

Where to Find the Reservoir? Late Valanginian Unconformity Associated Play in Kuwait*

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Search and Discovery Article #40683 (2011)

Posted January 18, 2011

*Adapted from oral presentation at AAPG International Conference and Exhibition, Calgary, Alberta, Canada, September 12-15, 2010

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Abstract

The Late Valanginian unconformity, with a hiatus of about four million years in southern Kuwait, separates the Zubair Formation from the underlying Ratawi Shale Formation. Both of these formations are dominantly siliciclastic and overlie a thick (1975-2300 feet in thickness) Early Cretaceous carbonate succession. This shift in sedimentation is attributed to the uplift and erosion in the hinterland westward in the Arabian Shield. The Zubair Formation consists of 1150-1450 feet thick sequence of interbedded sandstone, siltstone, and mudstone. A sandbody of variable thickness (0-60 feet), which is locally hydrocarbon bearing, is encountered at its base in a few geographically scattered wells. Log signatures, by comparing to the cores over similar zones, indicate them as channelized bodies which are associated with the Late Valanginian sequence boundary. Regional analyses suggest the development of northeasterly drainage during this time which eroded and incised into the exposed surface developing into incised valleys. Reservoir sandstone facies were deposited during the early phases of the channel development. These sandstone facies are overlain variably by the fine grained facies made up of interbedded sandstone, siltstone and mudstone which could act as vertical seal for fluid migration. These fine grained facies either relate to channel abandonment and/or were deposited in estuarine and marginal marine environments as a result of the following transgression. No entrapment is expected where (1) this upper seal is not an effective barrier to fluid flow and (2) where there is no trap development. In addition to the presence of four way closure and sealing faults, one of the effective trapping mechanisms is where sealing facies impinge against a paleohigh to provide lateral as well as top seal.

With this understanding, the play is based on finding the (1) possible paleoflow pathways and once found (2) mapping of the channels by using seismic inversion and attribute analysis. By assuming the flow to follow paleolow areas, the paleodrainage pathways could be figured out from the paleotopography which existed at the time of the earliest Zubair deposition. Consequently, potentially prospective exploration areas can be determined by using these along with other favorable play elements.

References

Sharland, P.R., R. Archer, D.M. Casey, R.B. Davies, S.H. Hall, A.P. Heward, A.D. Horbury, and M.D. Simmons, 2001, Arabian Plate Sequence Stratigraphy: GeoArabia, Special Publication, v. 2, 371 p.

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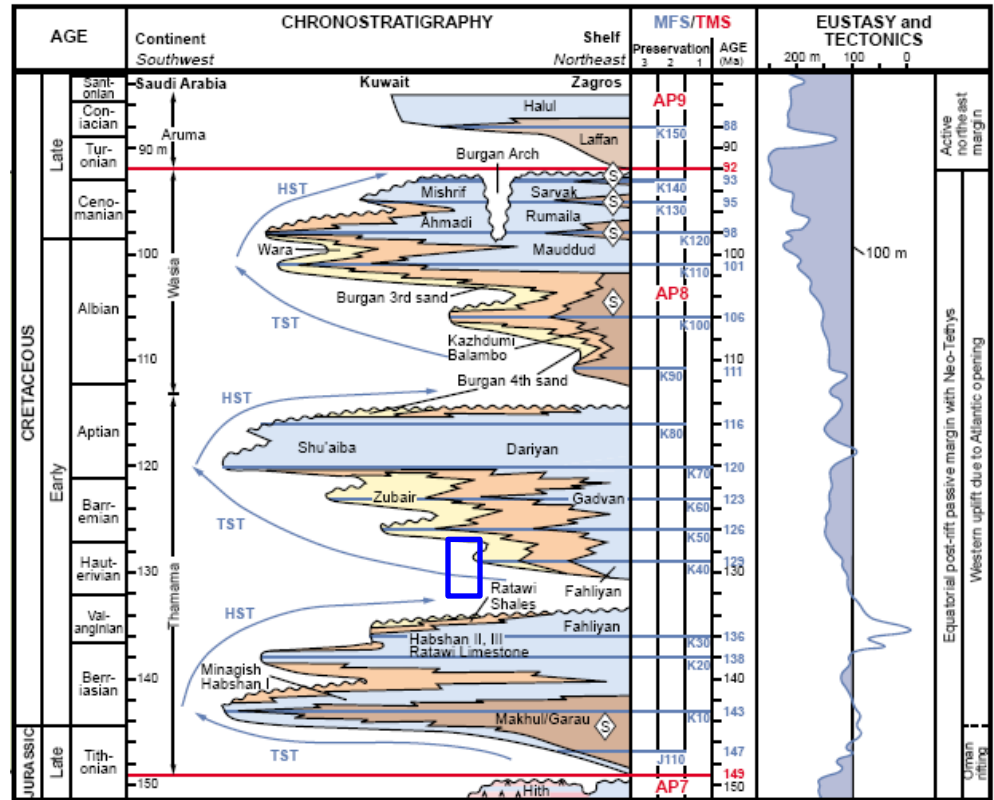
Outline

- **Stratigraphy**
- **The Play and the concept**
- **Case Studies**
- **Conclusions**

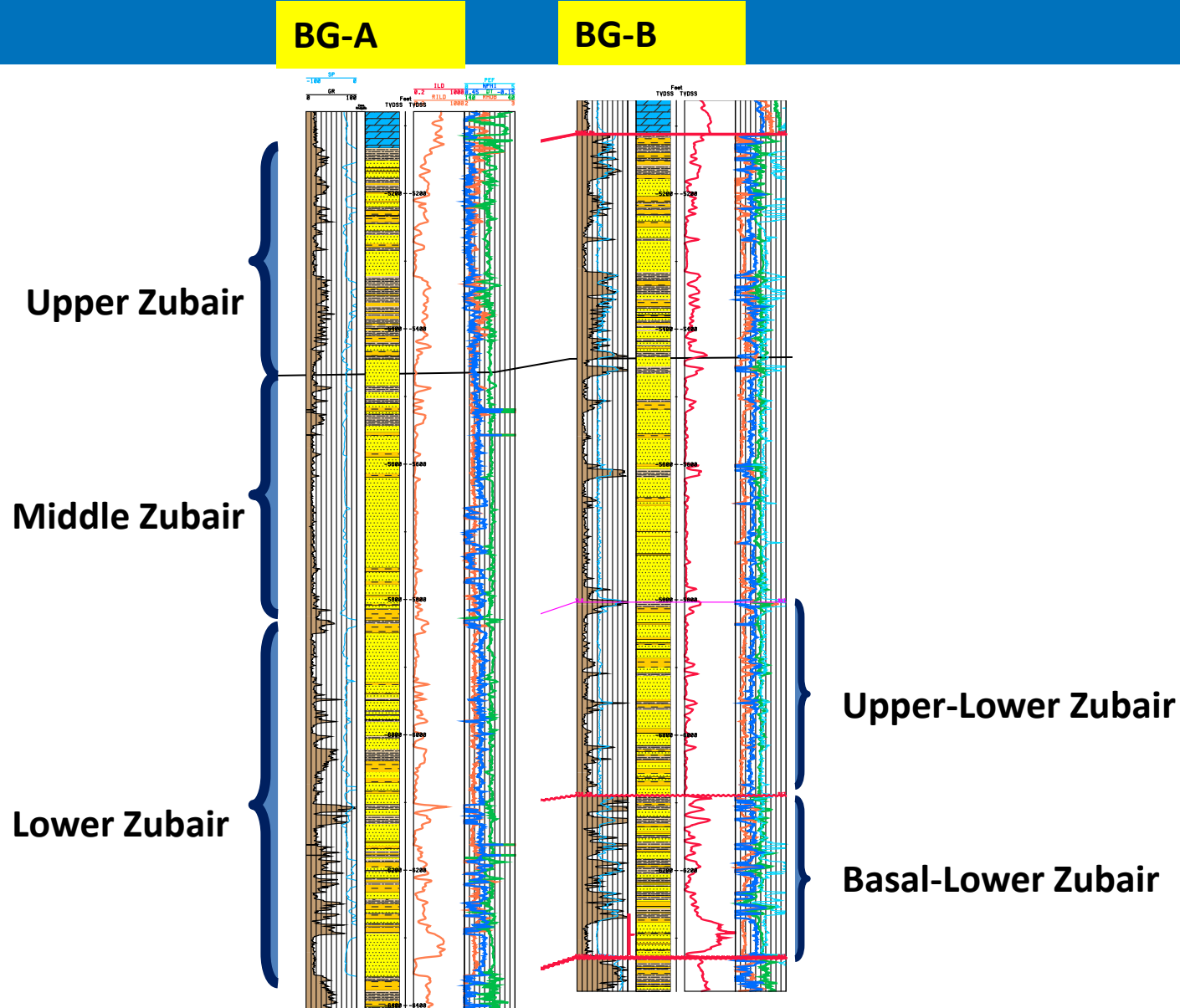
Stratigraphic section of the part Early Cretaceous in Kuwait.

Age	STAGE	GROUP	FORMATION
Early Cretaceous	ALBIAN	WASIA	Burgan
	APTIAN	THAMAMA	Shuaiba
	BARREMIAN		Zubair
	HAUTERIVIAN		
	VALANGINIAN		Ratawi Shale
	BERRIASIAN		Ratawi Limestone

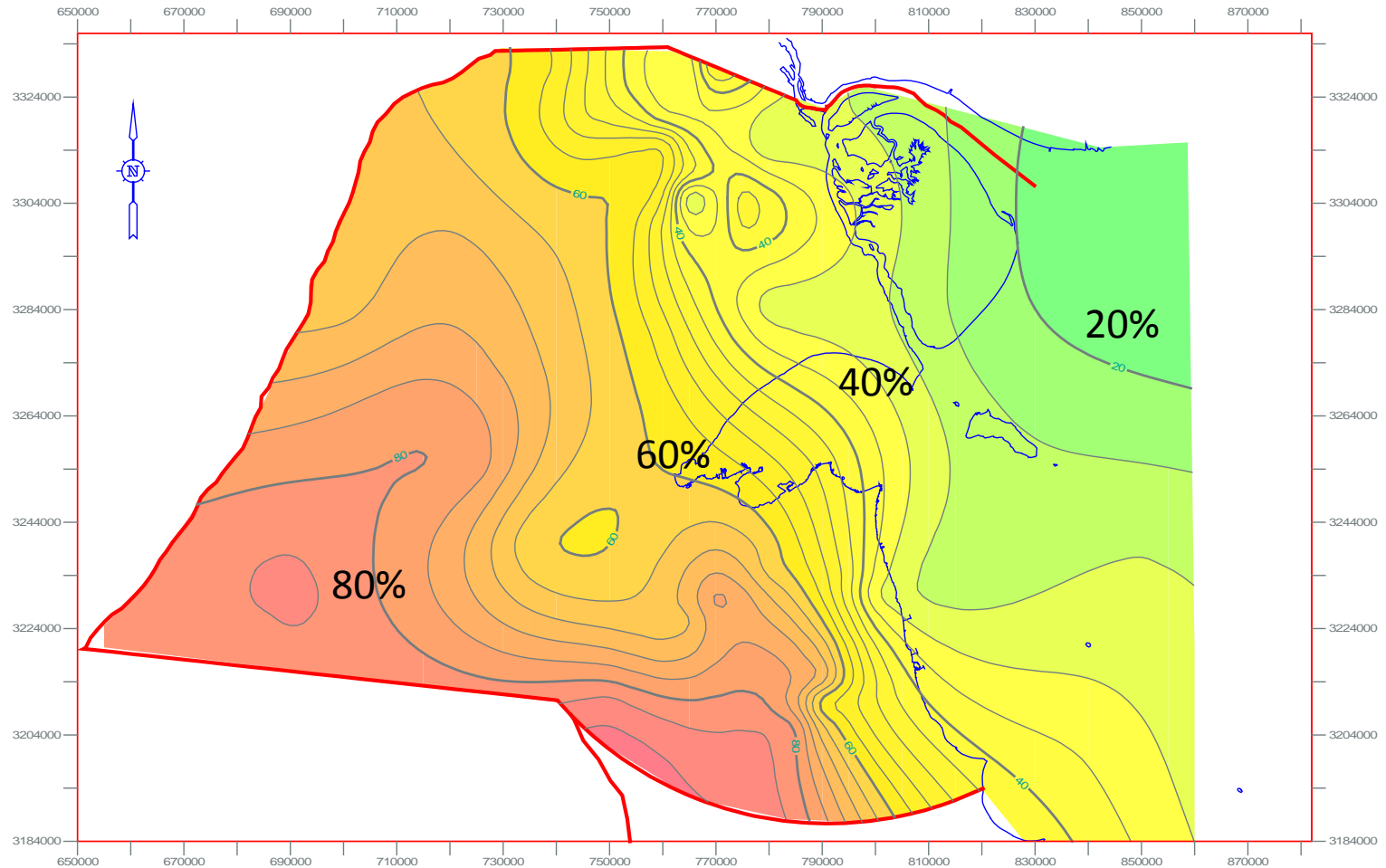
Chronostratigraphic section of the early to mid-Cretaceous across the Arabian Gulf Area (from Sharland et al., 2001) showing three 2nd order transgressive-regressive cycles within megasequence AP8. The Valanginian Ratawi Shale Formation is part of the basal 2nd order cycle and is highlighted by the blue box.



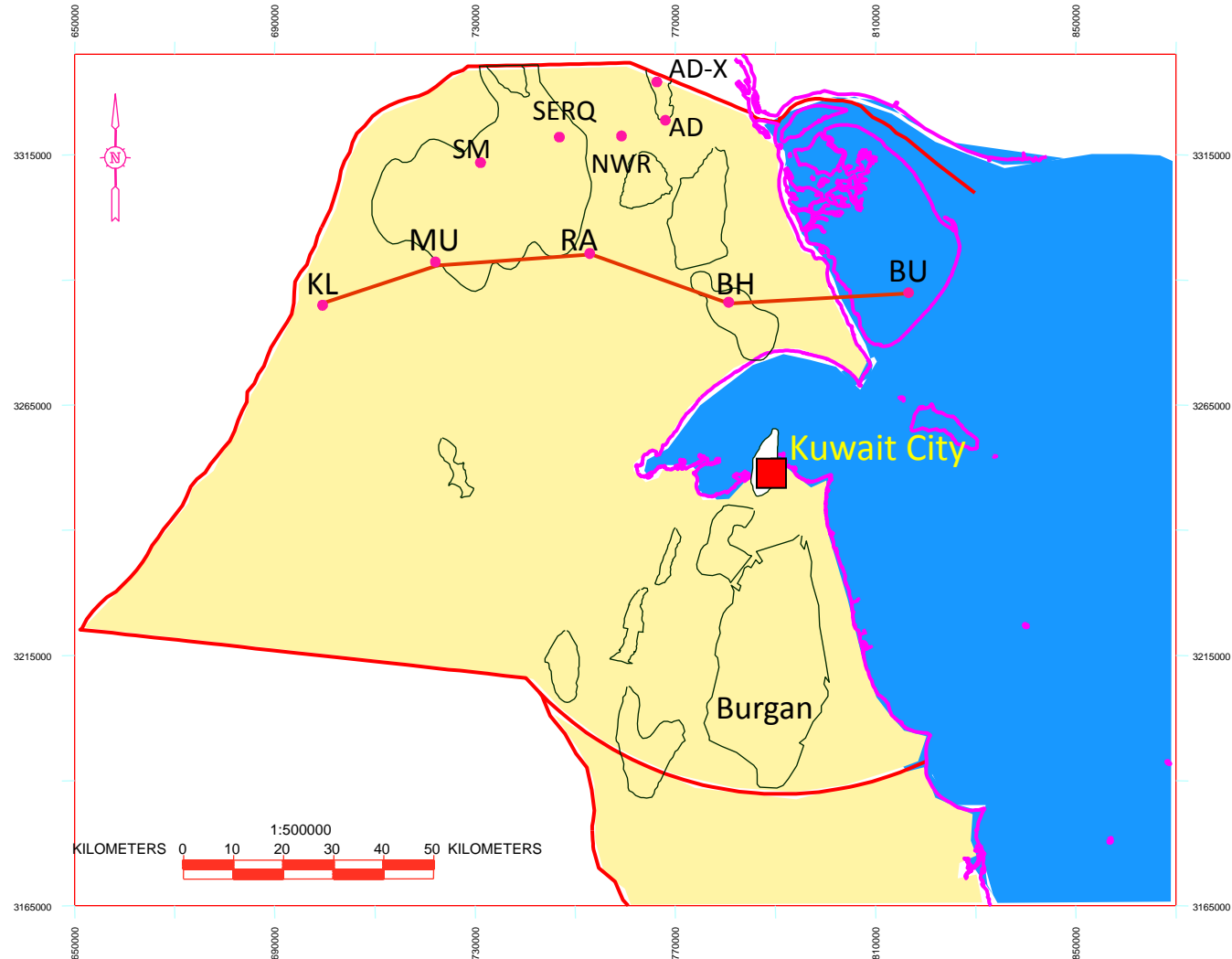
Zubair Formation



Zubair Sand Percent Map



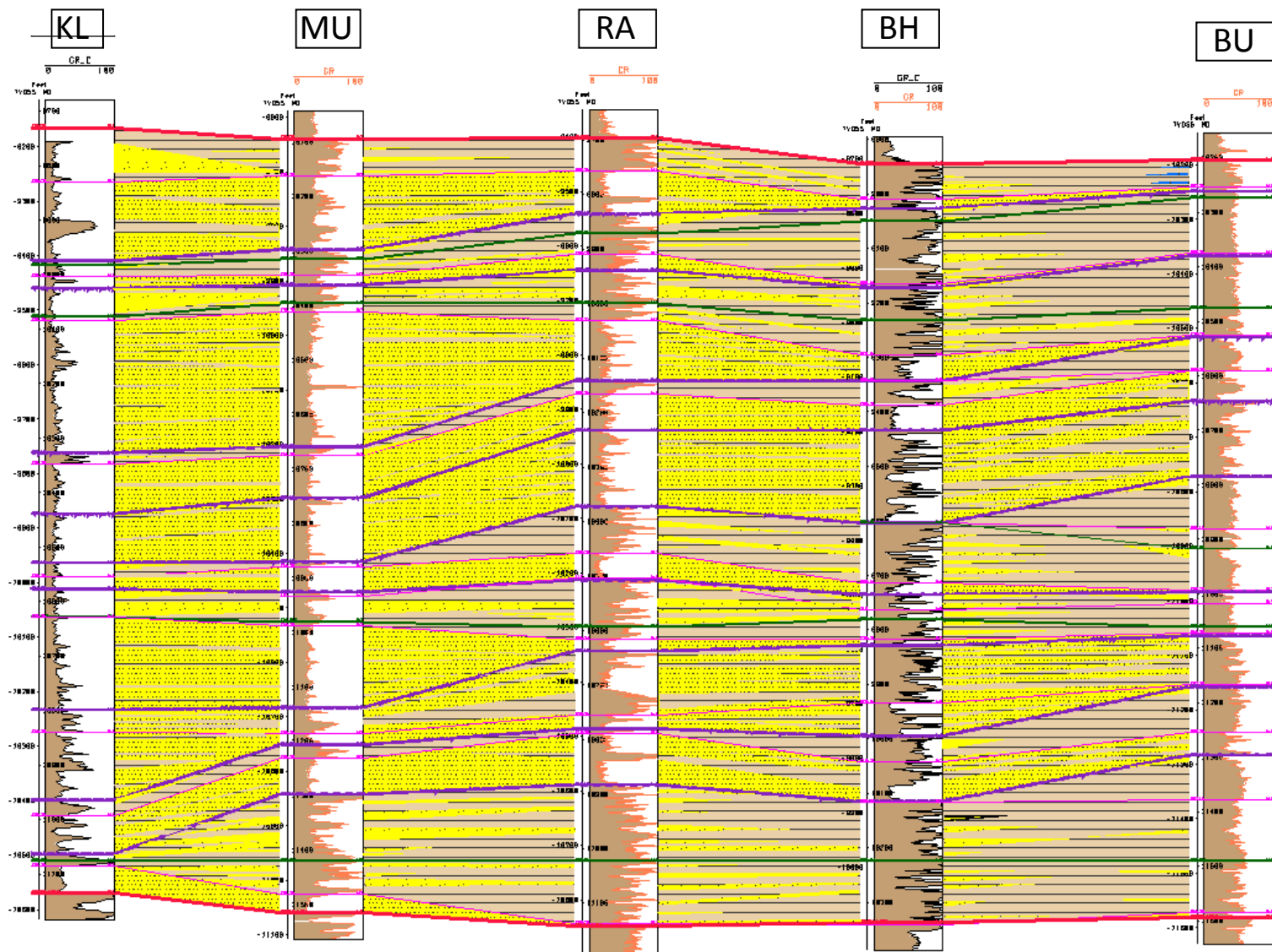
Kuwait Map showing location of Cross Line.



Regional correlation within the Zubair Formation along depositional dip.

W

E



Concept

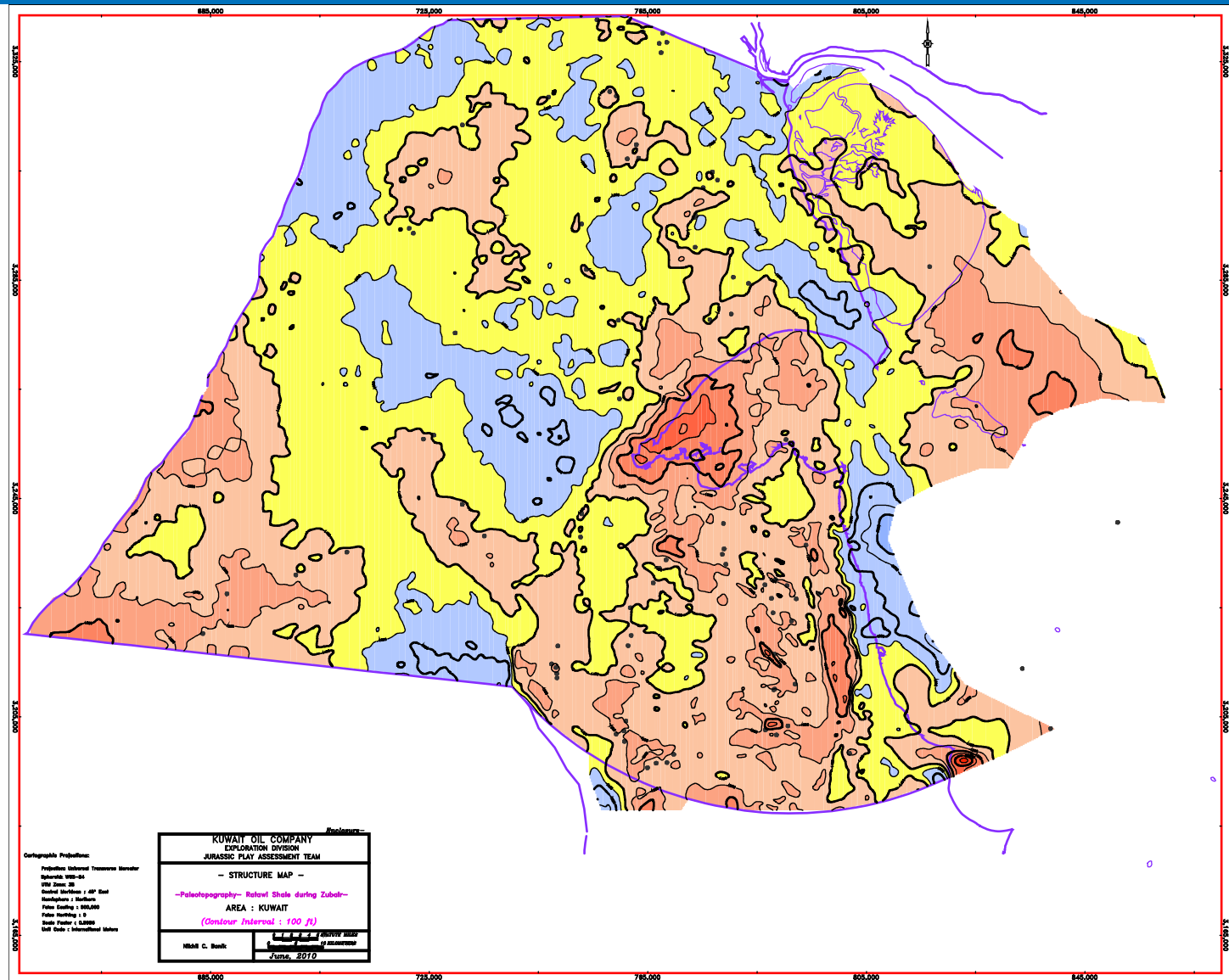
- Northeastward drainage development during Valanginian unconformity time.
- Trace the paleoflow pathways to find reservoir sandbodies.
- Locally imply other geological and geophysical understanding.

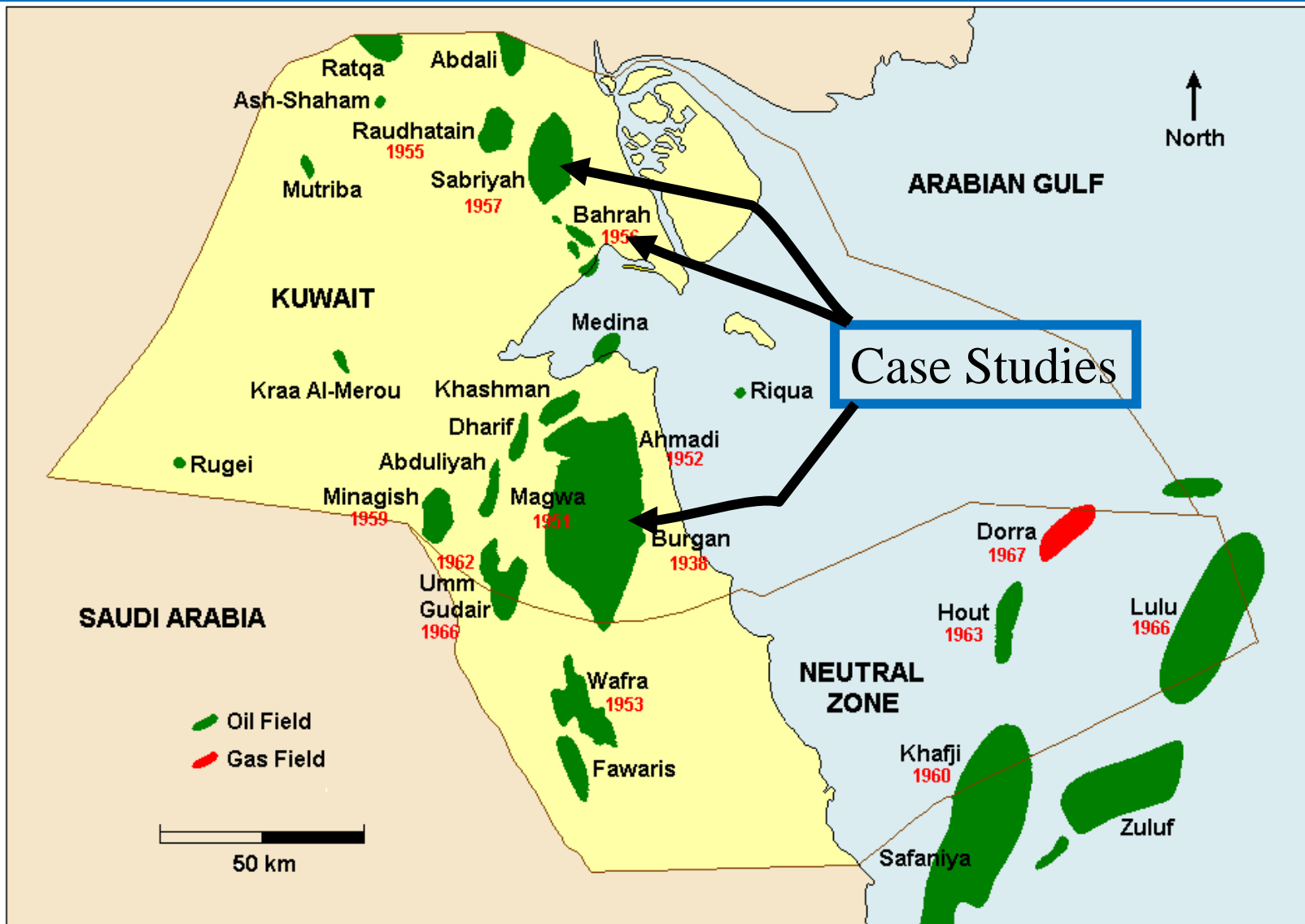
Ratawi Shale paleotopography during Zubair Deposition

Warm color-
High Area

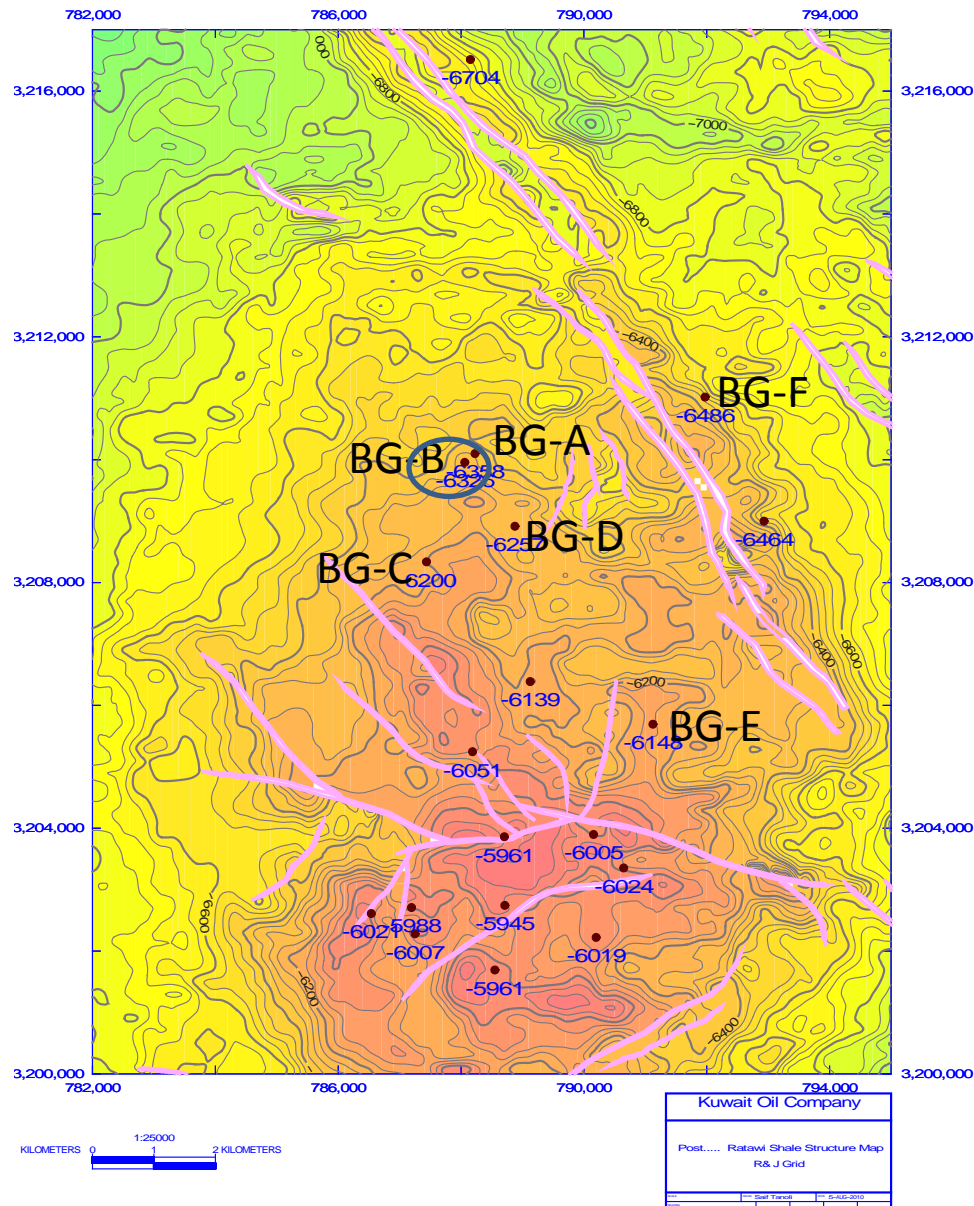
Yellow-
Medium

Blue: Low
area



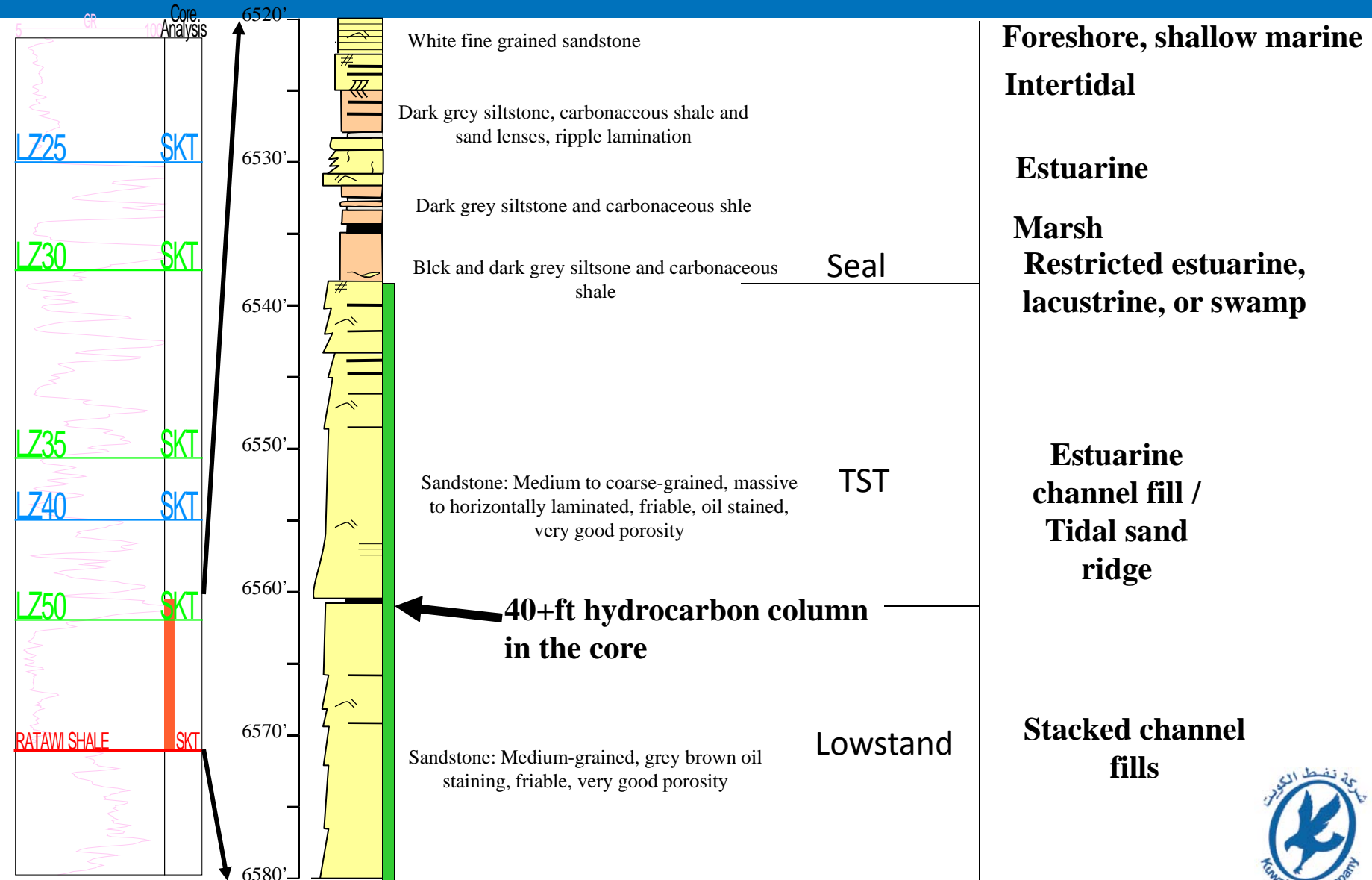


Burgan Dome



Basal Zubair Core in BG-B

Environments



Burrowed muddy
carbonaceous sandstone.

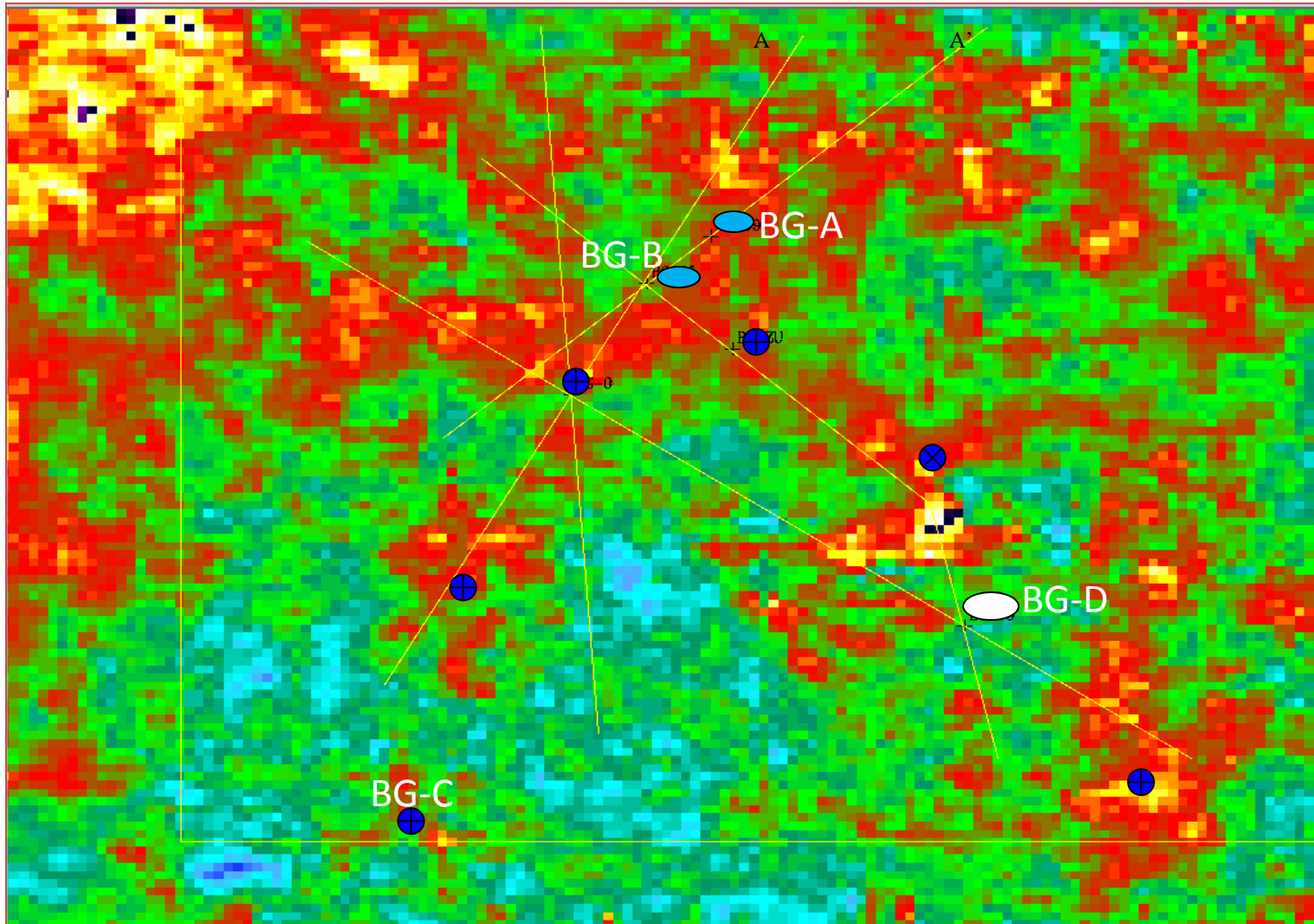
Fining Upward sequence

Sandstone.

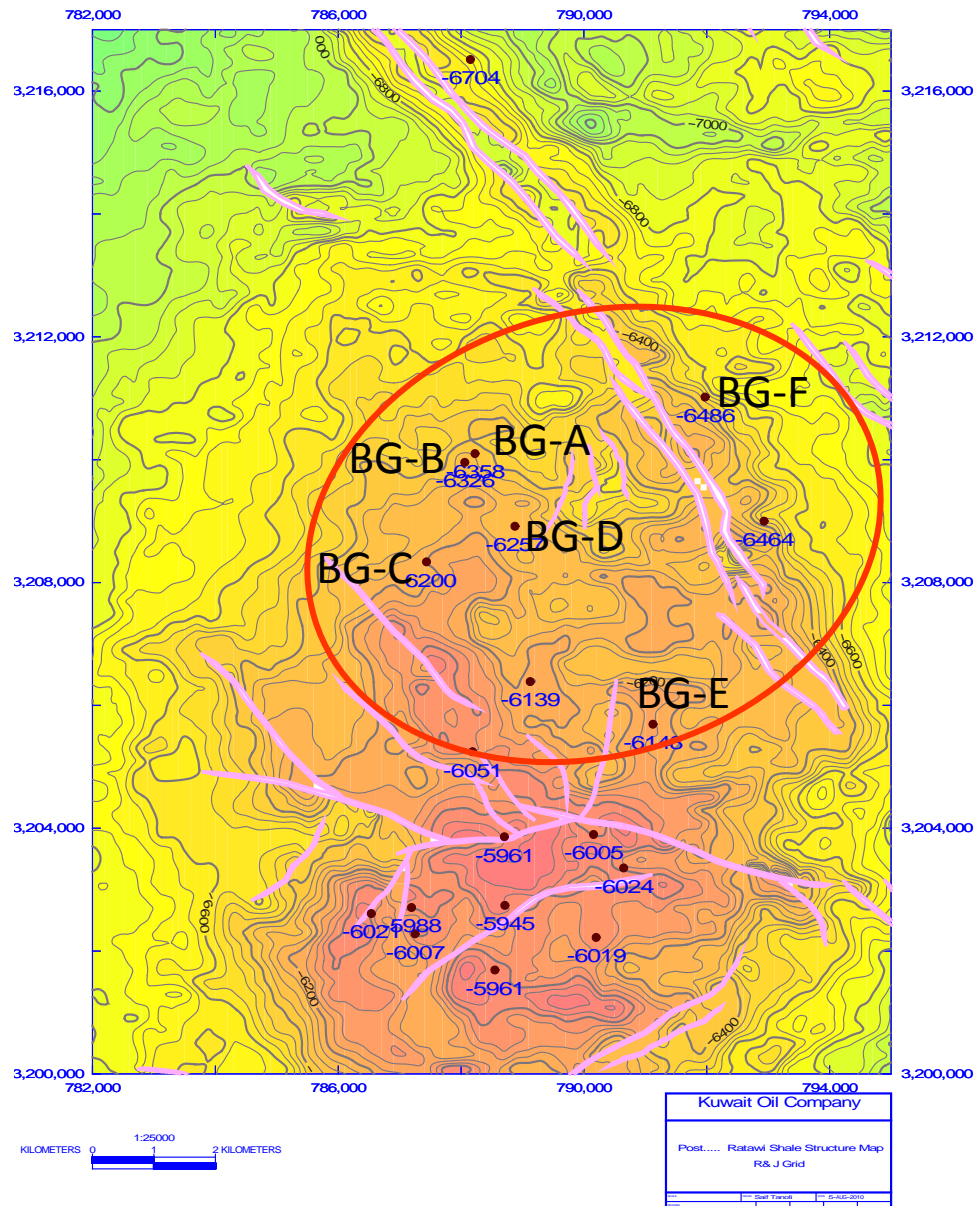


The Zubair Play in the Burgan Area

Seismic Amplitude Map with Proposed Well Locations



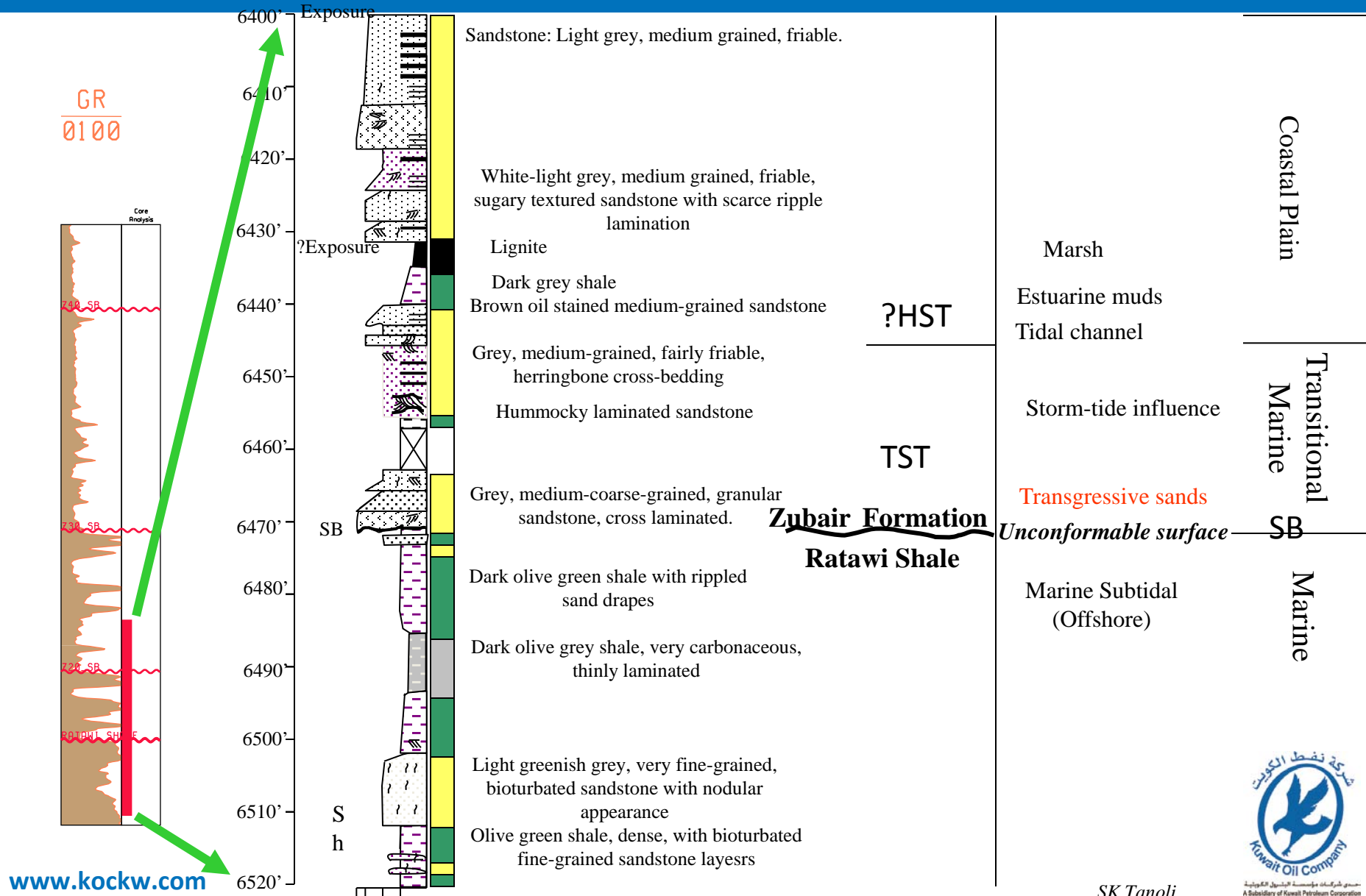
Burgan Dome



BG-C Base Zubair-Top Ratawi Shale Core

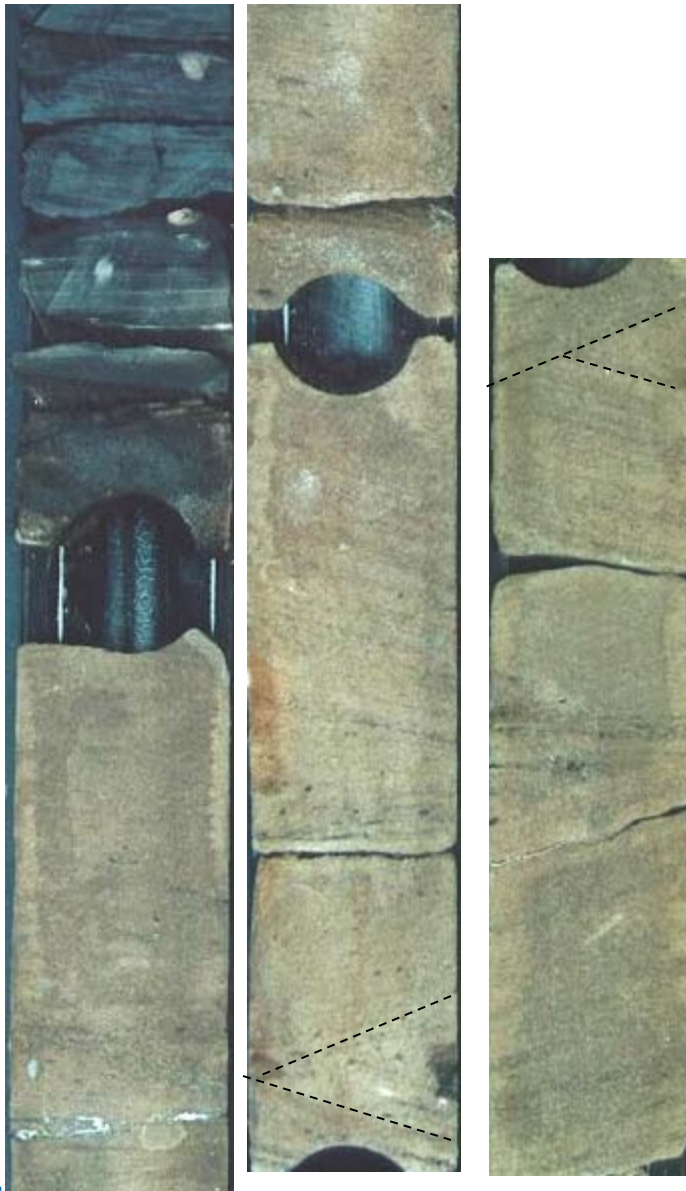
Description

Environments



BG-C Zubair Formation

Bi-directional cross stratified sandstone Facies



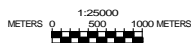
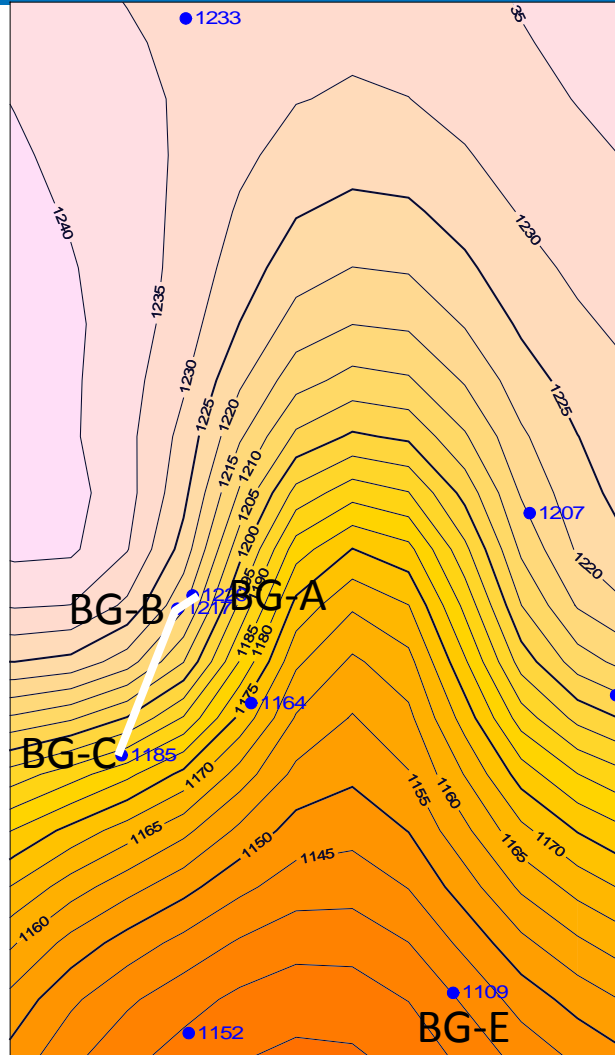
Cross bedded sandstone & shale Facies



Granular sandstone Facies



Palaeotopographic Map



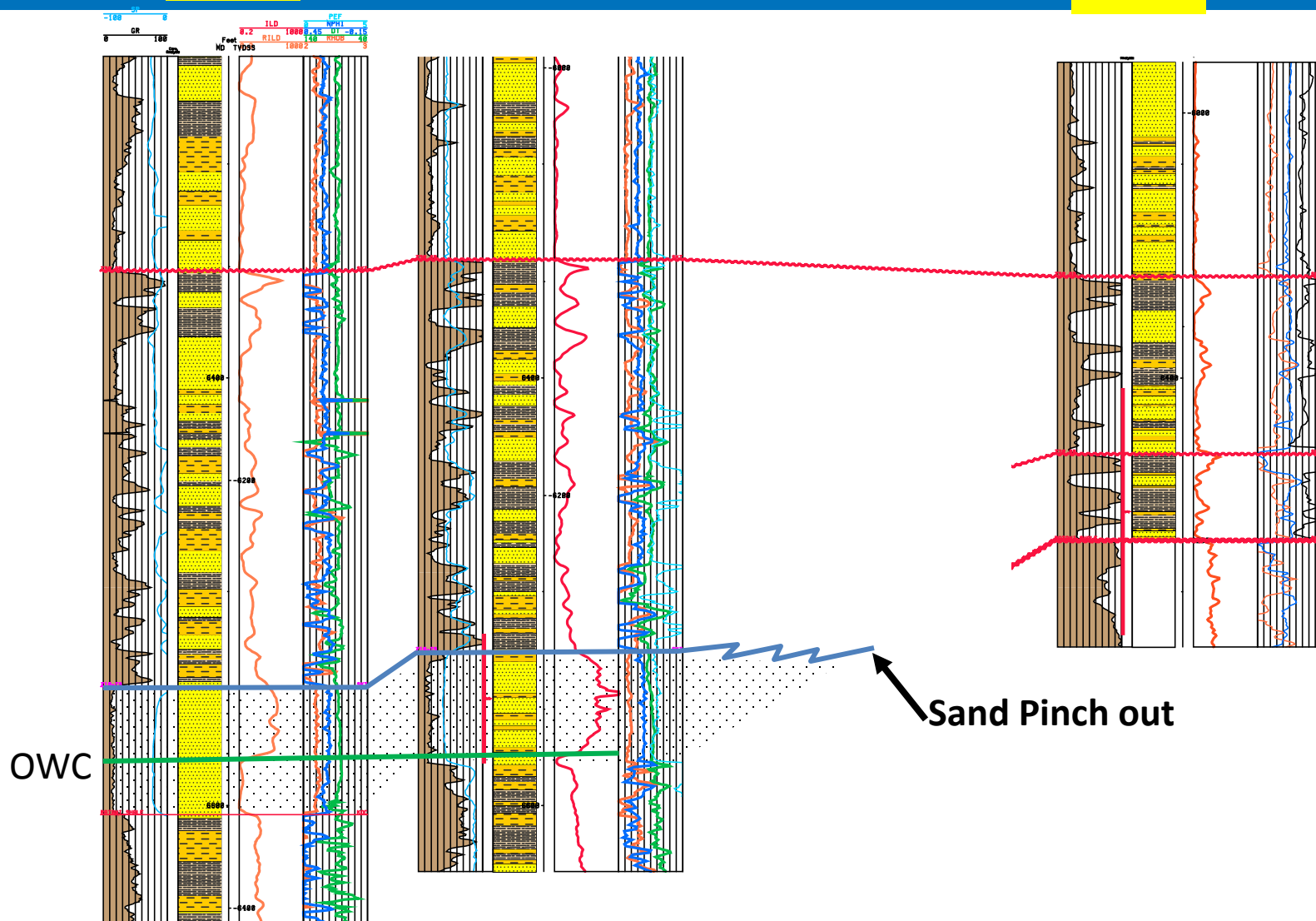
Kuwait Oil Company		
Burgan		
Zubair Thickness Map		
1-25000	Self Tanker	20-FEB-2008



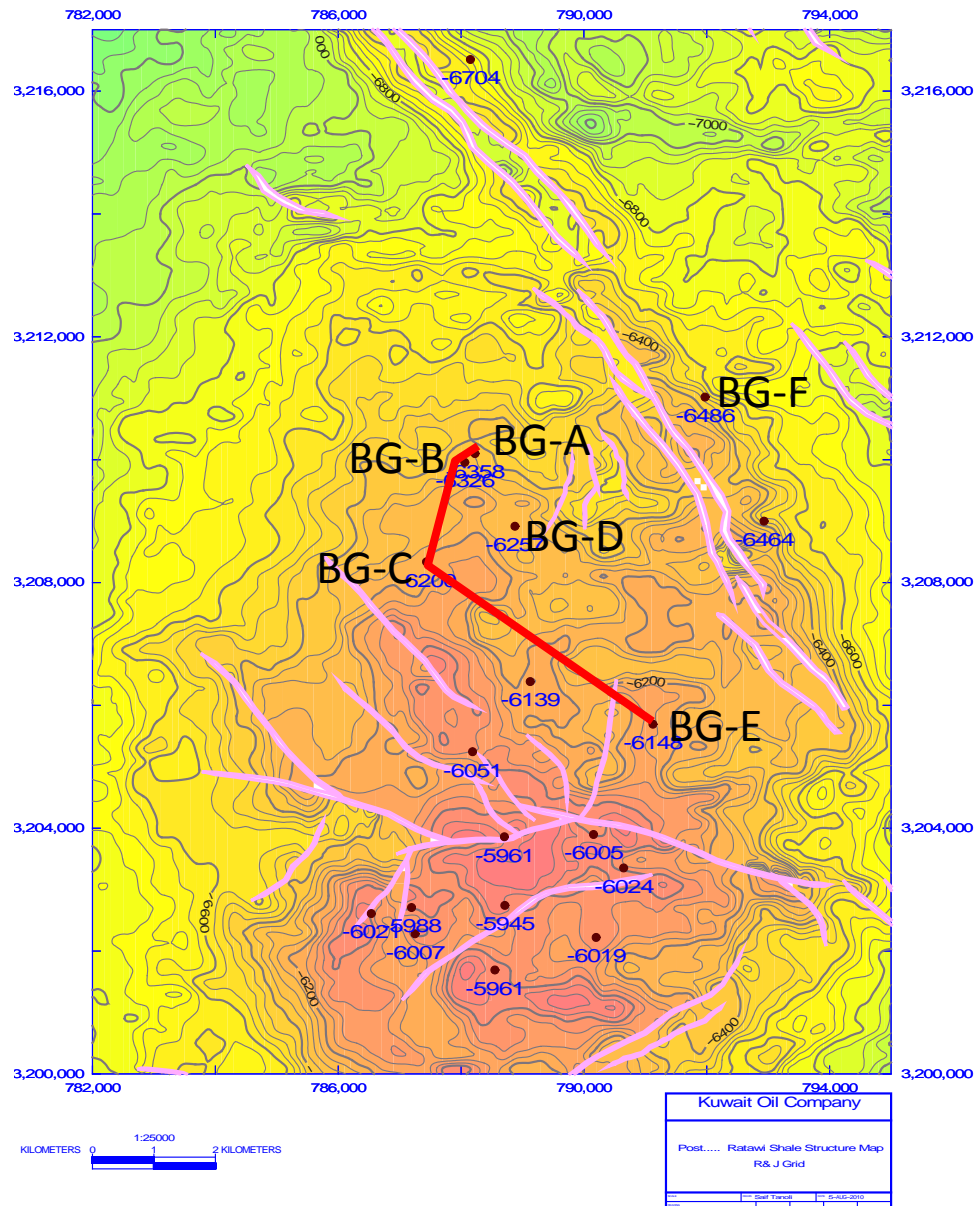
BG-A

BG-B

BG-C

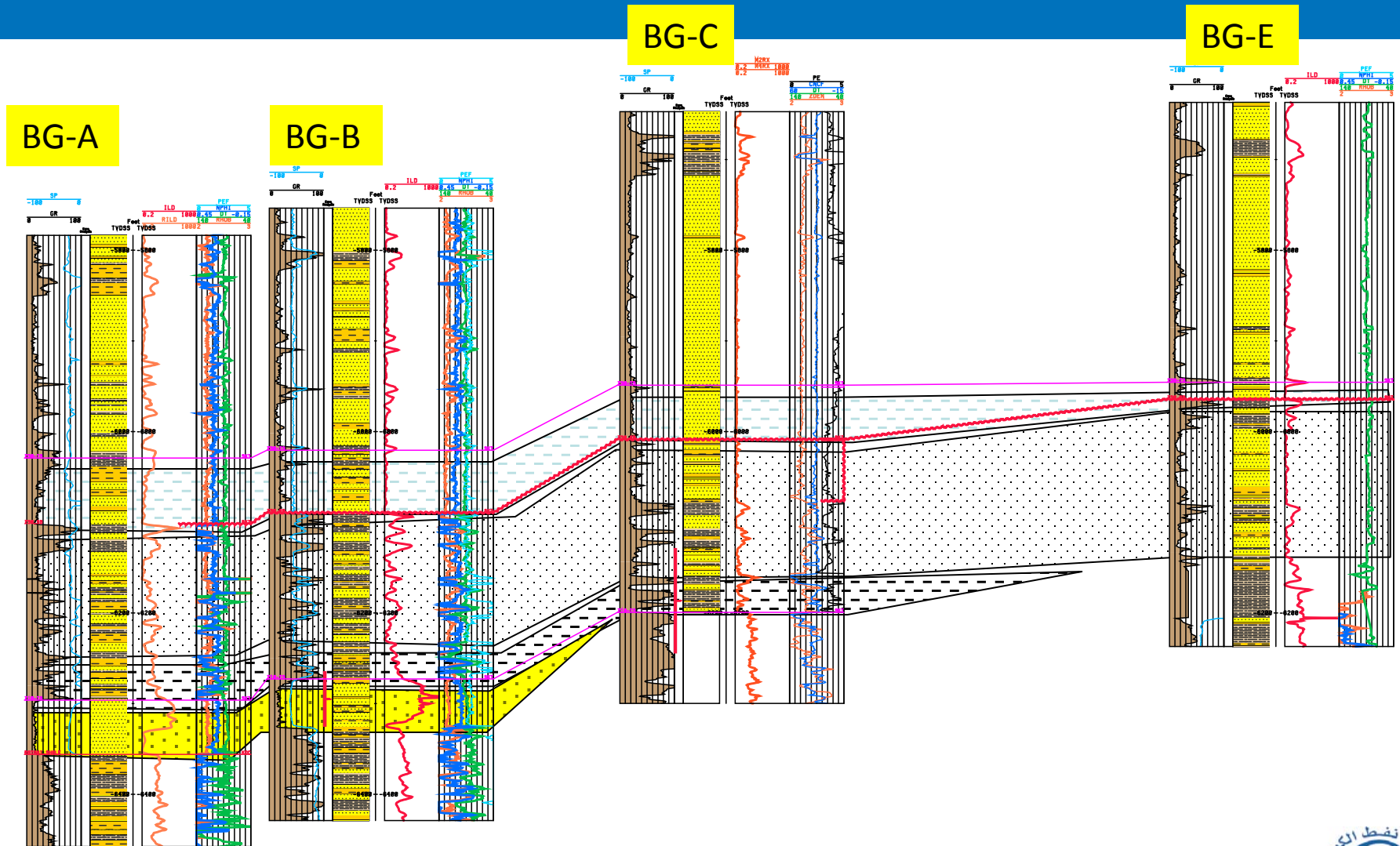


Burgan Dome

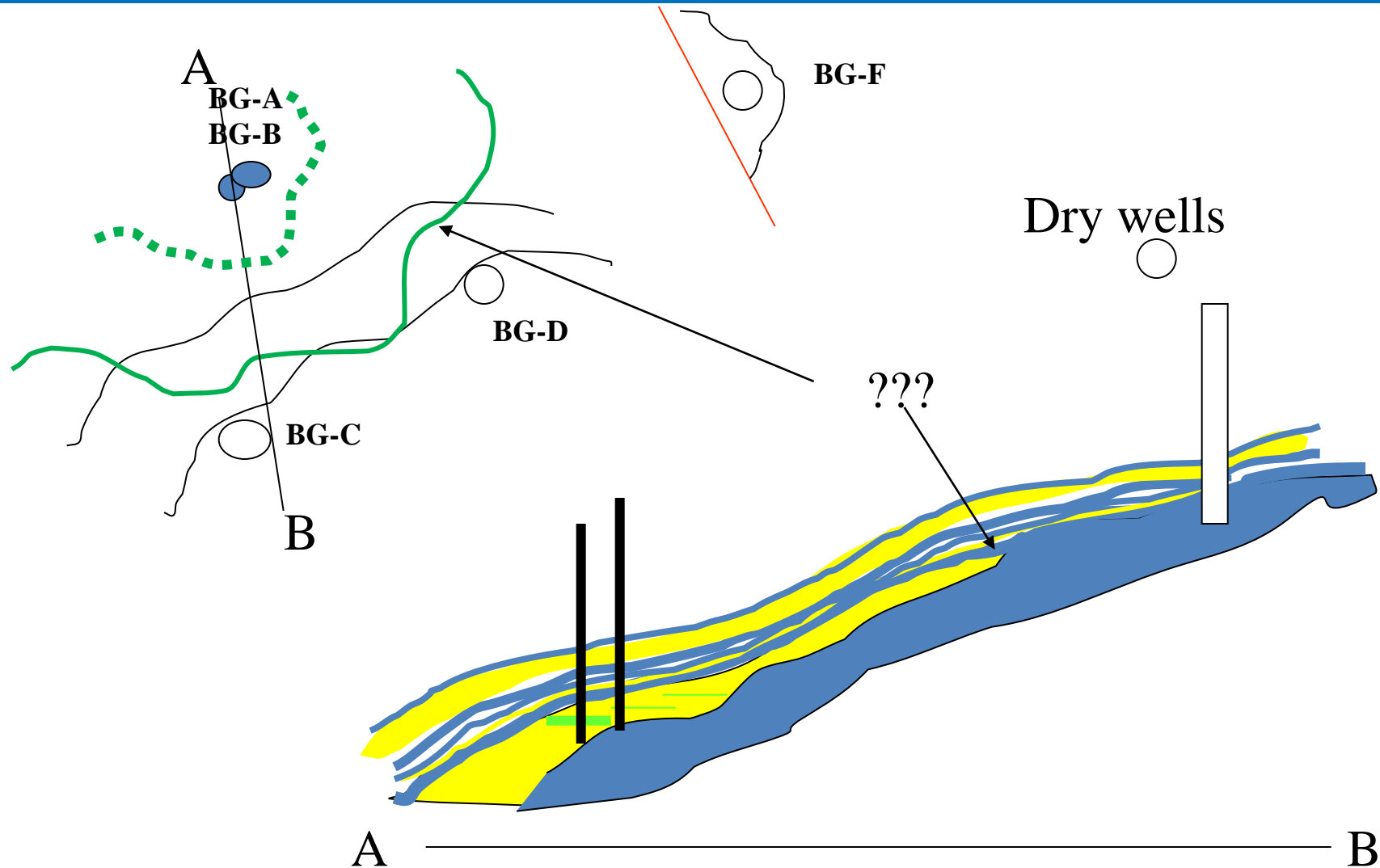


Updip basal facies pinchout

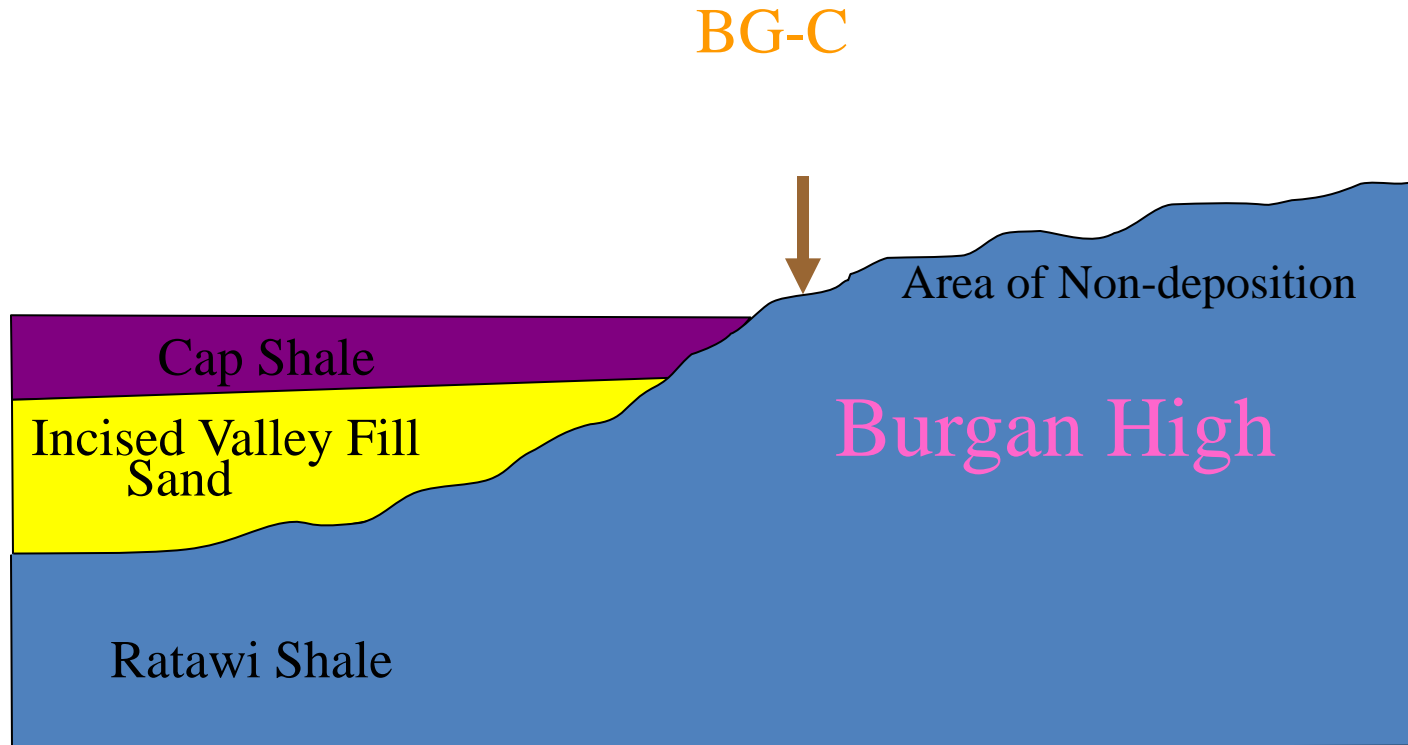
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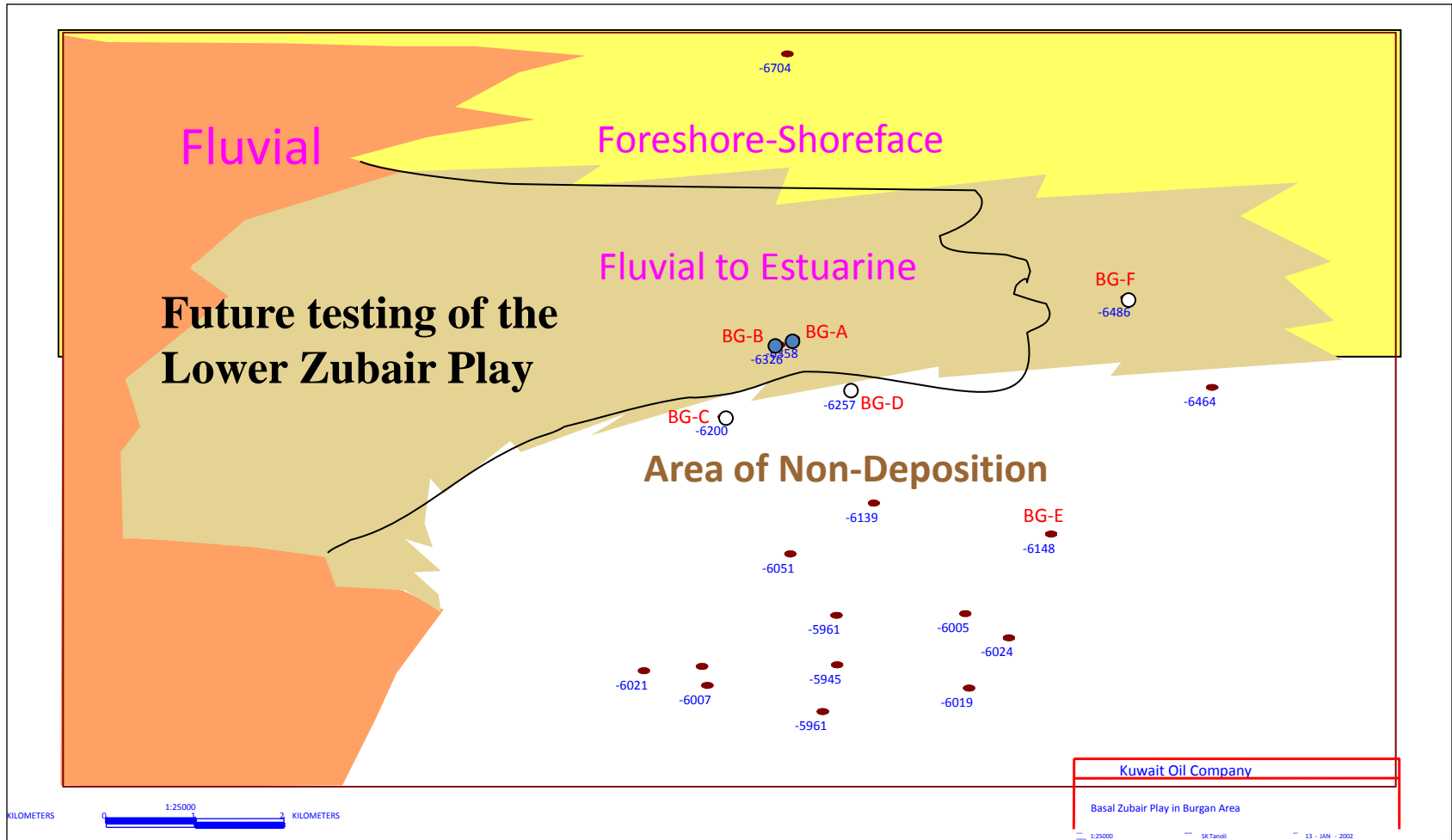
Upside Lower Zubair large scale Stratigraphic pinch out play



The Zubair Play in the Burgan Area



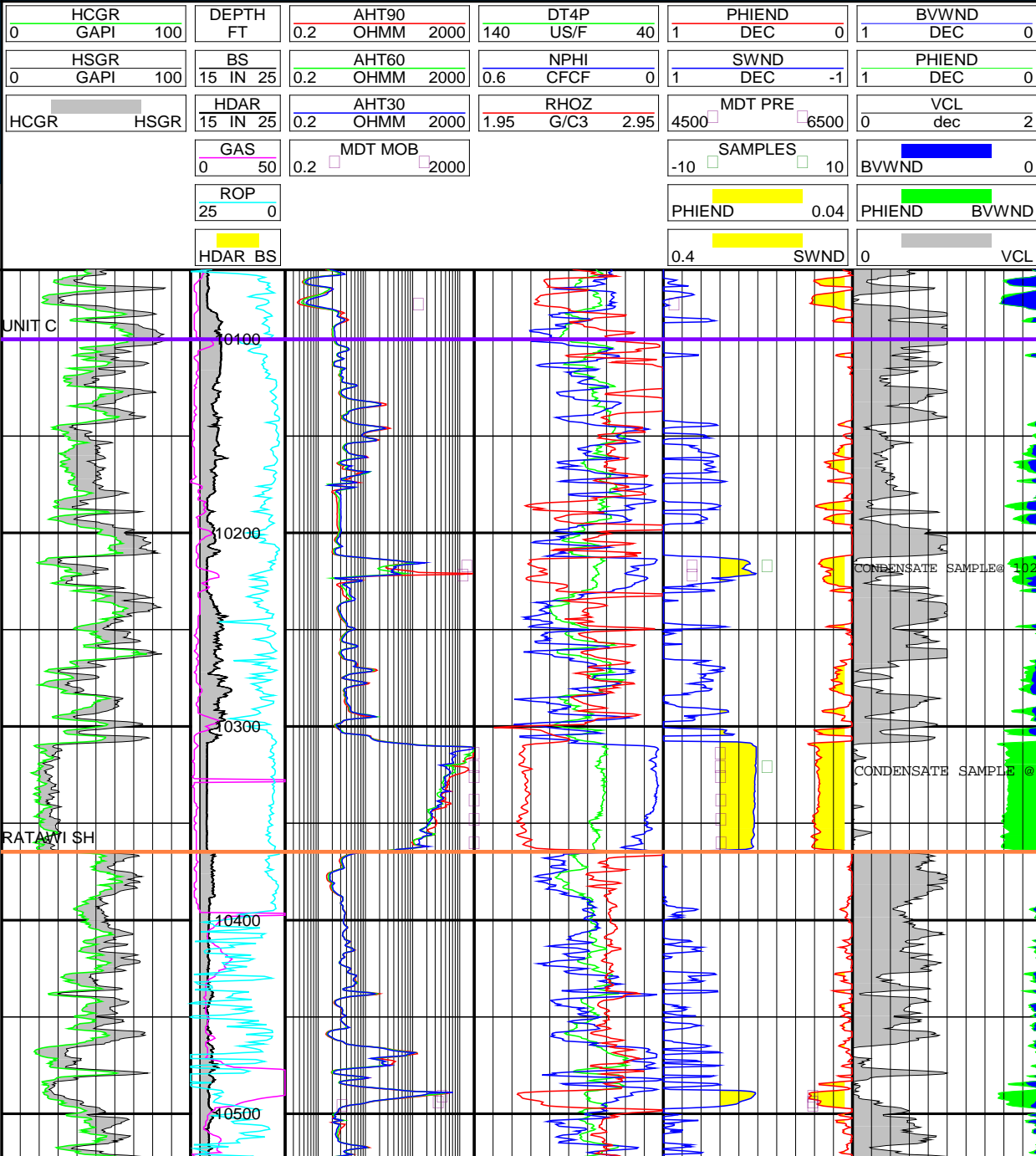
The Zubair Play in the Burgan Area



Sabriyah Area

- About 56 feet thick sand at base Zubair in one well.
- None of the other existing wells have more than 20 feet of sand at the base of the formation.
- Struggle is on to trace the sandbody.

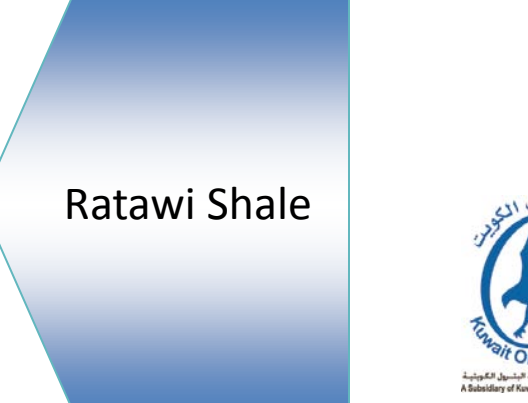
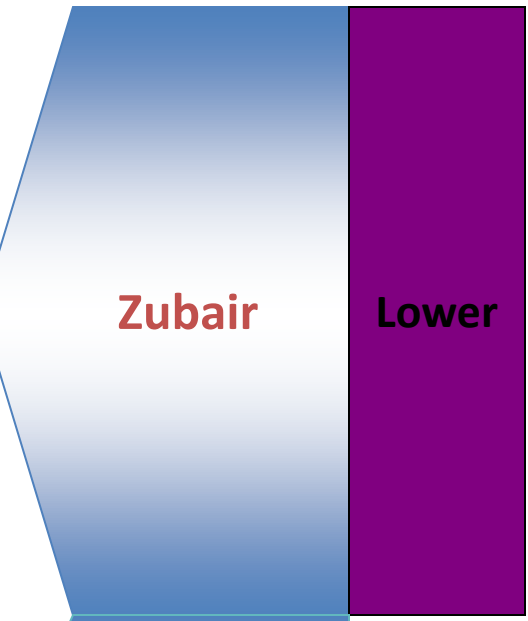




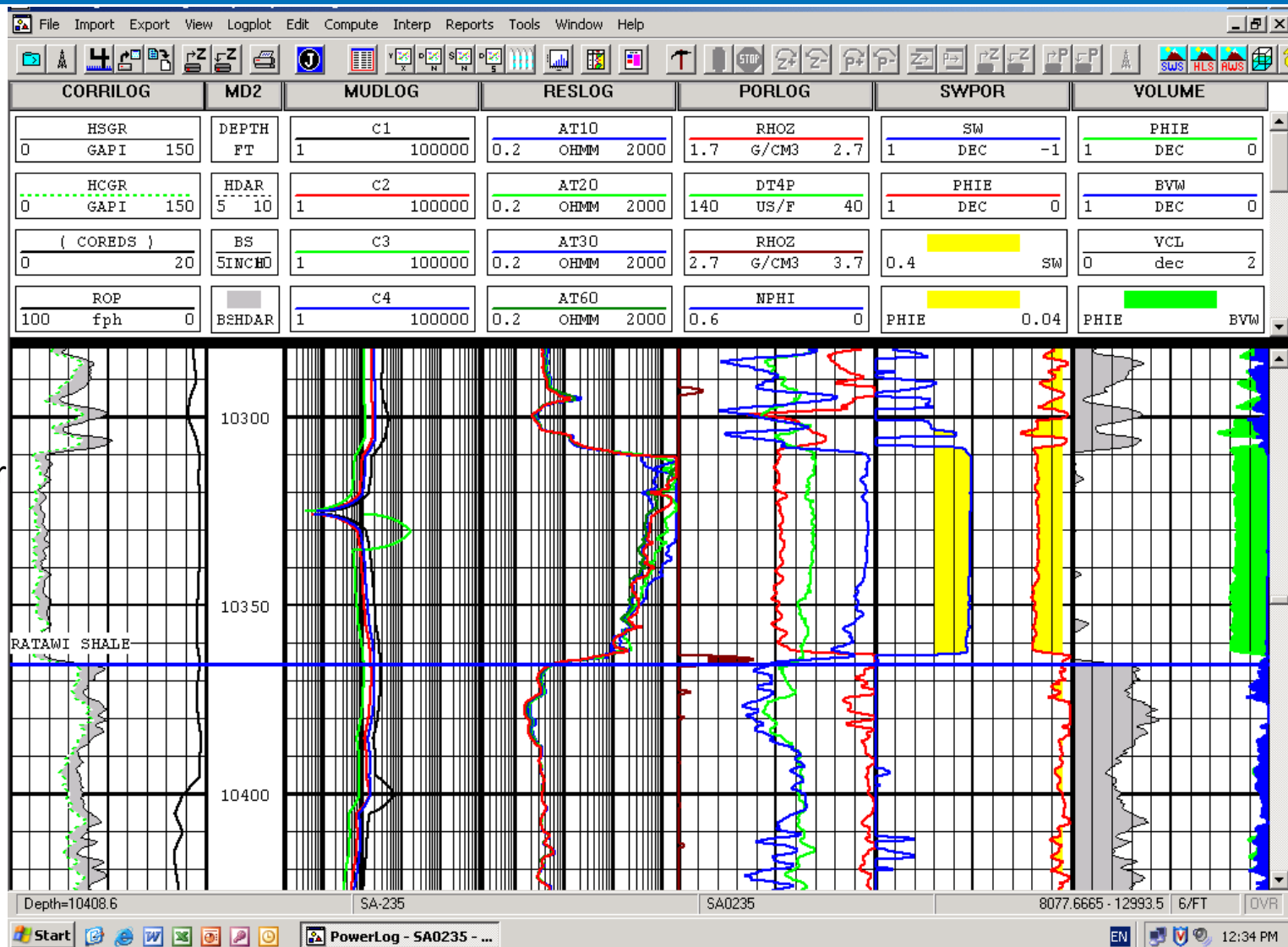
SA-A

Conventional OH logs Analyses

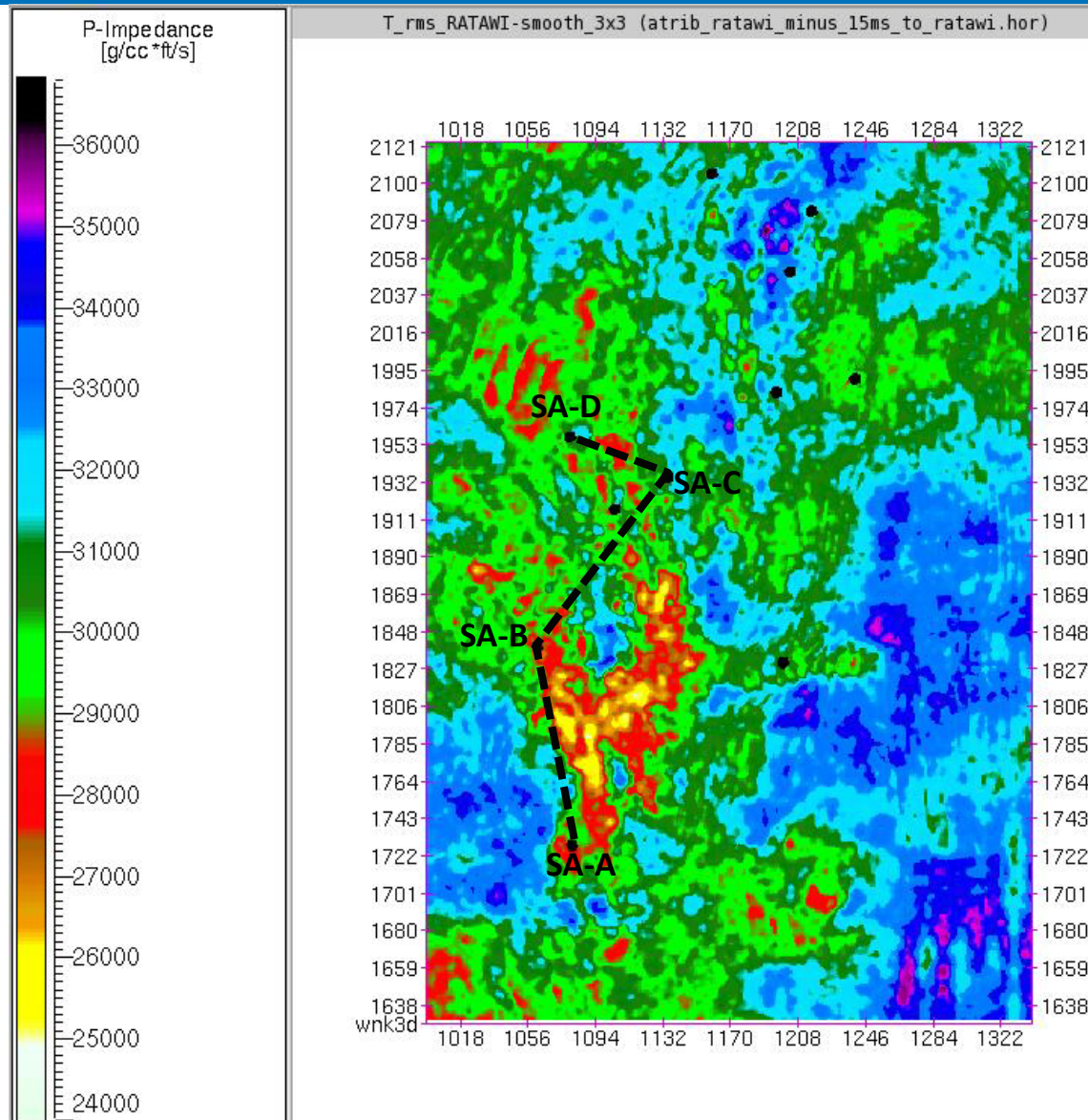
Results with MDT data



Well SA-A: Close up of Base Zubair



Attribute map, RMS Ratawi to Ratawi -15ms



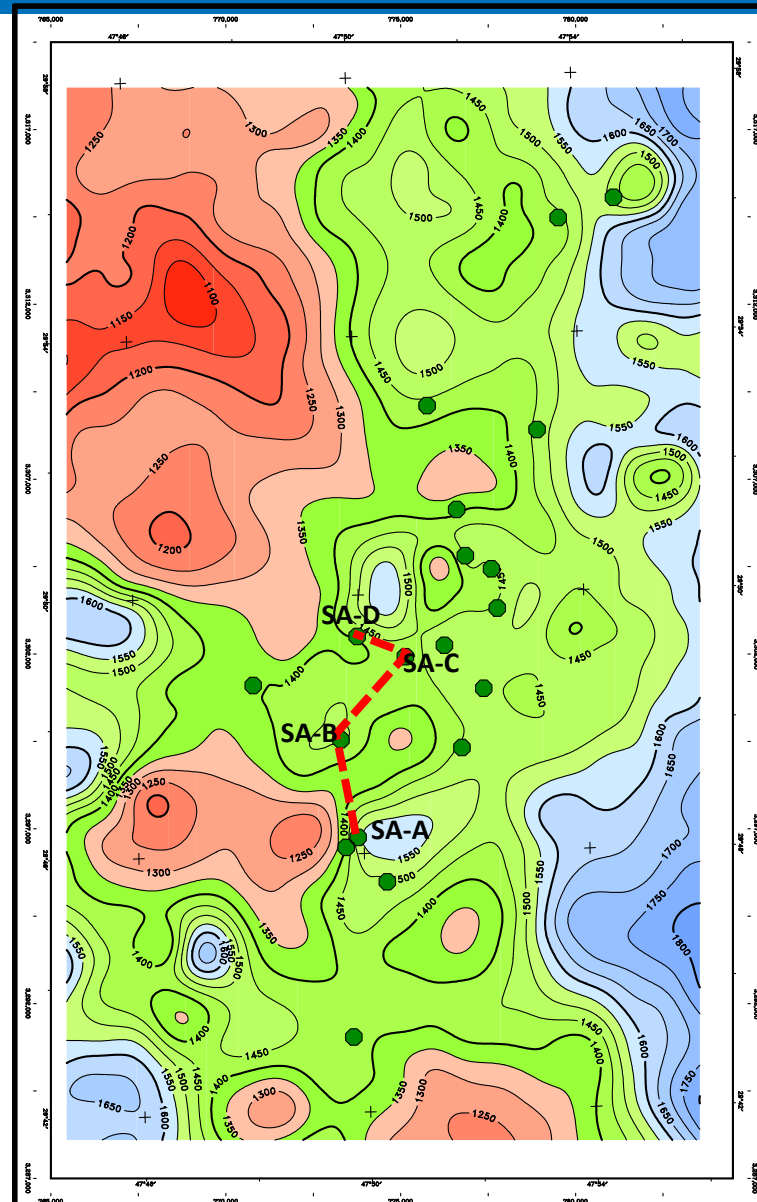
Low AI (yellow-Red) indicates high porosity.

Area: Sabriyah

Ratawi Shale paleotopography during Zubair Deposition

Red: High ground

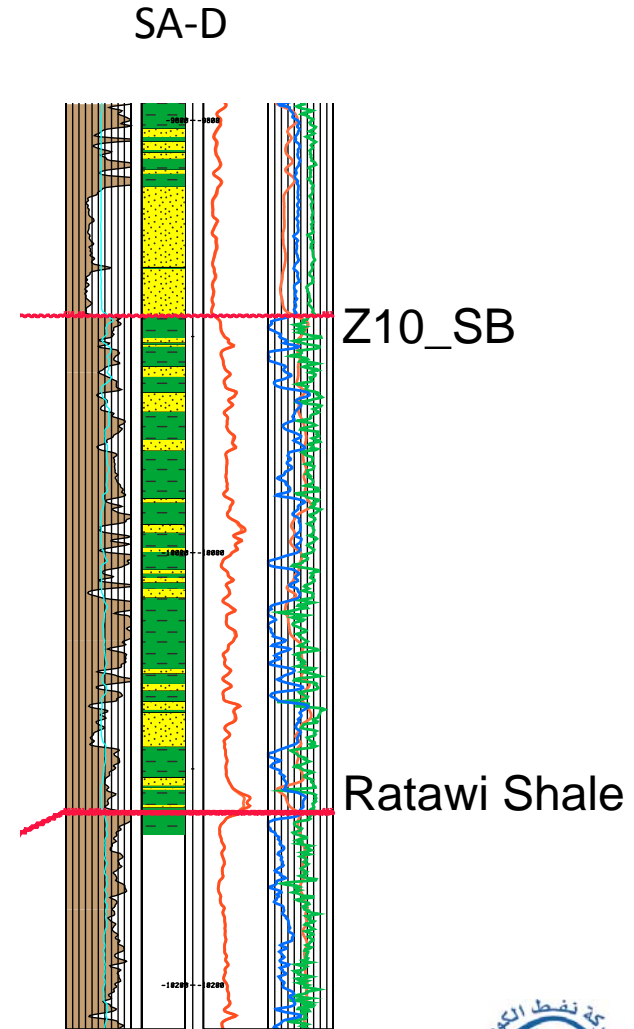
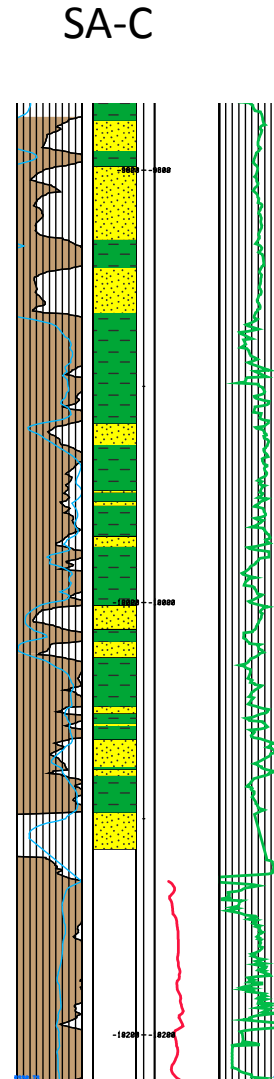
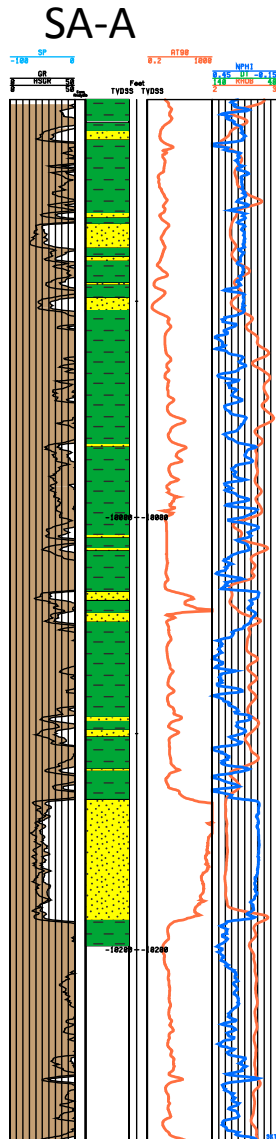
White: Low ground



S Lower Zubair section in Sabriya Field.

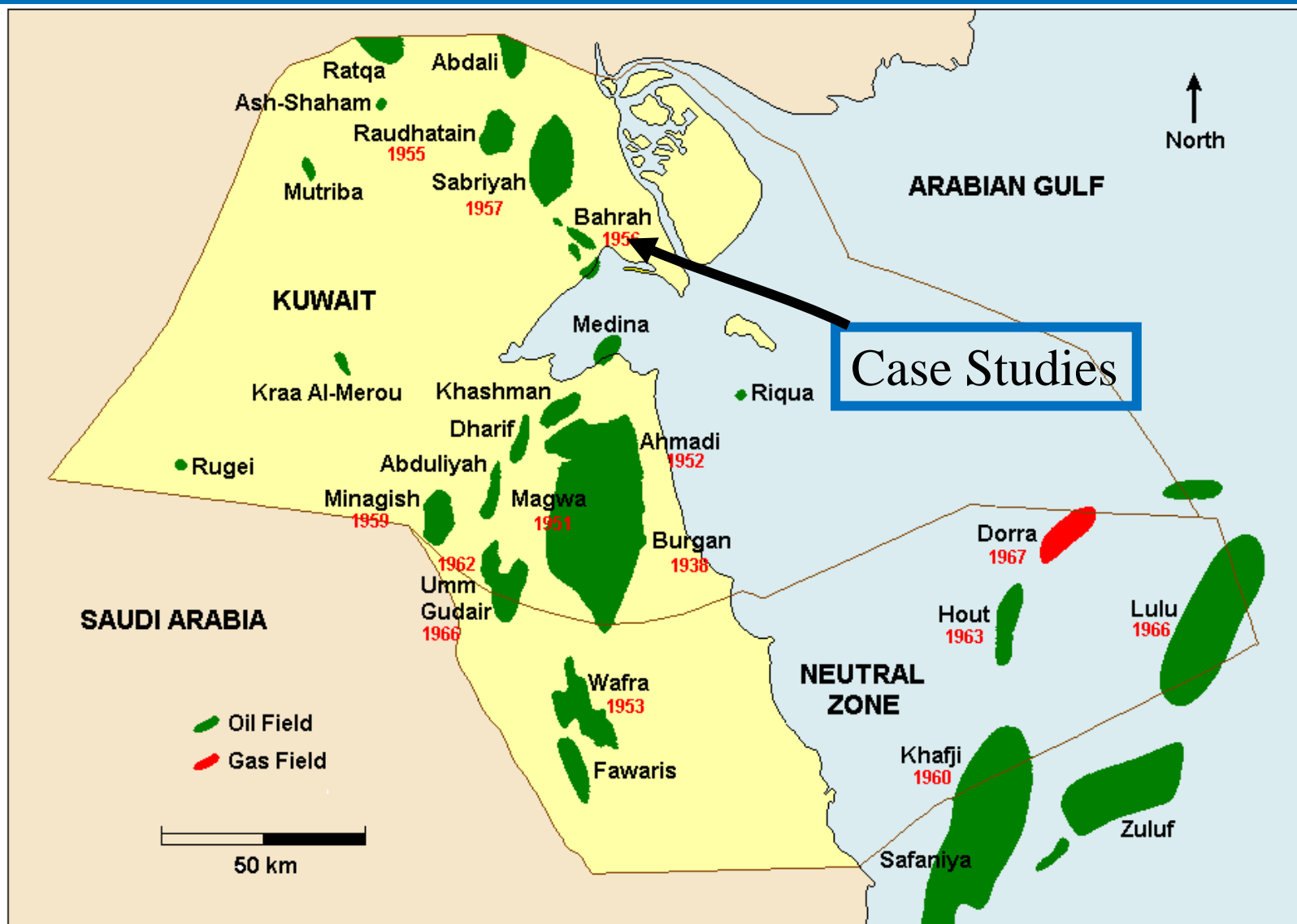
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Lower Zubair



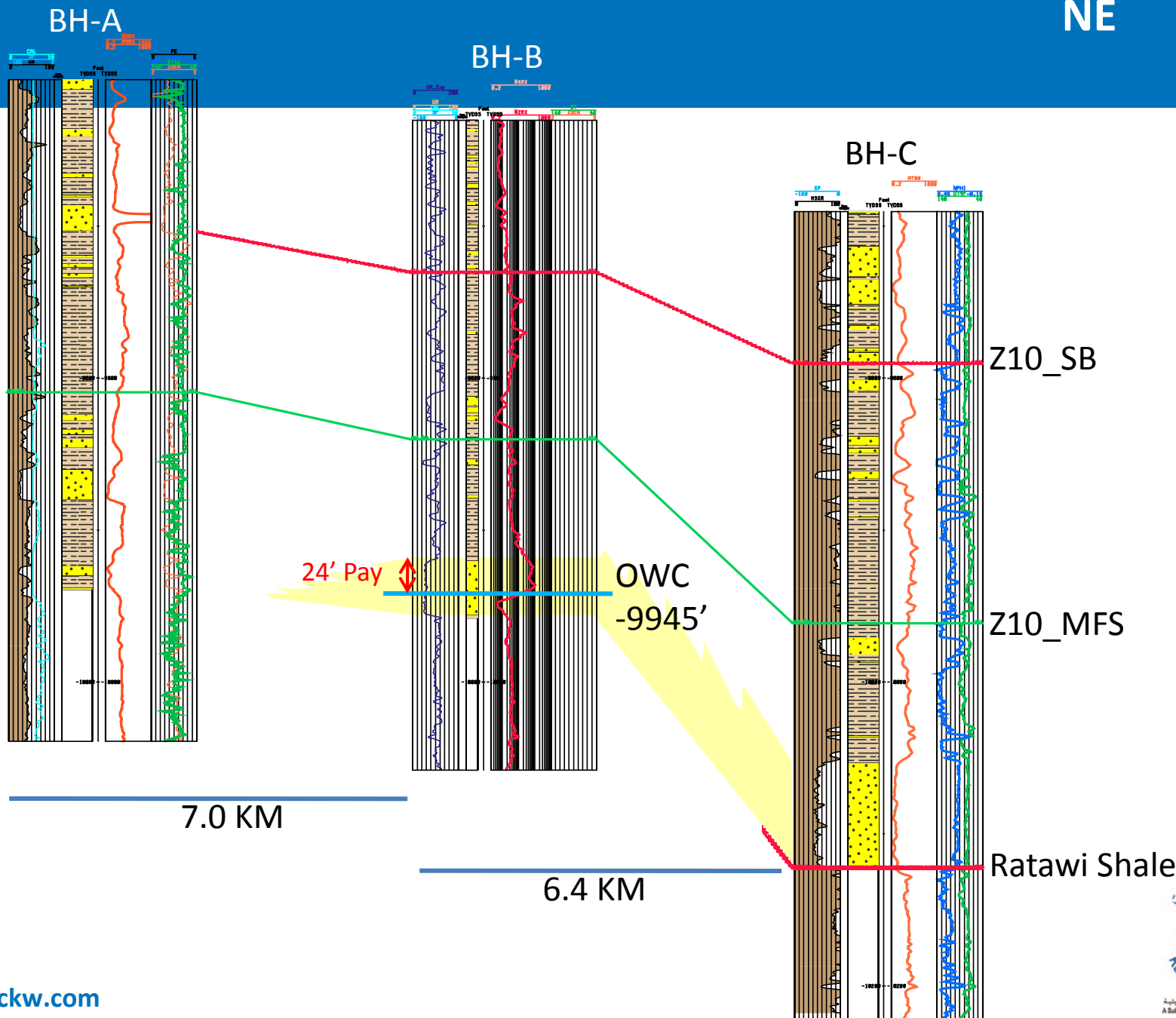
Bahra Area

- Up to 50 feet thick sand at base Zubair.
- No universal homogenous distribution of the basal Zubair sandbody.
- Pay only in a well within the closure.



SW

NE



Conclusions

- Base Zubair reservoir distribution is at least partly related to the drainage development during Valanginian time.
- Variable mechanisms for hydrocarbon entrapment in the base Zubair sandstones.
- In case of Burgan, updip impingement of the overlying lower coastal plain muddier facies.
- In case of Sabriyah, normal structural closure and in Bahra 4 way closure + compartmentalization due to faulting.
- Local reservoir distribution help with seismic attributes.
- Regionally the play is being conceptually pursued.

Thank You



During a field trip in Oman; Dr. Oliver Weidlich in action.