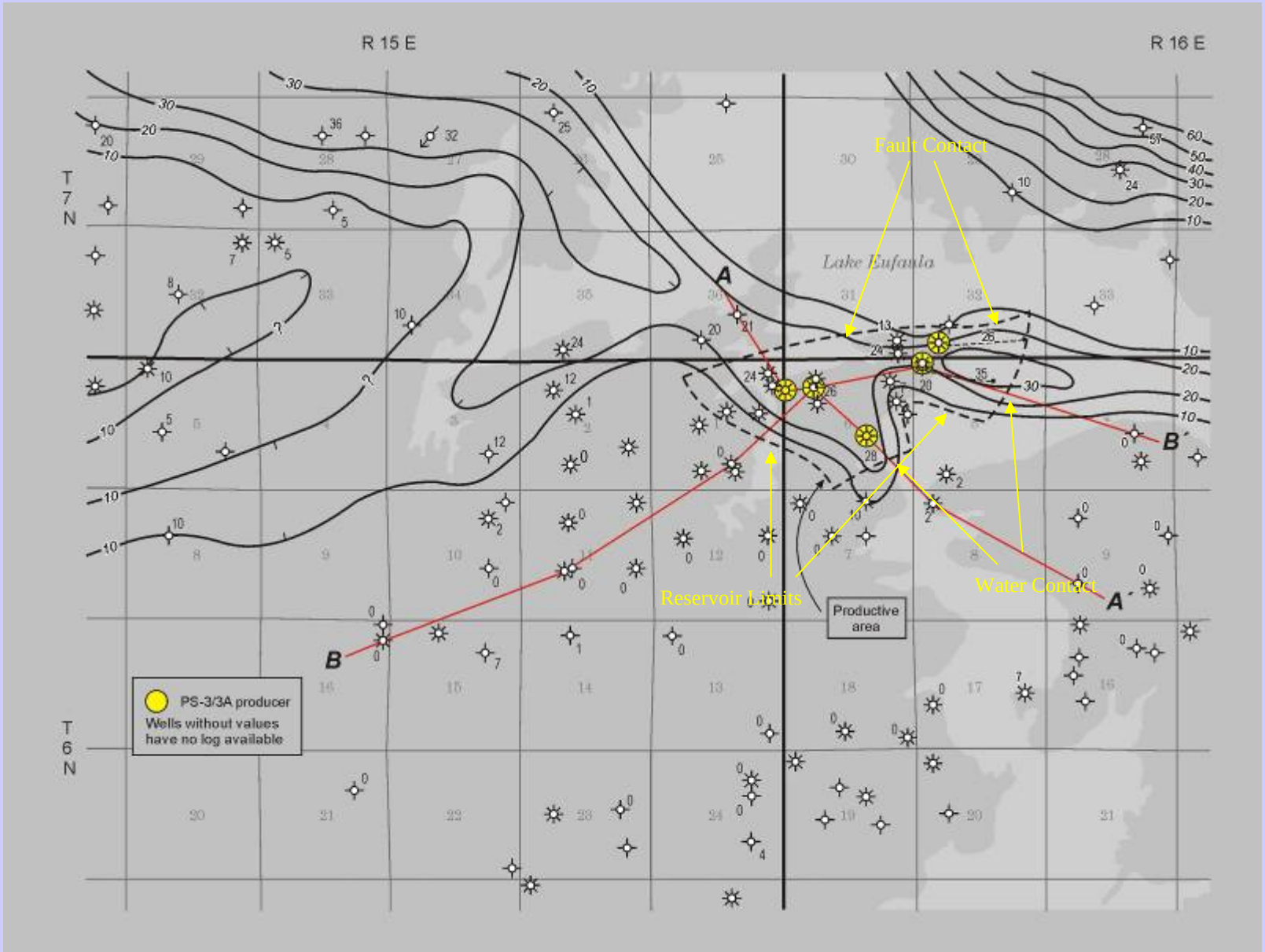
Hydrodynamic

Non (Un) Conventional

Reams Southeast Field
Middle Booch Structure Map



Reams Southeast Field
Middle Booch Net Sandstone Isopach
(Showing Combination Trap)



Hydrodynamic Trap

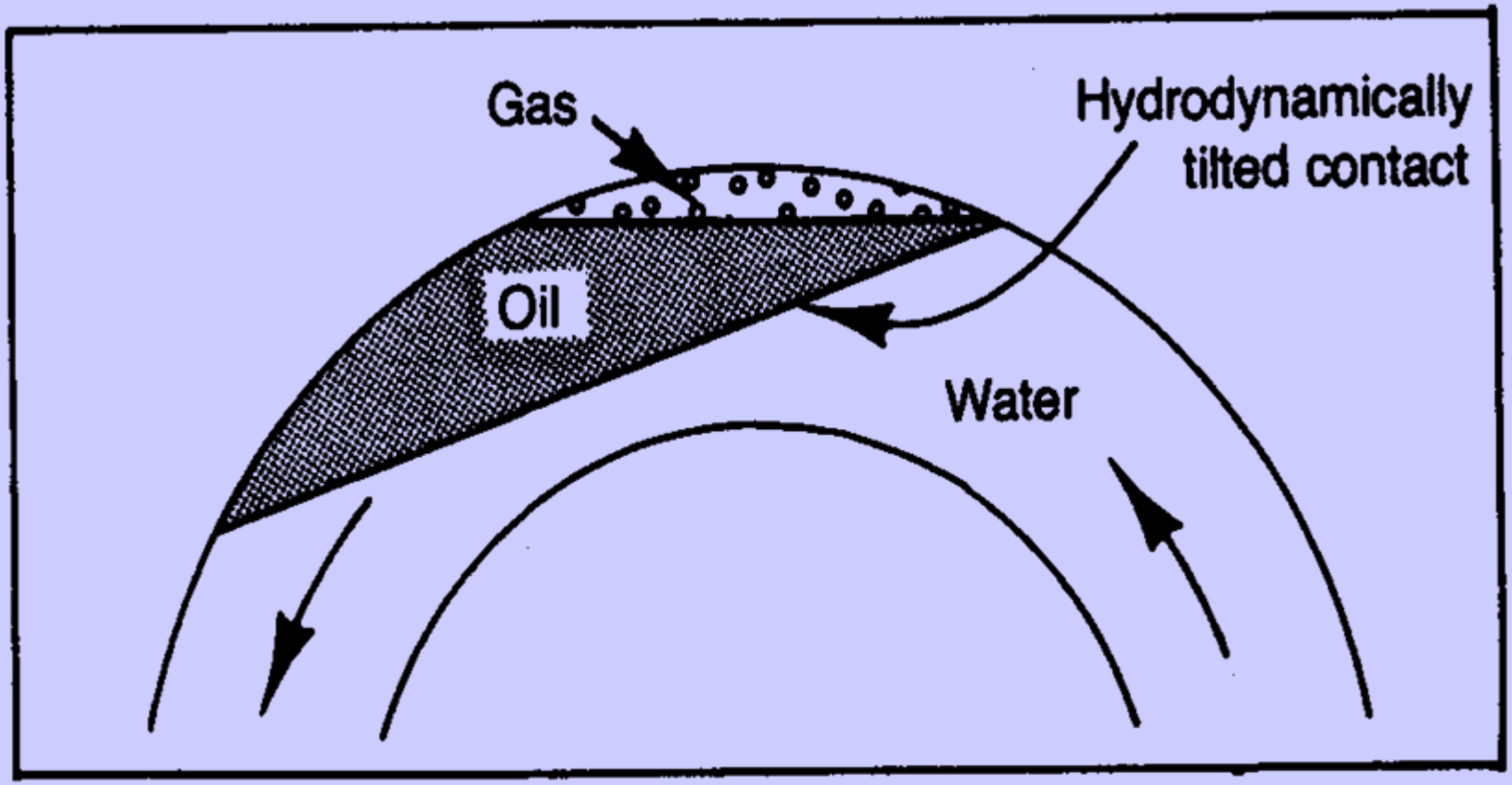


Fig. 244. Hydrodynamically tilted oil-water contact

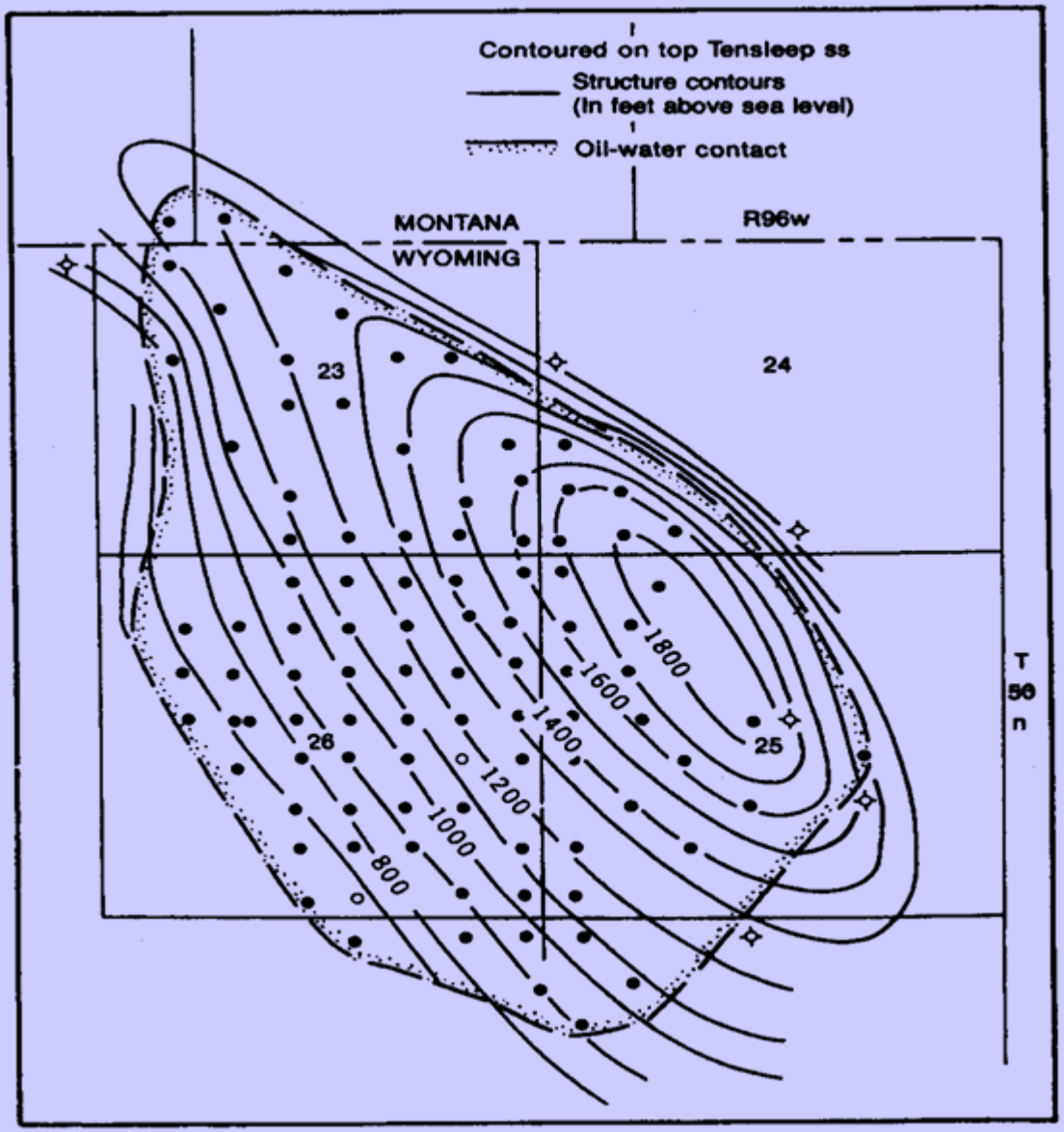
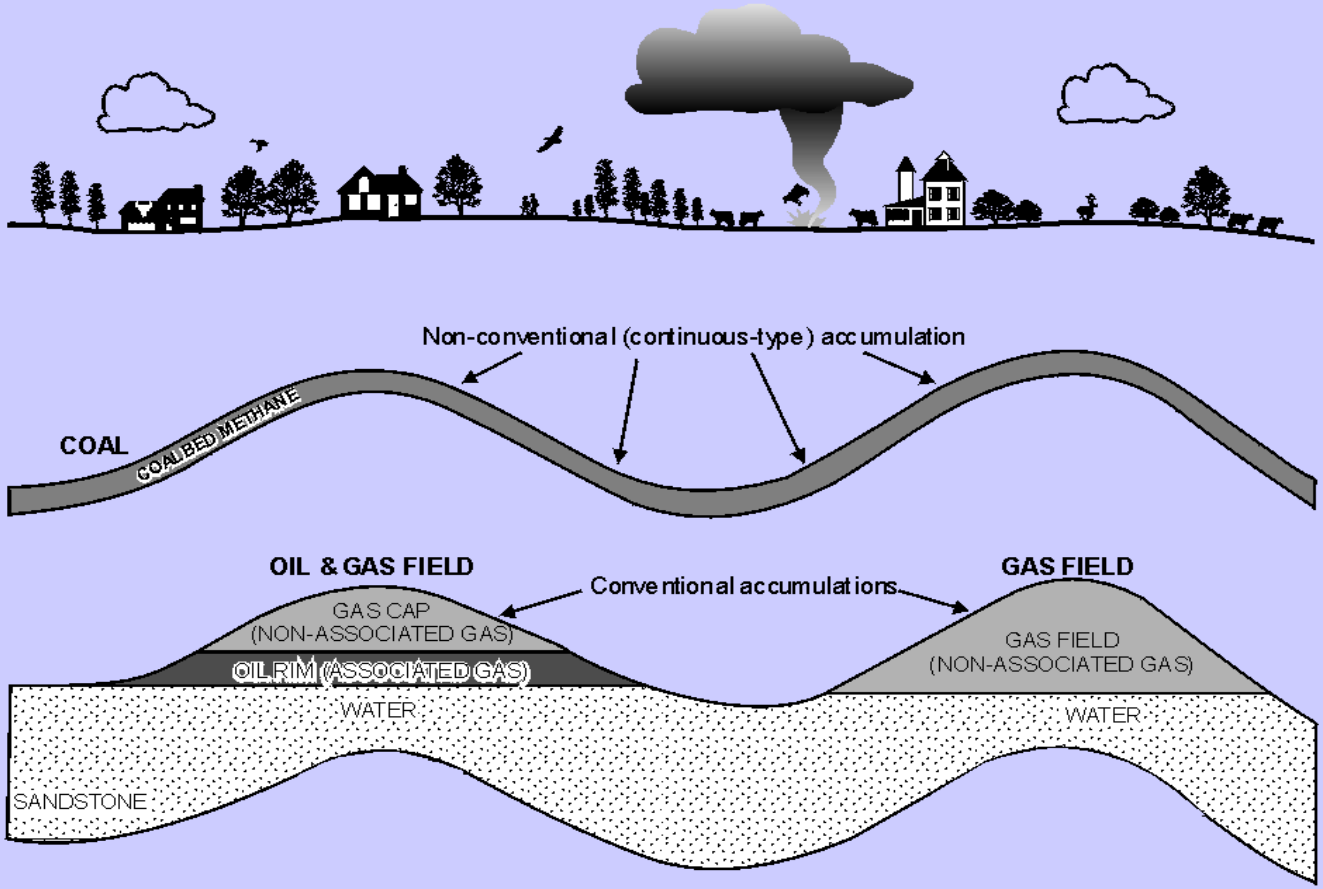


Fig. 243. Tilted oil-water contact, Frannie Field, Wyoming. From Hubbert, 1953. Permission to publish by AAPG.

Example Map View of Hydrodynamic Trap

Conventional vs. Non-Conventional Gas Accumulations

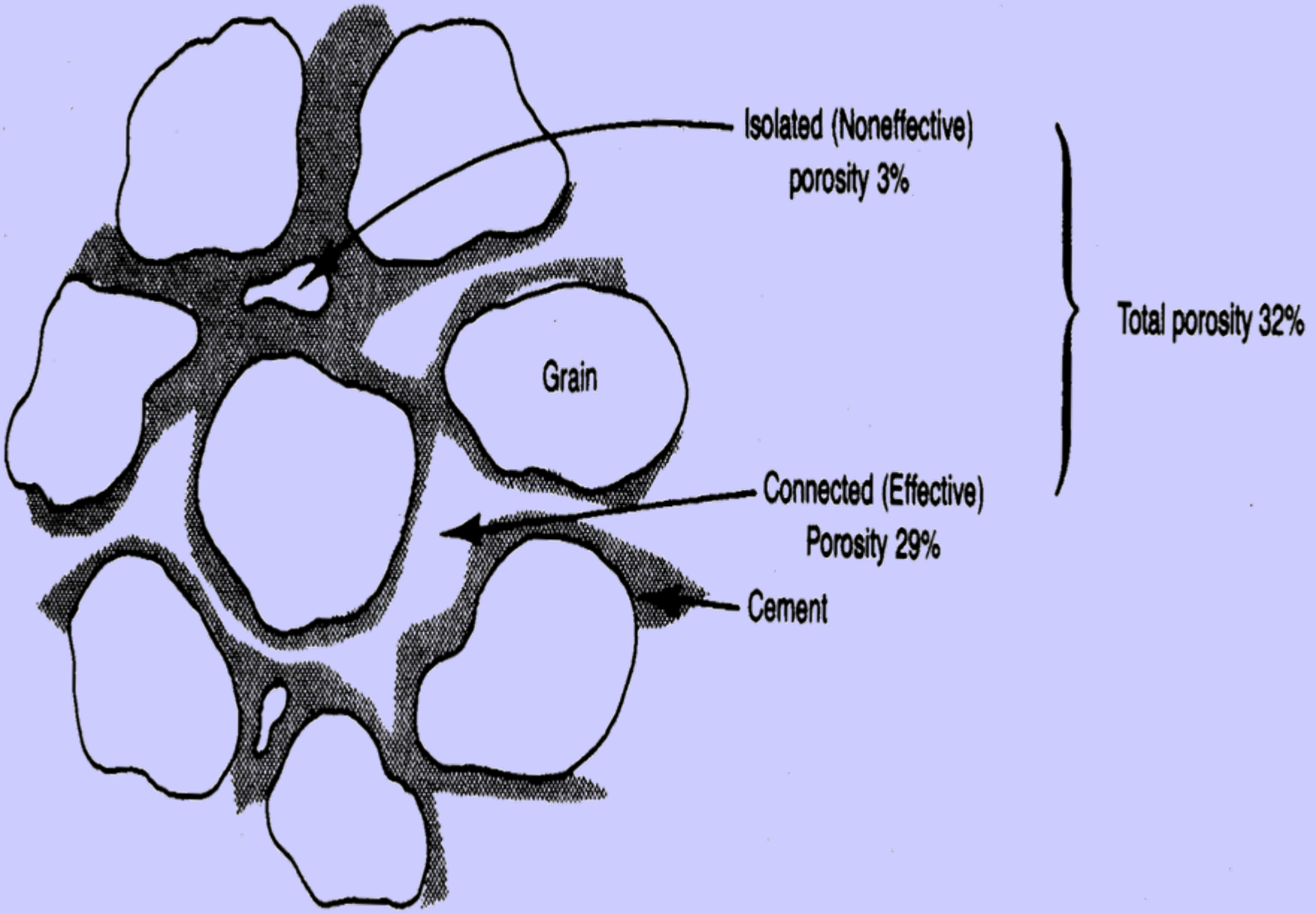


Petroleum System Summary

- **Source (Material and Rocks)**
- **Generation (Maturation)**
- **Migration**
- **Trap**
- **Reservoir**

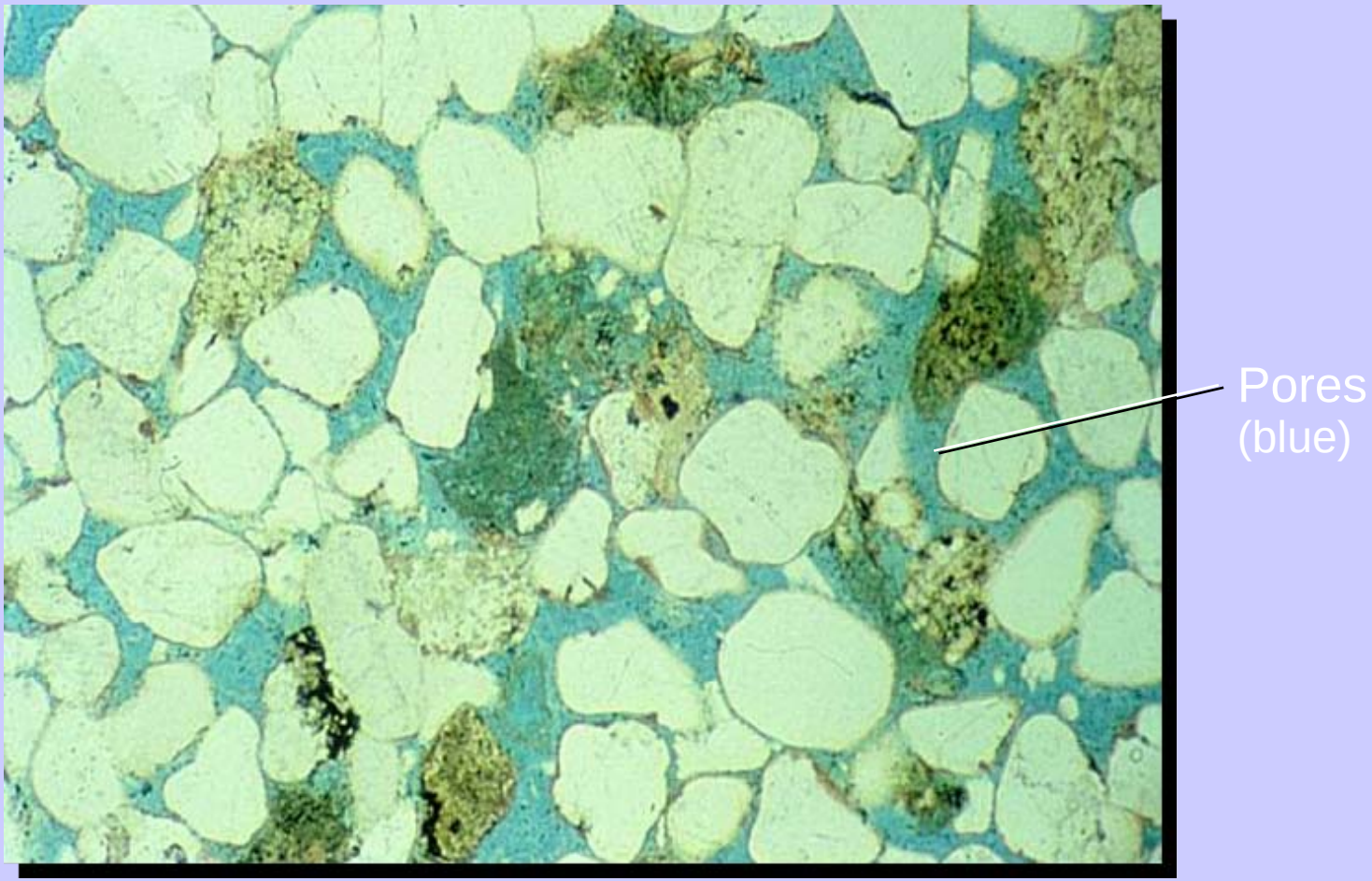
Reservoir Types

- Clastic
  - Blanket Sandstones (Marine Reworked)
  - Channels / Deltaics / Turbidites / Nearshore Marine
  - Others (Aeolian, Granite Wash)
- Carbonate
  - Limestone
  - Dolomite
- Unconventional
  - Gas-Oil Shale (tight sandstone/limestone)
  - Coalbed Methane
  - Others (hydrates, asphalts)


Isolated (Noneffective)
porosity 3%
Grain
Connected (Effective)
Porosity 29%
Cement
Total porosity 32%

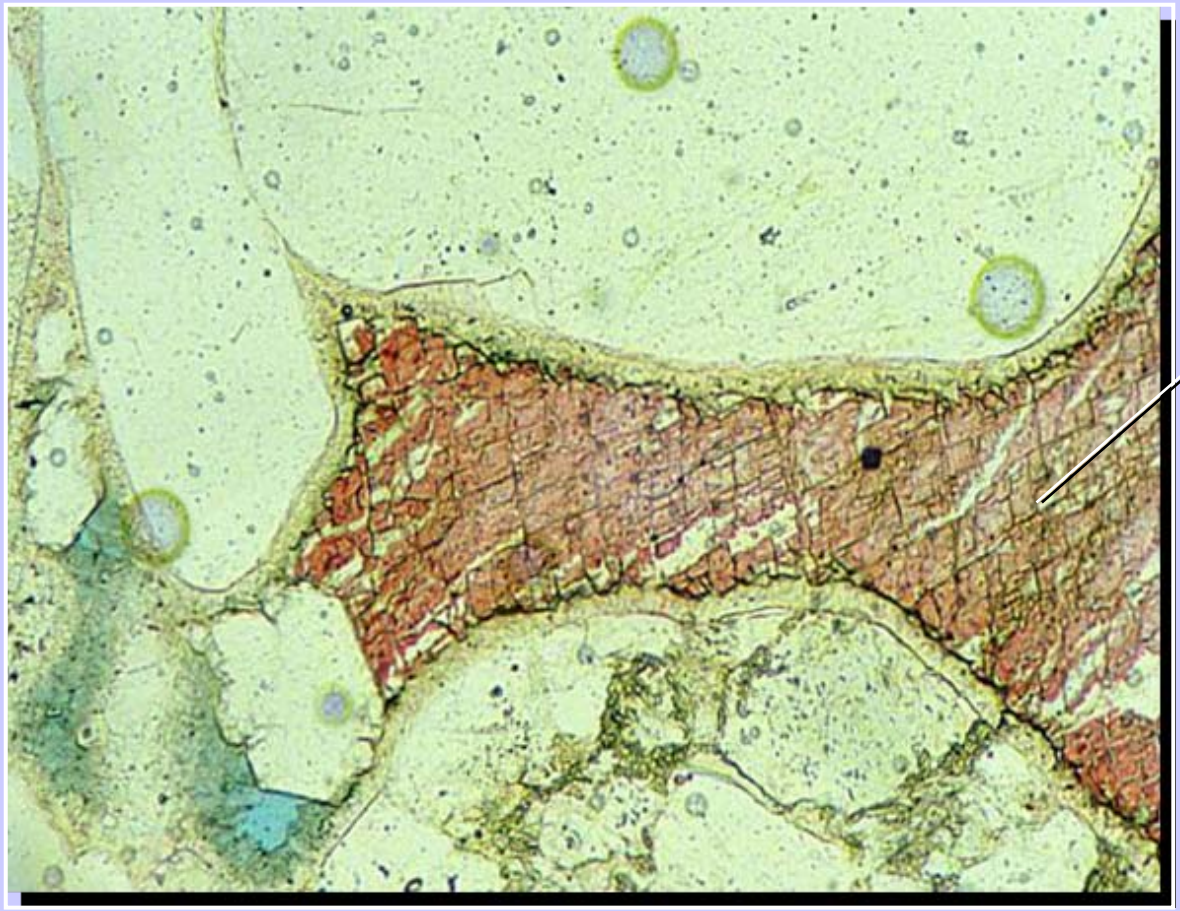
Reservoir Sandstone

Good Porosity = Lots of Space for Petroleum



Reservoir Sandstone

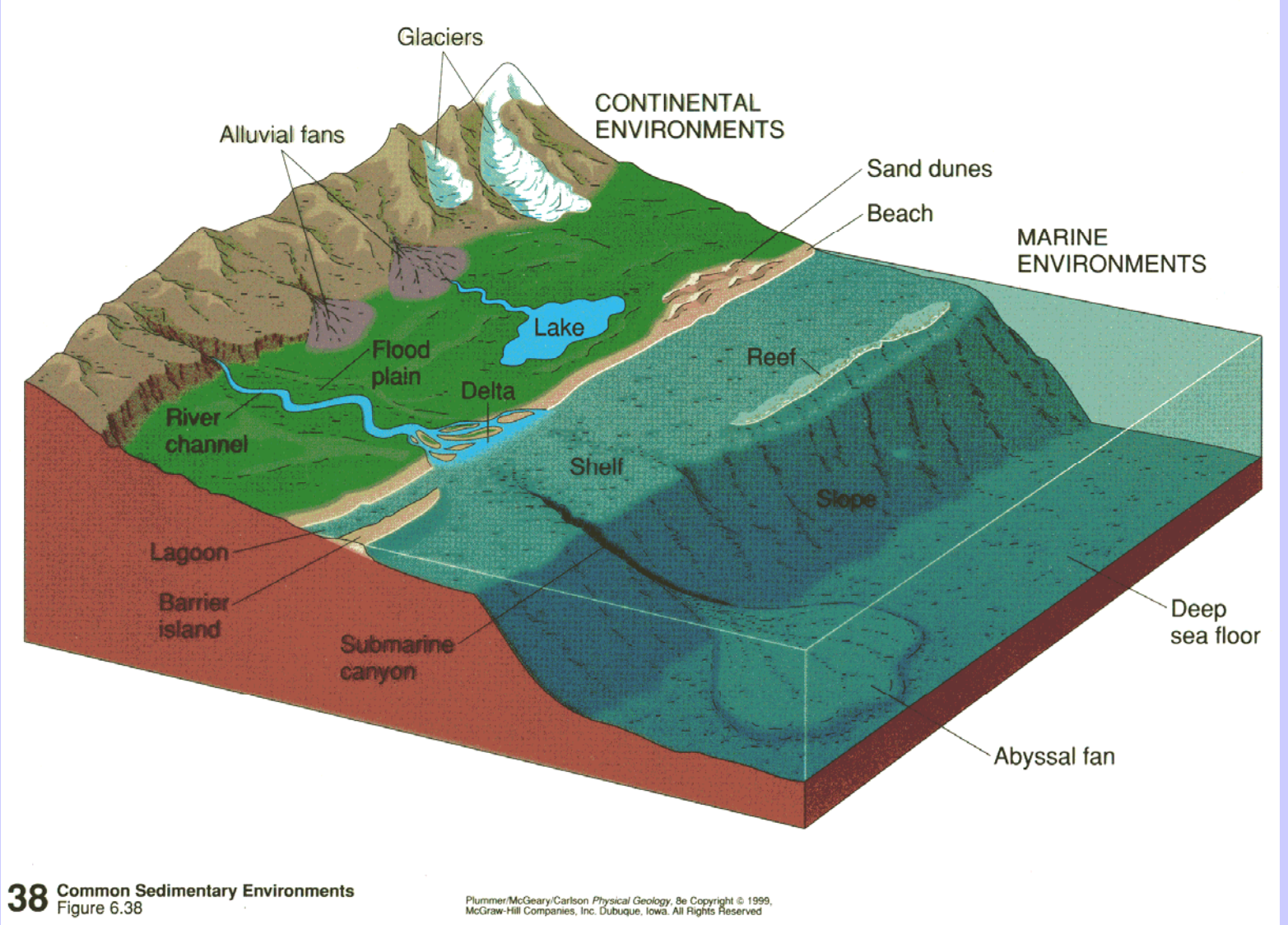
Pore-Filling Cement Reduces Quality



= Less Space for Petroleum

Clastics

Sedimentary Environments



38 Common Sedimentary Environments
Figure 6.38

Blanket Sandstone Reservoir
Simpson-Oil Creek (Oklahoma)

Aeolian Sandstone
Coconino (Arizona)

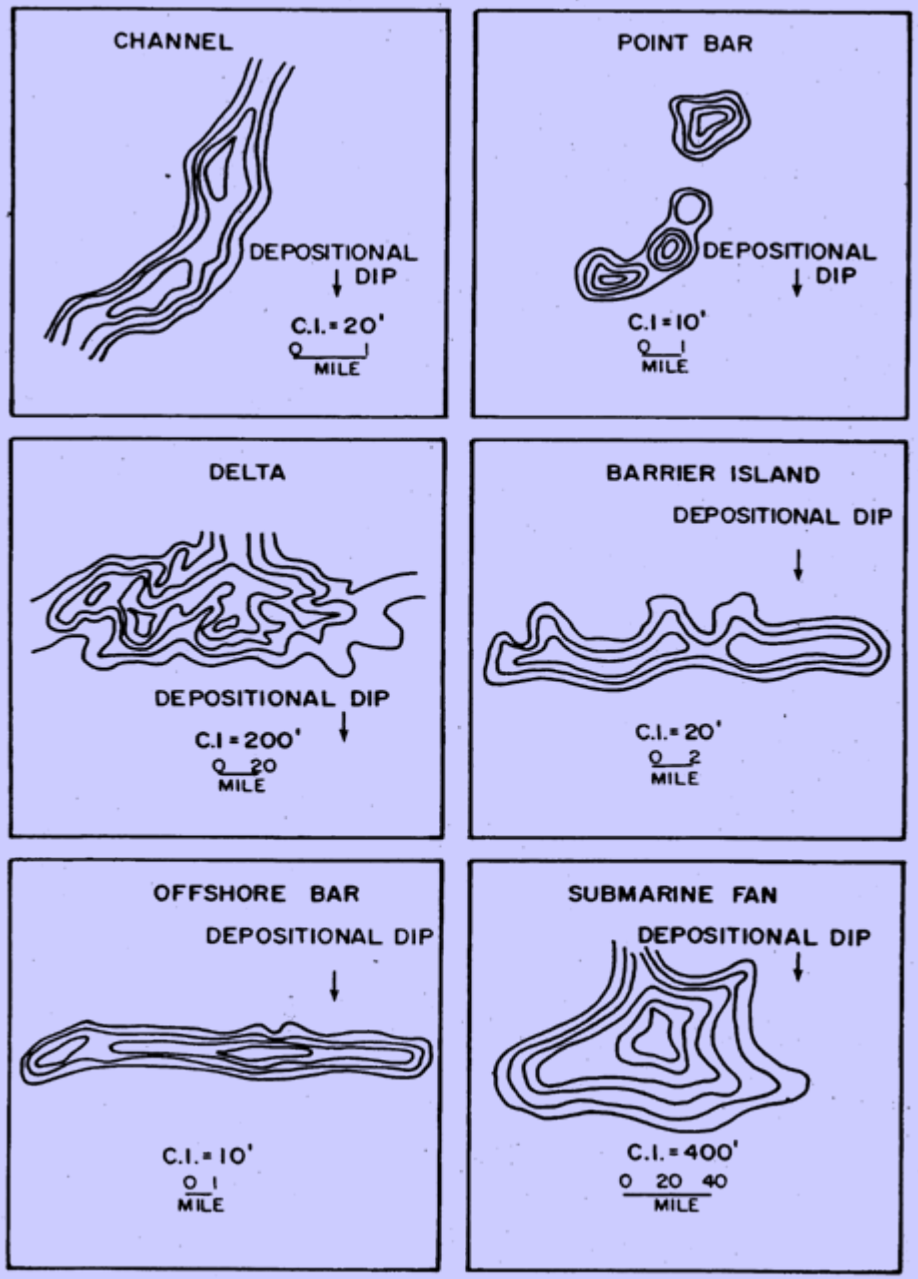
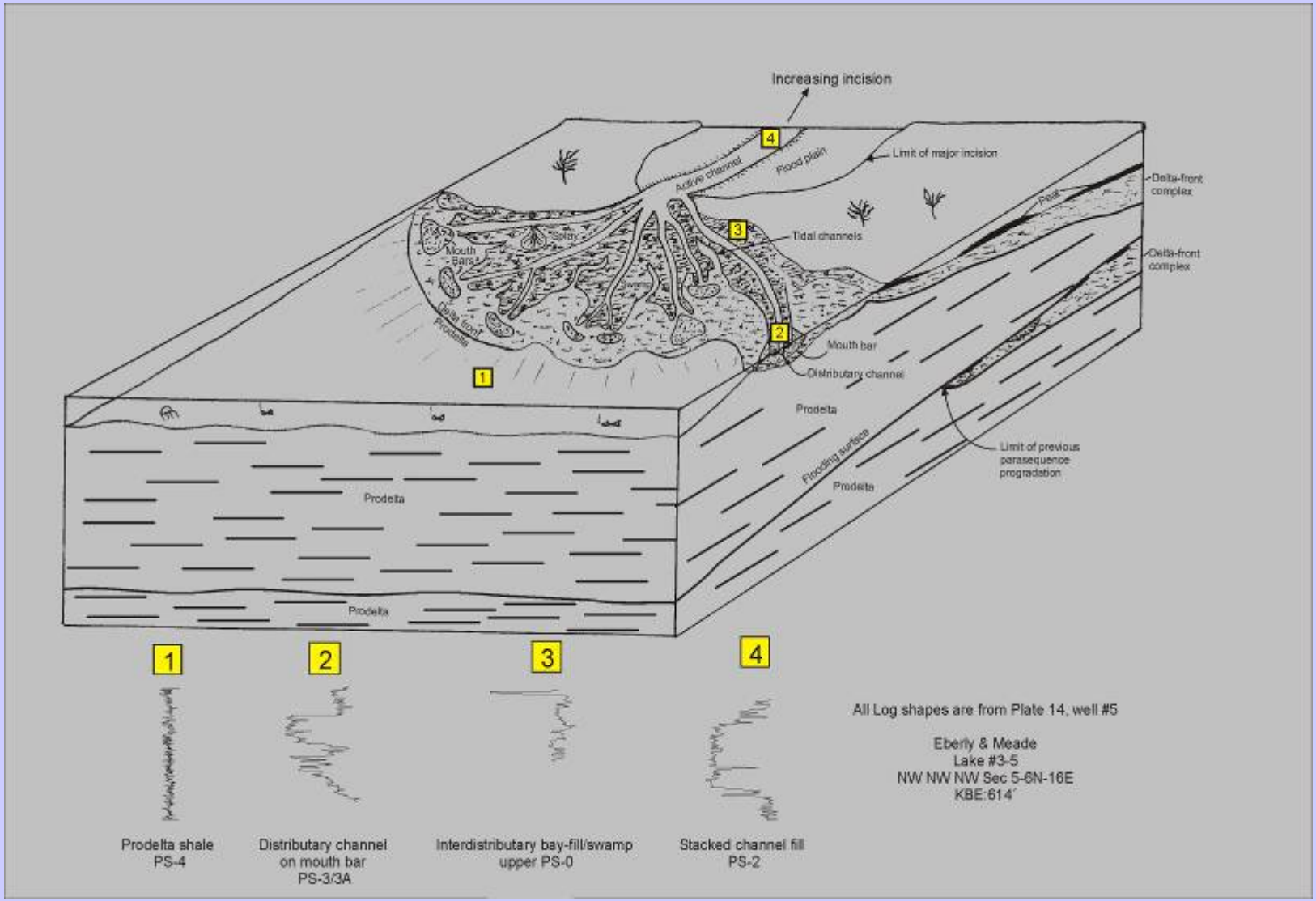


FIGURE 21: Typical isopach patterns associated with clastic sedimentation.

Very Generalized Isopachs of Sandstones in Variety of Depositional Environments

Modern Barrier Island
Gulf Coast

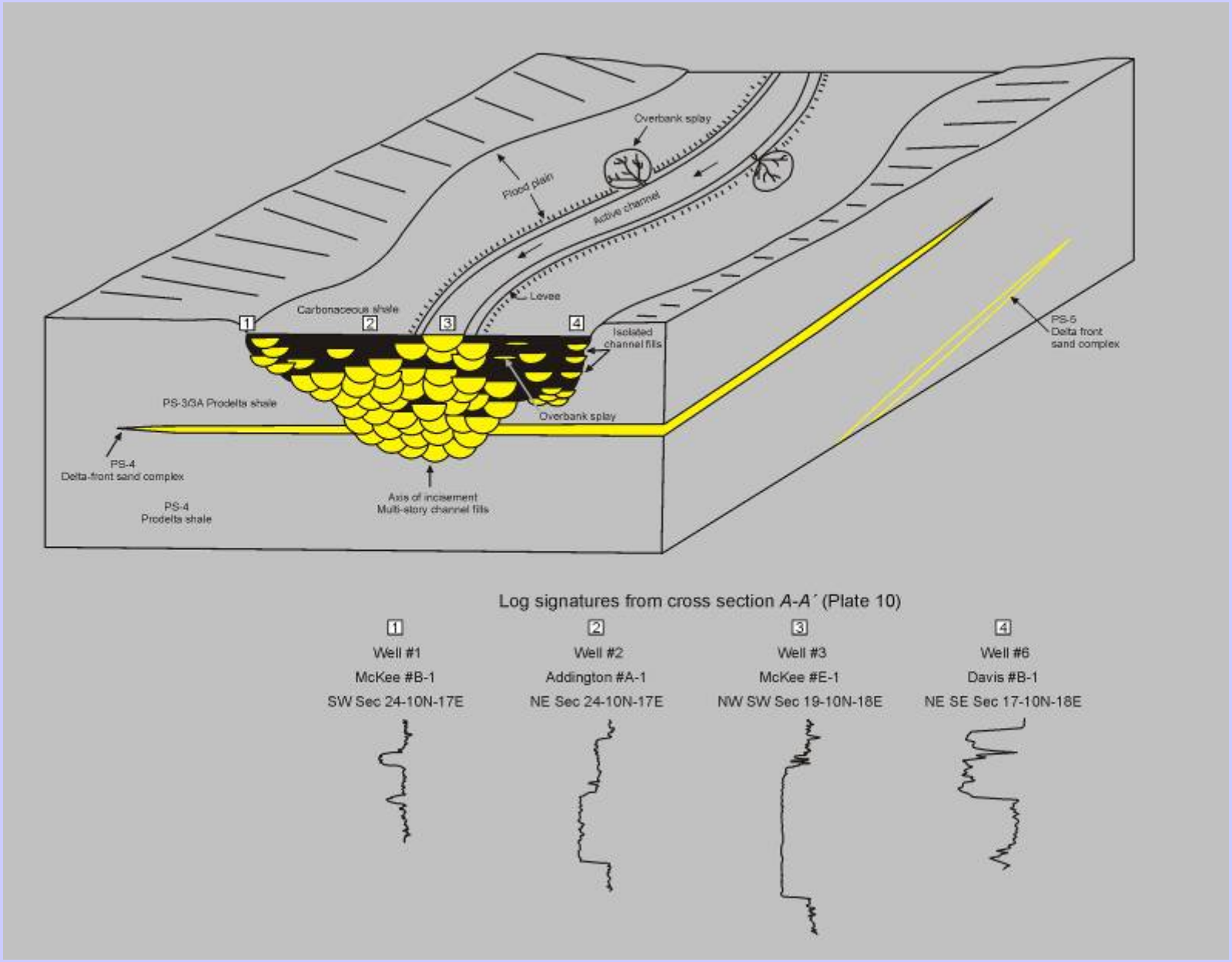
Idealized Tidal Delta
Oklahoma (Booch)



Overbank Sandstones
Oklahoma (Savanna)

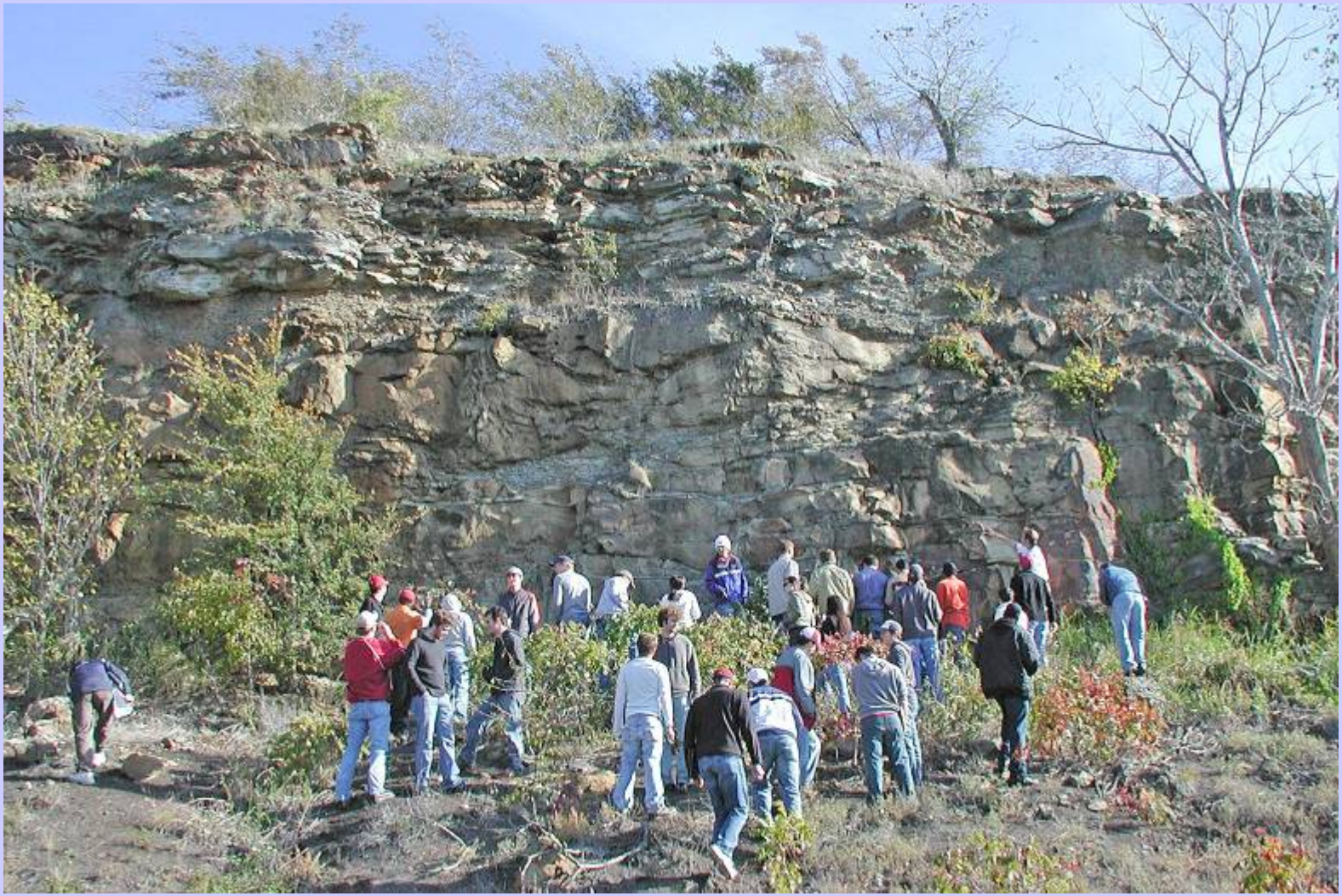
Modern Mahakam Delta Plain
East Kalimantan, Indonesia

Incised Valley Block Diagram



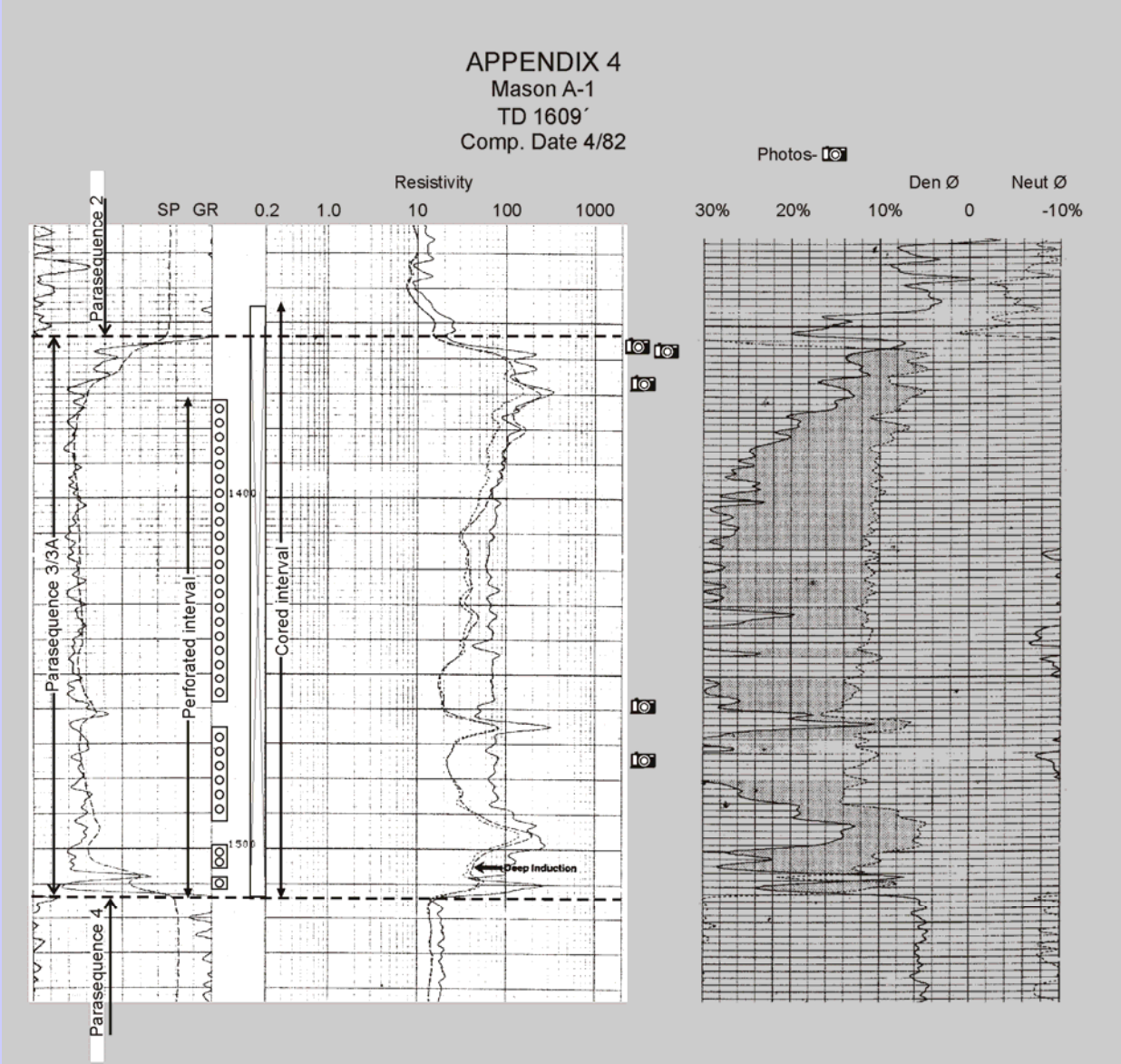
Fluvial (Incised Valley) Sandstone
Oklahoma (Hartshorne)

Fluvial Sandstone
Oklahoma (Red Fork)

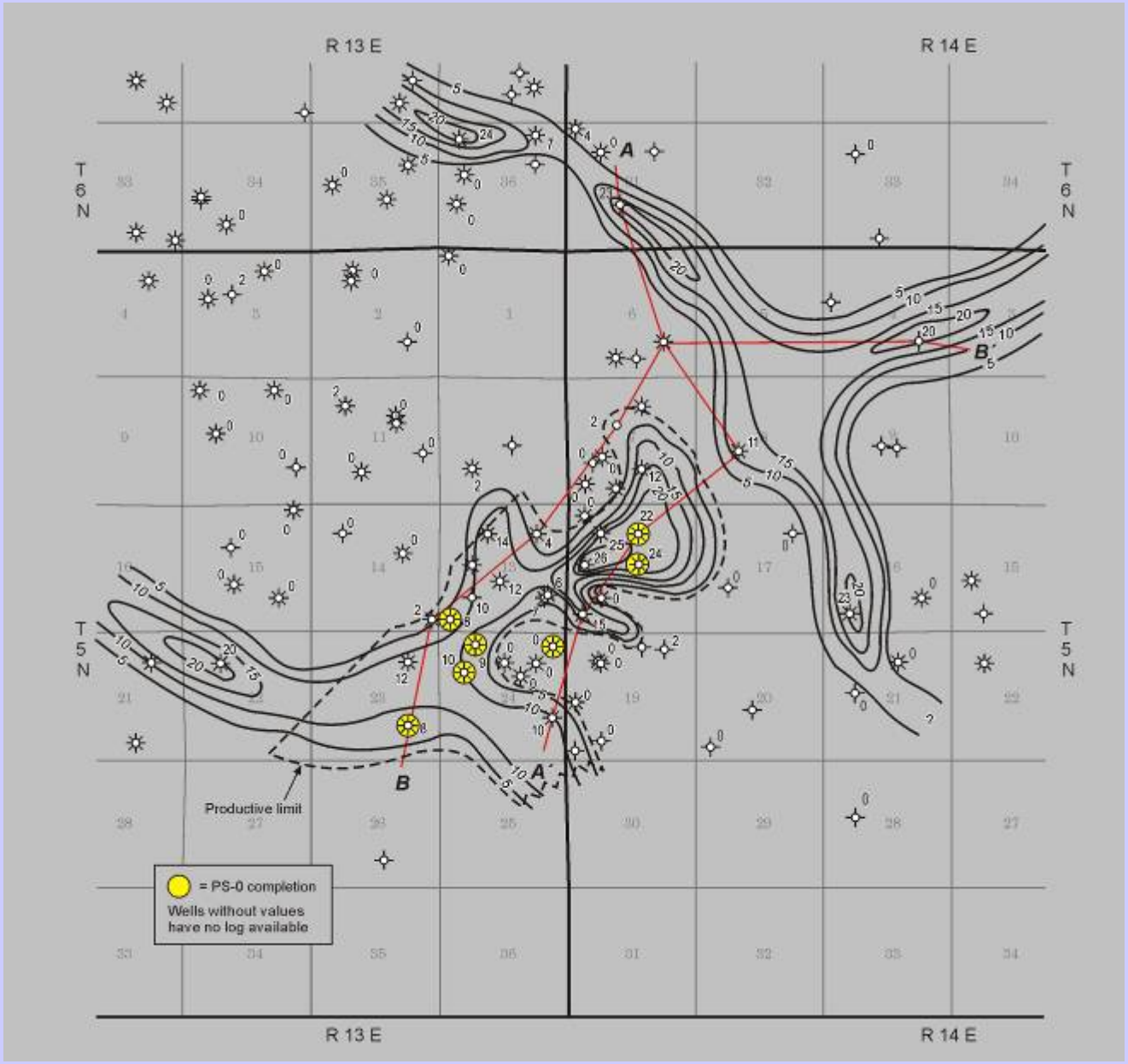


Fluvial Sandstone
Oklahoma (Red Fork)

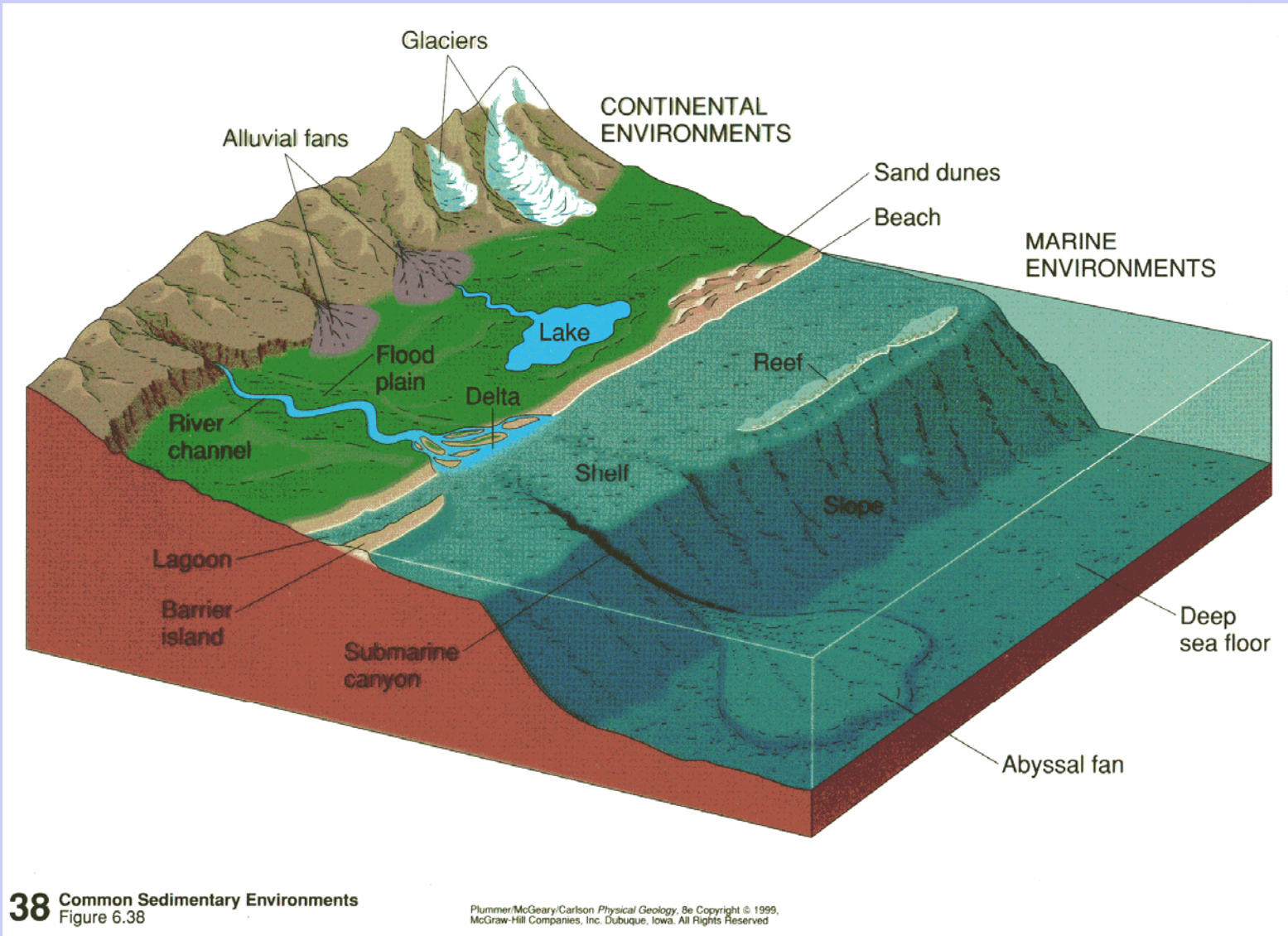
Well Log of Incised Valley-Fill Sandstone
Oklahoma's Brooken Field (Booch)



Fluvial Sandstone Isopach Map
Oklahoma (Upper Booch)



Sedimentary Environments

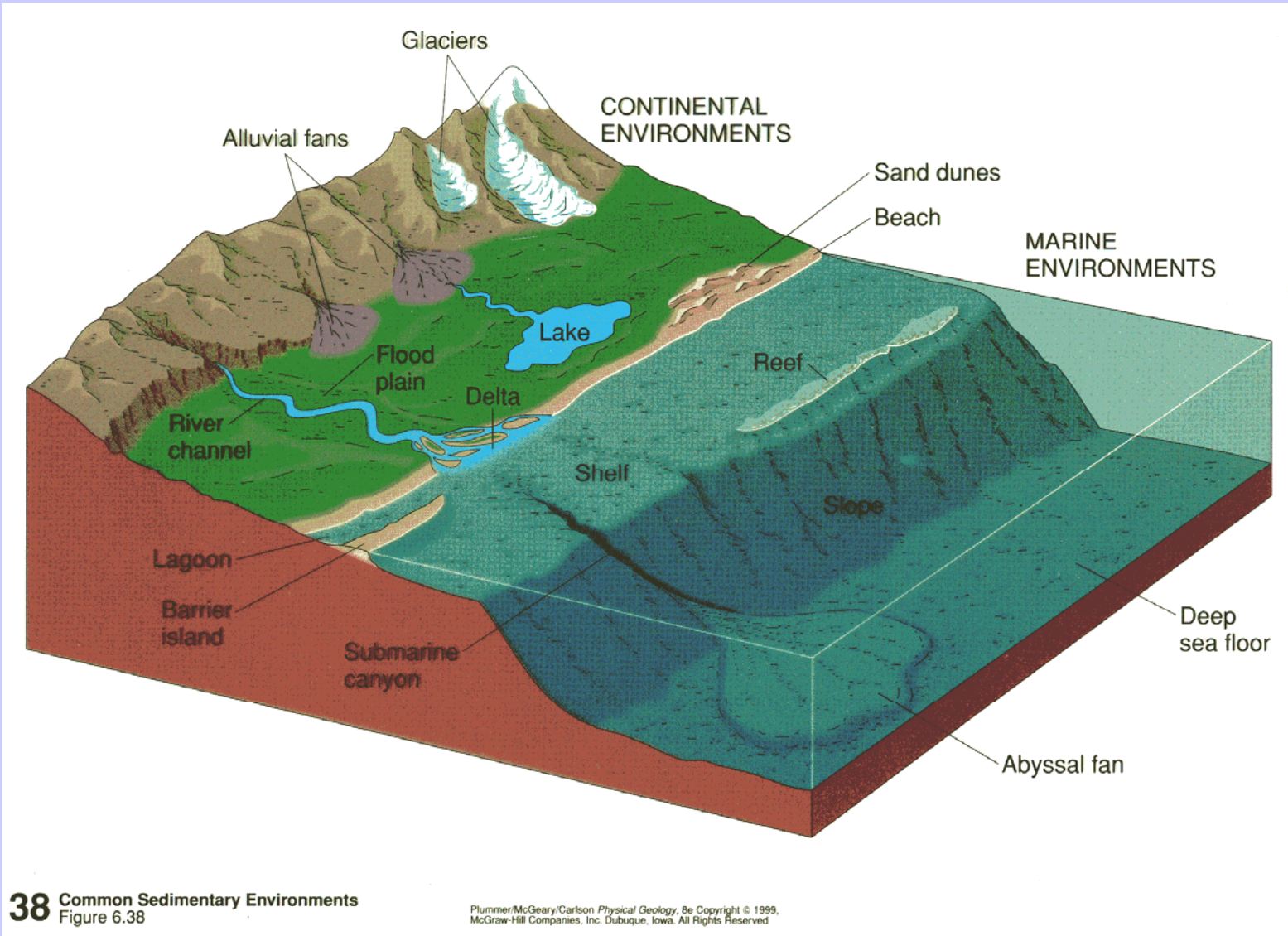


38 **Common Sedimentary Environments**
Figure 6.38

Turbidite Sandstone
Oklahoma (Atoka)

Carbonates

Sedimentary Environments



38 **Common Sedimentary Environments**
Figure 6.38

Carbonate Reservoir
Hunton Limestone (Oklahoma)

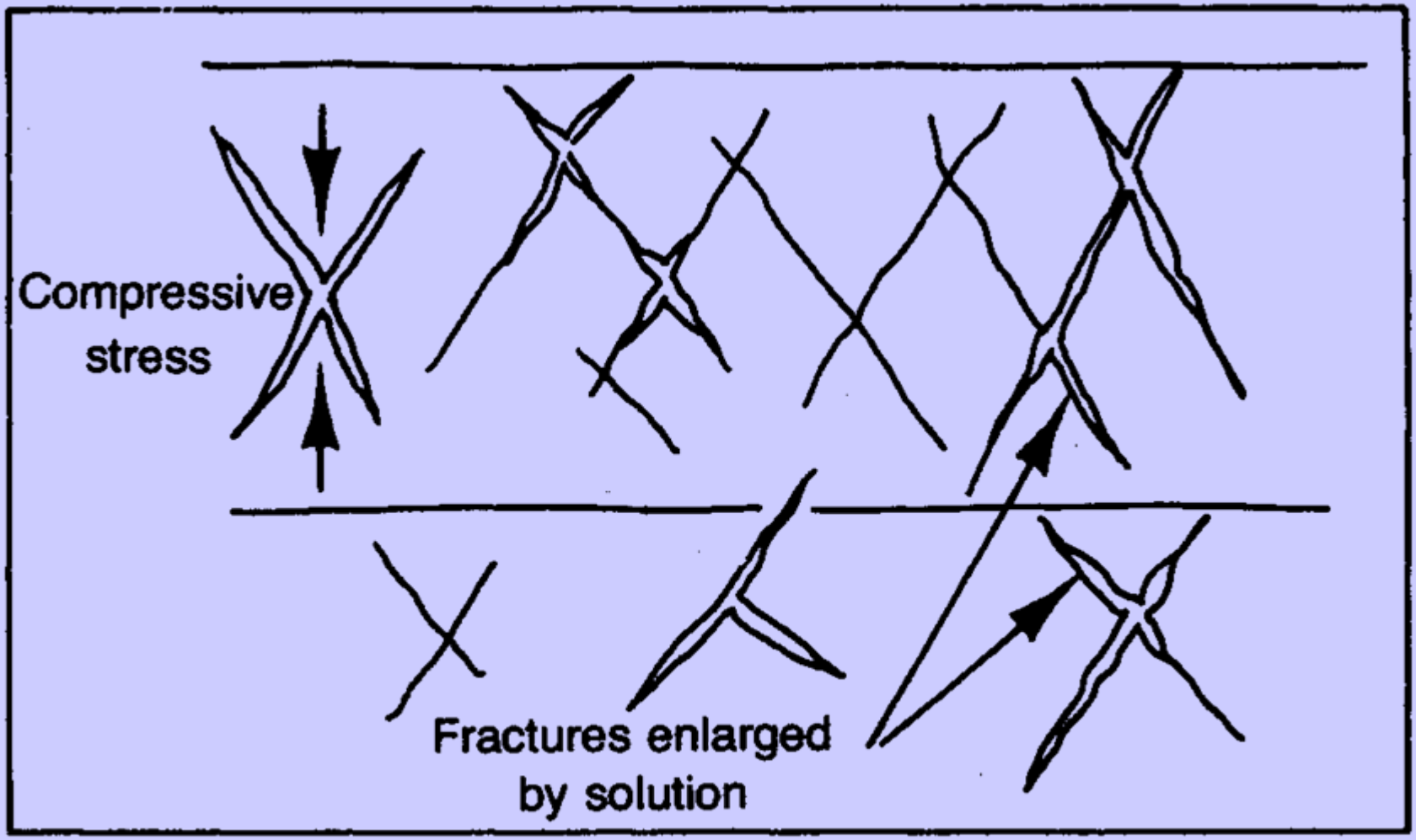


Fig. 387. Oriented fractures in rocks.

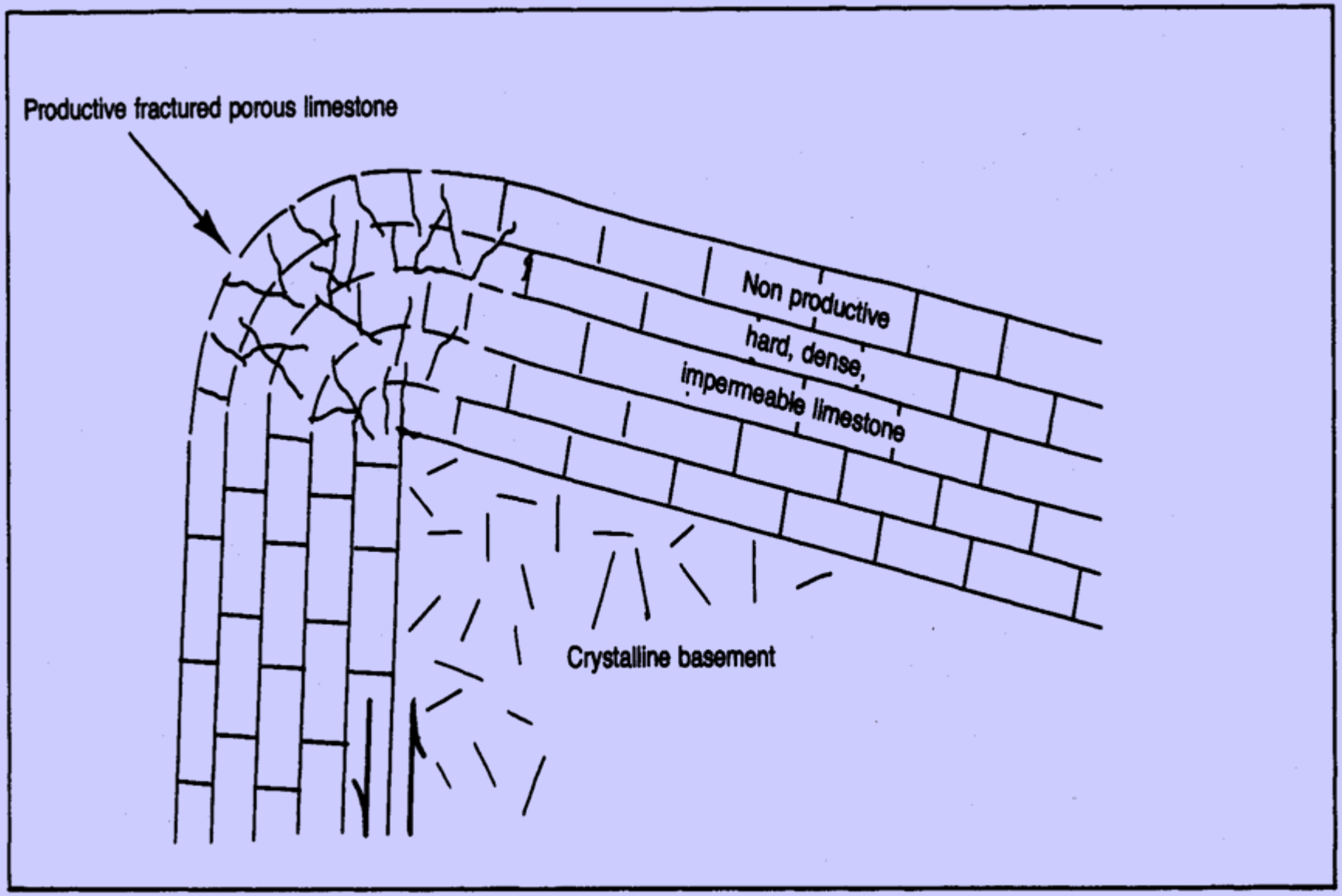


Fig. 406. Tectonic effect upon reservoir potential

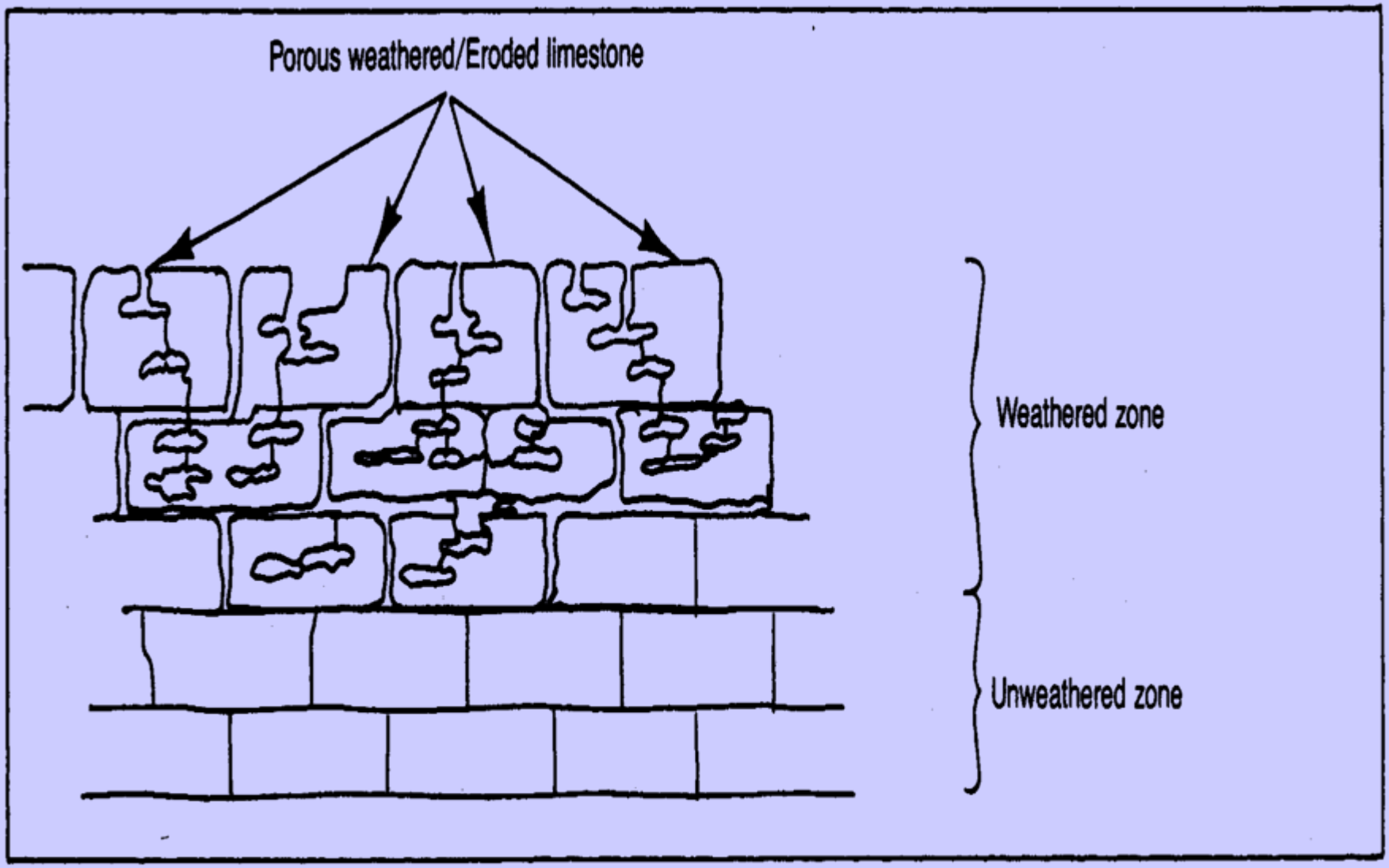


Fig. 403. Weathering and limestone porosity

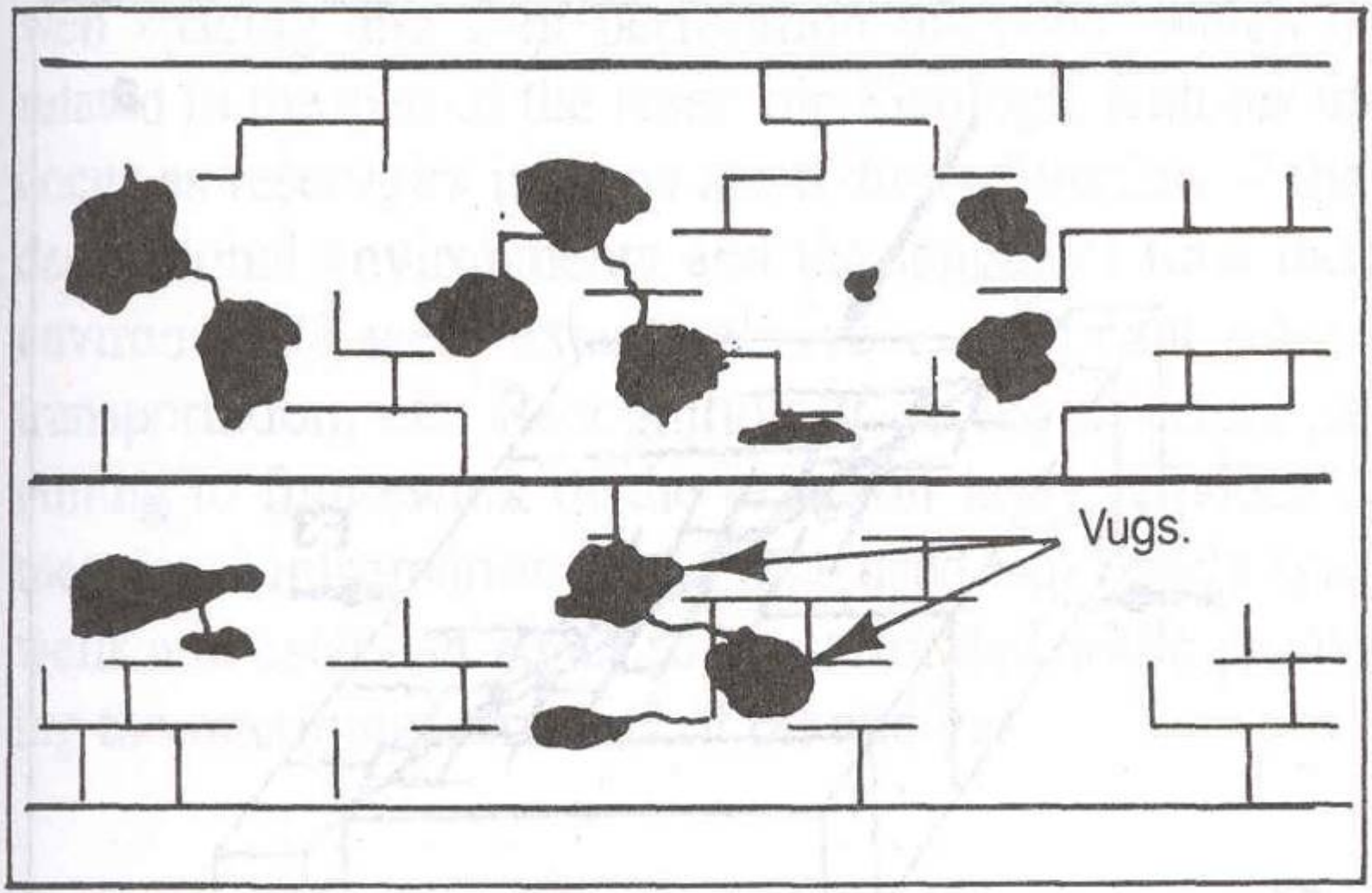
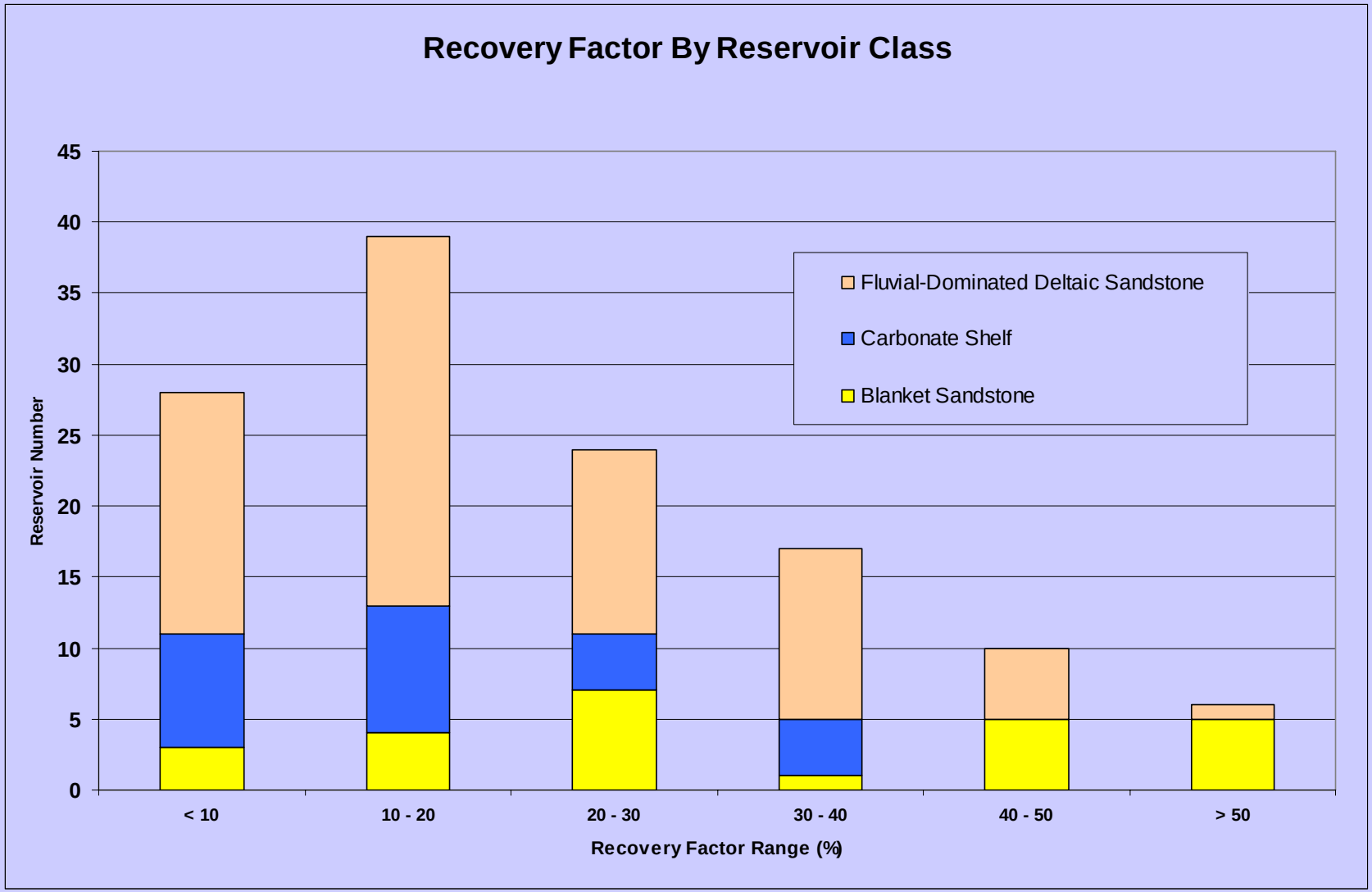


Fig. 386. Vugular porosity in carbonates

Carbonate Reservoir
Red Wall Limestone (Arizona)

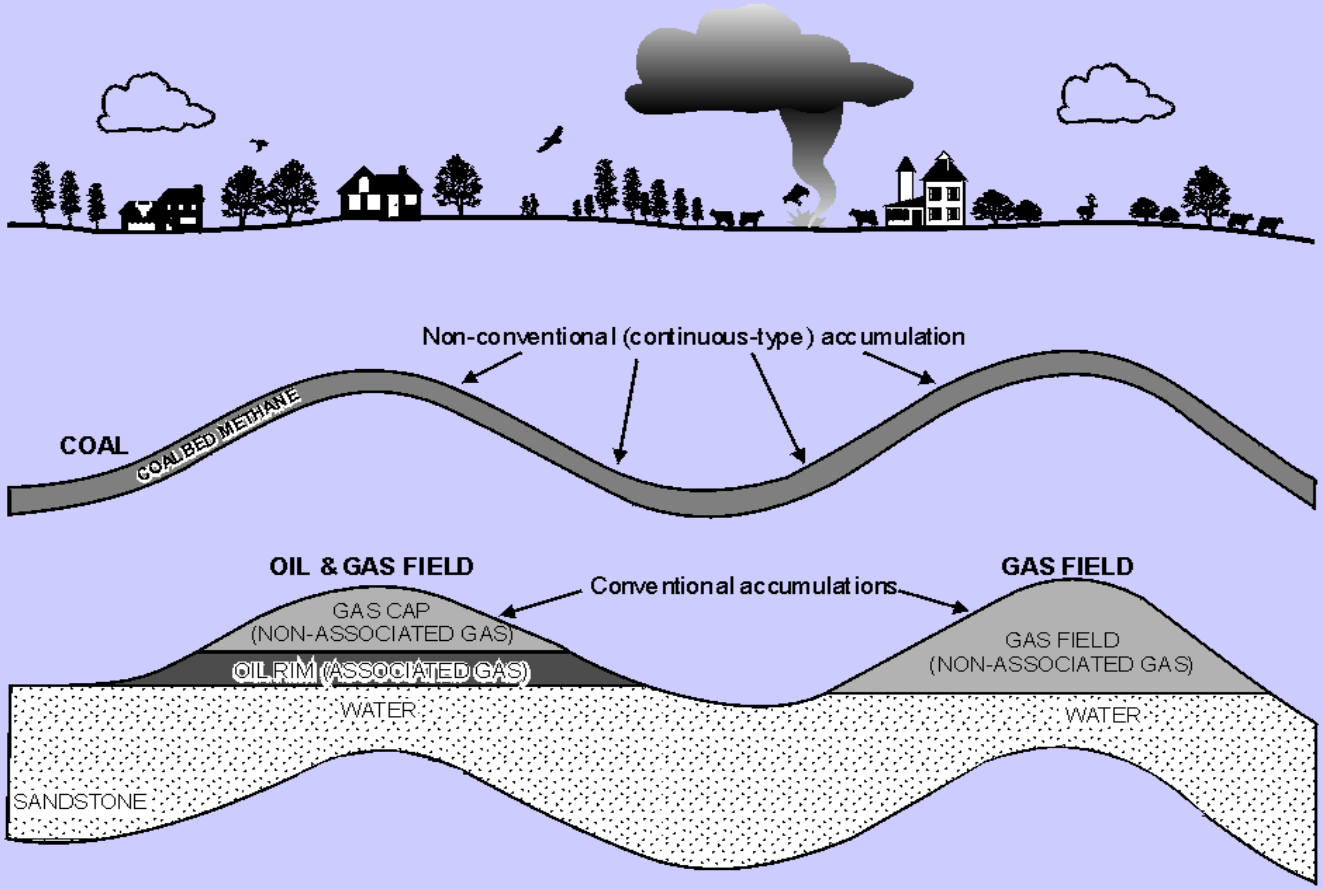
Carbonate Reservoir
Wapanuka Limestone (Oklahoma)

Oklahoma Recovery Factor Distribution



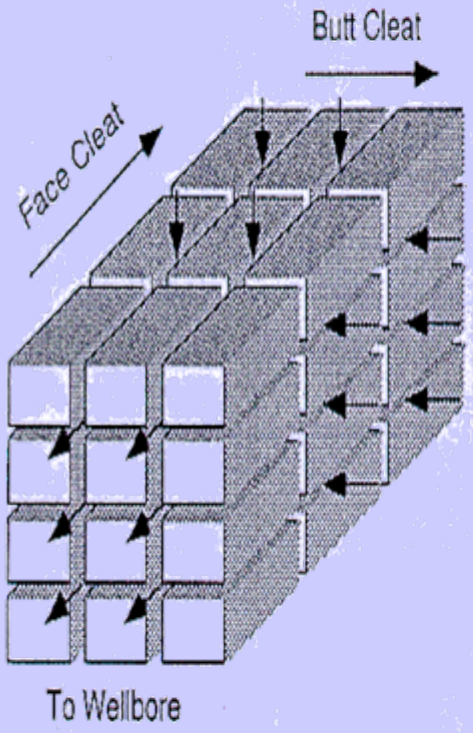
Unconventional

Conventional vs. Non-Conventional Gas Accumulations

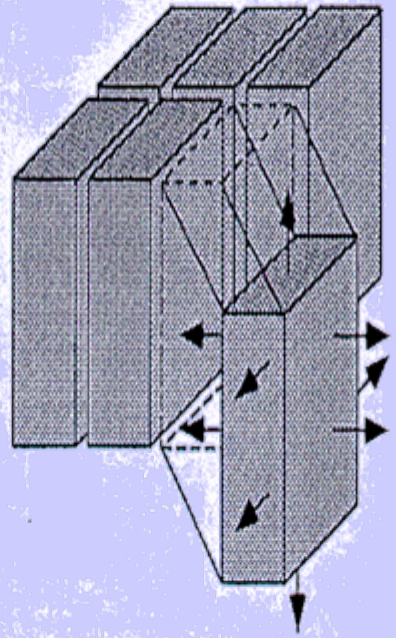


Surface Coal Mine in Oklahoma

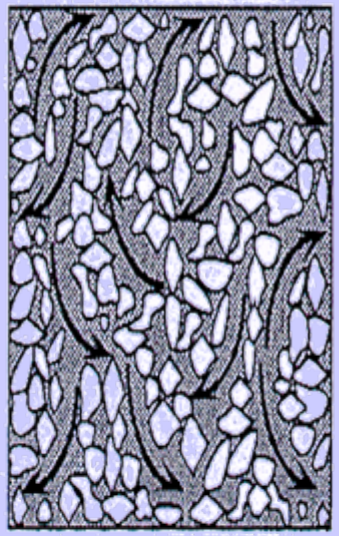
Gas Transport Mechanisms in Coal



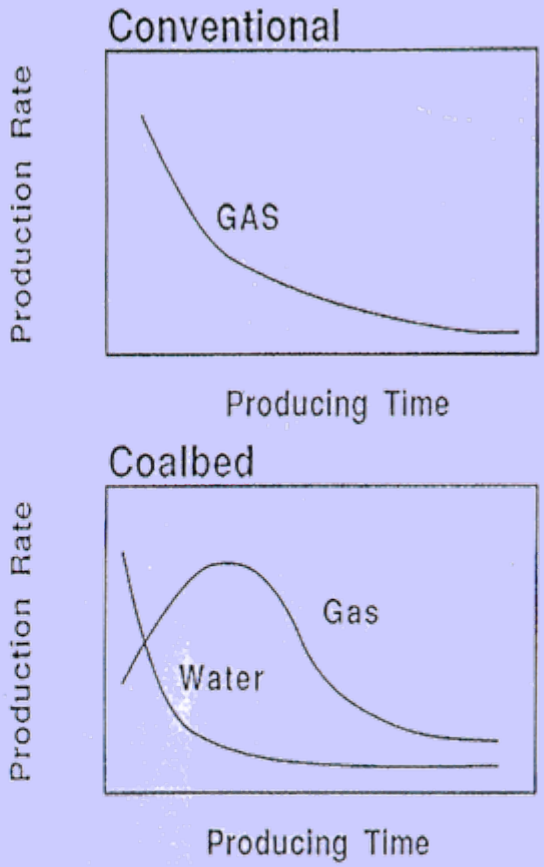
Fluid Production from Natural Fractures



Gas Desorption from Cleat Surfaces



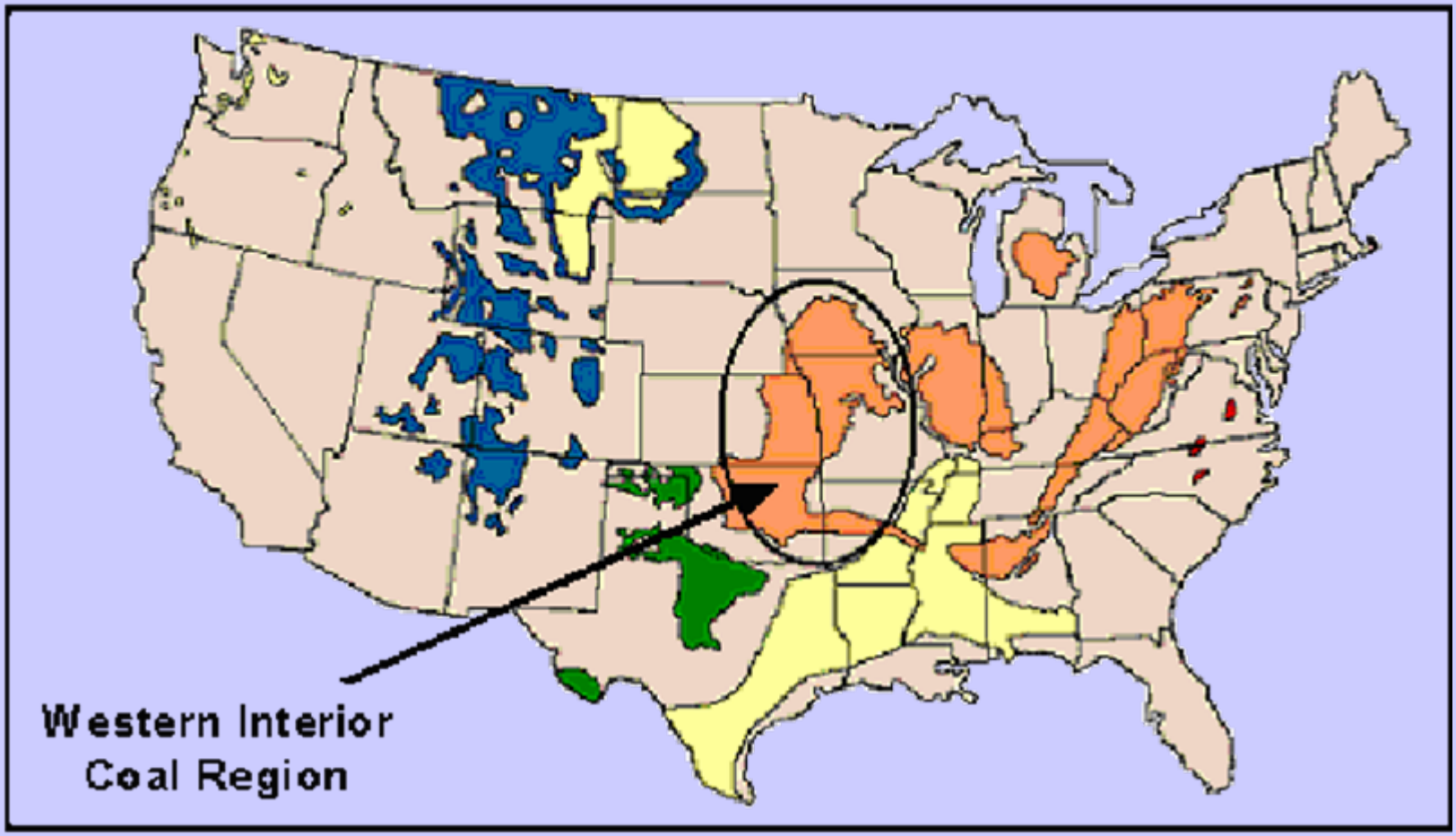
Molecular Diffusion through the Coal Matrix



Comparison of recovery trends for conventional gas wells and coalbed methane wells.

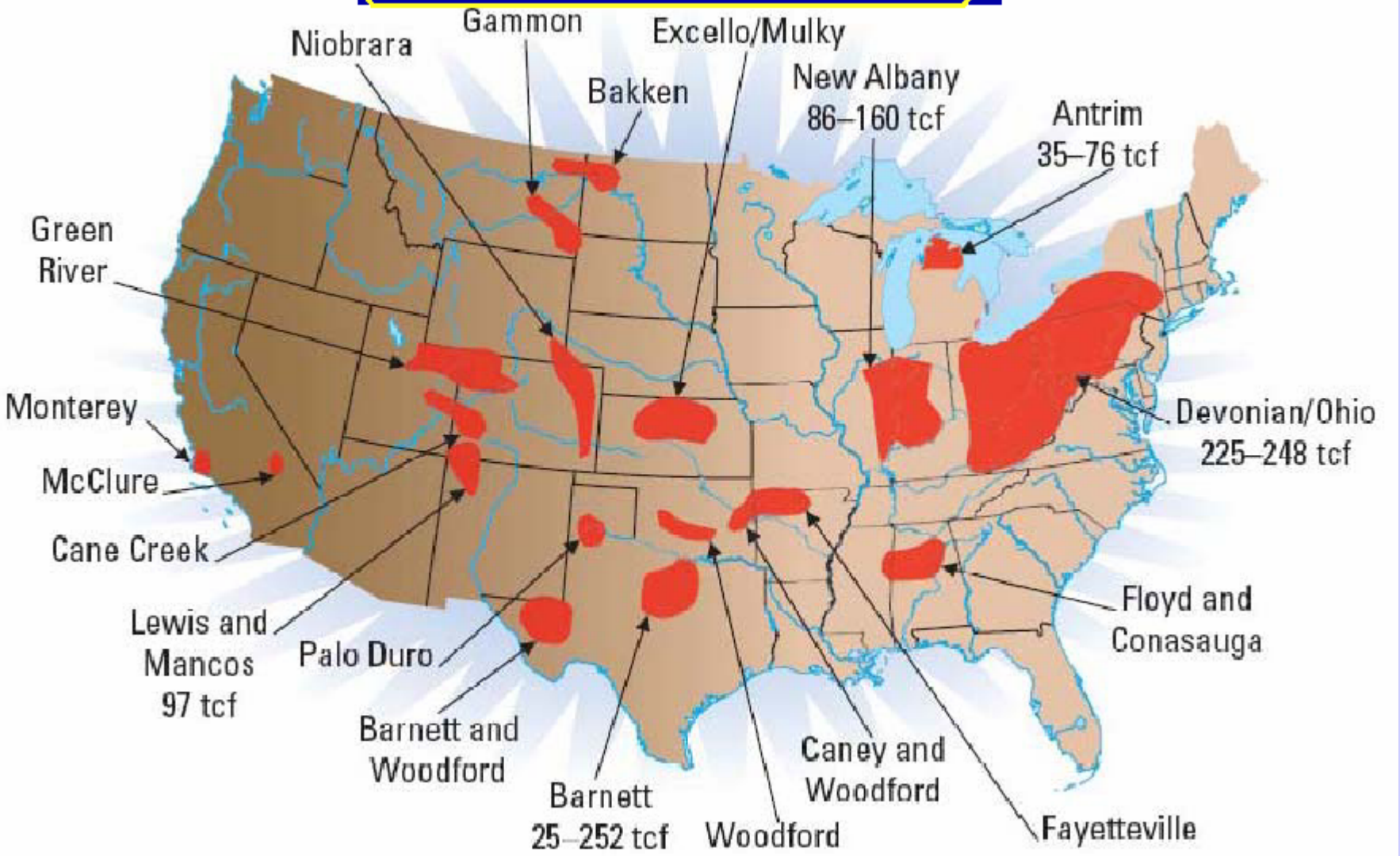
Coalbed Methane Well (Oklahoma)

U.S. Coal Basins



Woodford Shale (Oklahoma)

U.S. Shale Gas Basins



Athabasca Tar Sands

Methane Hydrates