

Structures of Northern Iraq and Syria, and Their Implications for Interpretation of the Region's Stratigraphy*

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Abstract

Several anticlines in northern Iraq and Syria were studied through the construction of balanced and restored cross sections. The data suggest that while each of the anticlines developed due to compression related to the Zagros Orogeny, they are the result of inversion of normal faults with a long history of episodic extension. Viewing these structures as part of the development of the foreland rather than elements of the Zagros fold belt allows a regional perspective that differs from the traditional tectonic zoning of the Arabian plate. This interpretation suggests that the structural fabric of the Northern Arabian plate is inherited from Precambrian trends and the geologic history of the region is one of recurrent reactivation of pre-existing features. The region's history is similar to other areas at the northern periphery of the African Continent where relatively stable blocks, or mesetas are separated by linear tectonic basins which have undergone late stage inversion.

The tectonic basins may have initiated as Precambrian suture zones or strike-slip fault zones. However, most of the sediment accumulated in these basins during later Phanerozoic periods of extension and rifting. The tectonic imprint on eustatic depositional cycles produced different stratigraphic successions on the mesetas when compared to the stratigraphy of the basins. The stratigraphy of the mesetas are dominated by high stand sequences and unconformities whereas the basins are dominated by low stand sequences and condensed zones in which the facies tracts are often modified by tectonism. These differences in local stratigraphy present major problems for workers attempting to resolve the regional stratigraphy by correlating well log data without the aid of seismic data.

The Campanian to Maastrichtian interval provides an effective example. During the Campanian, fringing Rudist reefs developed around the mesetas with a correlative condensed interval in the basins, whereas during the Maastrichtian these units are overlain by Olistostromes and basinal marls in the basins and correlative unconformities on the mesetas. The evidence indicates

that the Shiranish Formation cannot be a lateral time transgressive equivalent of Campanian Rudist biohermal units including the Massive, Pilsner, Hartha, and Aqra-Bekhme Formations. The Rudist biohermal units developed on opposite sides of rift basins which later filled with the Shiranish Formation.

Selected References

Al-Qayim, B. and L. Salman, 1986, Lithofacies analysis of Paleogene mixed carbonate area north Iraq: *Journal of the Geological Society*, v. 19/3.

De Righi, R.M. and A. Cortesini, 1964, Gravity Tectonics in Foothill Structure Belt of Southeast Turkey: *AAPG*, v. 48, p. 1596-1611.

Dunnington, H.V., 1958, Generation, migration, accumulation, and dissipation of oil in northern Iraq, *in* L.G. Weeks (editor) *AAPG Habitat of oil: A Symposium: AAPG Special Publication 18*, p. 1194-1251.

Jassim, S.Z. and J.C. Goff, 2006, Phanerozoic development of the northern Arabian Plate, *in* S.Z. Jassim and J.C. Goff, (eds.), *Geology of Iraq*, p. 32-44.

Kent, P.E., F.C. Slinger, and A.N. Thomas, 1951, Stratigraphic exploration surveys in south-west Persia: *Third World Petroleum Congress, Proc., Section 1*, p. 141-161.

Kent, W.N. and R.G. Hickman, 1997, Structural development of Jebel Abd Al Azia, Northeast Syria: *GeoArabia Manama*, v. 2/3, p. 307-330.

Structures of Northern Syria and Iraq and their Implications for interpretation of the region's stratigraphy

Notes by Presenter: This talk is a sequel to a talk that I gave earlier this year at GEO1010 on structures of the Kirkuk Embayment, Zagros Orogeny. In this talk I would like to illustrate the interrelationship between the structures and the regions stratigraphy. I will suggest that the geology of the northern Arabian plate is similar in many ways to that of Moroccan North Africa.

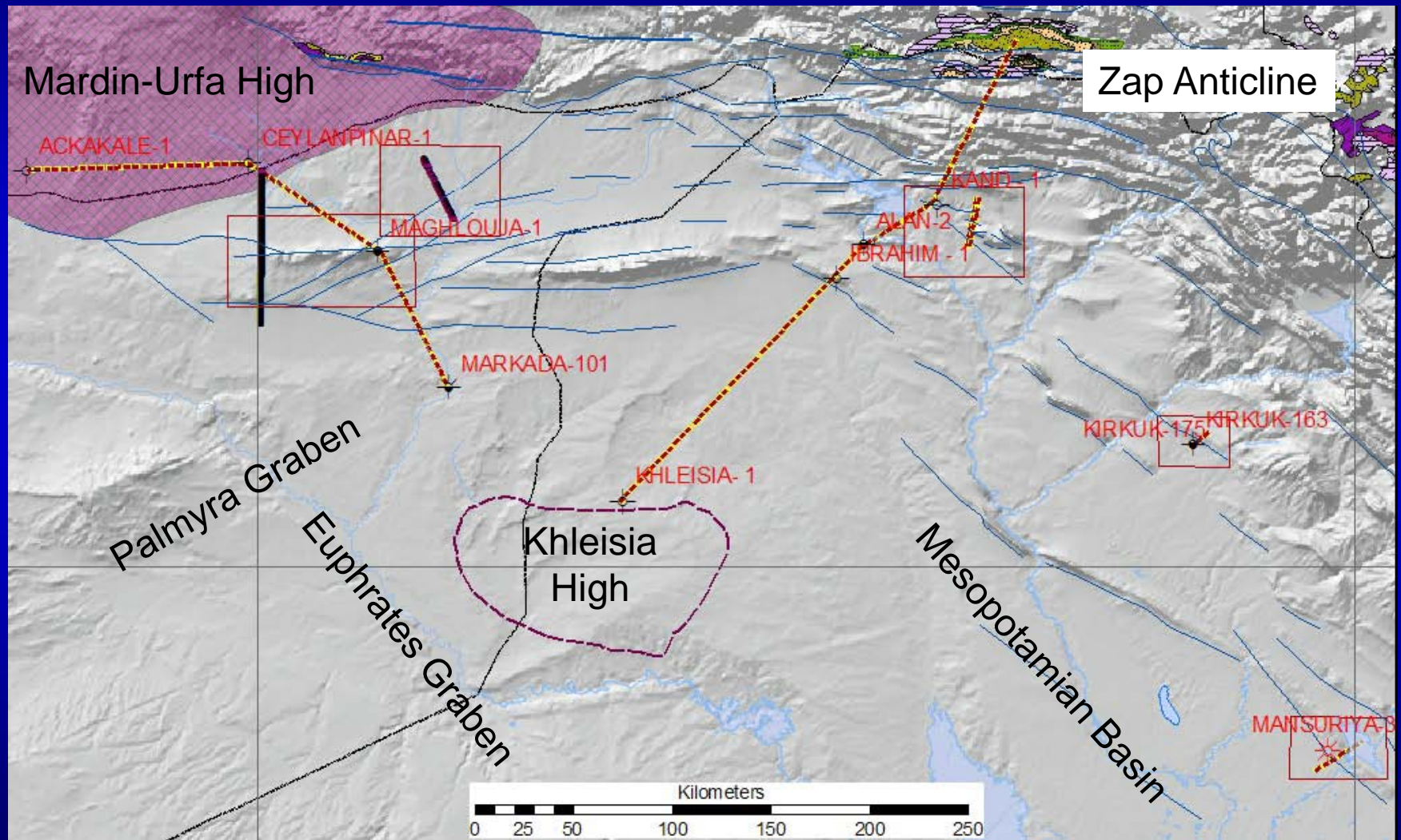
Acknowledgements

Ministry of Oil, Iraq
for the generous use of their data

Outline

- Regional Structural Overview
- Brief description of individual structures
- Conclusions from structural elements
- Discussion of the Maastrichtian / Campanian stratigraphy example
- Conclusions

Index

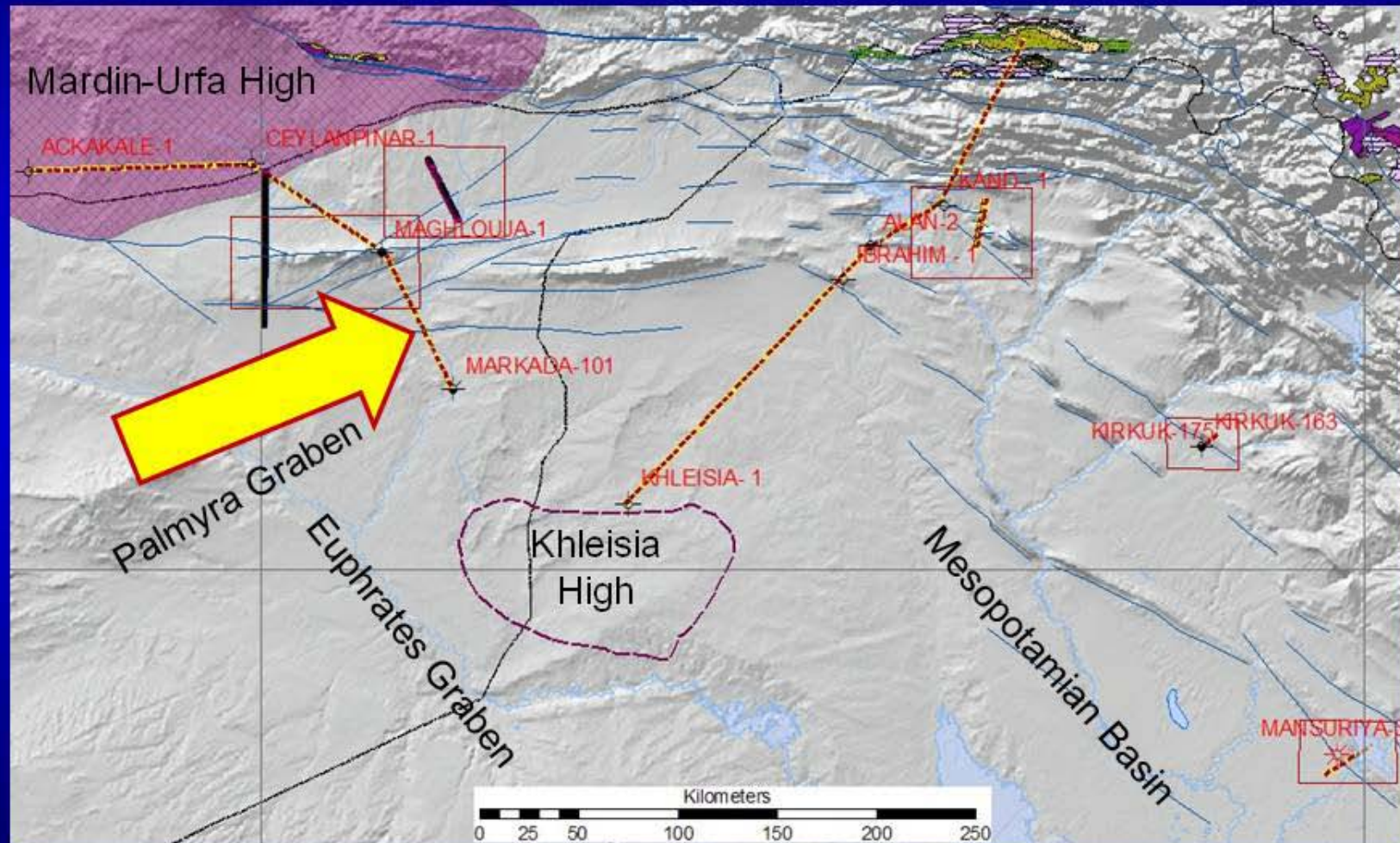


Notes by Presenter (for previous slide):

Index Map - Location of regional features, cross sections and structures discussed:

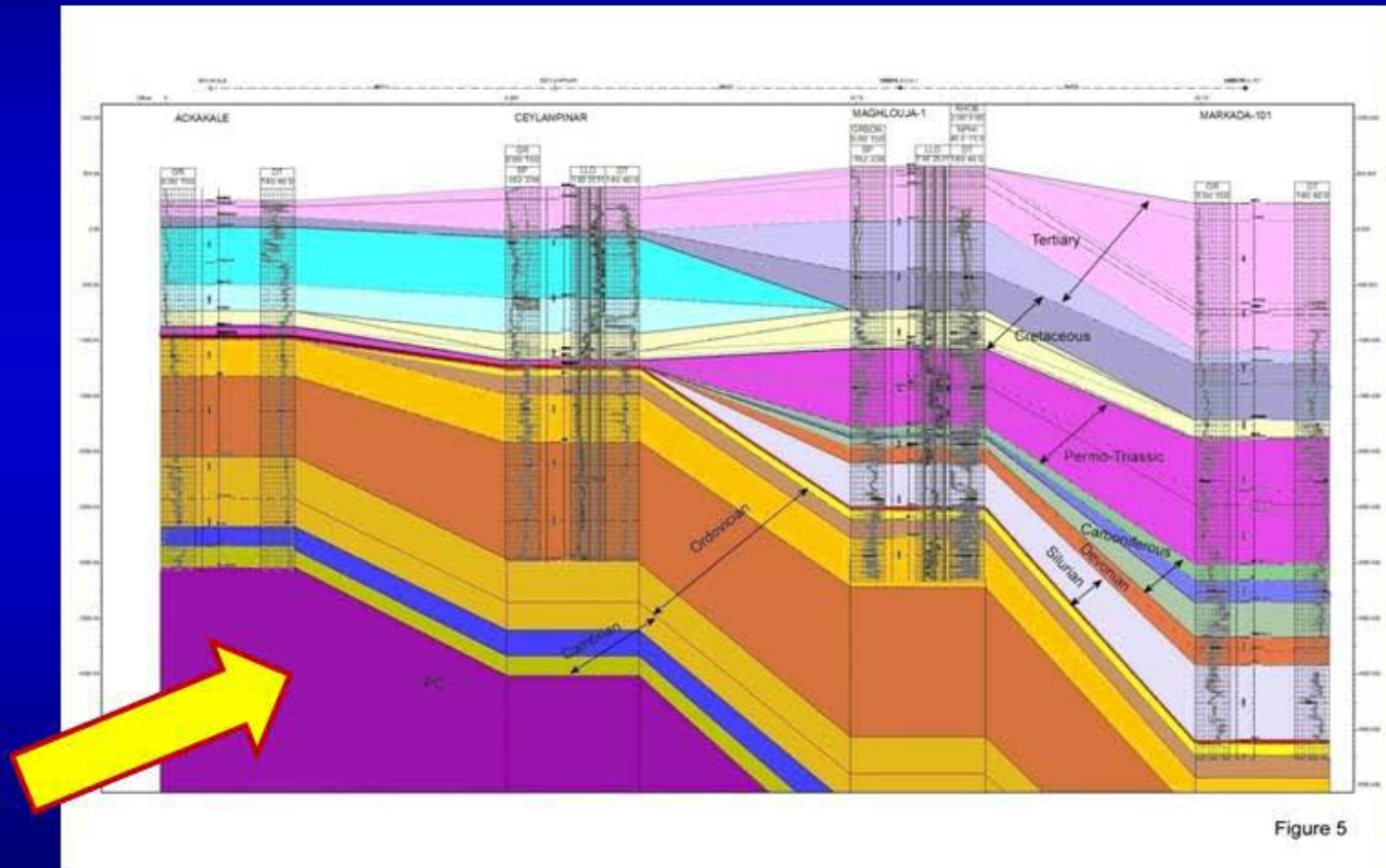
- Khleisia High, Mardin – Urfa High, Zap Anticline
- Palmyra Graben, Euphrates Graben, Mesopotamian basin
- The location of the structures discussed in this talk
- And the location of two regional Cross Sections

Well Cross Section 1



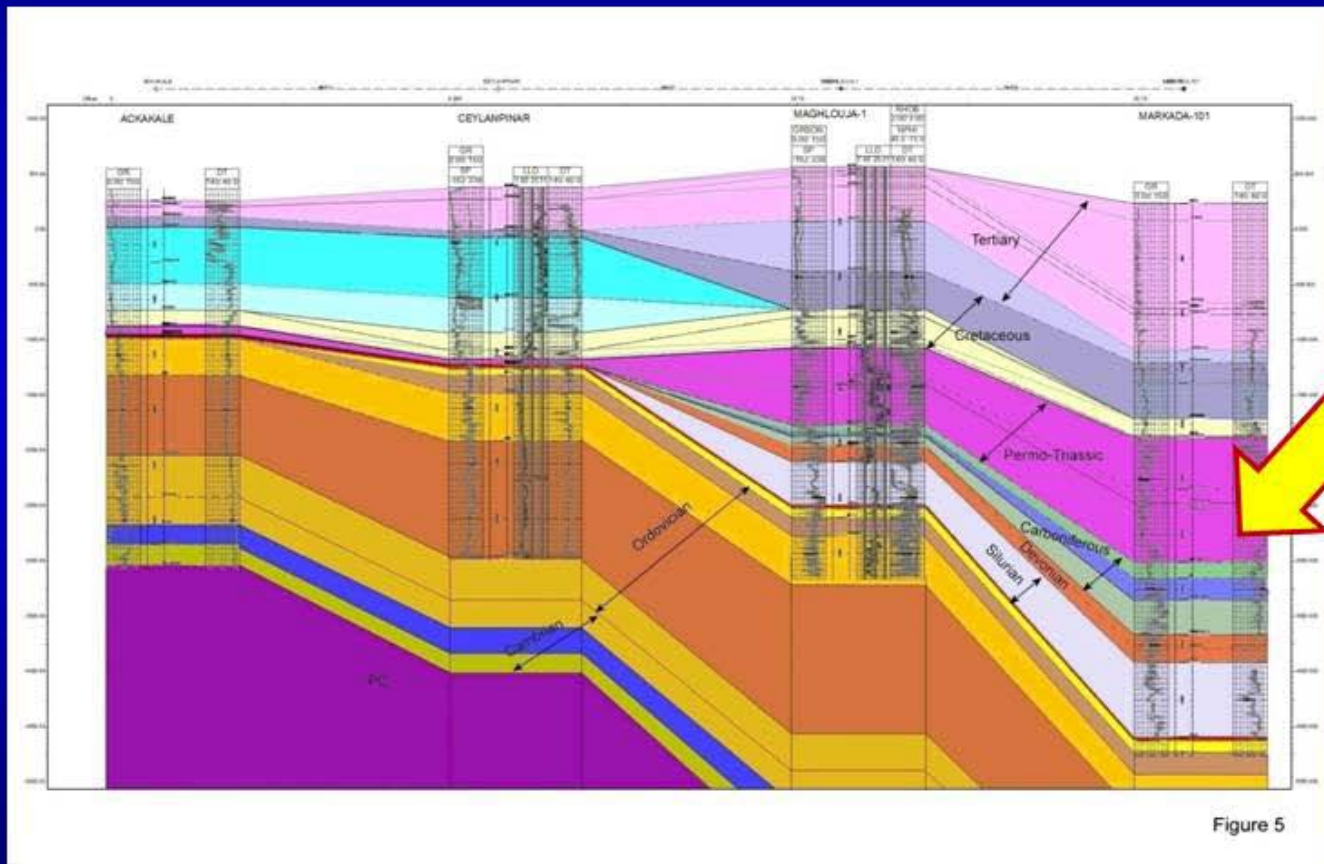
Notes by Presenter: First Regional Cross Section

Mardin Meseta



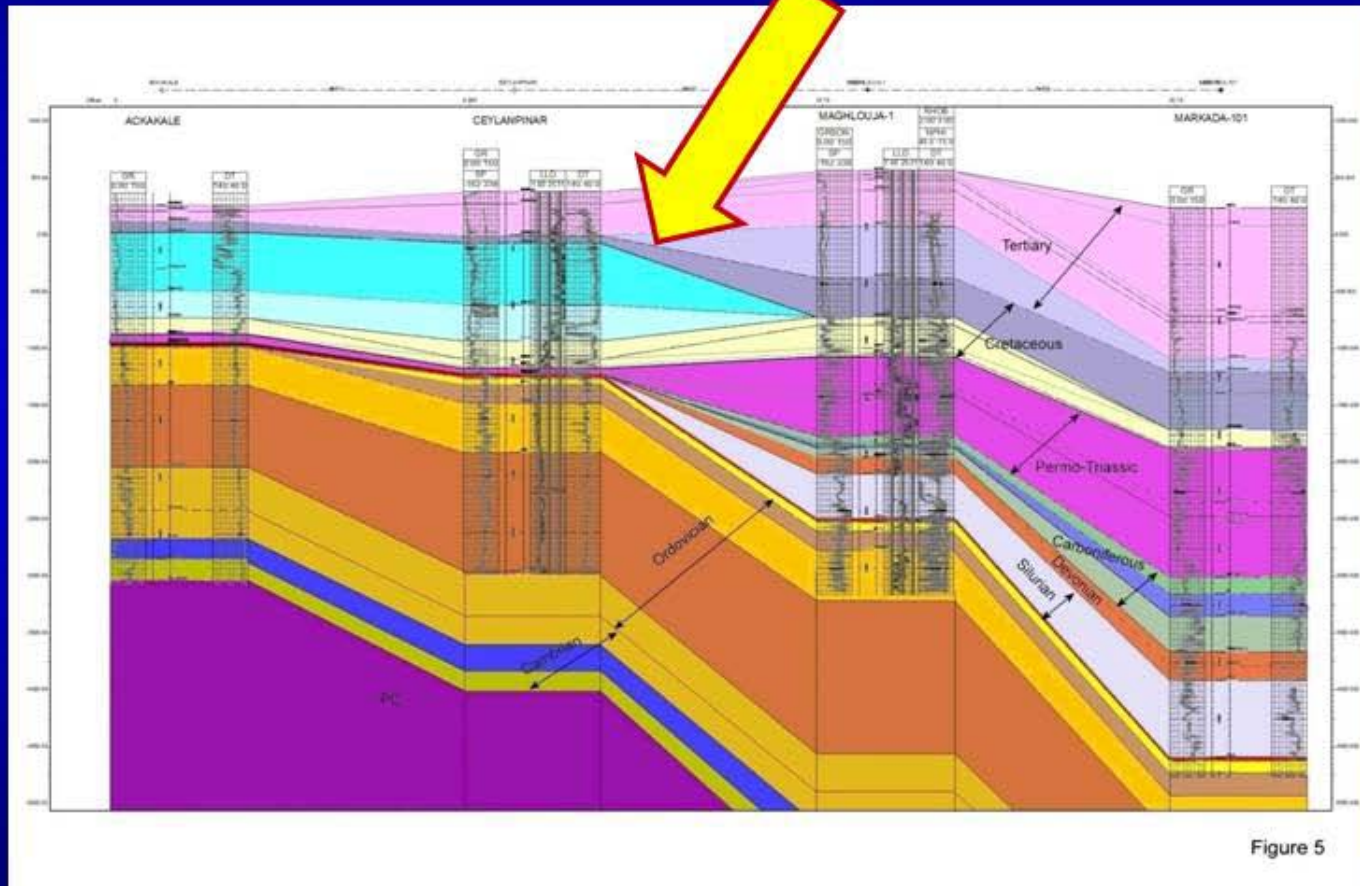
Notes by Presenter: This cross section shows a basement feature that has been active since the Late Ordovician

Mardin Meseta



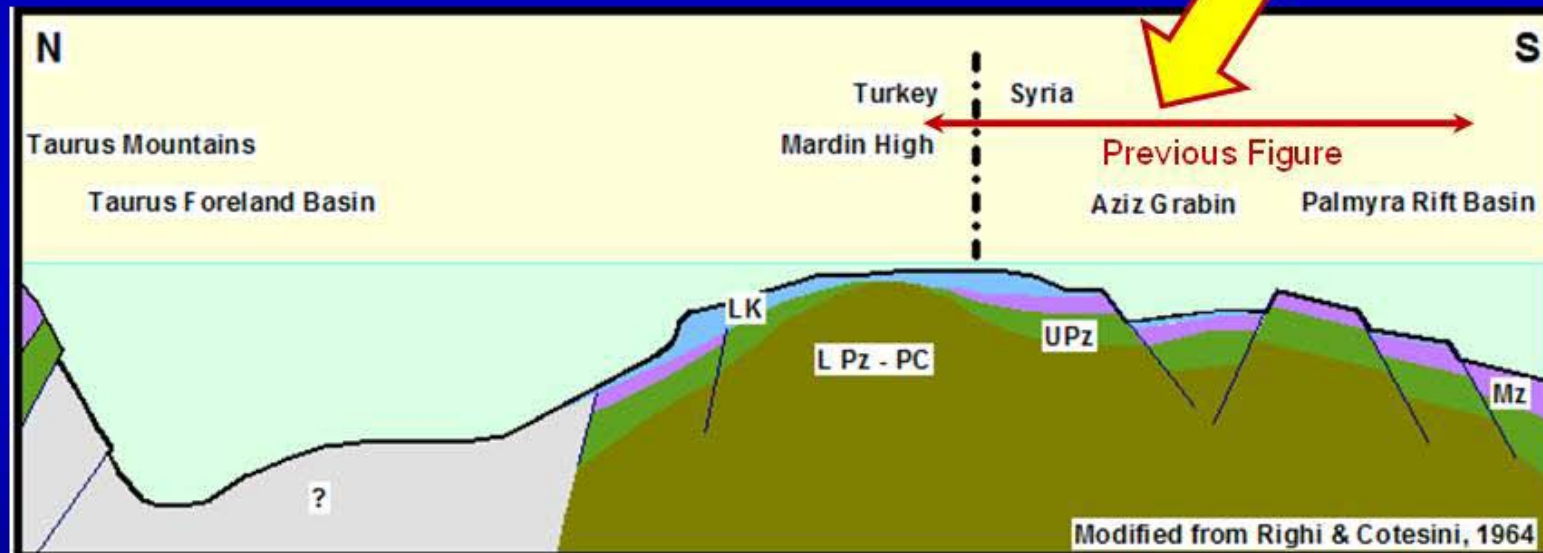
Notes by Presenter: The persistence of this feature is demonstrated by most of the stratigraphic units thinning onto the high either by deposition or by truncation

Mardin Meseta



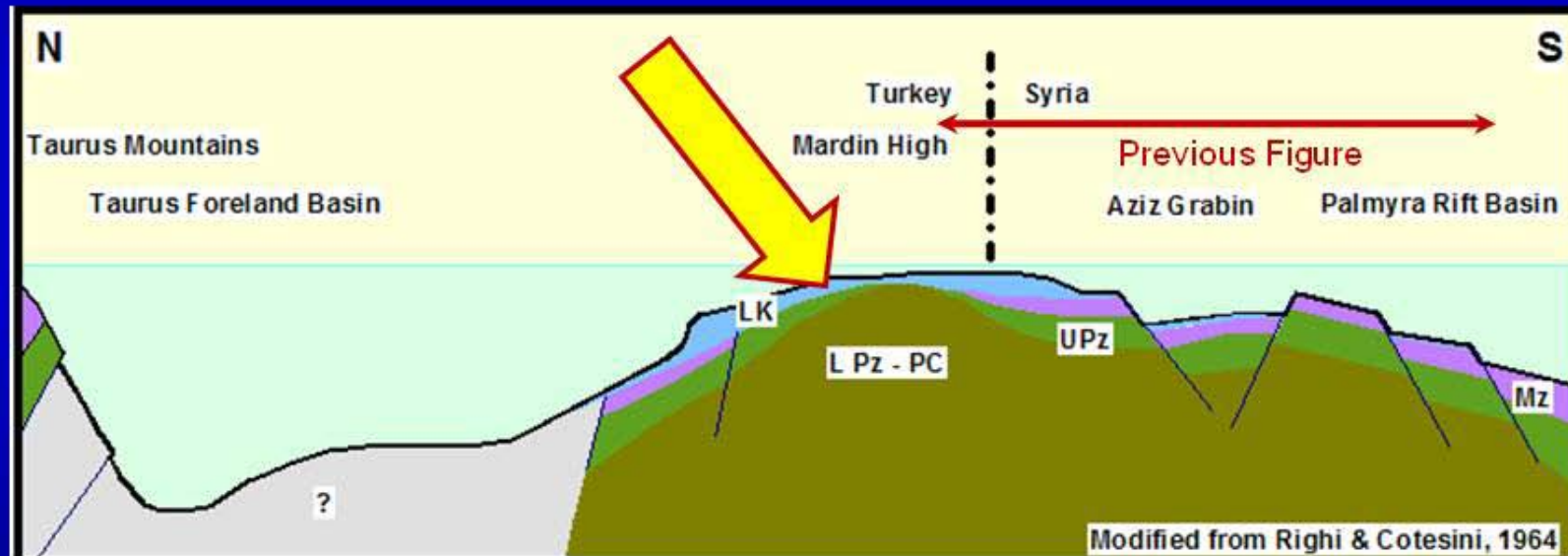
Notes by Presenter: The cross section also shows the highstand carbonate sequence developed on this basement feature.

Schematic Cross Section



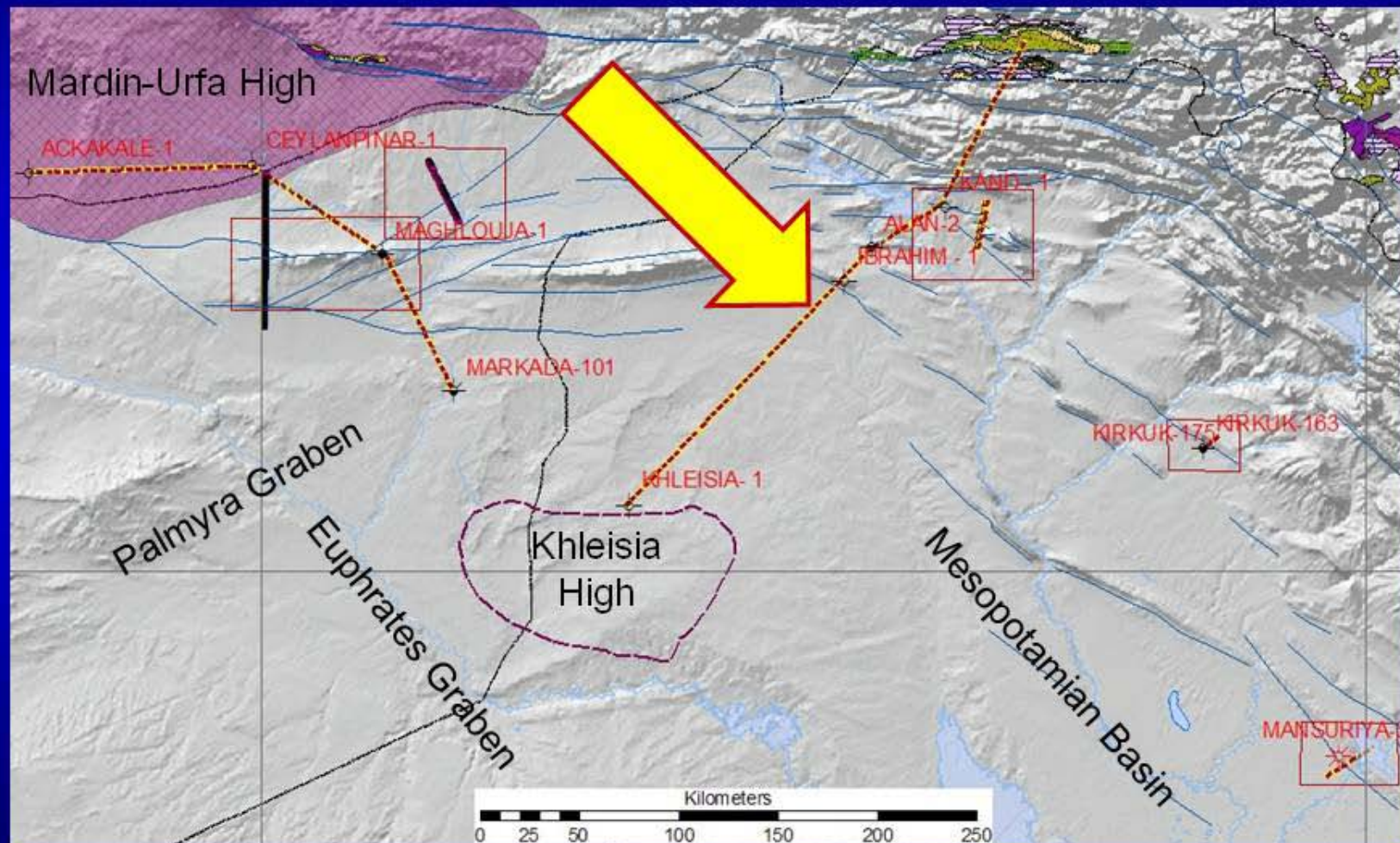
Notes by Presenter: This diagrammatic cross section illustrated the basement high with respect to the Zagros Mountains and their associated foreland basin. The location of the previous cross section and the highstand platform carbonate unit.

Schematic Cross Section



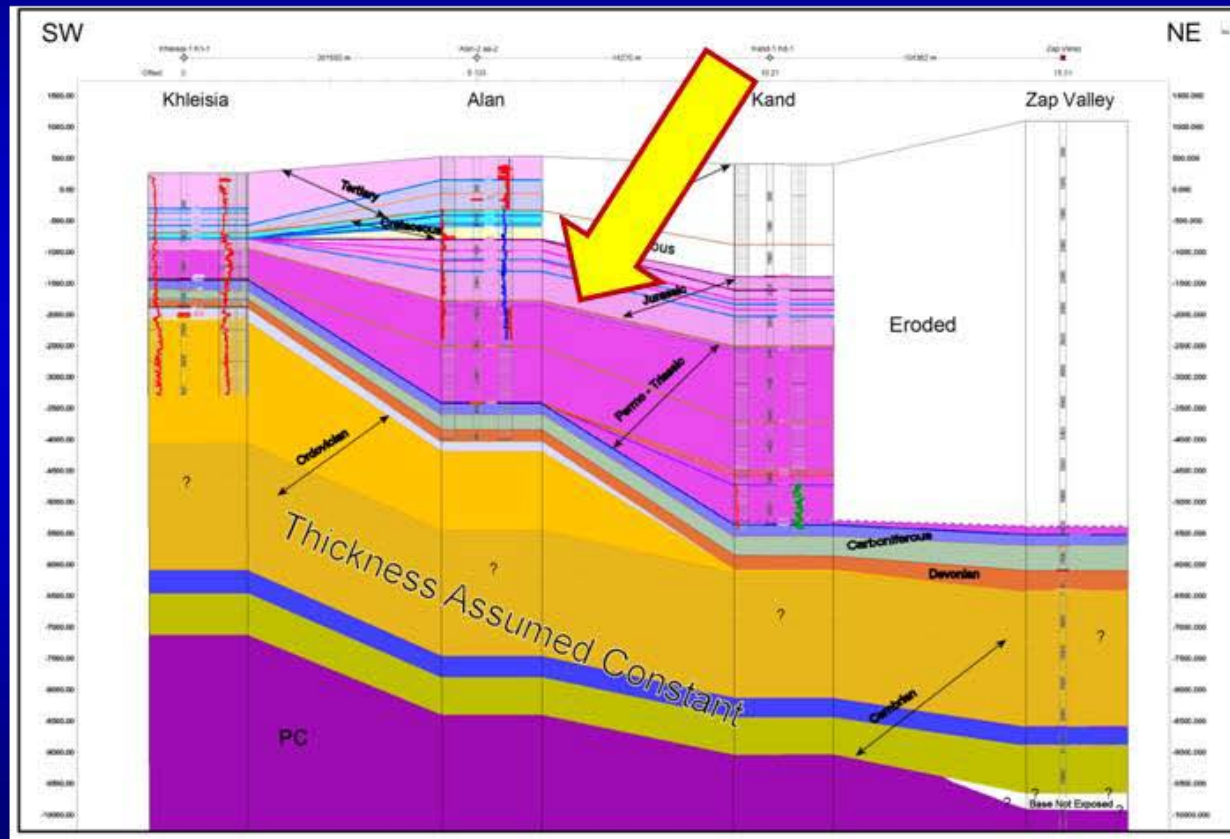
Notes by Presenter: And the highstand platform carbonate unit.

Well Cross Section 2



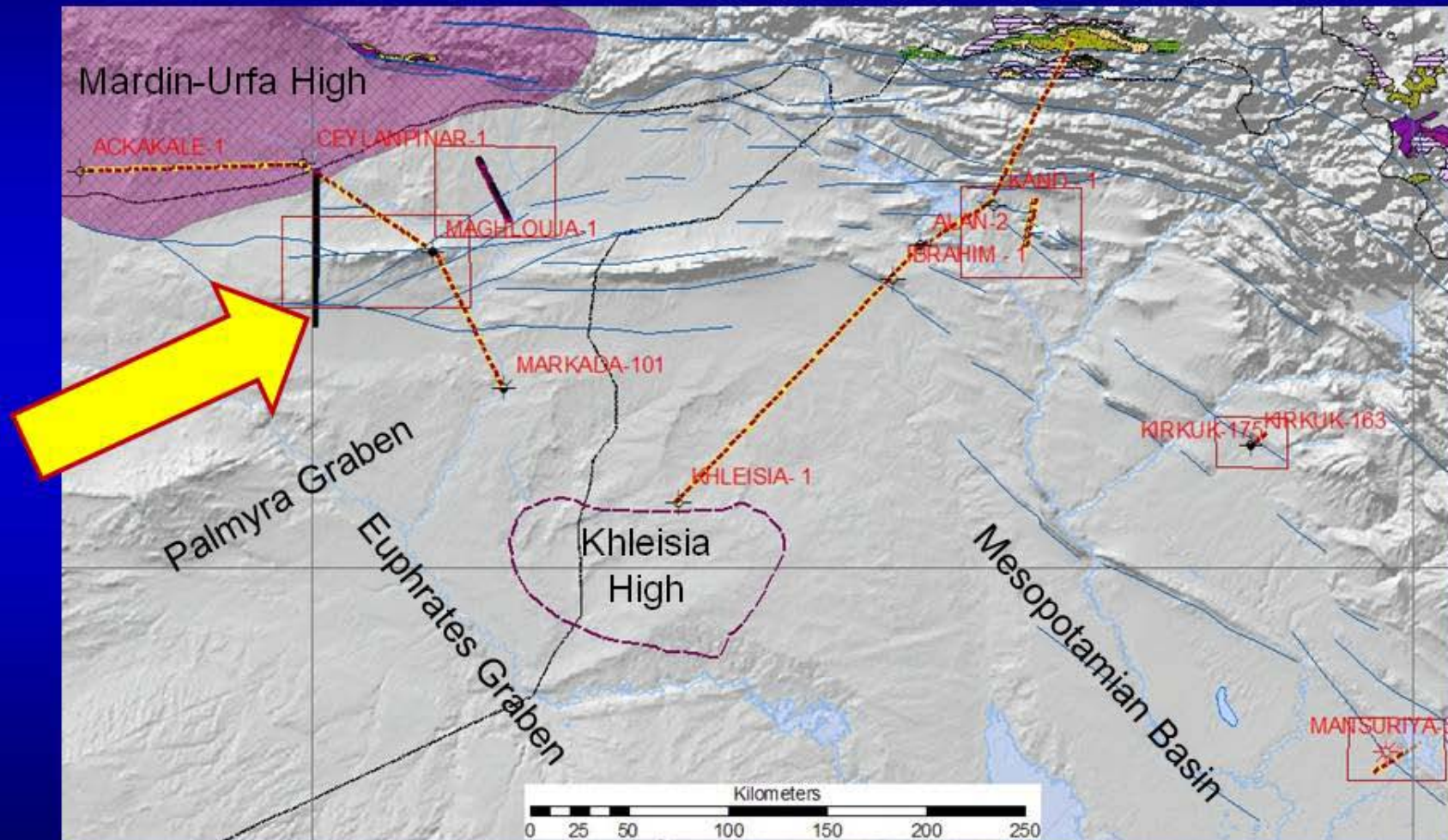
Notes by Presenter: This map shows the location of a cross section from the Khleisia High in Iraq to the Zap Anticline in Turkey

Khleisia – Zap Valley Cross Section



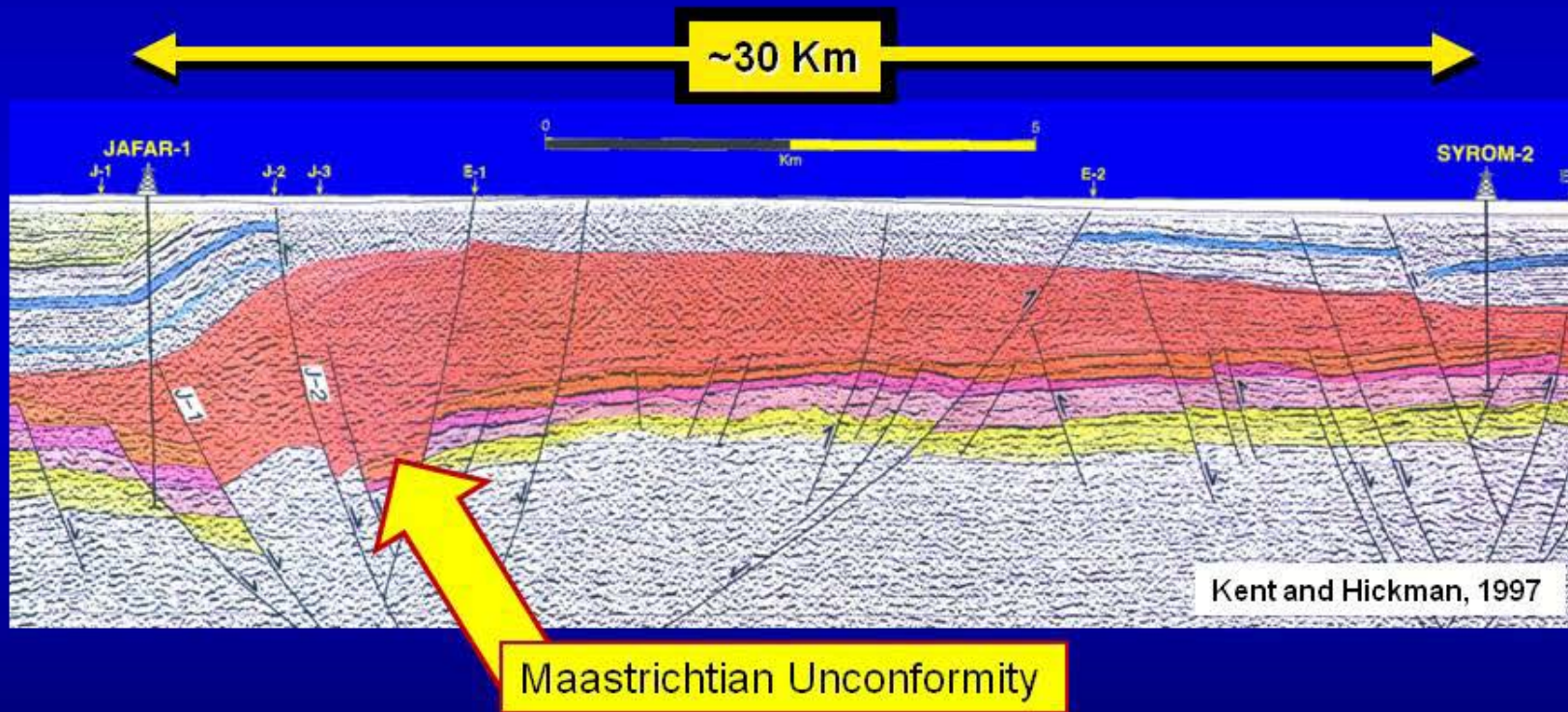
Notes by Presenter: The cross section shows a basement high with the Late Paleozoic through Tertiary stratigraphy thinning onto it. Lack of control well control prohibits showing the distribution of the Late Cretaceous highstand carbonate distribution. We will see this later based on seismic data.

Jabal Abd Al Aziz



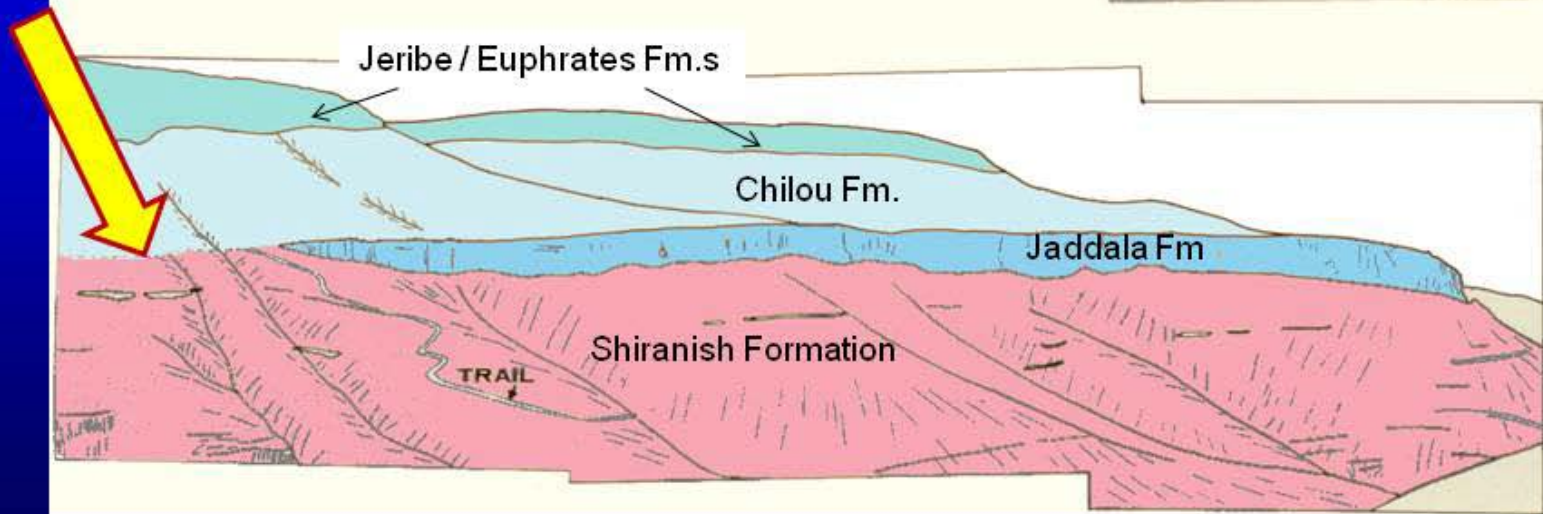
Notes by Presenter: Location of Jabal Abd Al Aziz as shown by Seismic Line SY-34

Jabal Abd Al Aziz



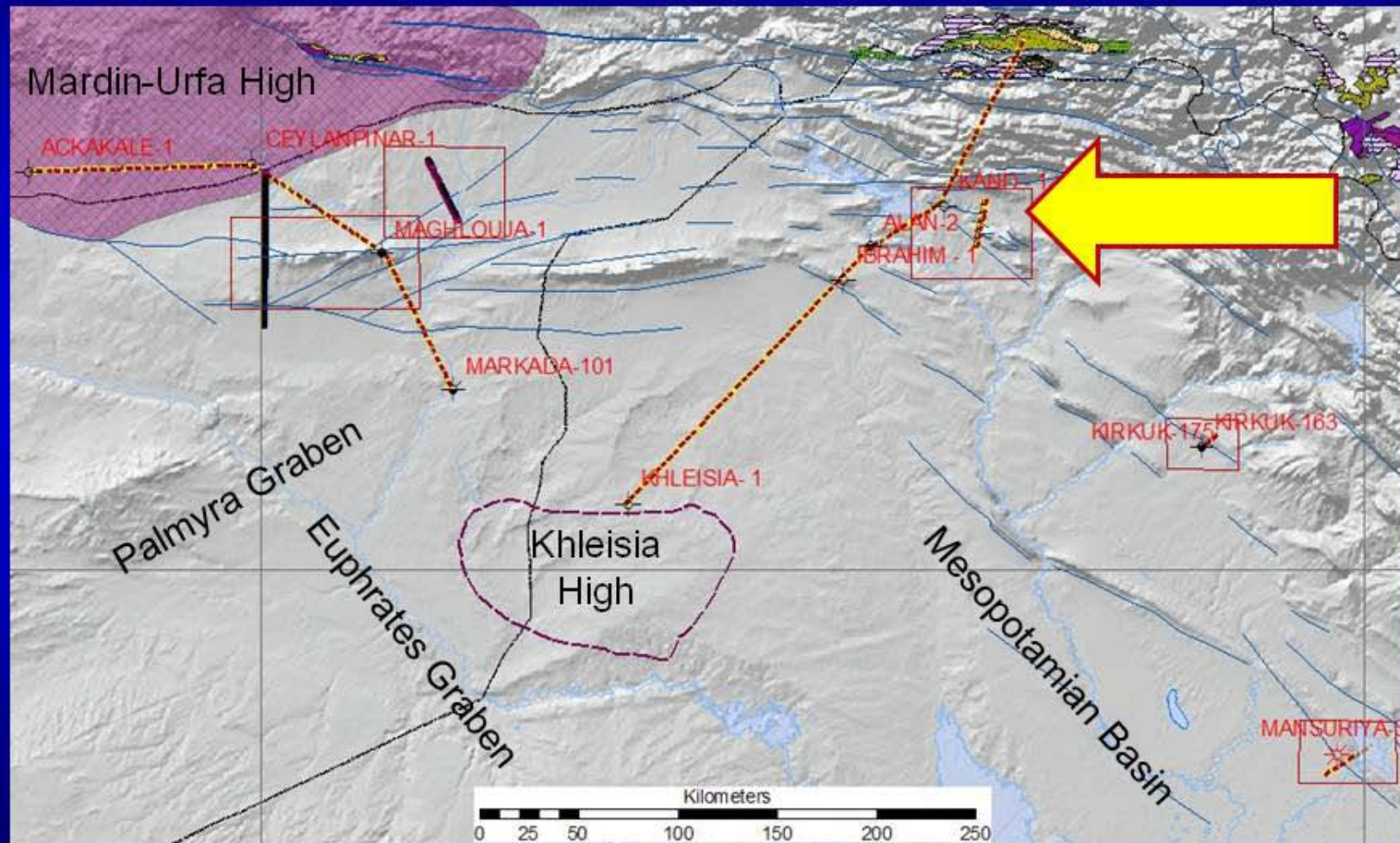
Notes by Presenter: Jabal Abd Al Aziz is an inverted graben filled with Maastrichtian Shiranish

Post Shiranish Growth



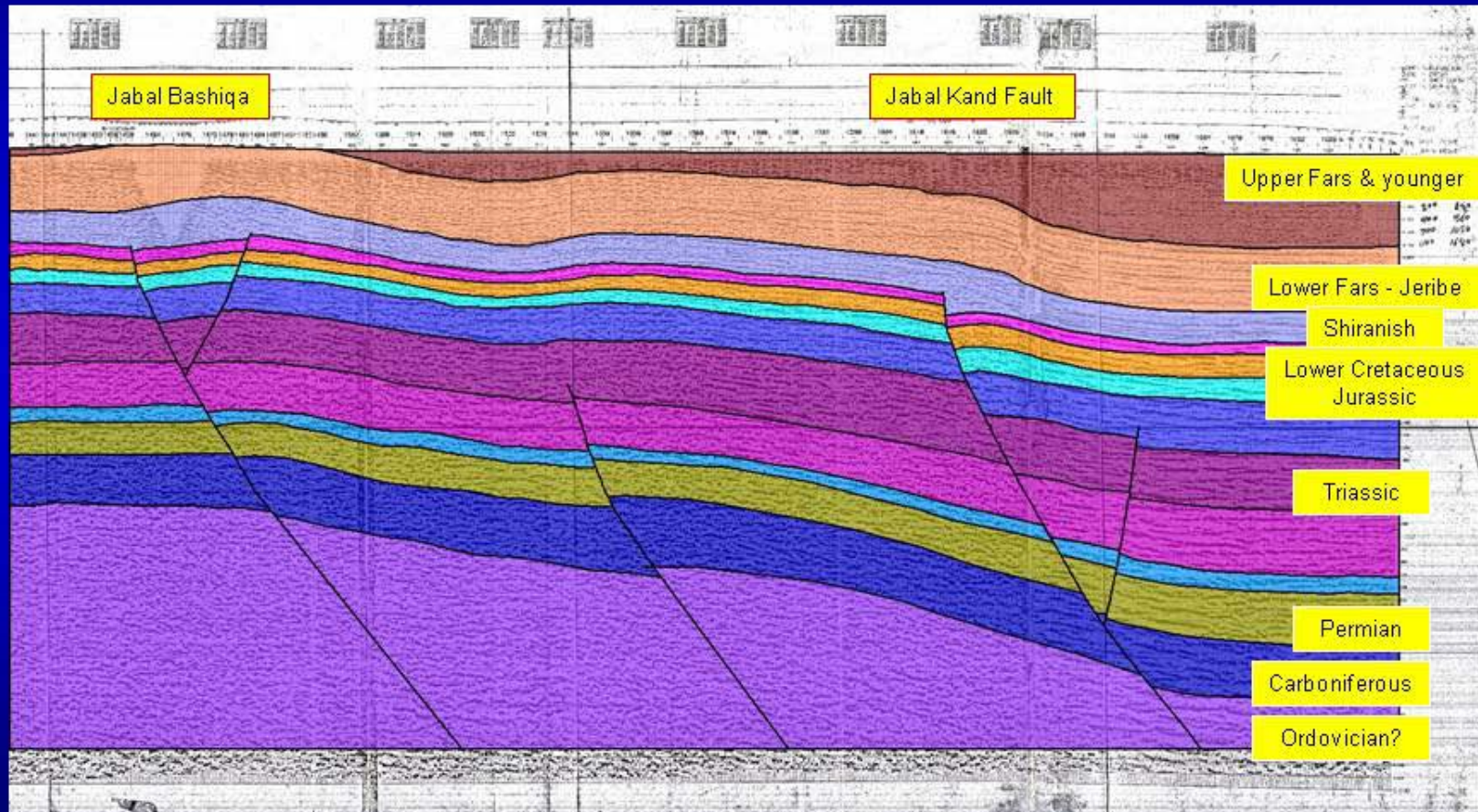
Notes by Presenter: Absence of the Paleocene Aaliji and thinning of the Eocene Jaddala over the crest of the Anticline demonstrate early growth of the inverted anticline.

Jabal Kand and Jabal Bashiqa



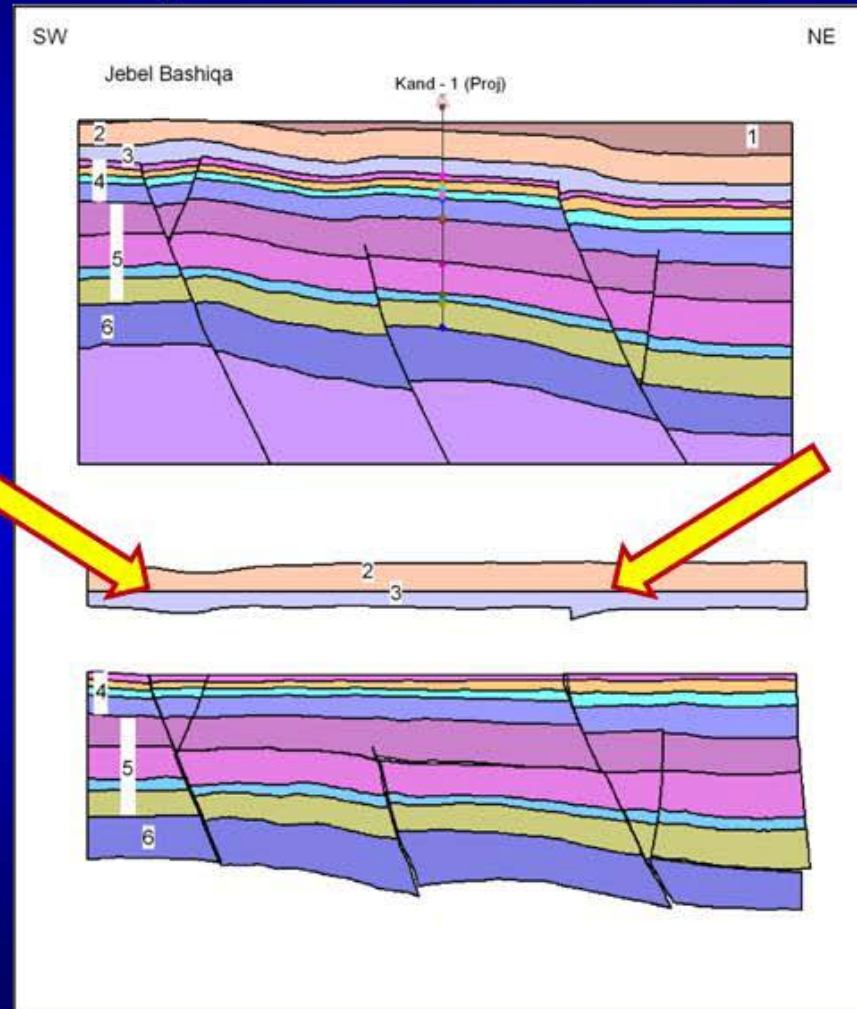
Notes by Presenter: Location of Jabal Kand and Jabal Bashiqa

Bashiqa – Kand Structures



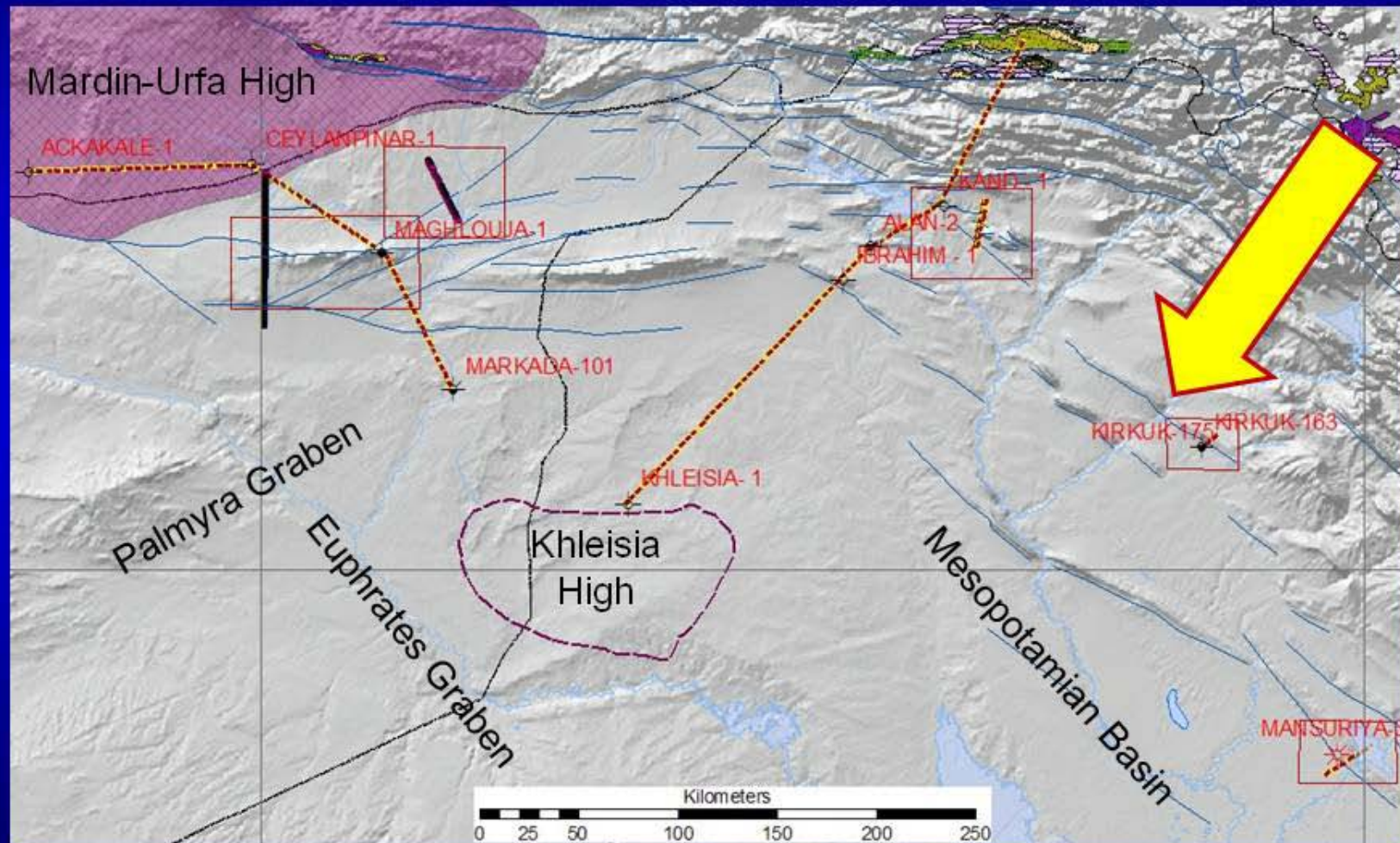
Notes by Presenter: This seismic line crosses the plunge of and the ends of Jabals Kand & Bashiqa

Bashiq-Kand Restoration



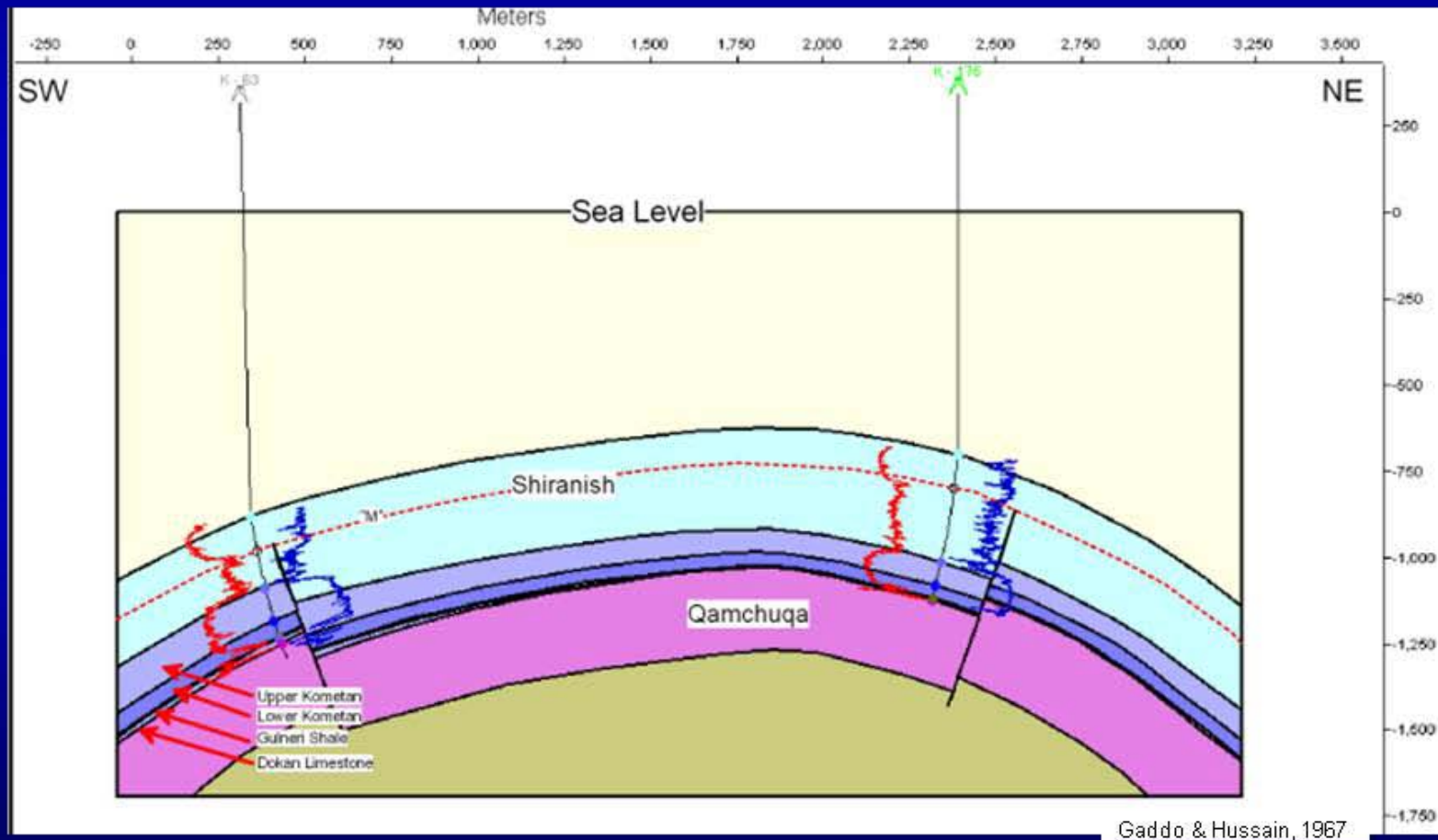
Notes by Presenter: At top is the interpretation converted to depth with the formation tops from the Kand – 1 well projected in to the section. At the bottom is a restored section showing thickening of the Maastrichtian Shiranish associated with both fault systems

Kirkuk Structure



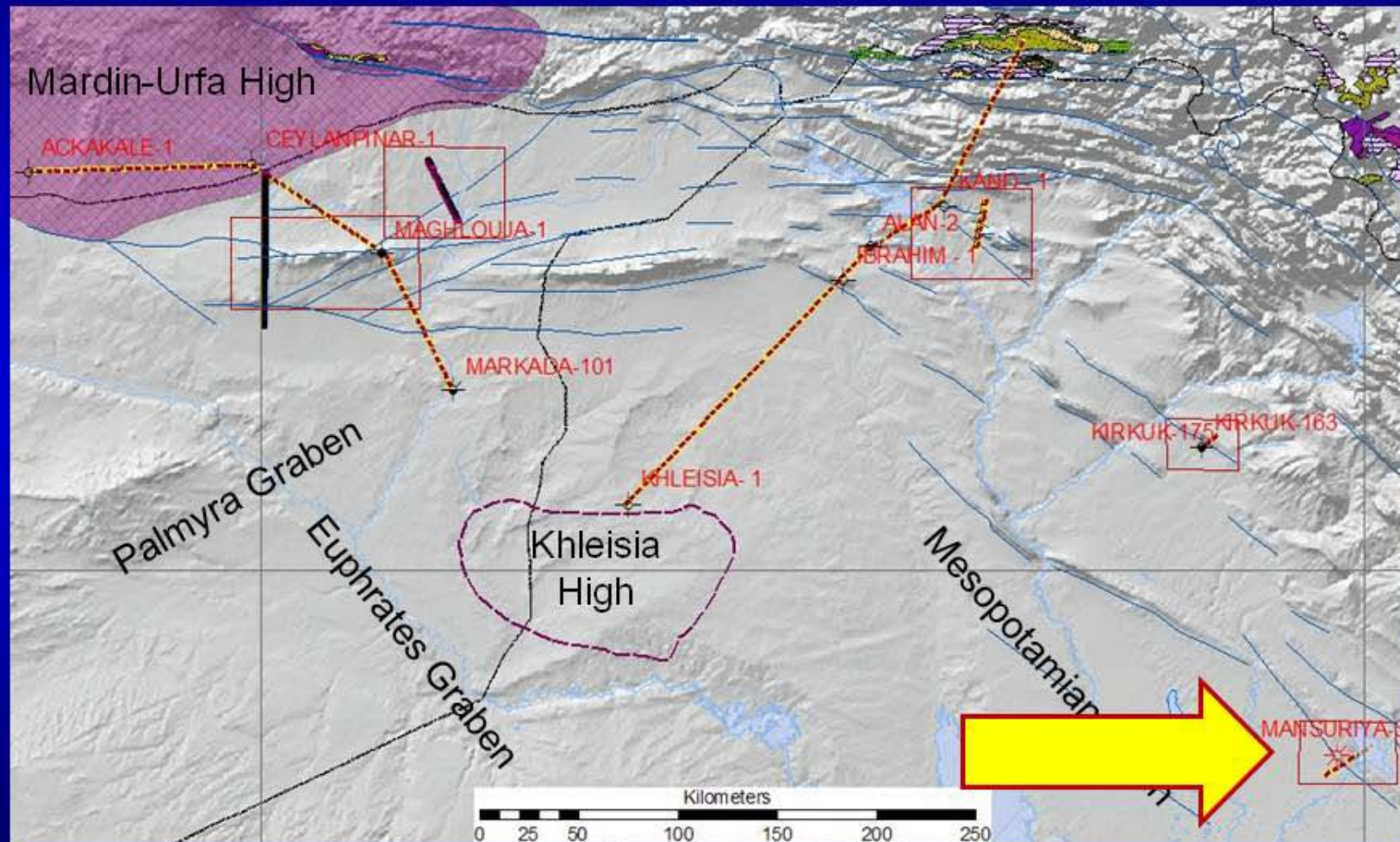
Notes by Presenter: This map shows the location of the Kirkuk Structure

Kirkuk Structure



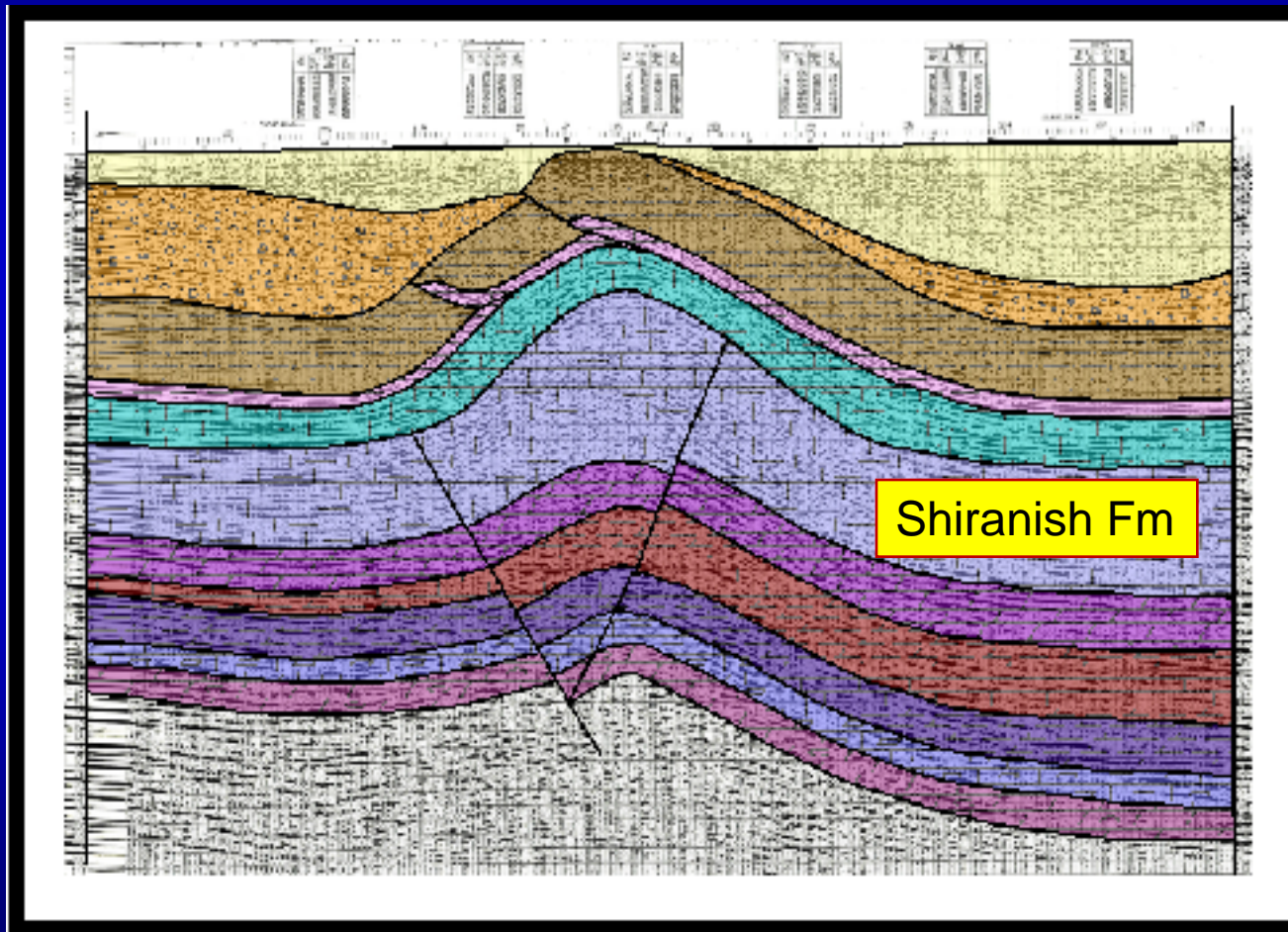
Notes by Presenter: This cross section by Gaddo and Hussain modified by the addition of the well log data shows the thickening of the Shiranish below the “M” log marker at the crest of the anticline.

Mansuriya Structure

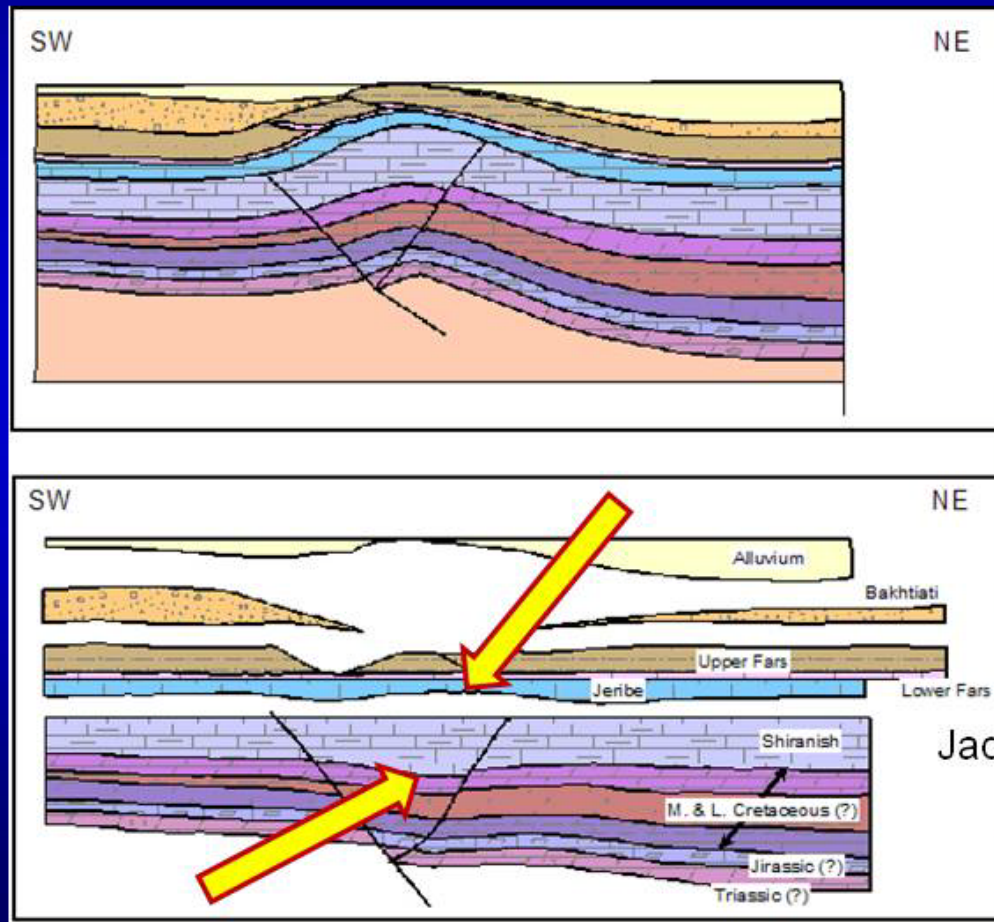


Notes by Presenter: The map shows the location of the Mansuriya Structure.

Mansuriya Seismic



Mansuriya Restoration



Notes by Presenter: At the top is the interpretation converted to time using the seismic stacking velocity. At the bottom is a restoration of the interpretation illustrating thickening of the Shiranish at the crest of the structure at the Mansuriya fault. The interpretation also shows the absence of the Paleocene to Oligocene and thinning of the Miocene Jeribe at the crest of the anticline.

Structural Elements

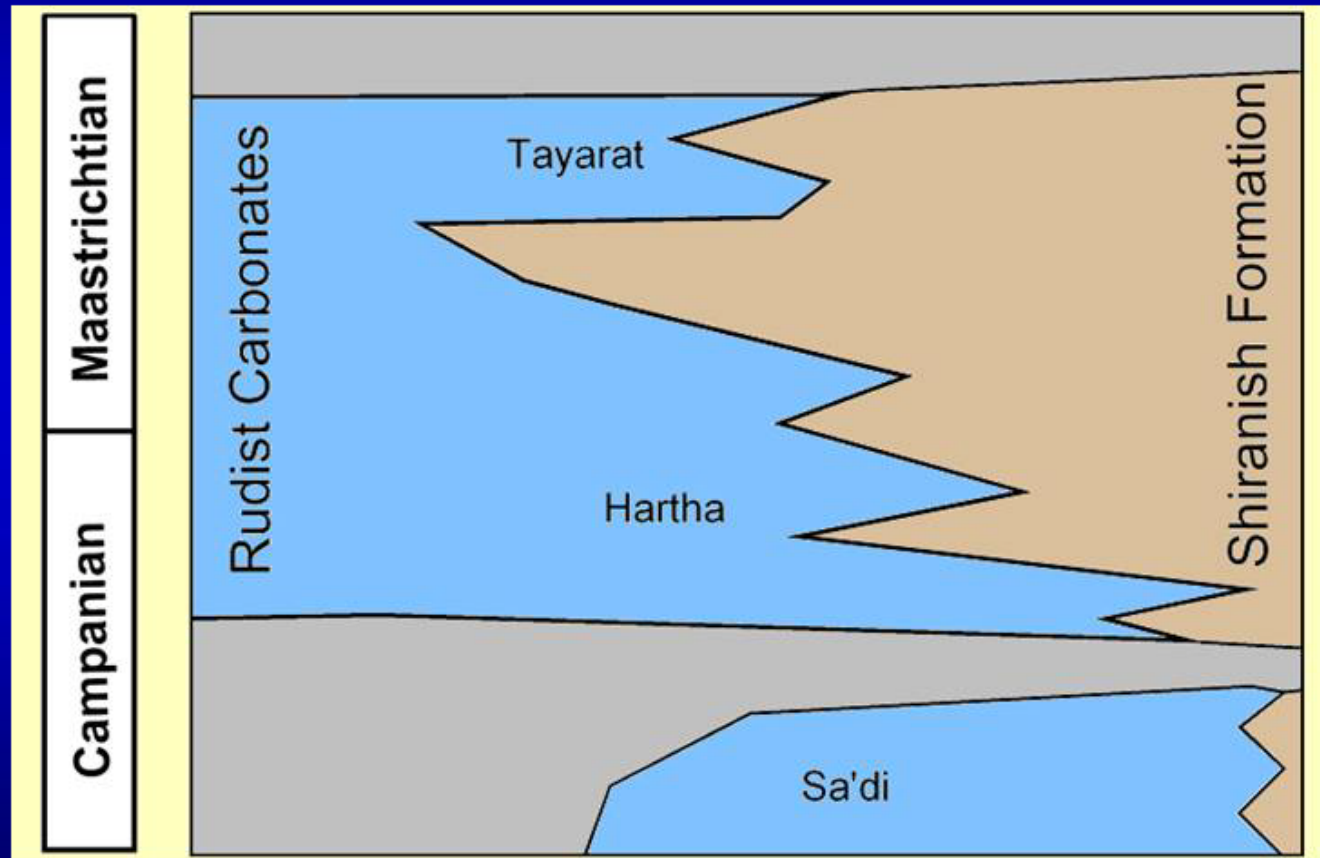
- Deposition focused in old rift basins and Maastrichtian grabens / Mestas are dominated by unconformities & high-stand sequences
- Early Maastrichtian extension reactivated normal faults throughout the region
- Anticlines grow “simultaneously” by inversion of normal faults, rather than propagate toward the foreland on detachment faults

Notes by Presenter (for previous slide):

The Structural elements show:

- Deposition focused in old rift basins and Maastrichtian grabens / Mestas are dominated by unconformities & high-stand sequences
- Early Maastrichtian extension reactivated normal faults throughout the region
- Anticlines grow “simultaneously” by inversion of normal faults, rather than propagate toward the foreland on detachment faults

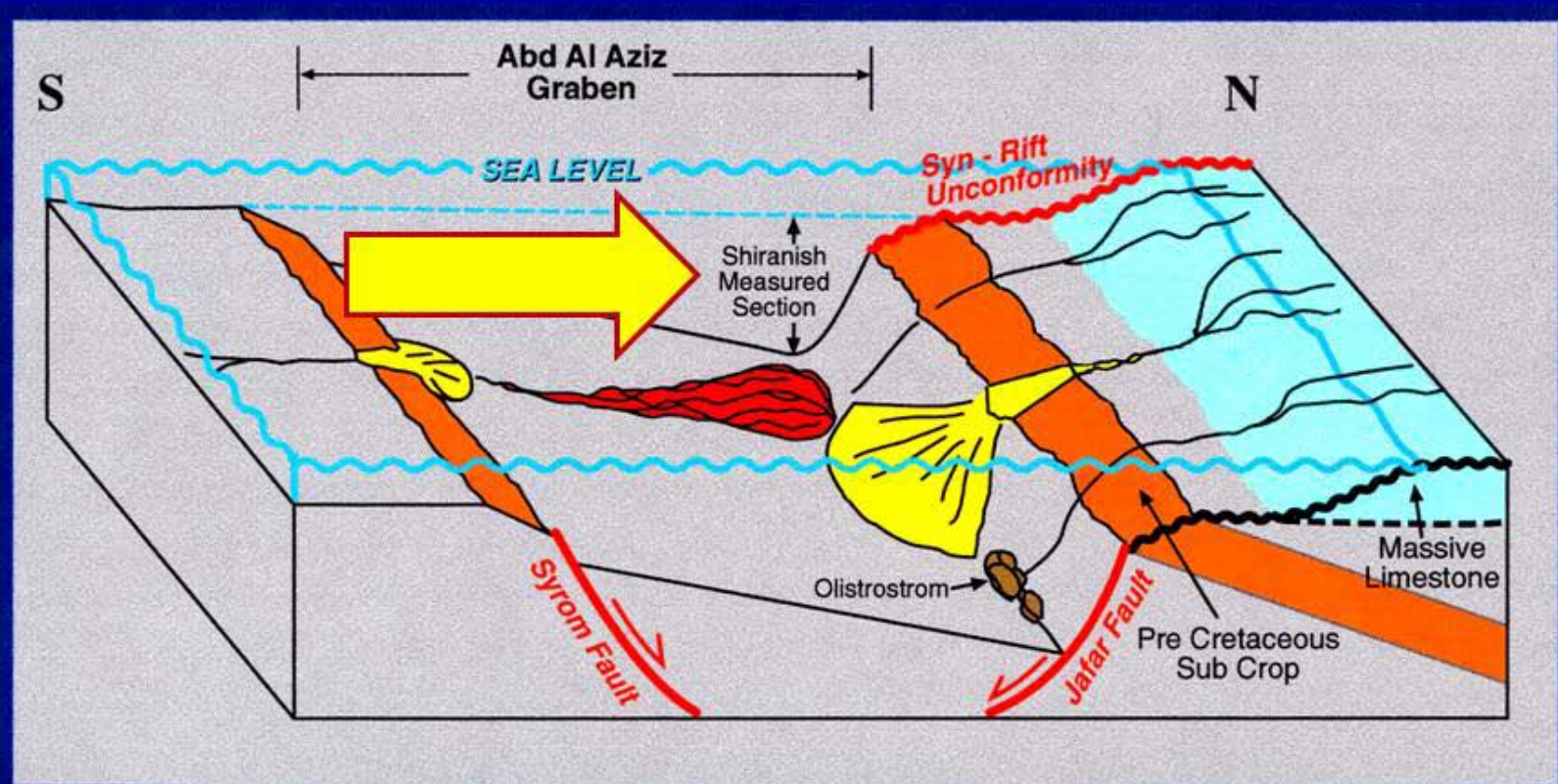
Stratigraphic Example



after Jassim & Goff, 2006

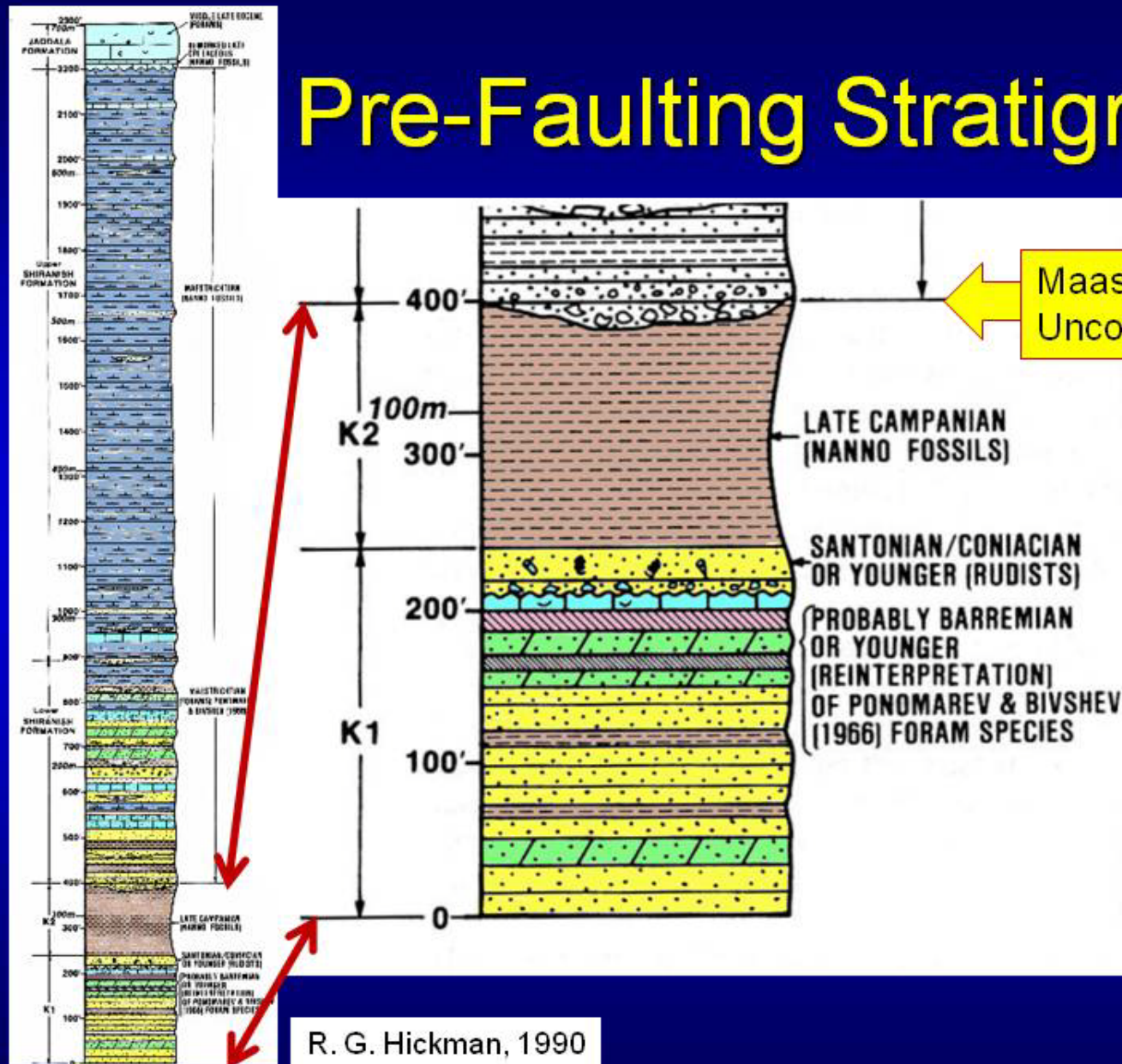
Notes by Presenter: Example of stratigraphic interpretation influenced by structural interpretation using the Maastrichtian graben fill and the highstand Rudist carbonates

Shiranish Formation



Notes by Presenter: Maastrichtian graben fill as illustrated by a measured section from the Aziz Graben

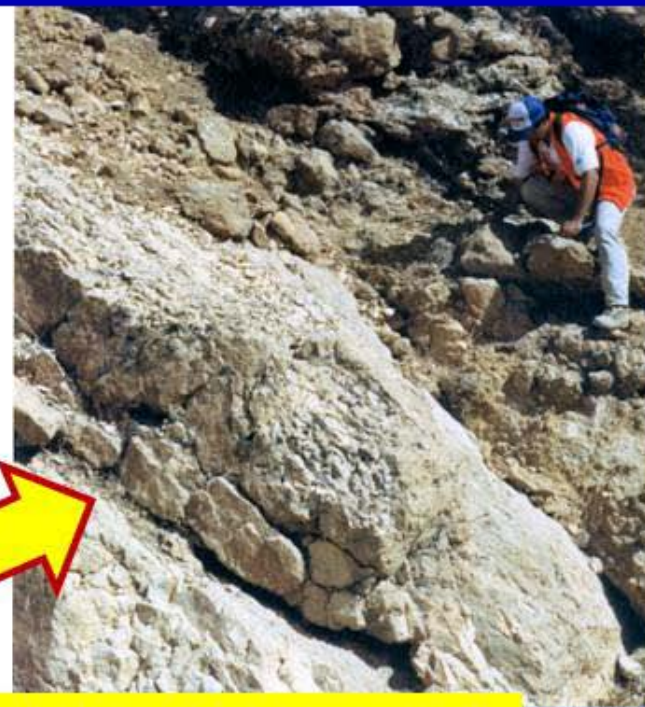
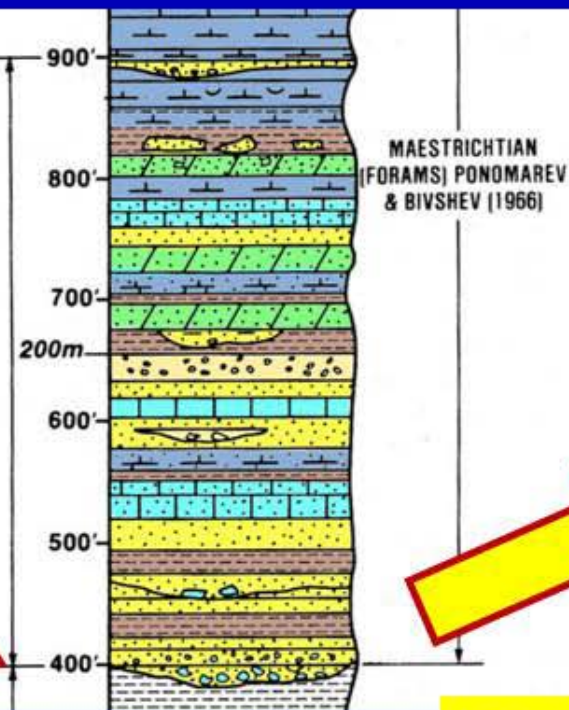
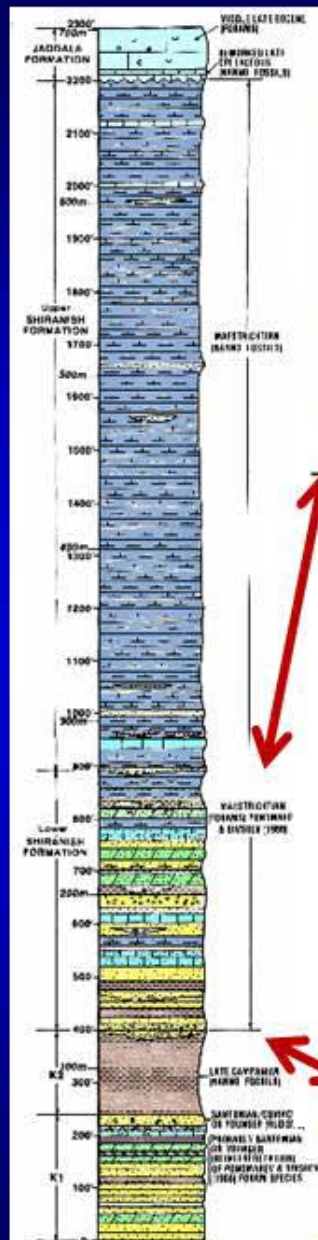
Pre-Faulting Stratigraphy



R. G. Hickman, 1990

Notes by Presenter: At the base is Late Campanian shale overlain unconformably by Maastrichtian syn-tectonic sediments

Syn-Tectonic Graben Fill

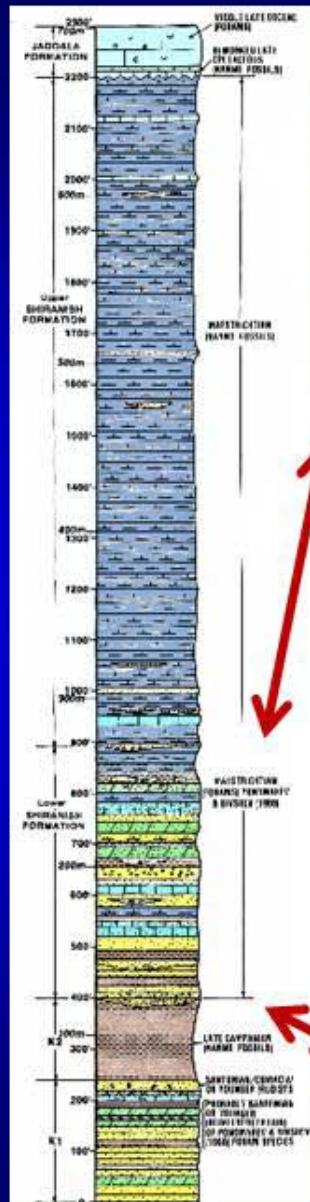


Large blocks of Paleozoic units

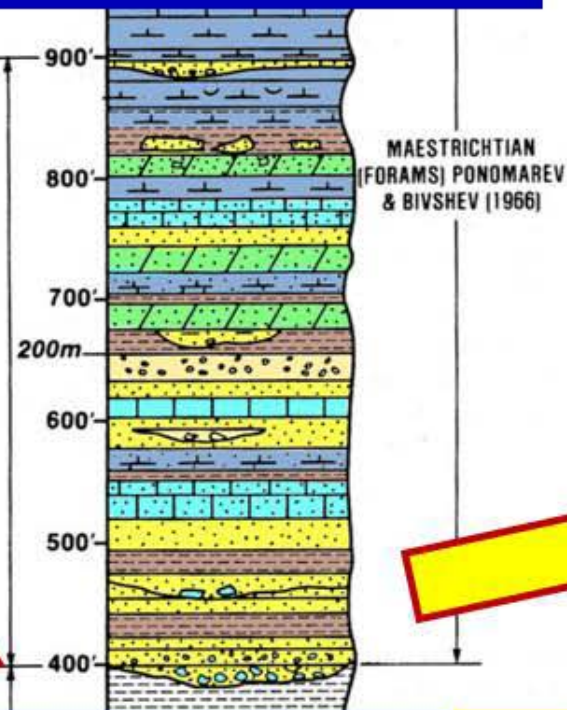
R. G. Hickman, 1990

Notes by Presenter: The syn-tectonic units include massive blocks of Paleozoic units

Syn-Tectonic Graben Fill



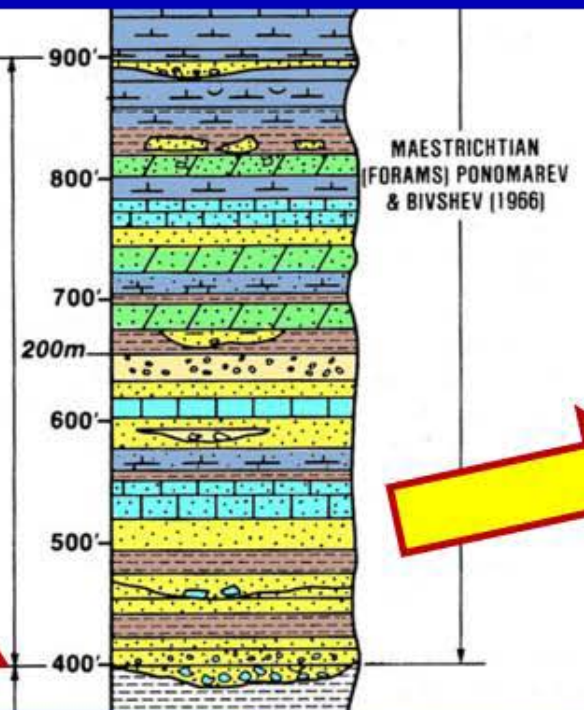
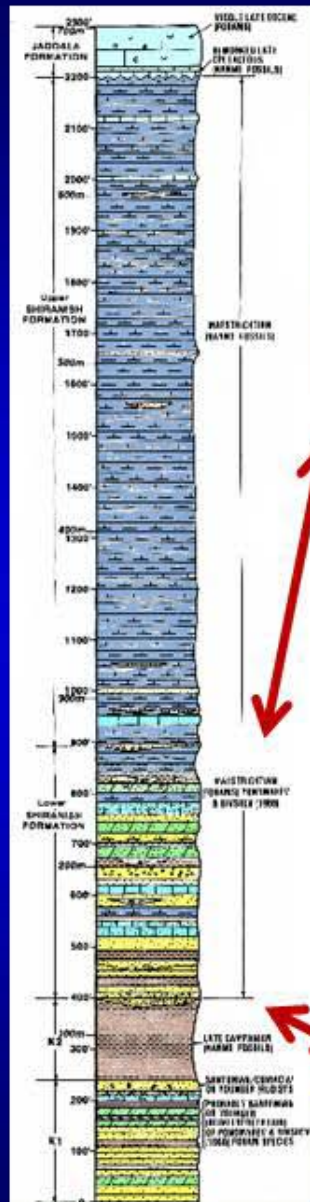
R. G. Hickman, 1990



Transported blocks of Rudist Limestone

Notes by Presenter: Transported blocks of Campanian Rudist Carbonate

Syn-Tectonic Graben Fill



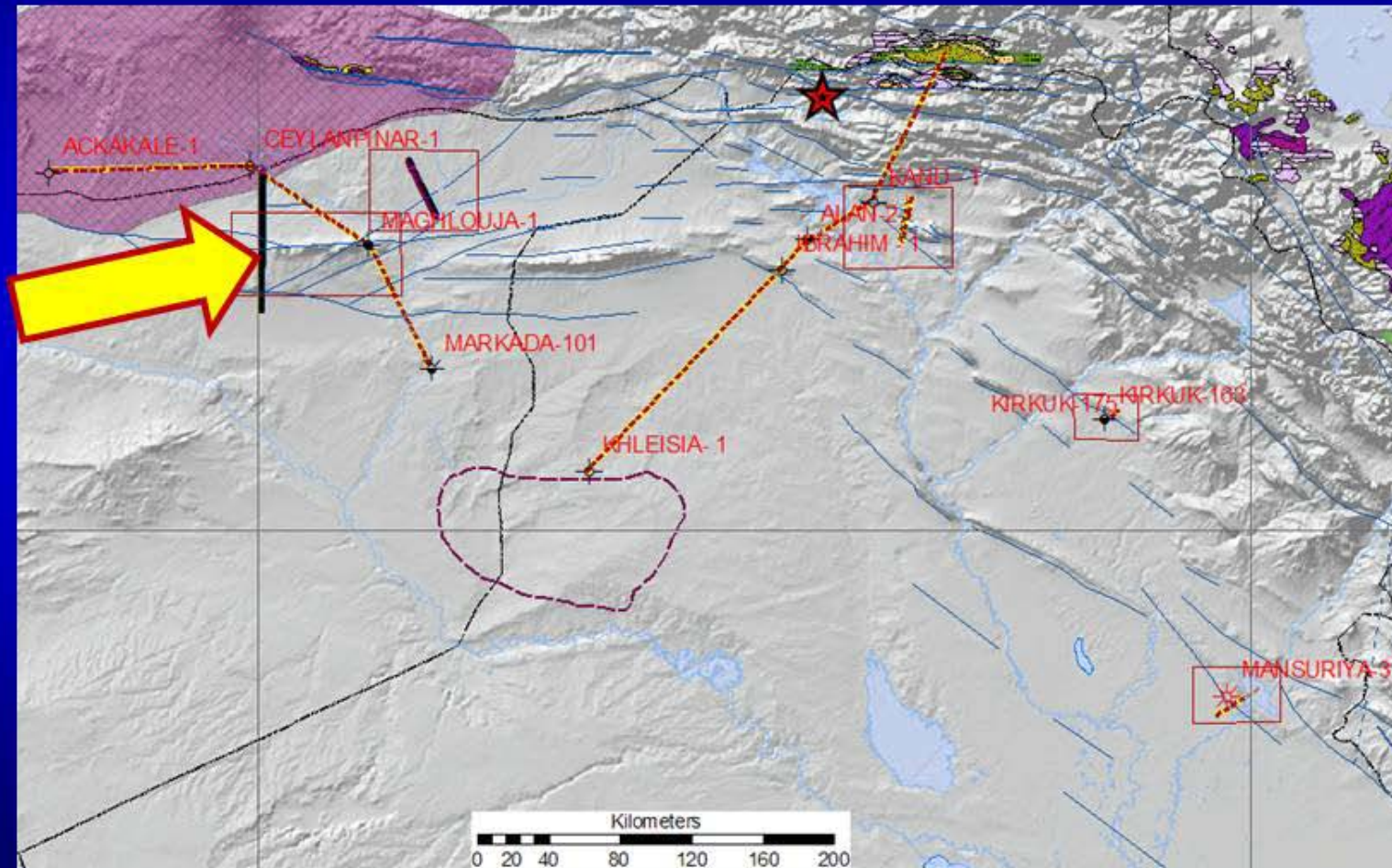
Sandstone filled Channels

R. G. Hickman, 1990

Syn-Tectonic Graben Fill & Hydrocarbon Migration

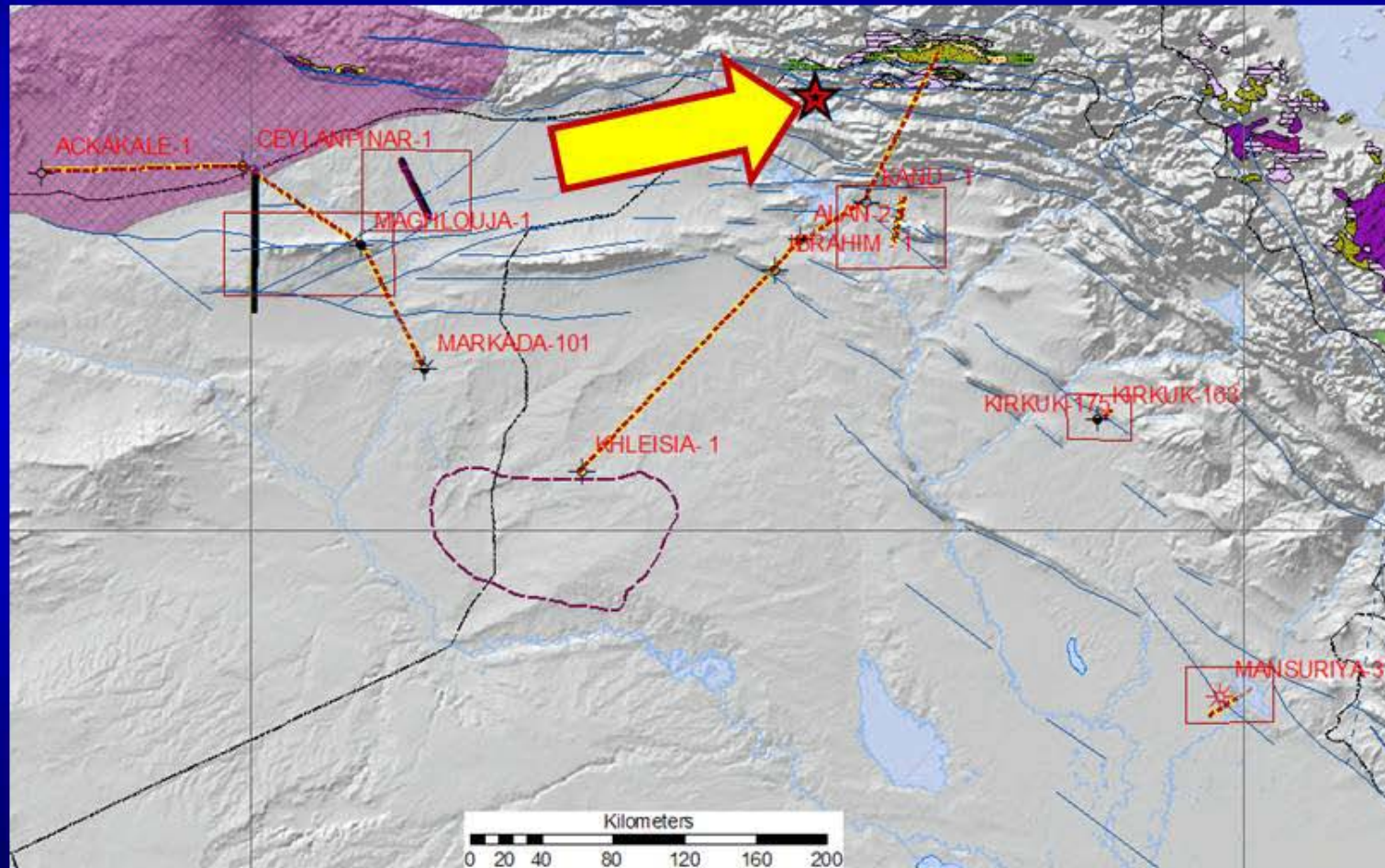
“Bitumen pebbles in Maestrichtian Flysch conglomerates and reef-type limestones suggest escape to surface of large volumes of oil during the Upper Cretaceous” (Dunnington, 1958)

Abd Al Aziz Shiranish Section



Notes by Presenter: Location of the described section for comparison with the Type Section

Shiranish Type Section



Notes by Presenter: Location of the Shiranish Type Section

2300'
1700m
JADDAIA FORMATION
VED. LATE EOCENE
FOSSILS
WORKED LATE
EPOCH FOSILS
MIRMO FOSILS

2200'
2100'
2000'
1900'
1800'
1700'
1600'
1500'
1400'
1300'
1200'
1100'
1000'
900'

Upper SHIRANSH FORMATION

Maastrichtian

1,300' (396.2m)

607' (185m)

AGE
FOLIO
FOLIO
FOLIO
LITHOLOGY

MAASTRICHTIAN
A
B
C

From Al-Qayim, et al., 1986

E. Maastrichtian
Campanian

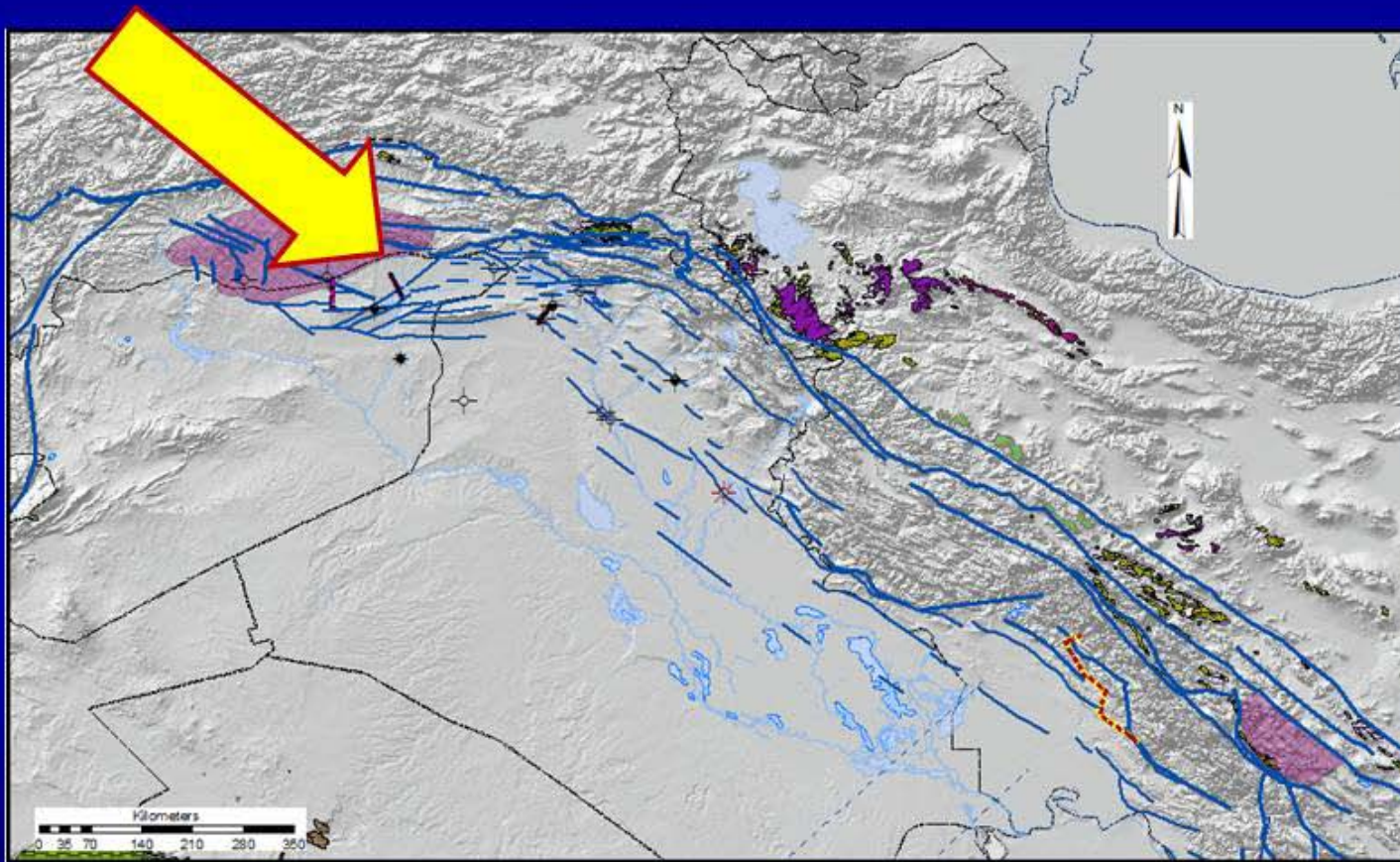
1,800' (548.6m) Hickman, 1990

Notes by Presenter: The upper part of the Shiranish that is lithologically similar to the type section is twice as thick. The type section as described by Al-Qayim shows Early Maastrichtian overlying Campanian carbonates.

Highstand Rudist Carbonates

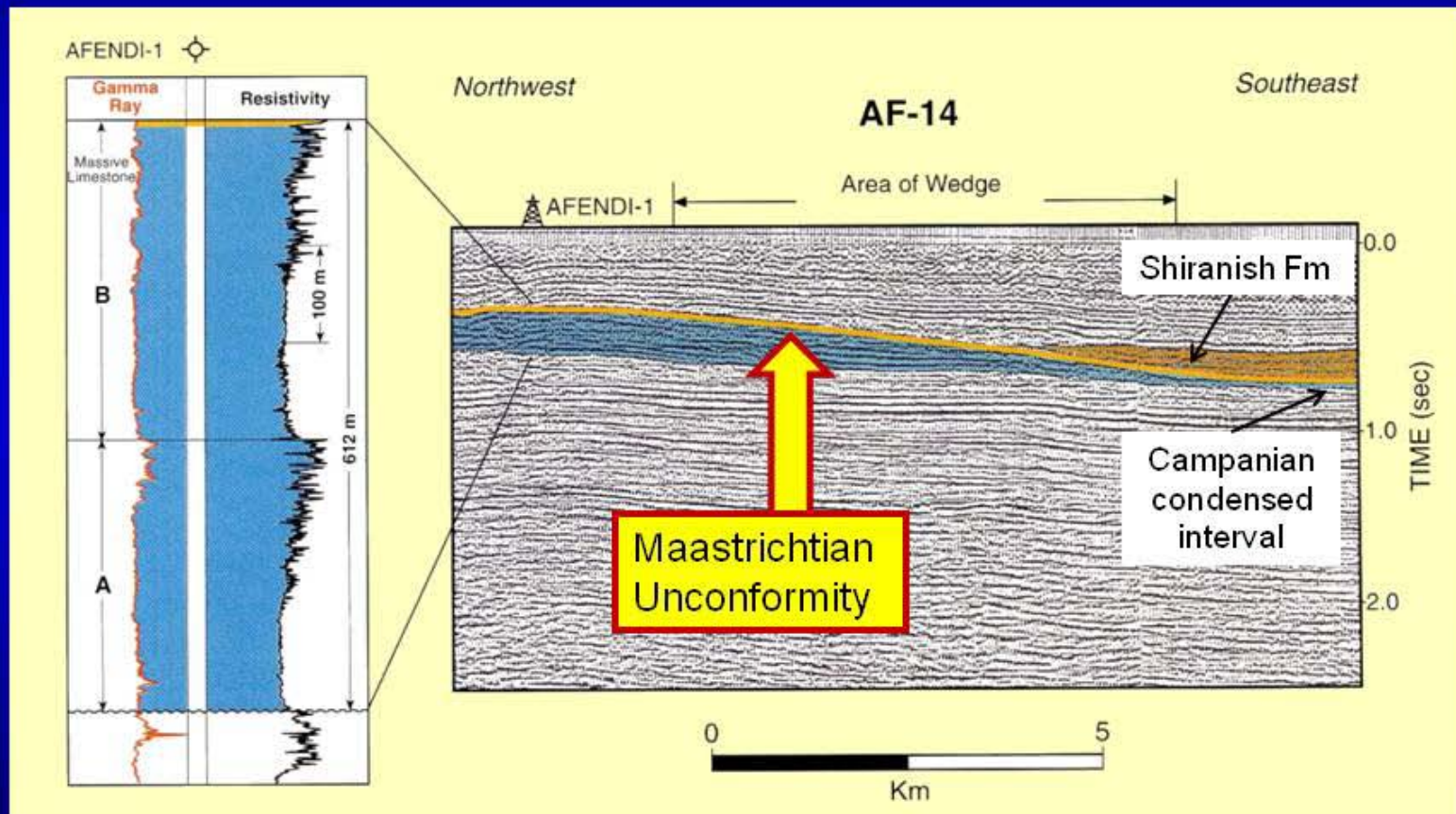
Notes by Presenter: Next we look at the highstand Rudist carbonates

Seismic Line AF-14



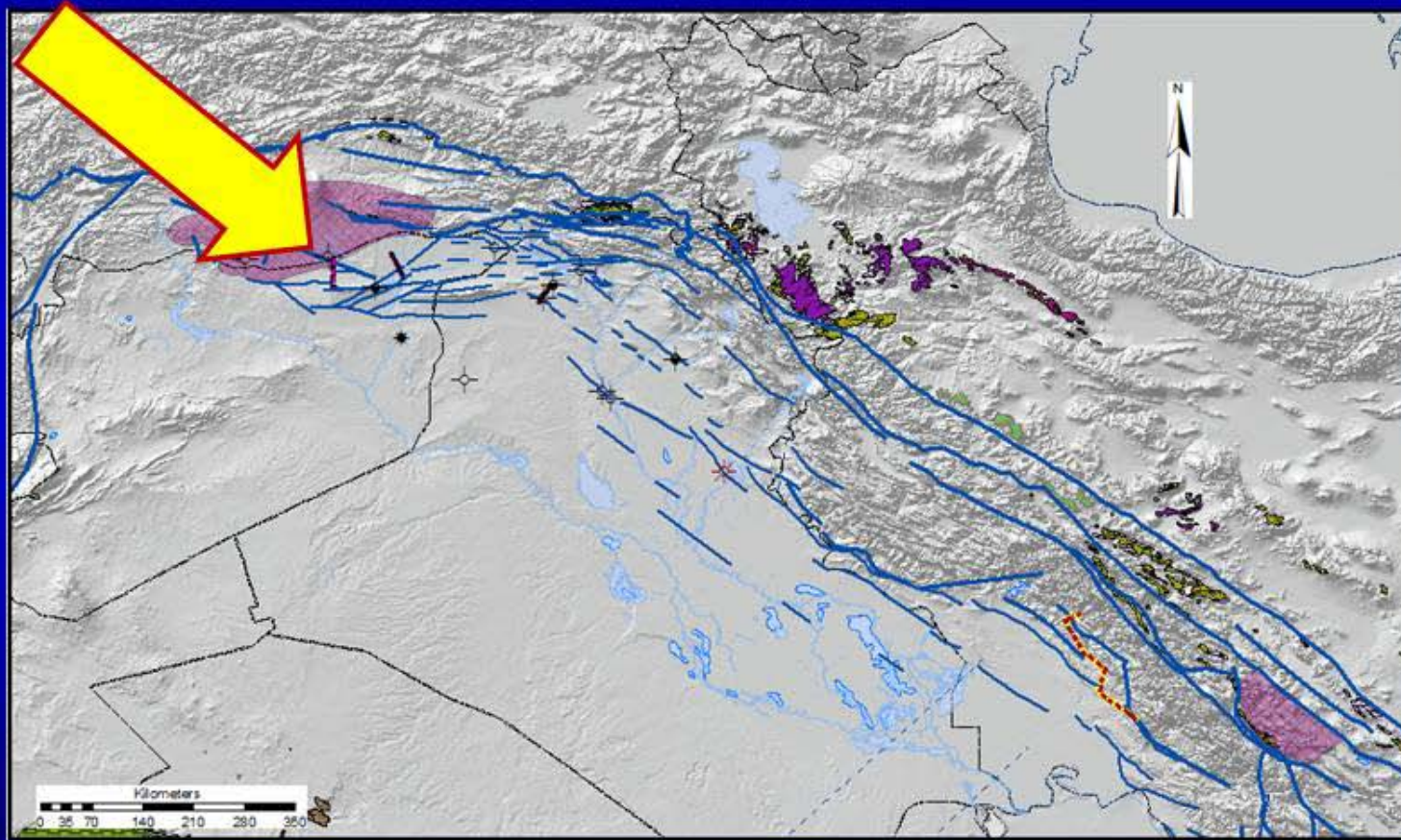
Notes by Presenter: Seismic line AF-14 and correlation with the Afendi well provide evidence for the relationship between the Mardin Group and the Shiranish.

Mardin Group Down-lap



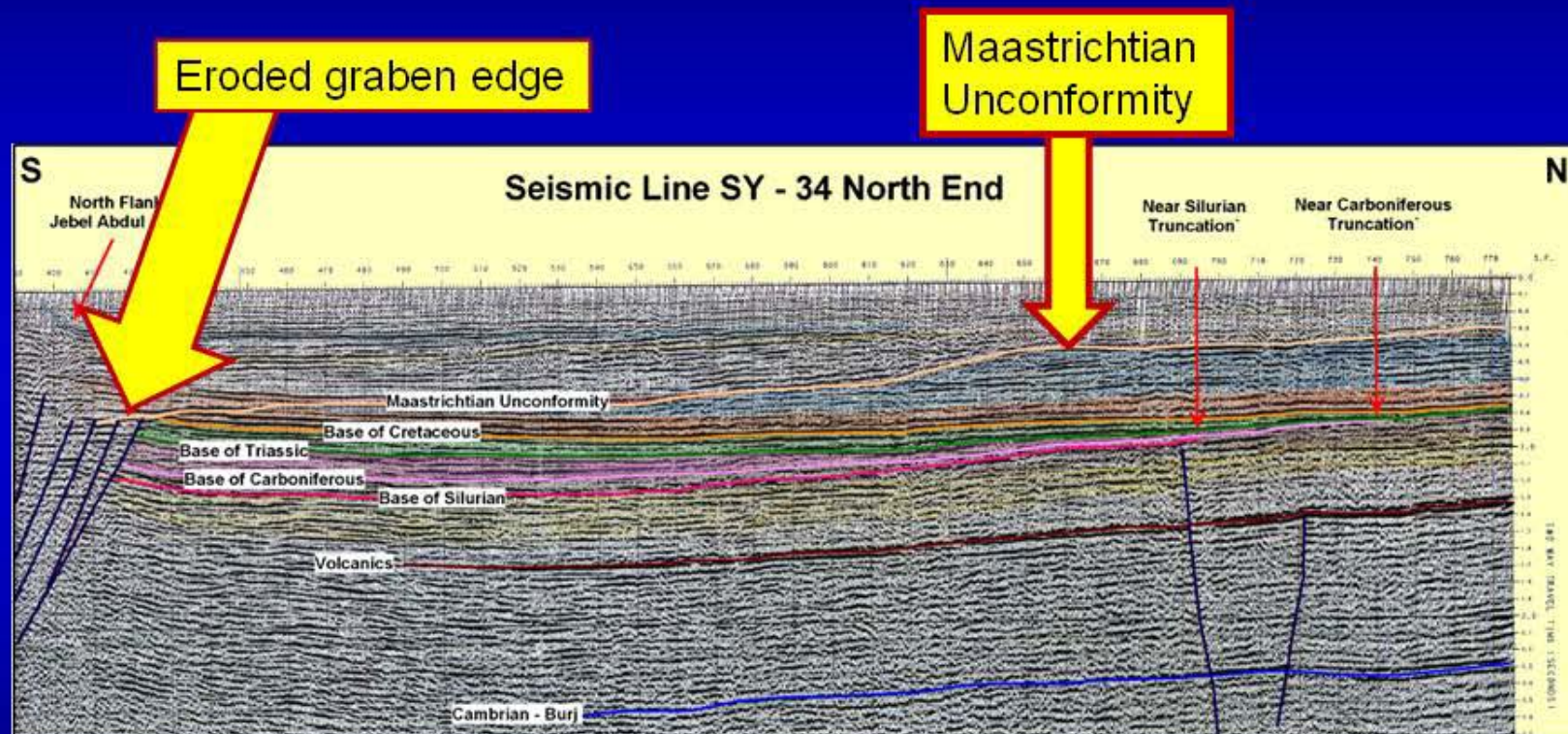
Notes by Presenter: The seismic line shows down lap of the Rudist ramp to a condensed interval overlain by on lapping Shiranish above the Maastrichtian unconformity

Seismic Line SY-34 North End



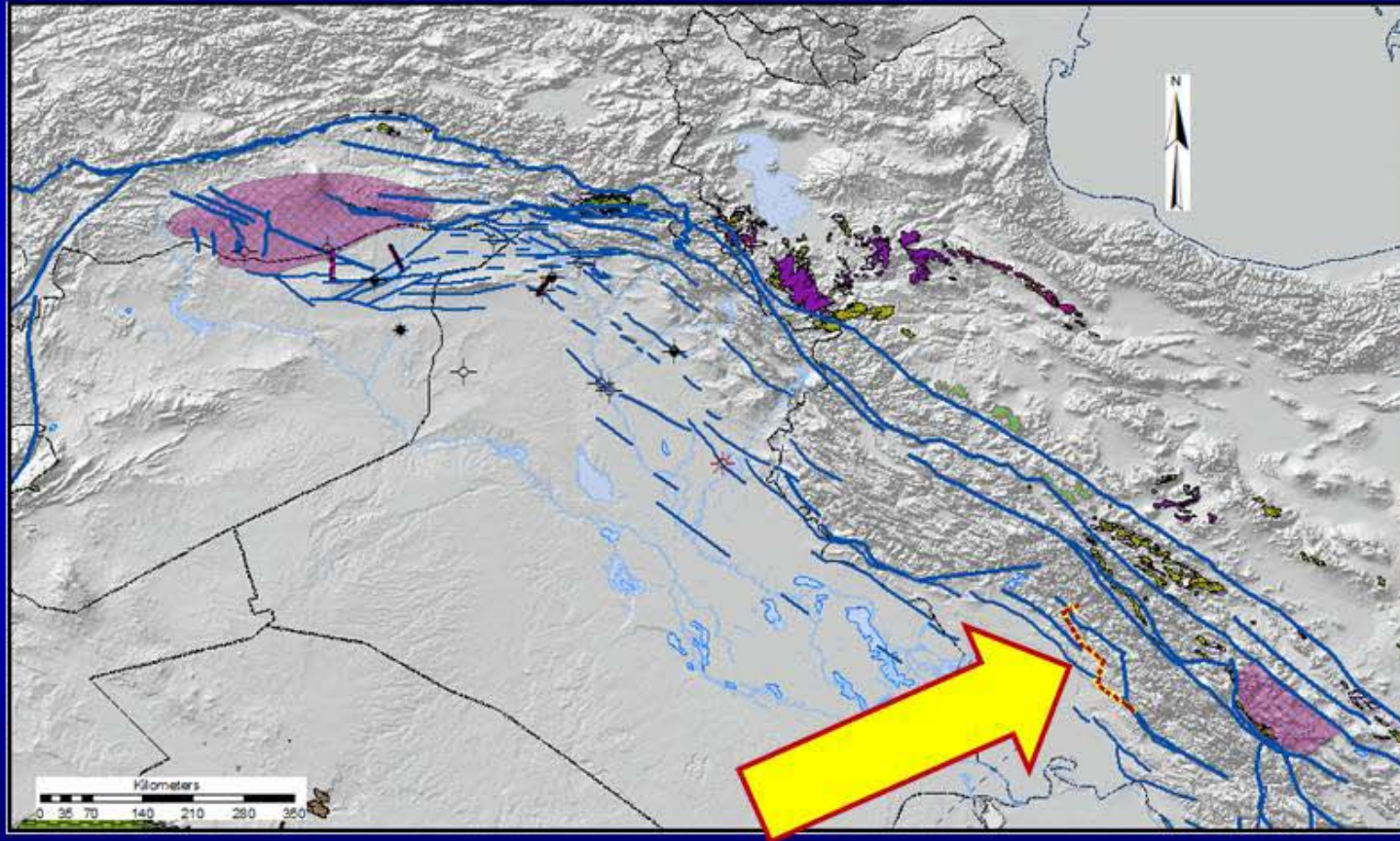
Notes by Presenter: Following the Carbonate Ramp along strike to Seismic line Sy-34

Mardin Group Down-lap



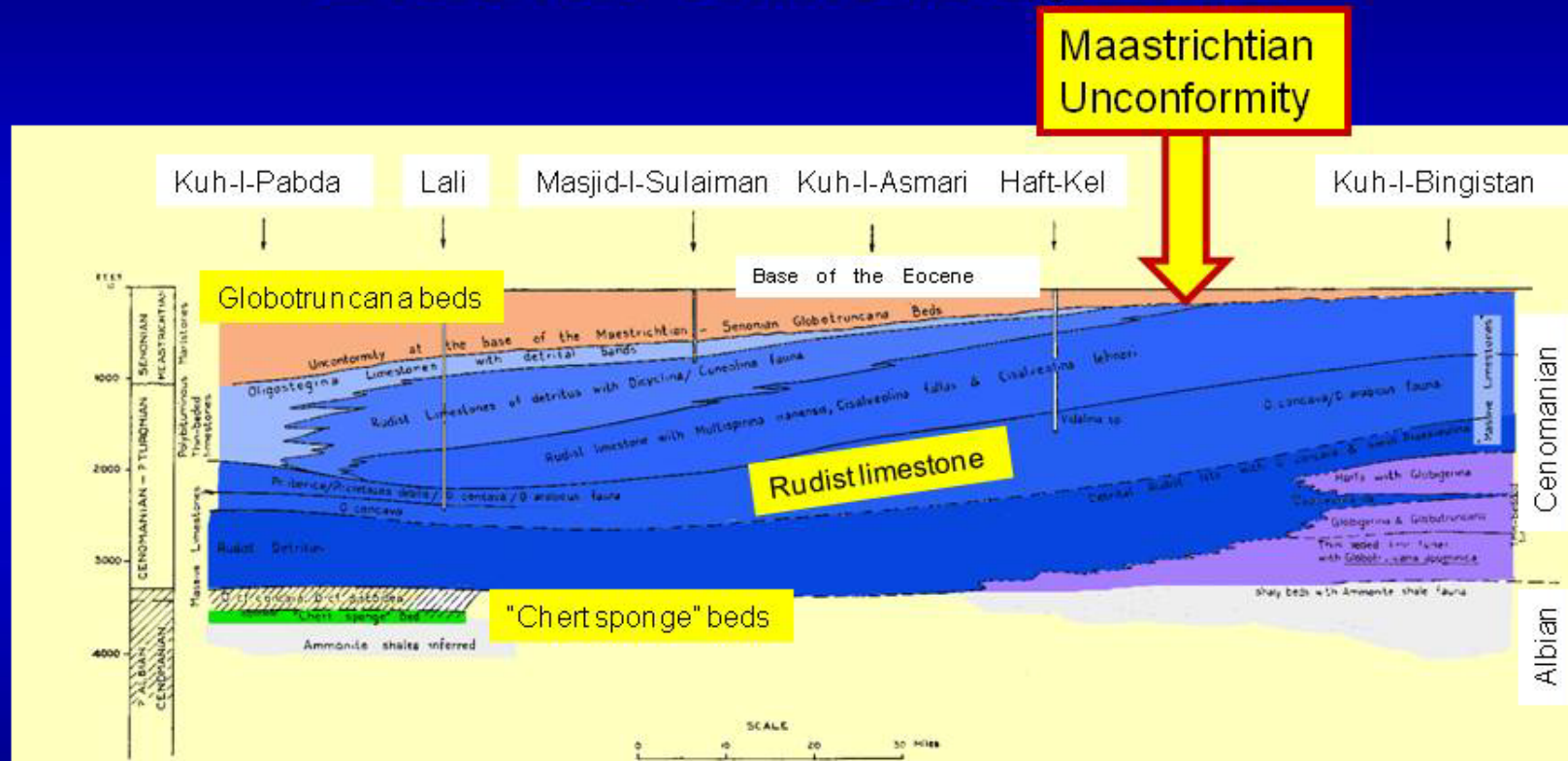
Notes by Presenter: We see erosion of the Aziz Graben edge by the Maastrichtian Unconformity

Middle Cretaceous, Central District Oilfields, Iran



Notes by Presenter: Now we will jump to the other side of Iraq to look at a cross section by P. E. Kent in the Central oil district of Iran

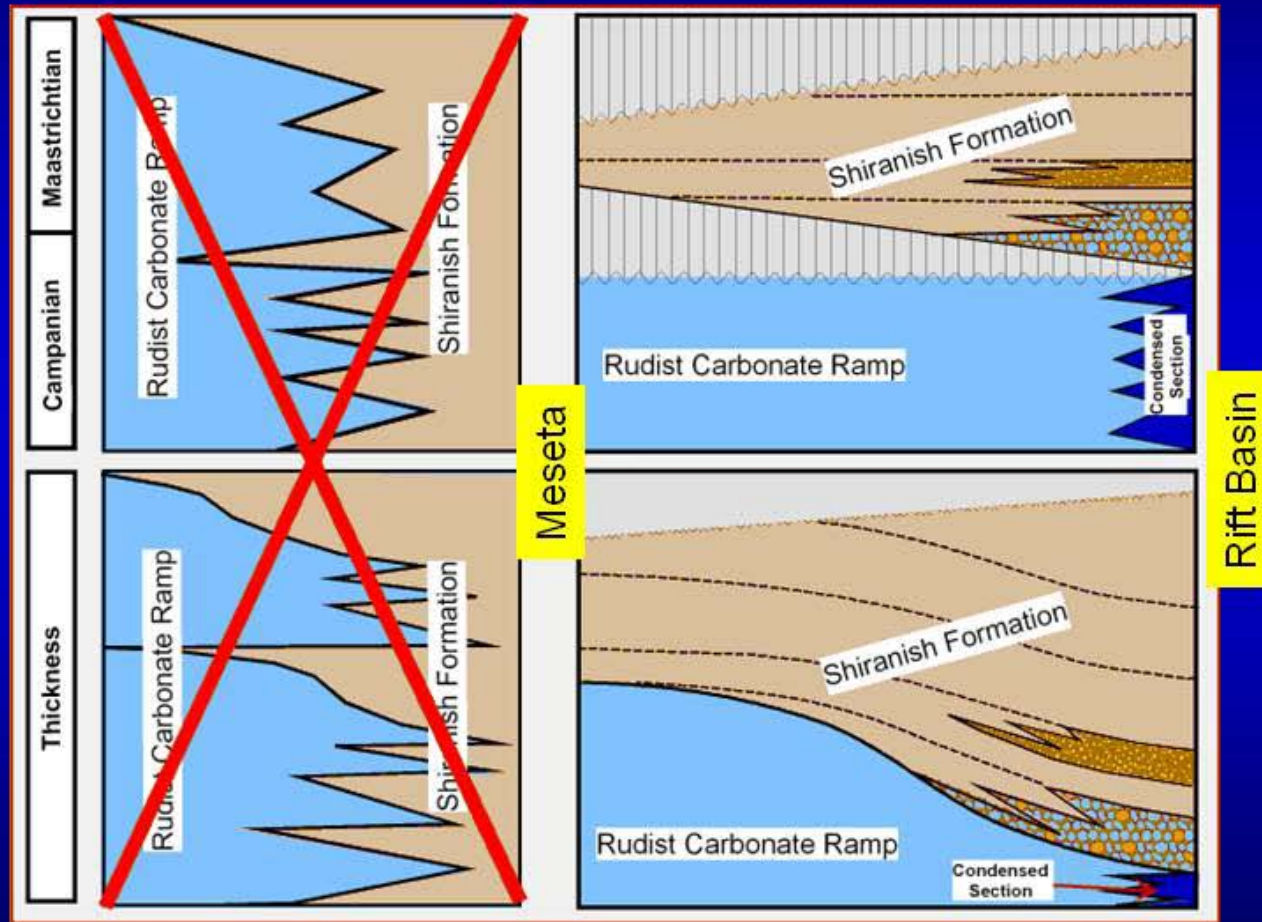
Middle Cretaceous, Central District Oilfields, Iran



From P.E Kent, 1951

Notes by Presenter: Here we also see the Campanian Rudist ramp overlain by an unconformity at the base of the Maastrichtian.

Time & Stratigraphy

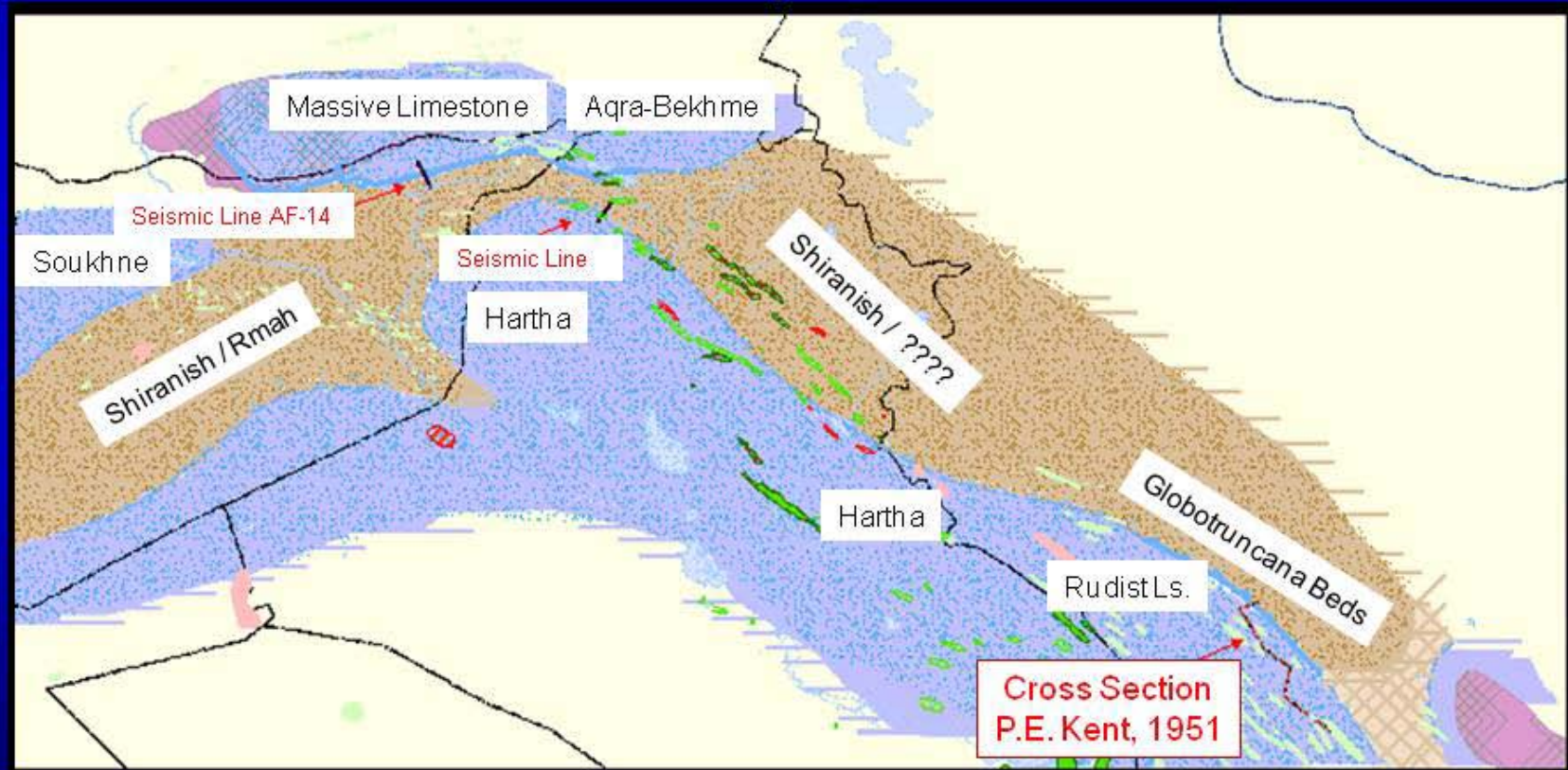


Notes by Presenter: The stratigraphic example suggests that the Rudist Ramp carbonates of the Mardin Group, Hartha formation, etc are not lateral equivalents of the Shiranish, but that the Shiranish overlays them unconformably and that their true lateral equivalent are condensed units like the Rmah Formation in Syria. And that the Mesetas and Grabens have different stratigraphy

Facies Map

Mesetas = Highstand Sequences & Unconformities

Rift Grabens = Lowstand Sequences & Condensed Sections



Notes by Presenter: This map suggests the distribution of facies in the Campanian & Maastrichtian

Conclusions

- Northeast Africa (Arabian Plate) is tectonically similar to Northwest Africa
- Pre-existing structural highs and rift-grabens dictate sedimentation
- Tectonism during deposition is not the exception