Reservoir Potential of Marwat and Khisor Trans Indus Ranges, Northwest Pakistan*

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Search and Discovery Article #50781 (2013)**
Posted May 20, 2013

*Adapted from oral presentation given at PAPG/SPE 2012 Annual Technical Conference, Islamabad, Pakistan, 3-5 December 2012

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Abstract

The Marwat-Khisor ranges constitute the central part of the Trans Indus ranges. These northeast trending fold-thrust belts represent the leading deformational front of the Kohat fold and thrust belt and form the southeastern border of Bannu Basin. Marwat Anticline constitutes the main topographic expression of the area along with frontal Khisor thrust. The Marwat Range hosts Siwalik rocks throughout its map trace, whereas exposed stratigraphy of the Khisor Range comprises Cambrian to Jurassic platform sediments, which are unconformably overlain by fluvial sediments of Siwalik Group. Exploratory wells drilled in the area along with surface geology provide information about the regional stratigraphic record. The sedimentary rock assemblages outcropping along the Trans Indus Range indicate a quiet period of continuous sedimentation in a shallow sea with the down sagging of the Kohat-Potwar Basin, occasionally interrupted by localized uplifts, resulting in unconformities. Multiple potential reservoirs are present throughout the stratigraphic sequence in the Trans Indus ranges ranging in age from Cambrian to Cretaceous. These mainly include shallow marine / deltaic clastics of Mesozoic and Paleozoic. This paper attempts to share our updated understanding about the potential of different reservoirs within the region in terms of their depositional settings, thickness, and depth and more importantly their overall hydrocarbon potential. This would help evaluate the risks involved in exploration, based on our recent experience of exploration work and making use of available well data, field observations, petrographic analysis, source rock analysis, and basin modeling. Recognition of continuity in facies along with approximation of depths to different reservoirs are some of the challenges faced in carrying out a successful exploration program, a task which is made more difficult due to the limited data available in the area. Different formations show wide range of thickness and facies variation and at times truncations of the entire formation towards east makes this area also attractive for stratigraphic cum structural plays.

Reservoir Potential of Marwat and Khisor Trans Indus Ranges, Northwest Pakistan

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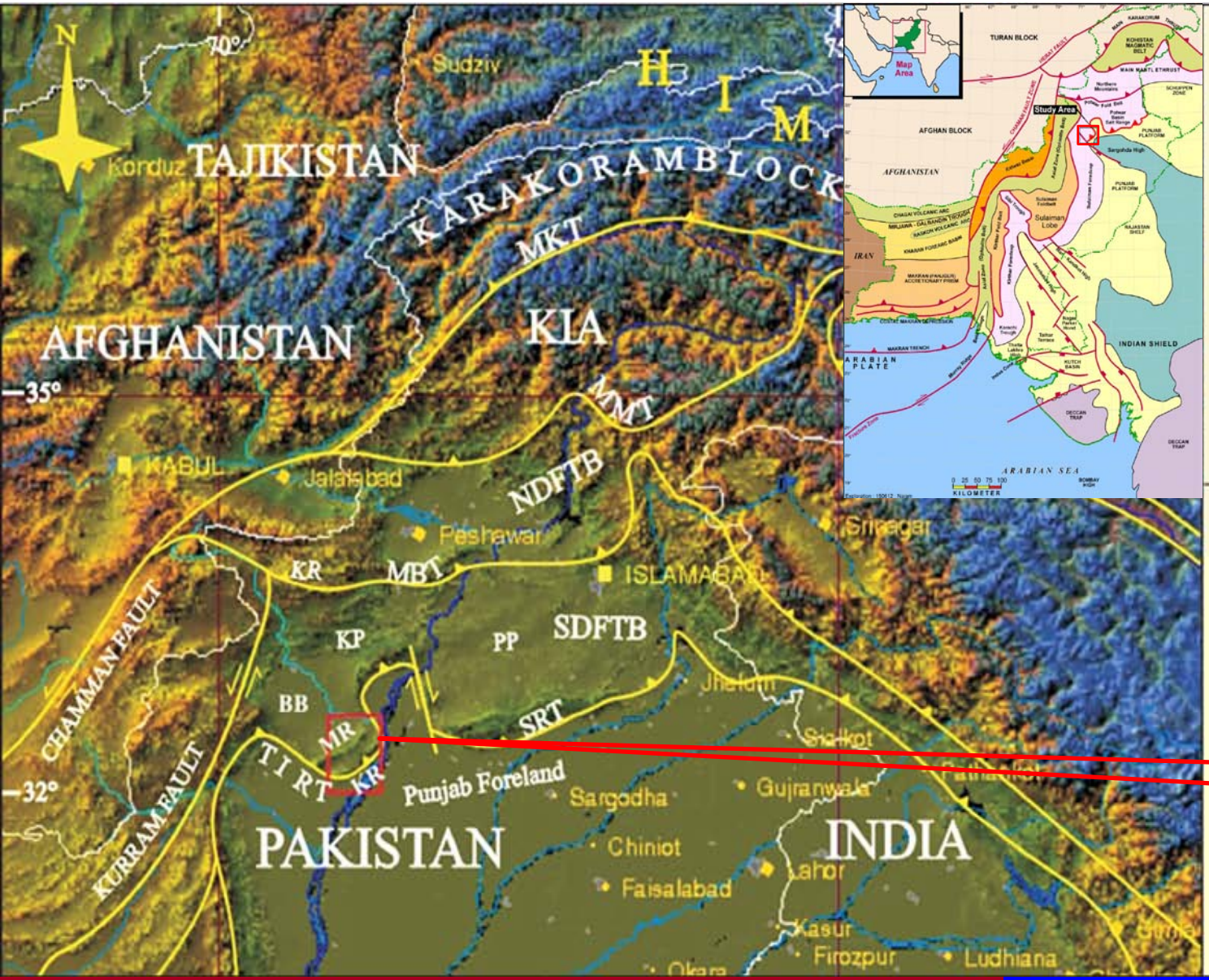
Contents

- Objectives
- Study Area and Regional Tectonic Framework
- Stratigraphy and Geological Map
- Reservoir Formations
  - Cambrian
  - Permian
  - Triassic
  - Jurassic
  - Cretaceous
- Reservoirs Correlation
- Conclusion
- Acknowledgement

Study Area and Regional Tectonic Framework



INDEX

MKT	Main Karakoram Thrust
MMT	Main Mantle Thrust
MBT	Main Boundary Thrust
SRT	Salt Range Thrust
TIRT	Trens Indus Ranges Thrust
KF	Kalabagh Fault
NDFTB	Northern Deformed Fold-Thrust Belt
SDFTB	Southern Deformed Fold-Thrust Belt
PP	Potwar Plateau
KP	Kohat Plateau
KR	Kohat Range
PB	Peshawar Basin
BB	Bannu Basin
MR	Marwat Range
KR	Khisor Range

200Km

STUDY AREA

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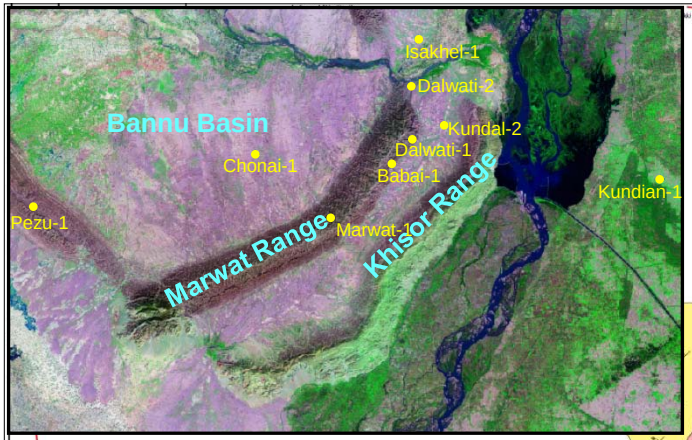
Stratigraphy and Geological Map

AGE		STRATIGRAPHY	LITHOLOGY
MIOCENE / PLIOCENE	Qss	SOAN	
	Tdp	DHOK PATHAN	
	Tn	NAGRI	
	Tc	CHINJI	
PALEOCENE		PATALA	
CRETACEOUS	Ke/Kl	Lumshiwal	
		CHICHALI	
JURAASIC	Jss	SAMANA SUK LST.	
		SHINAWARI	
	Jd	DATTA FM.	
TRIASSIC	Trk	KINGRIALI FM.	
	Trkt	TREDIAN SST.	
	Trm	MIANWALI FM.	
PERMIAN	Pzc	CHIDRU FM.	
	Pzw	AMB FM. WARGAL FM.	
	Pza		
	Pns	SARDHAI FM.	
	Pnw	WARCHA SST.	
	Pnt	DANDOT FM	
CAMBIRAN	Clg	TOBRA FM.	
		BAGHANWALA /KHISOR	
		JUTANA	
		KUSSAK	
		KHEWRA SST	
PC			



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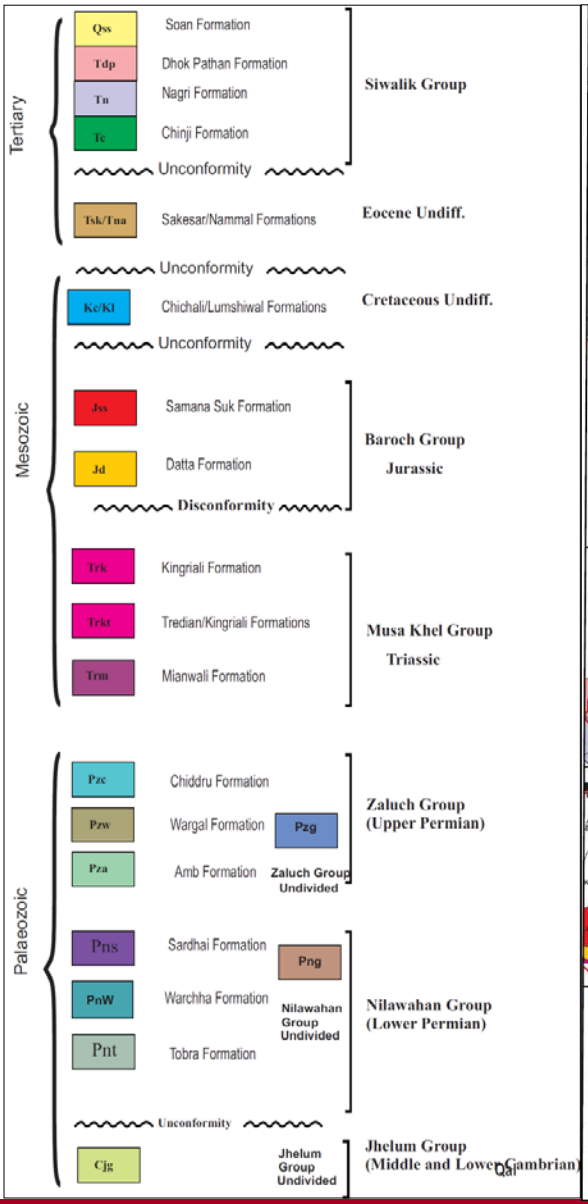
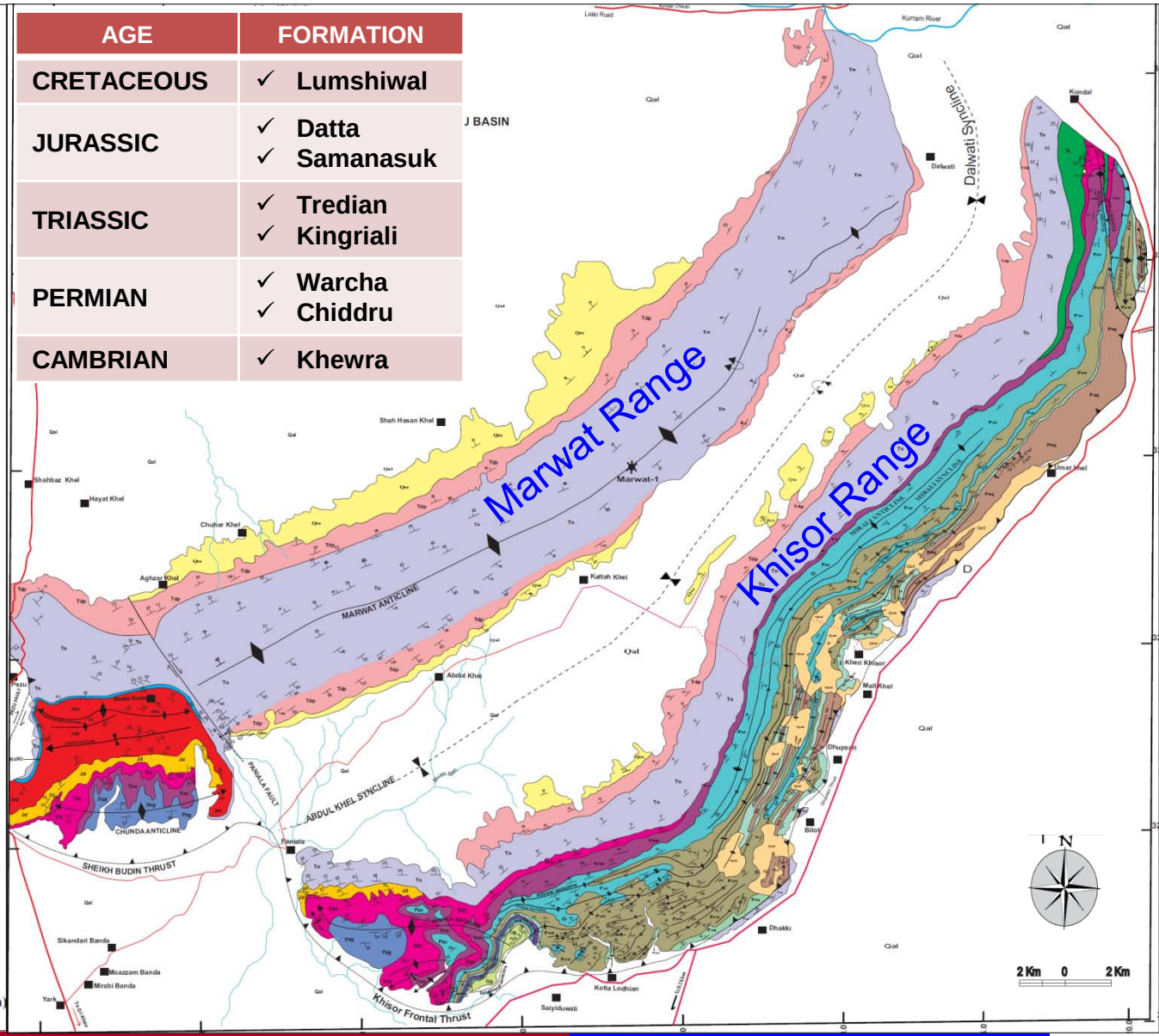
Reservoir Formations

AGE	FORMATION
CRETACEOUS	✓ Lumshiwal
JURASSIC	✓ Datta ✓ Samanasuk
TRIASSIC	✓ Tredian ✓ Kingriali
PERMIAN	✓ Warcha ✓ Chiddru
CAMBRIAN	✓ Khewra





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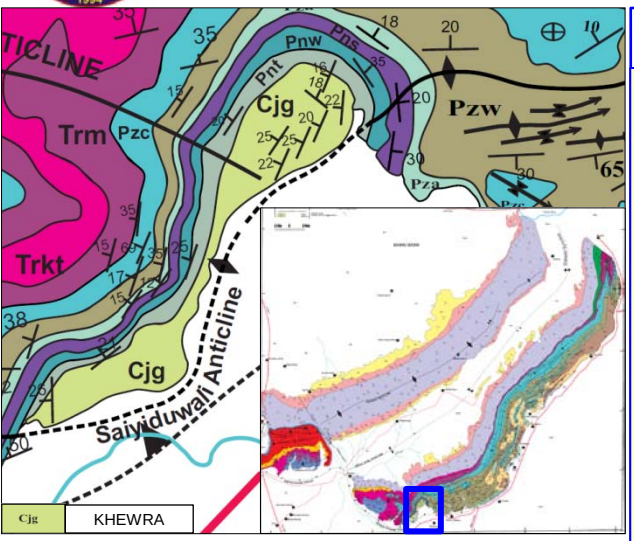
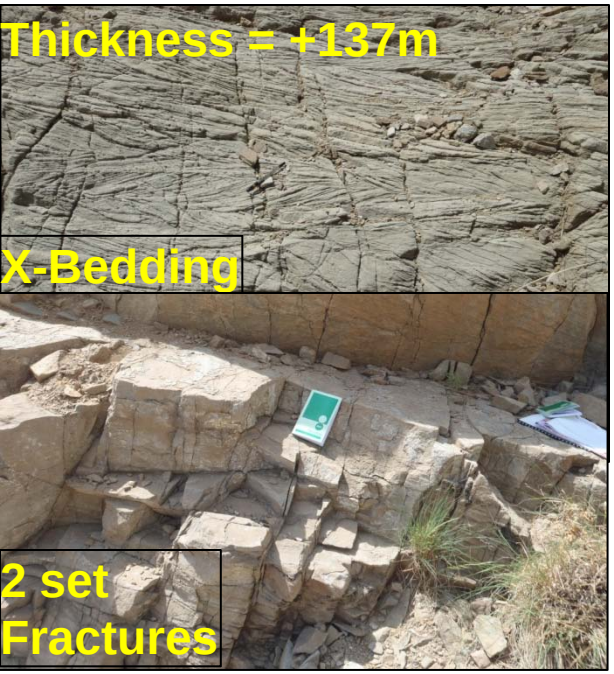
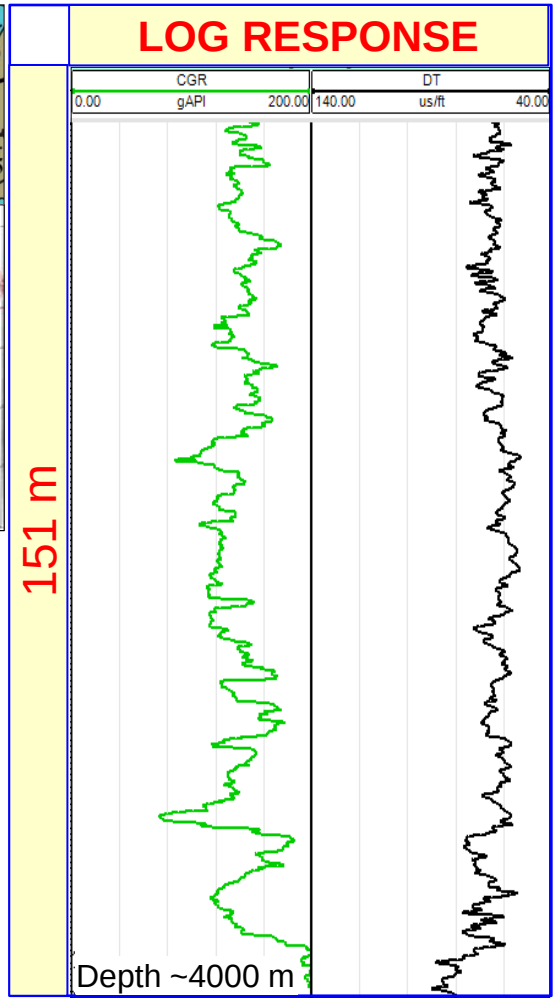
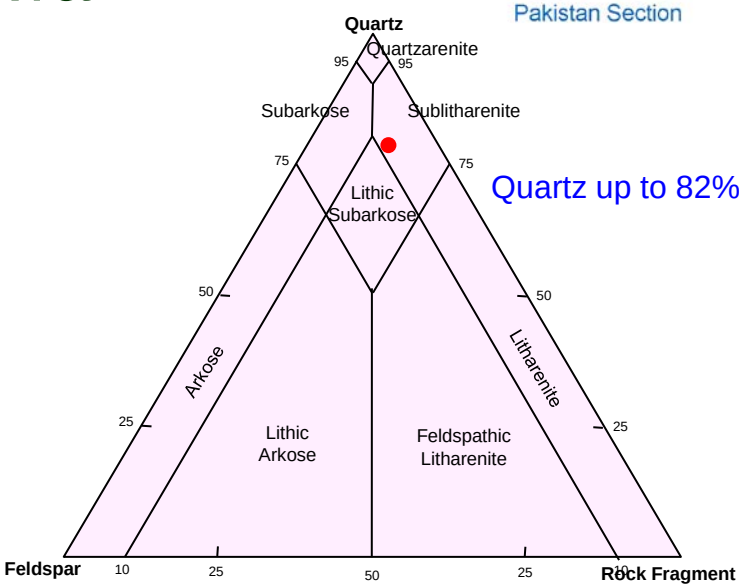
Cambrian – Khewra

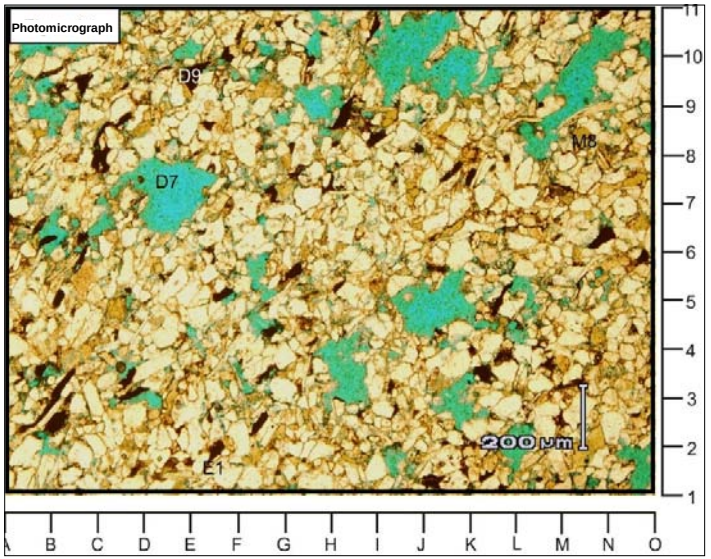






Log	Surface sample
Avg. Φ	Plug Φ
13%	21.6 %





Showing Opaque mineral (D9), Mica (E1), Glauconite (M8) and Porosity (D7). Grains are closely packed and mostly long to pointed contact. (Mag X04)

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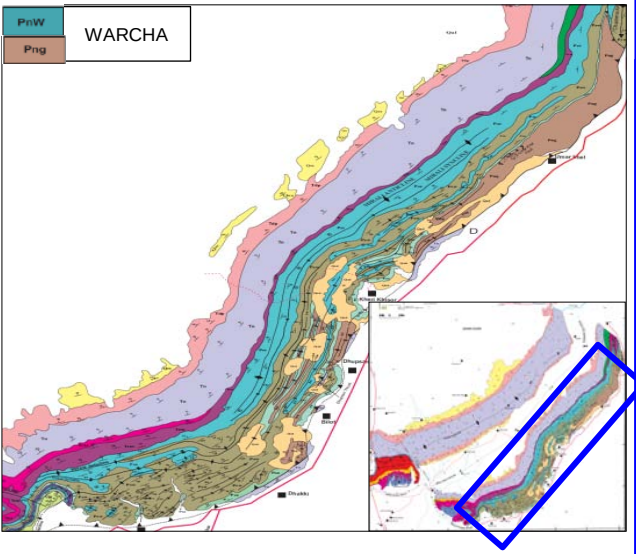
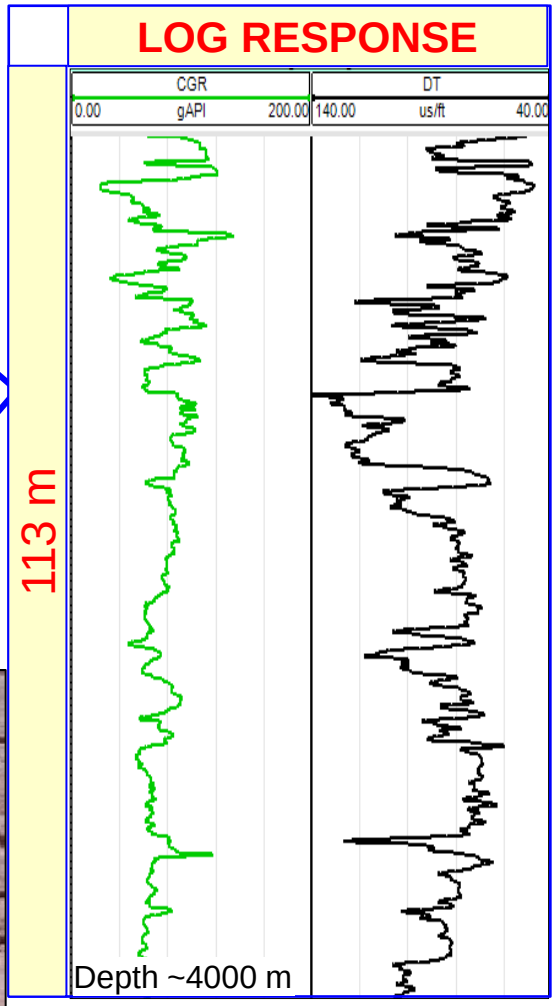
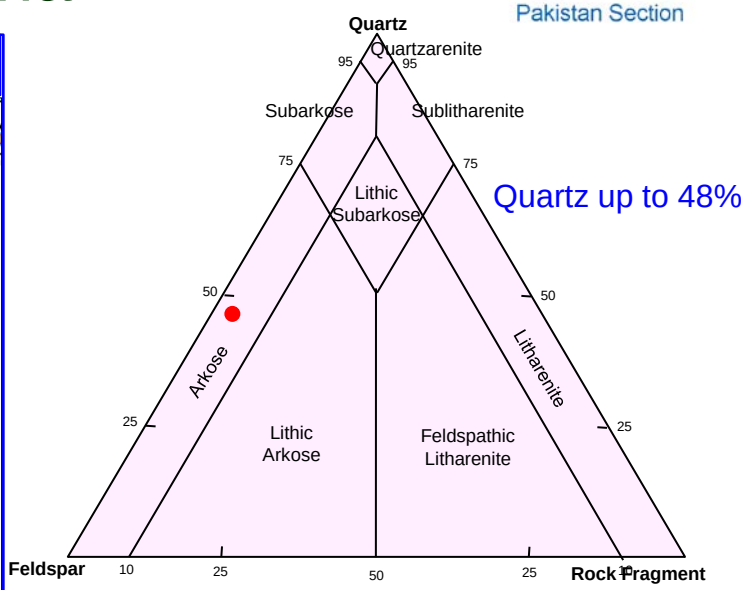
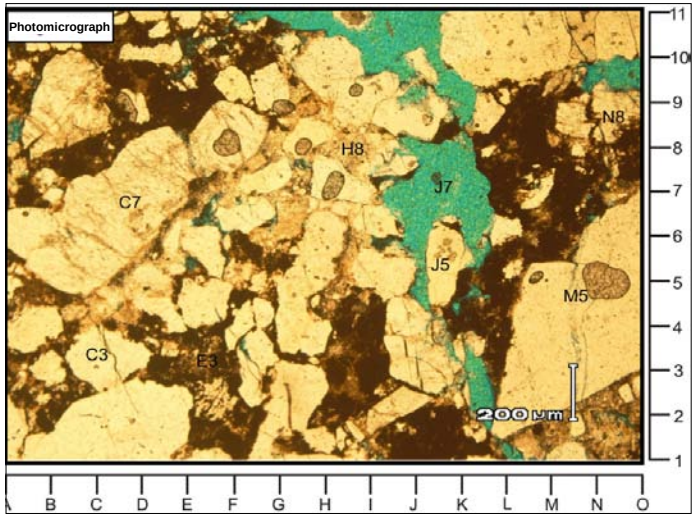
Permian – Warcha





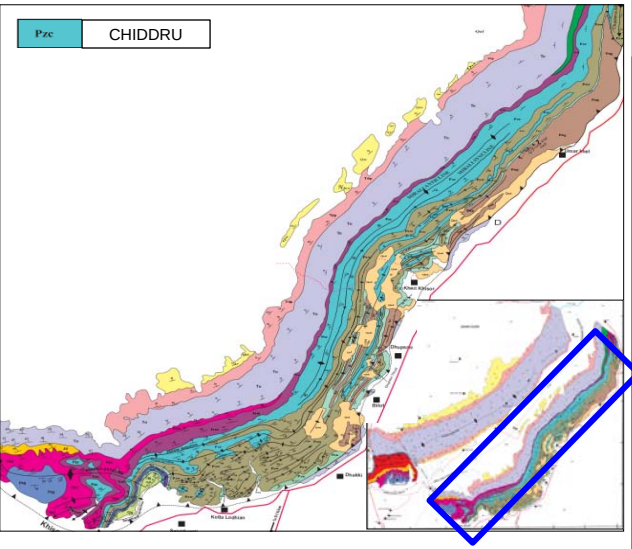


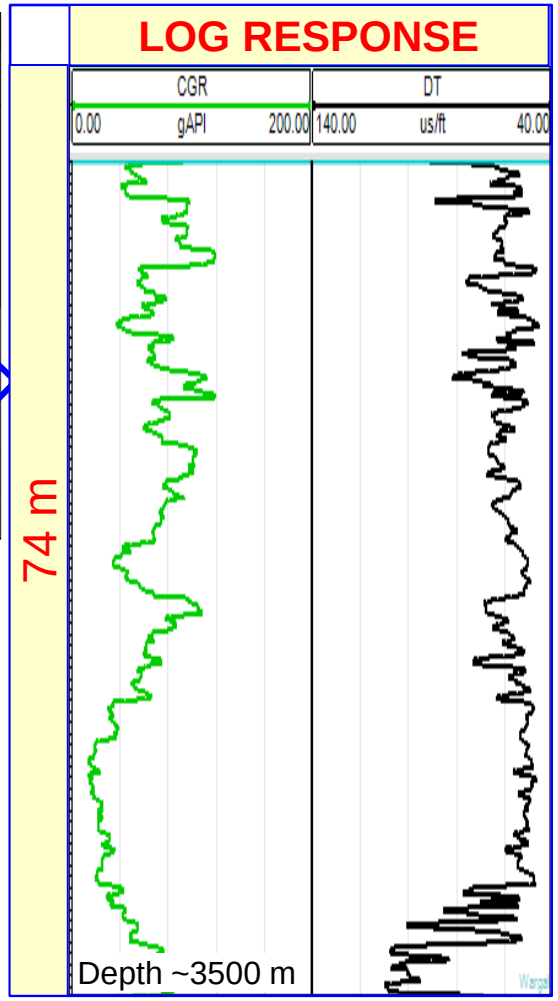
Log	Surface sample
Avg. Φ	Plug Φ
18%	10%

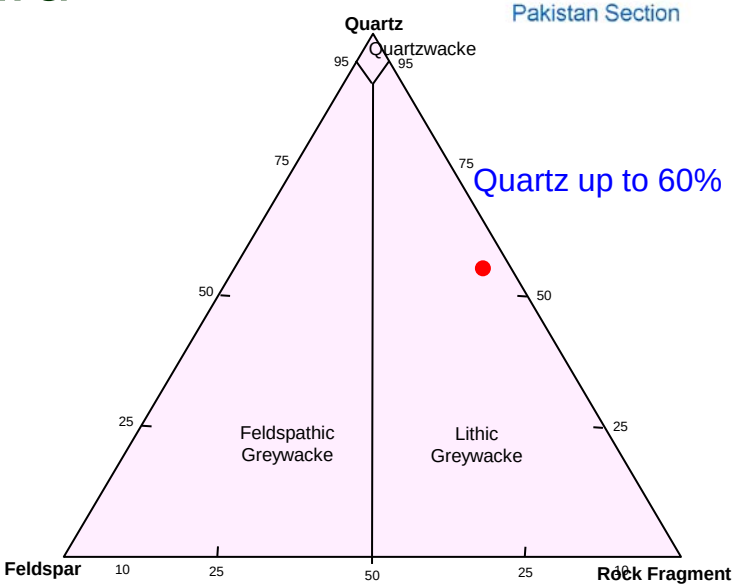


Microcline Feldspar (C7), Polycrystalline Quartz (C3), Silica cement (H8), Monocrystalline Quartz (M5 & J5), dirty fractured Quartz (N8), Effective porosity (J7) and calcite matrix overlapping by iron oxidation (E3). Grains are closely packed (Mag X04)

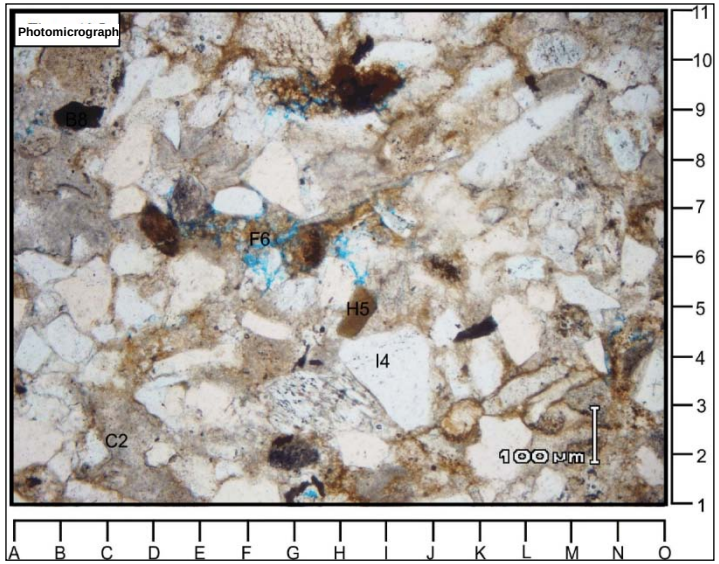
Permian – Chiddru





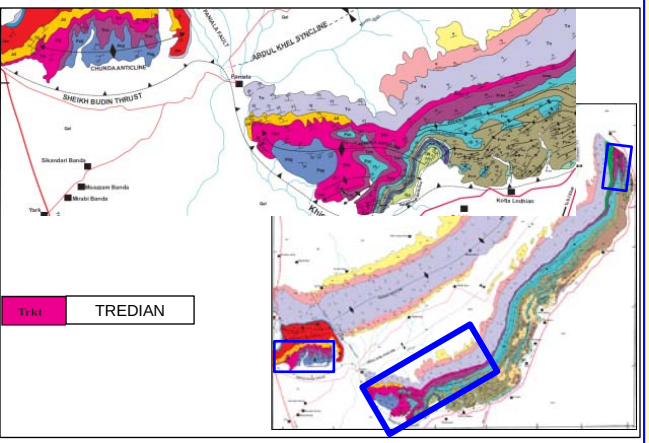


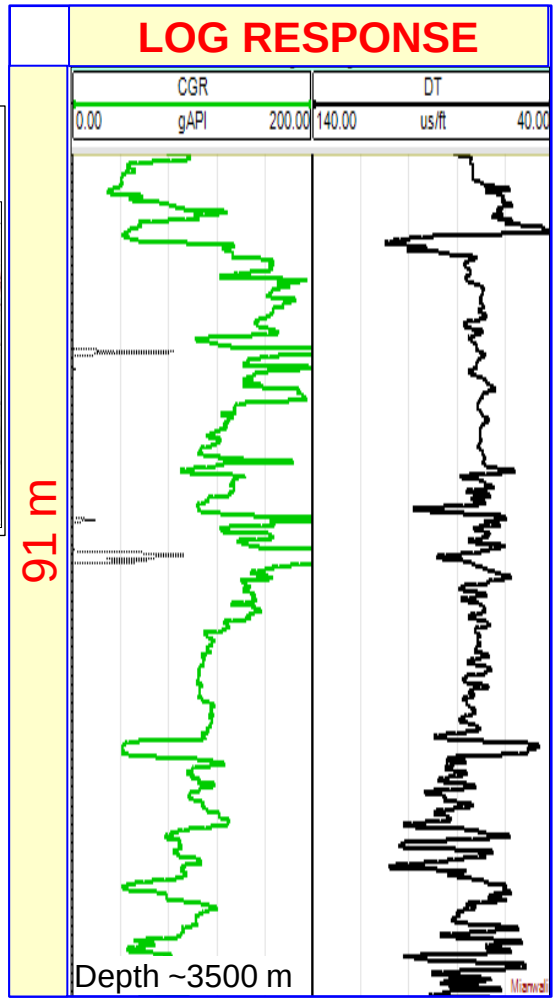
Avg. log Φ = 7-10%



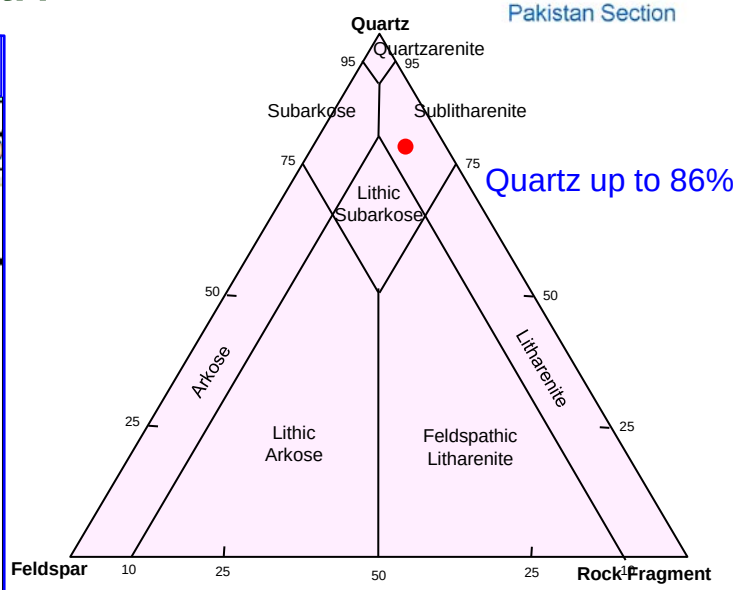
Showing Monocrystalline quartz (I4), Opaque mineral (B8), Brown Tourmaline (H5) embedded in calcite matrix (C2) and Intergranular porosity (F6) (Mag X10)

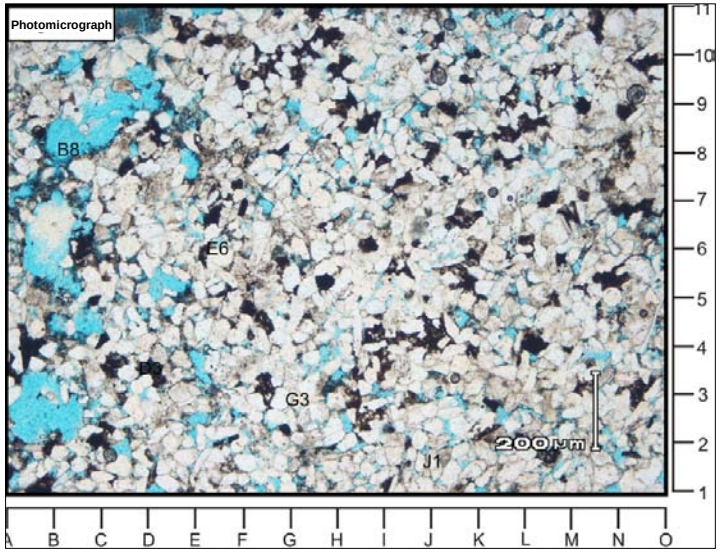
Triassic – Tredian





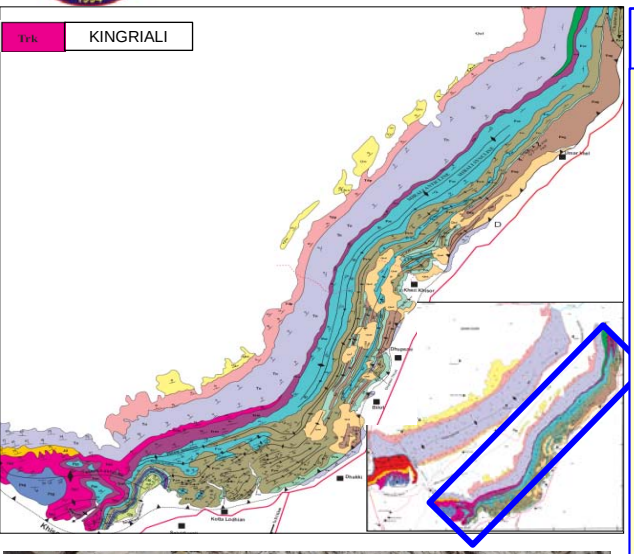
Log	Surface sample
Avg. Φ	Plug Φ
15%	26%



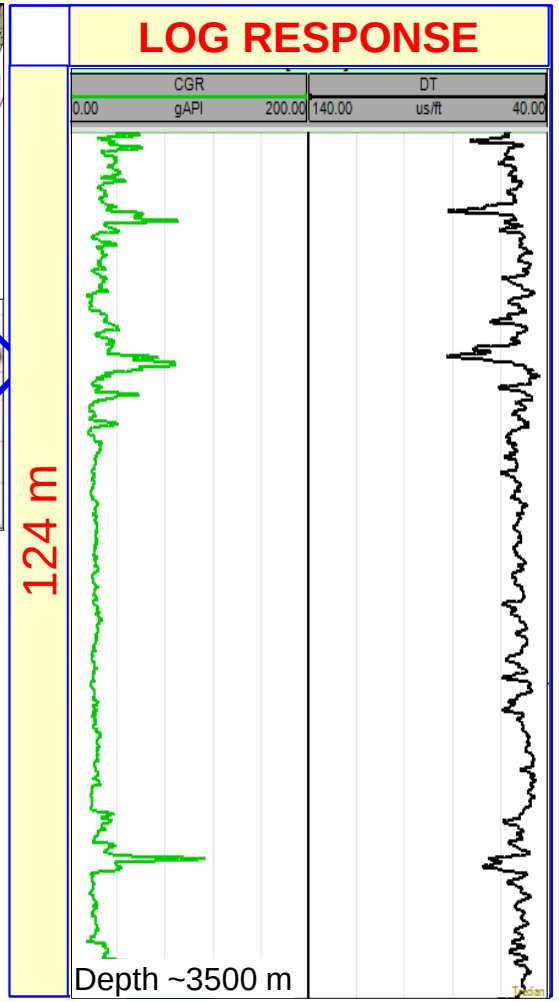


Showing Monocrystalline Quartz (F6), Mica (G3), intergranular porosity (B8) and Plagioclase (J1) embedded in oxidized matrix (D3) (Mag X04)

Triassic – Kingriali



LOG RESPONSE

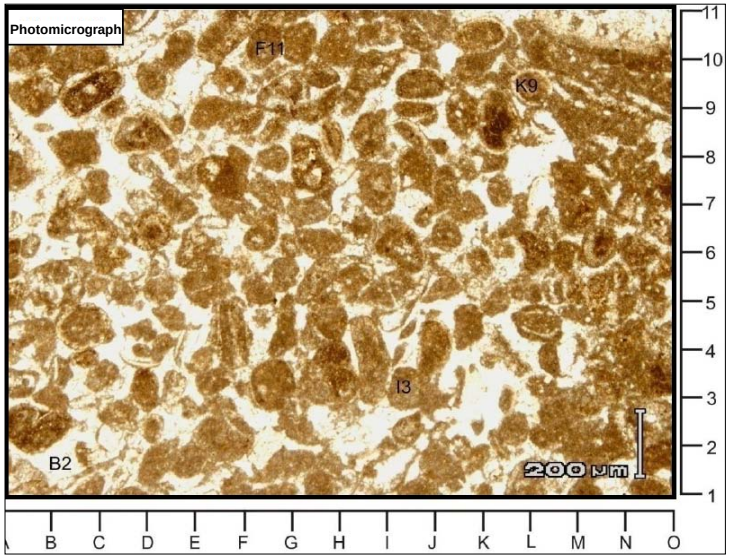


Log	Surface sample
Avg. Φ	Plug Φ
2-4%	0.6%

CLASSIFICATION

Folk's (1962)	Dunham's (1962)
Peloidal Biosparrite	Grainstone (poorly washed)

Bioclasts	30%
Peloids	25%
Ooids	10%
Matrix	05%
Sparry calcite cement	30%



Showing Grainstone displaying Peloid (I3), Micritized biserisal Foram (F11) and Ooid (K9) embedded in granular mosaic cement (B2) (Mag.X04)

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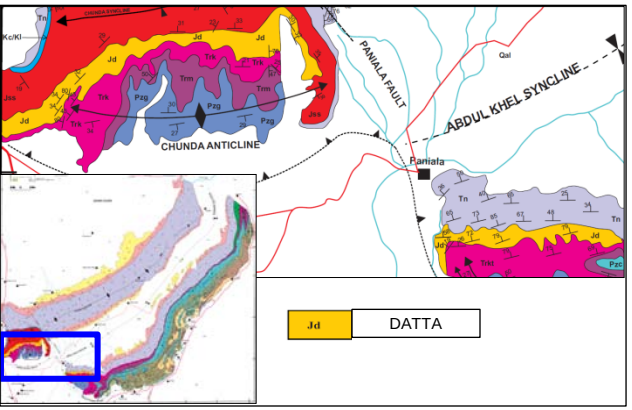
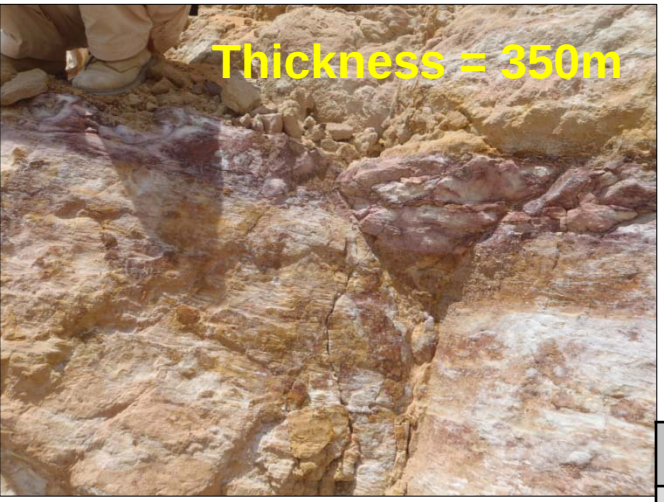
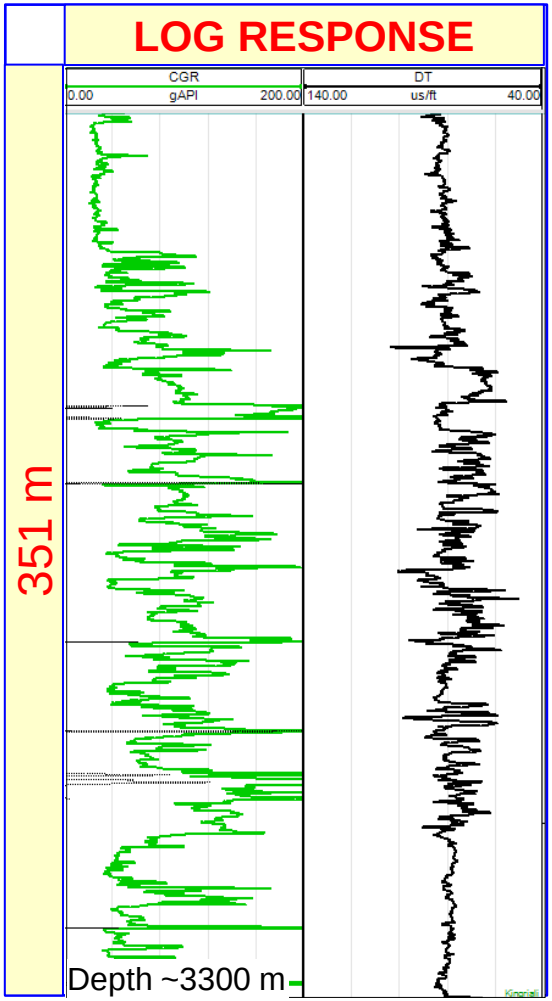
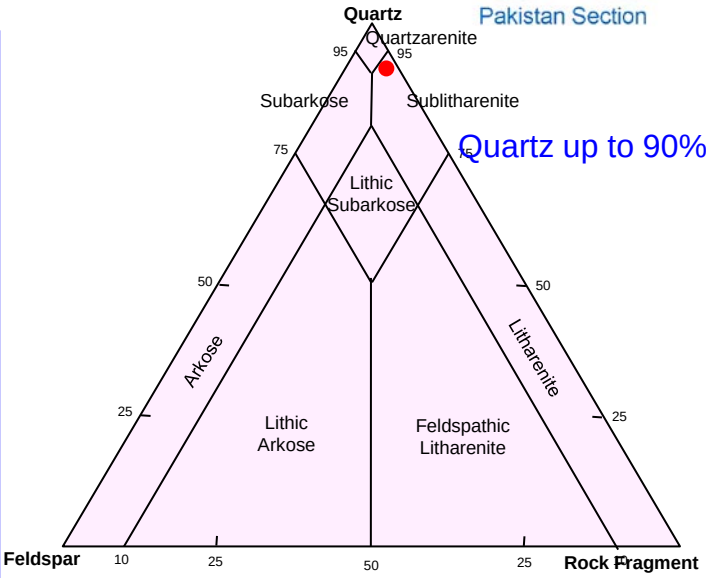
Jurassic – Datta

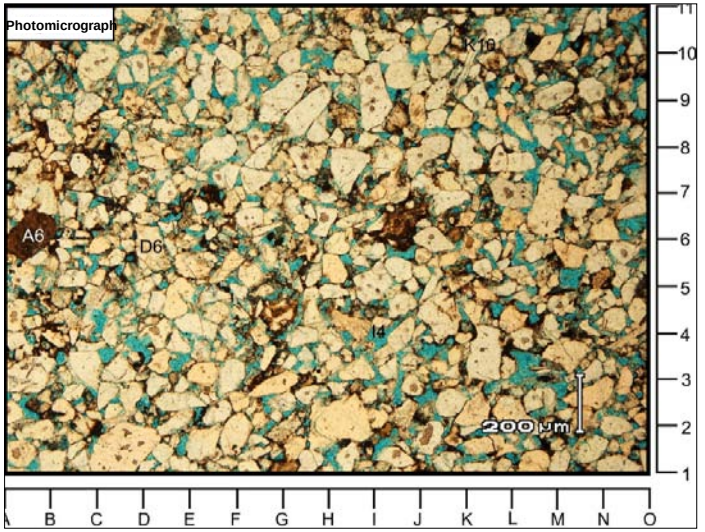






Log	Surface sample
Avg. Φ	Plug Φ
20%	18-30%





Showing Zoned Plagioclase (D6), Mica (K10), Fractured Quartz (D5), Rock Fragment-siltstone (A6), Intergranular effective porosity and high permeability (I4). Grains are loosely packed and mostly pointed contact. (Mag X04)

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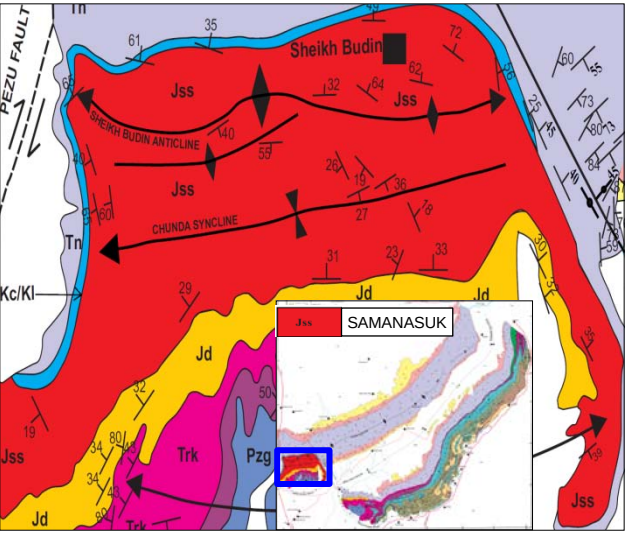
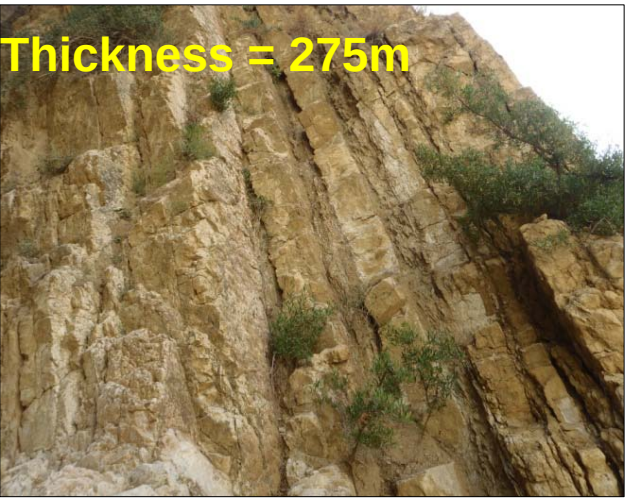
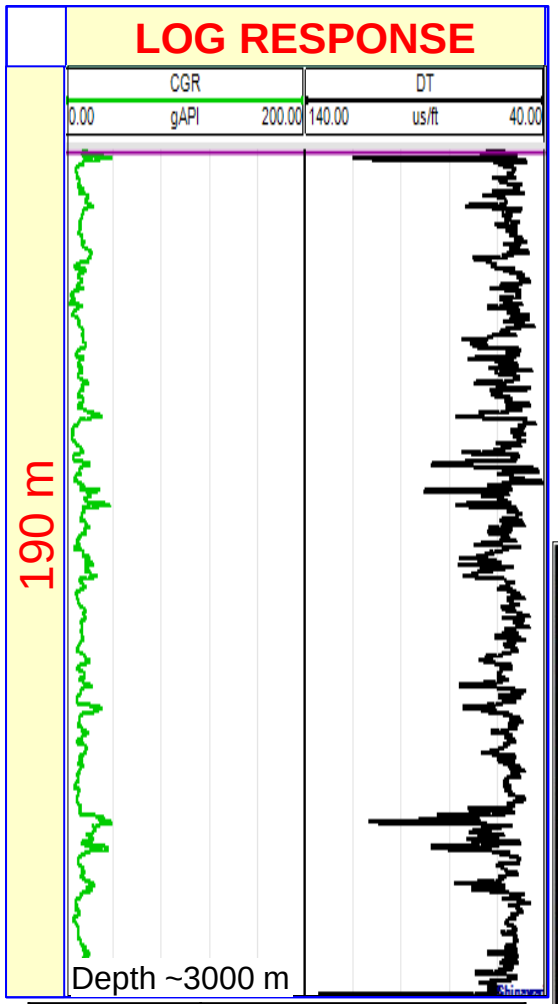
Jurassic – Samanasuk



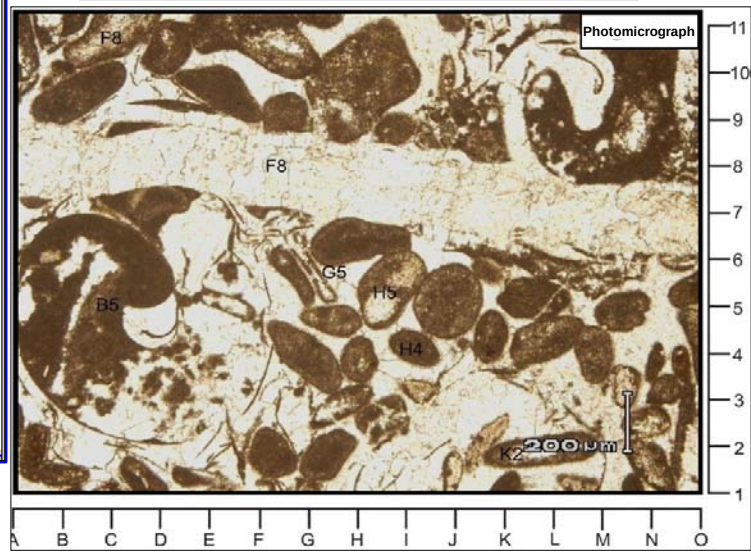




Log	Surface sample
Avg. Φ	Plug Φ
2%	0.7%

CLASSIFICATION	
Folk's (1962)	**Dunham's (1962)**
Bio-Pel Sparite	Grainstone

Peloids	38%
Bioclasts	35%
Ooids	05%
Intraclast	02%
Sparry calcite cement	20%



Showing Grainstone displaying Peloid (H4), Lumpy micritized ooid (H5), Gastropod (B5), Fracture (F8) and Micritized algae (K2) embedded in sparry cement (G5) (Mag.X04)

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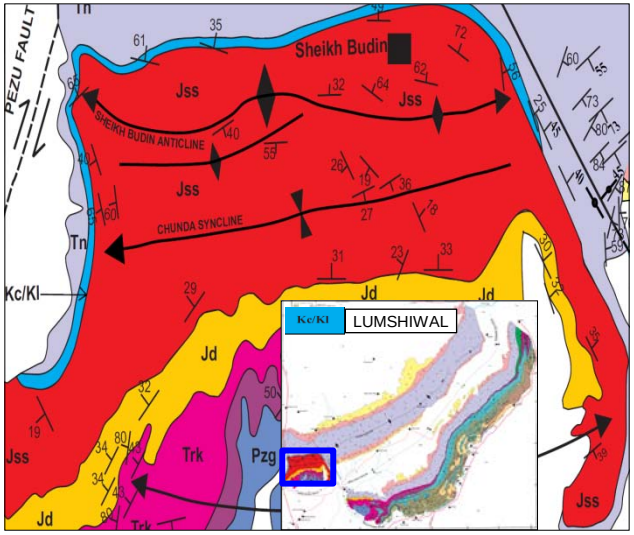
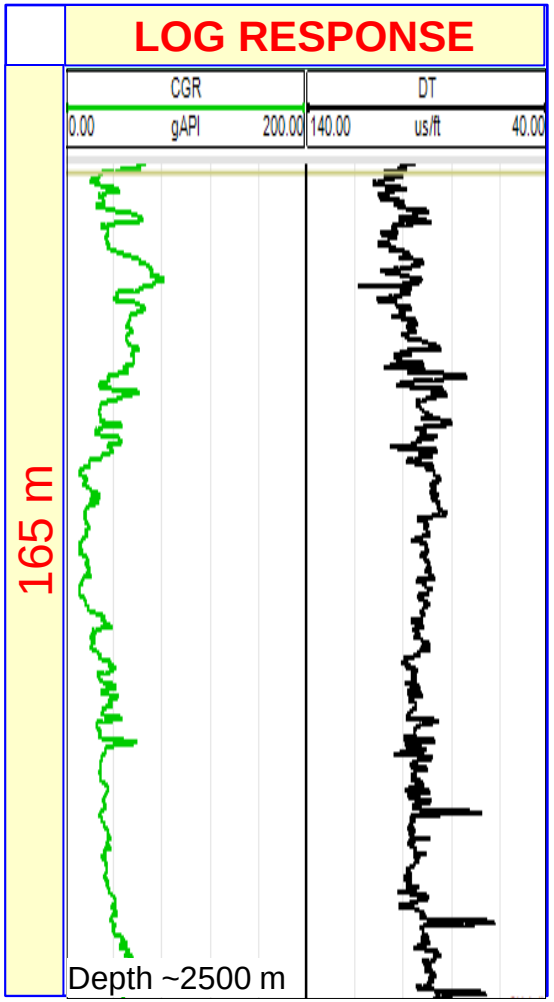
Cretaceous – Lumshiwal

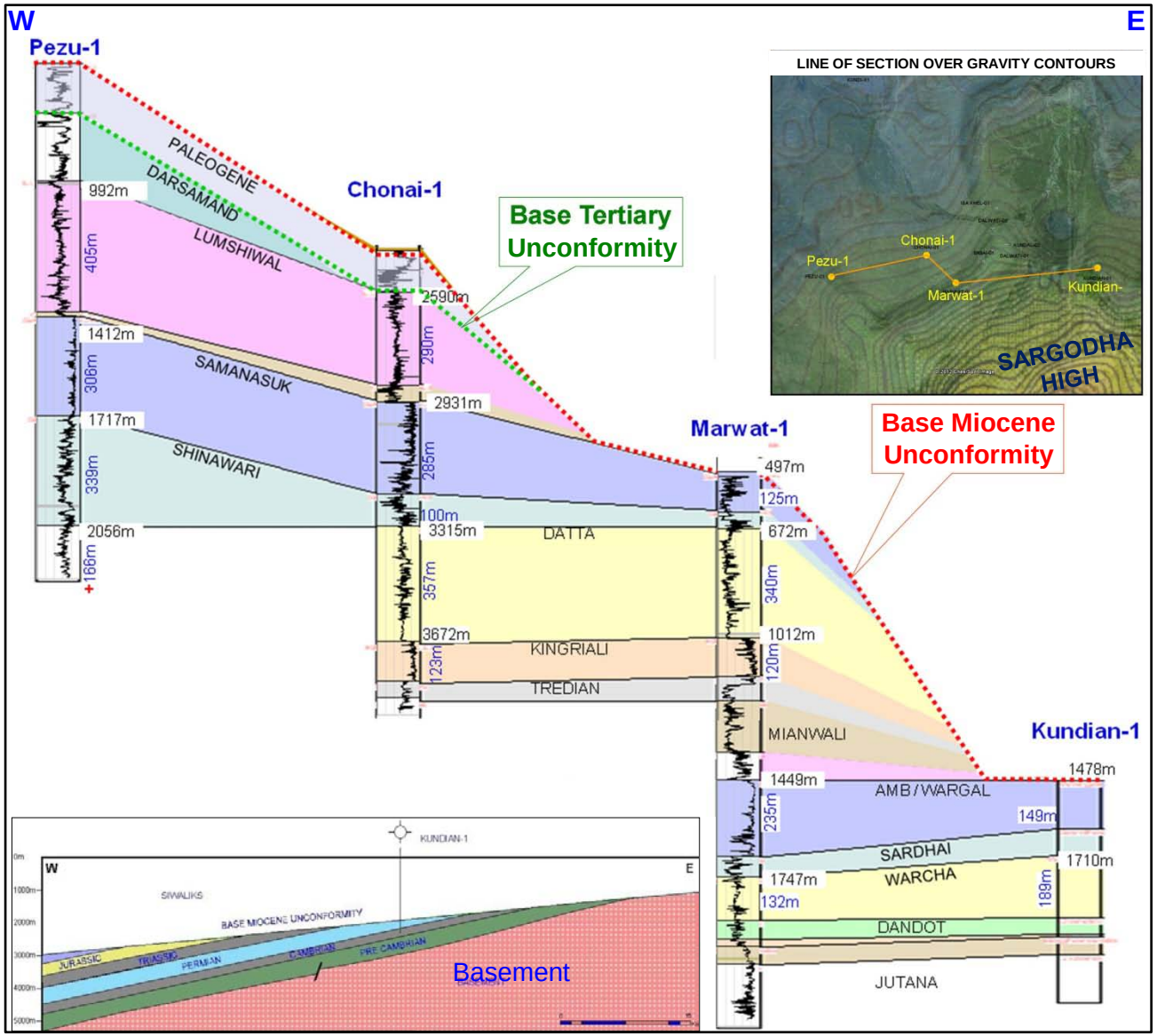




Avg. log Φ = 20 - 25%

Reservoirs Correlation

- Uplifting of Sargodha high eroded Lower Tertiary and older sediments
- Basement exposed in the east (at Sargodha High)
- Sediments of Early Eocene to Cambrian gradually truncates below the unconformity
- Stratigraphic gap narrows westwards where Miocene sediments overlie Late Eocene carbonates
- Long term exposure can lead to better porosities



Conclusion

- Clastics of Mesozoic and Paleozoic have multiple reservoirs with good range of porosity
- Carbonate sequence also have good reservoir potential
- Surface geology along with drilling activity shows ample thicknesses of the reservoir formations to be economical
- Better understanding of reservoir characteristics along with facies distribution would develop by additional data

Acknowledgment

- PPL, MGCL, GHPL and SAITA Management are acknowledged for permission to present this paper

- We are grateful to Mr. Syed Manshoor Ali Naqvi of Spud Energy Pty Ltd for their valuable review and productive feedback

Thank You