

A Synthesis of Myanmar Petroleum Geology and Potential*

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Abstract

With occurrences of numerous surface oil seeps, Myanmar became one of the oldest known oil producing countries in the world. The oil industry in Myanmar dates back to 10th Century AD, when the king granted the right to extract oil from shallow hand dug wells in the Yenangyaung area, Magway Region. Local trade of crude oil was started in 1824 and later in 1853 the crude oil was exported to Britain for the extraction of wax for candles, for use as a lubricant and in oil lamps. In a regional plate tectonic framework, Myanmar is situated on the active convergent plate boundary zone between the Indian Plate and Eurasian Plate. Plate mosaic in the Myanmar region constitutes the Indian Plate, Eurasia Plate, Burma Plate, and Sunda Plate. The plate mosaic is separated by three different types of plate boundaries: (1) the convergent plate boundary (subduction) between the Indian Oceanic Plate and continental Burma Plate which encompasses the west and south, (2) the continent to continent convergent plate boundary between the Burma Plate and continental Eurasia plate in the north, and (3) the transform boundary in the east among the Eurasia, Sunda and Burma plates.

References Cited

Aung, K.K., 2014, Where Shall We Go to Find Oil and Gas Discovery Especially in Myanmar Onshore Blocks: Myanmar Oil and Gas Enterprise, Myanmar Oil and Gas Week, Yangon, Myanmar.

Thein, M., 2000, Stratigraphic Units of Myanmar: http://kyawlinnzaw.weebly.com/uploads/4/5/1/3/4513060/stra_correlation.pdf. Website accessed April 2016.



The First AAPG/EAGE/MGS Oil & Gas Conference



A synthesis of Myanmar petroleum geology and potential

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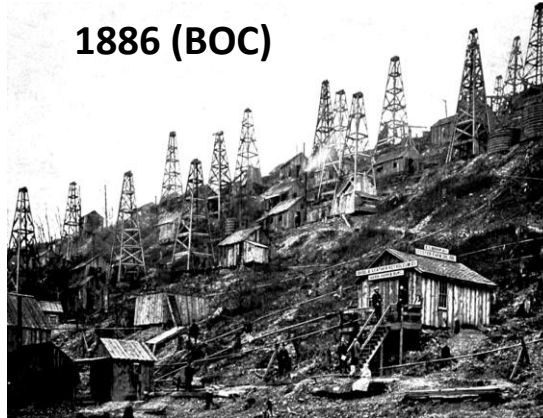
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HISTORY OF MYANMAR OIL INDUSTRY

Up to 1824 (Twinza Yo)



1886 (BOC)



1963 (POI)



2014

Zawtika



Yadana

1998 (MOGE)



1974 (MOC)



- The oil industry in Myanmar dated back to 10th Century AD, when the king granted the right to extract oil from shallow hand dug wells in the Yenangyaung in Magway Region.
- Local trade of crude oil was started in 1824 and later in 1853 the crude oil was exported to Britain.
- In 1866, the Burmah Oil Company (BOC) was founded and monopolised the oil industry.
- In 1974 the state owned oil industry (MOC) demarcated 25 shallow water blocks and launched exploratory drilling in offshore areas with foreign companies and itself.
- The first onshore production sharing contract bidding round was started in 1988 and multinational oil companies invested for exploration and production.

CURRENT PRODUCTION SHARING CONTRACTORS

Currently, 32 international companies from 20 countries are operating in 65 blocks

ONSHORE & OFFSHORE BLOCKS & OPERATORS

Sr No	Nos Of Block		Names Of Blocks	Names Of Companies	Countries of Companies
	ON	OFF			
1	2		A,E	Nobel Oil	Russia
2	2		B2, EP-3	ONGC Videsh	India
3	2		C1, H	Pacific Hunt Energy	Canada
4	1		F	NPCC	China
5	3	5	G, EP-2, MOGE-3 M-3, M-9, M-11, MD-7, MD-8	PTTEP SA, PTTEPI	Thailand
6	1		I	Jubilant	India
7	2	2	K, RSF-5, MD-2, MD-4	Eni B.V.	Italy
8	1		R	SNOG Pte Ltd	Myanmar
9	1		EP-1	Brunei National	Brunei
10	1		EP-4	Bashneft B.V.	Russia
11	1		EP-5	PT ISTECH	Indonesia
12	2		MOGE-1, IOR-2	Gold Petrol	China
13	4	3	RSF-2 & RSF-3, IOR-5, IOR-7, M-12 M-13,M-14	PCMI/ PCML	Malaysia
14	1		RSF-9	Geopetrol	Switzerland

ONSHORE & OFFSHORE BLOCKS & OPERATORS

Sr No	Nos Of Block		Names Of Blocks	Names Of Companies	Countries of Companies
	ON	OFF			
15	3	1	MOGE-2, IOR-4 & IOR-6 A-6	MPRL	Myanmar
16	1		MOGE-4	CAOG S.a.r.l	Luxembourg
17		3	A-1, A-3, AD-7	Daewoo	Korea
18		4	A-4, A-7, AD-2, AD-5	BG & Woodside	UK, Australia
19		1	A-5	Chevron (Unocal)	USA
20		3	AD-1, AD-6, AD-8	CNPC	China
21		1	AD-3	Ophir	UK
22		3	AD-9, AD-11 MD-5	Shell & MOECO	Netherland
23		1	AD-10	Stat Oil & ConocoPhillips	Norway USA
24		3	YWB, M-5, M-6	Total	France
25		1	M-2	PVEP	Vietnam
26		2	M-4, YEB	Oil India	India
27		1	M-8	Berlanga	Netherland
28		1	M-15	Transcontinental	Australia
29		2	M-17, M-18	Reliance Industries Ltd	India
	28	37	Blocks (Total 65)	Companies (32)	20

2 Onshore Blocks (PSC -J & O) PSC contracts have not been signed yet with Petroleum Exploration Pvt (Pakistan)
1 Offshore Shallow Water Block (M-7) PSC contract has not been signed yet with Tap Oil Ltd (Australia)

REGIONAL GEOLOGY

- In a regional plate tectonic framework, Myanmar is situated on the active convergent plate boundary zone between Indian Plate and Eurasian Plate.
- Plate mosaic in Myanmar region constitutes Indian Plate, Eurasia Plate, Burma Plate and Sunda Plate, separated by three different types of plate boundaries;
 - (1.a) the convergent plate boundary (subduction) between Indian Oceanic Plate and continental Burma Plate which encompasses in the west and south,
 - (1.b) the continent to continent convergent plate boundary between Burma Plate and continental Eurasia plate in the north, and
 - (2) the transform boundary in the east among Eurasia and Burma plates.
 - (3) the divergent plate boundary between Burma and Sunda plates.
- The plate movements with respect to boundaries influence the formation and distribution of hydrocarbon traps.

PLATE MOSAIC AND PLATE BOUNDARIES IN MYANMAR REGION.

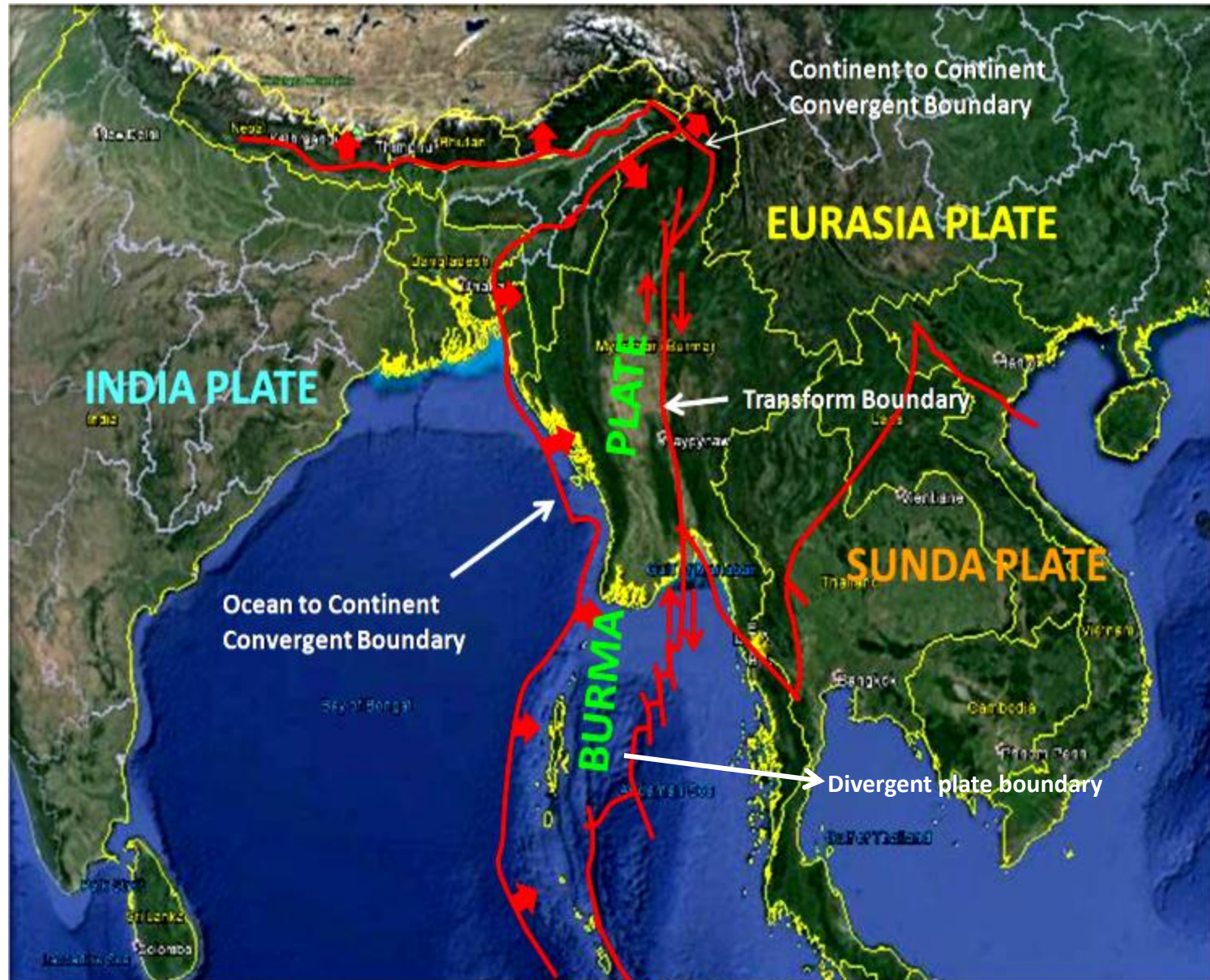
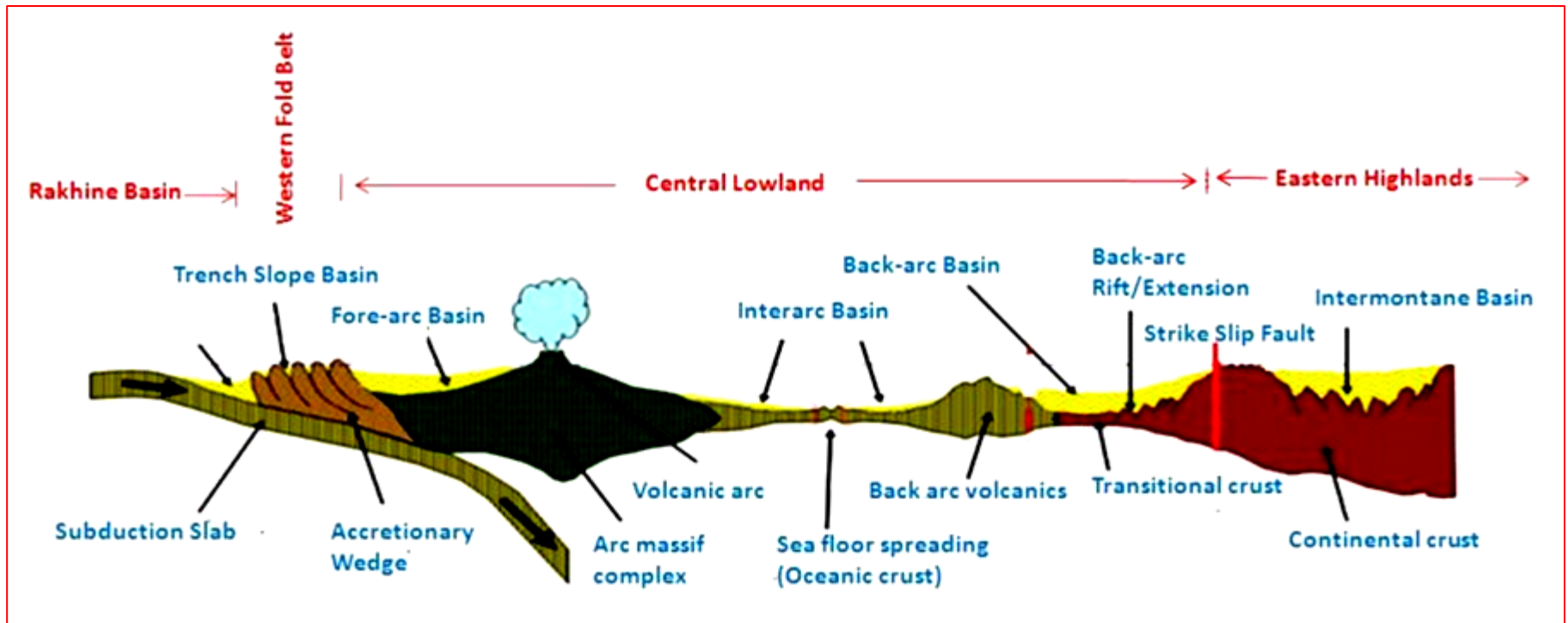
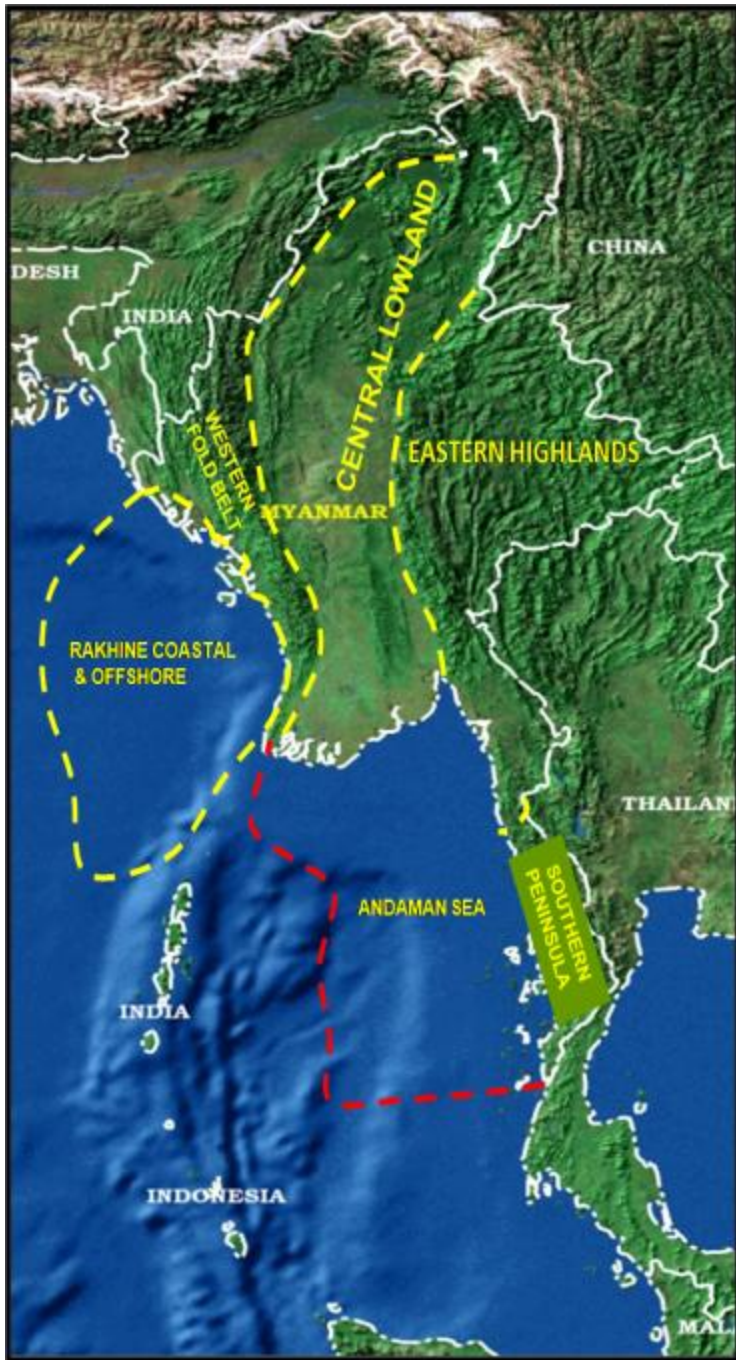


PLATE TECTONIC MODEL OF MYANMAR

As a result of three different plate movements, the plate tectonic model of Myanmar is characterized by subduction zone, accretionary prism, volcanic arc, fore-arc/ back-arc basin complex, plate dextral faults and intermontane basins.





GEOTECTONIC PROVINCES OF MYANMAR

Myanmar region can be divided into six geotectonic provinces;

- (1) Rakhine coastal and offshore,
- (2) Western Fold Belt,
- (3) Central Lowland,
- (4) Eastern Highlands,
- (5) Southern Peninsula, and
- (6) Andaman Sea.

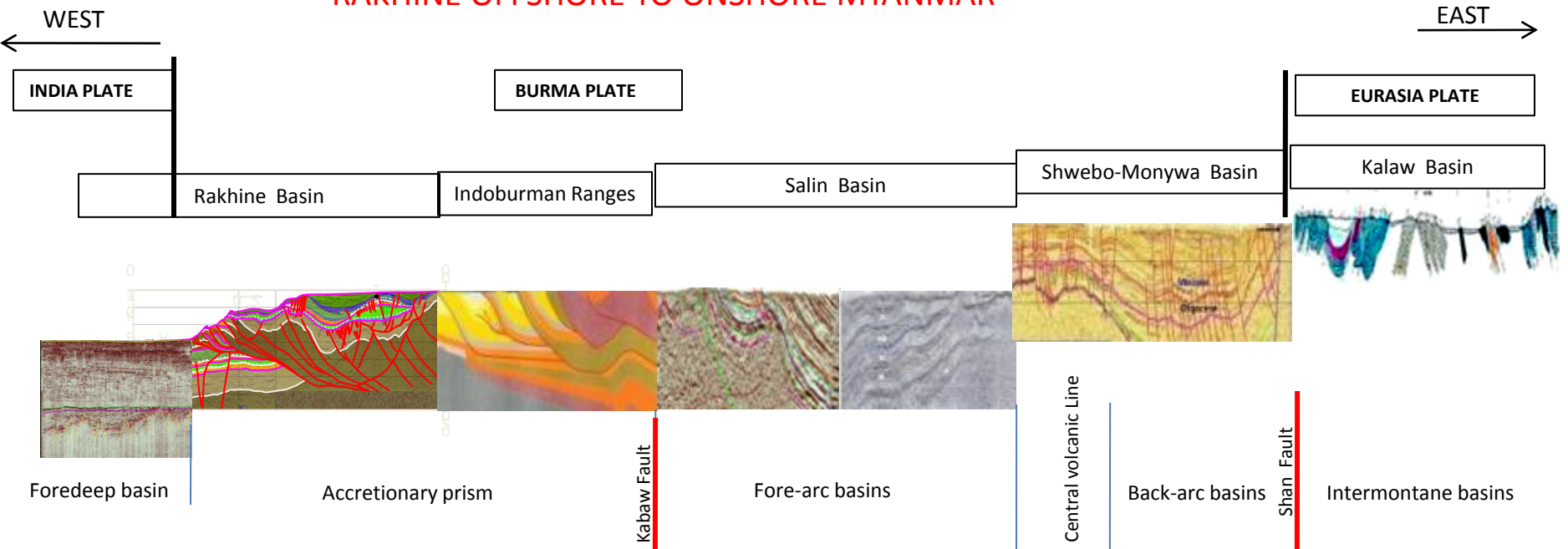
Rakhine shallow water and coastal area, Western fold belt, Central lowland and west Andaman sea areas are located on the Burma plate. Rakhine deepwater area is on the Indian oceanic plate and the Eastern highlands are part of Eurasia plate while east Andaman sea area and Southern peninsula are westernmost segment of the Sunda plate.

TECTONO-STRATIGRAPHY AND STRUCTURAL STYLE

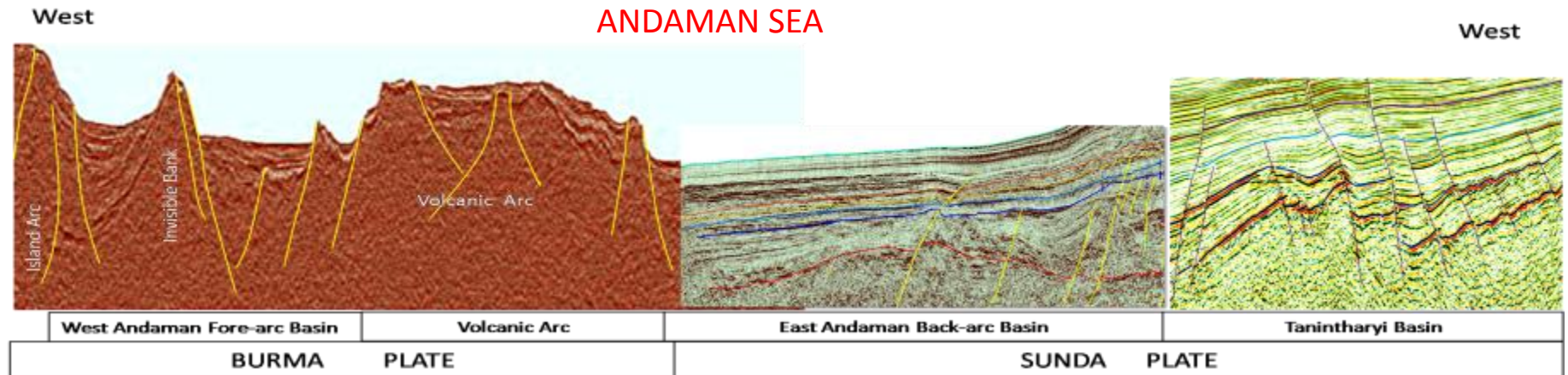
- In view of resting on different plates, each province has specific tectono-stratigraphy and structural style.
- The present day structural fabrics in these plates are the product of a series of poly phase collisions and rotations of the Indian Plate and micro plates from Mid-Jurassic to present and being largely modified by the active dextral shear inversion initiated since Late Miocene.
- The transpressional structures are dominated in the vicinity of convergent boundaries while transtensional structures are predominant in the region of transform and divergent boundaries.

STRUCTURAL STYLES OF MYANMAR PLATE MOSAIC

RAKHINE OFFSHORE TO ONSHORE MYANMAR



ANDAMAN SEA



SEDIMENTARY BASINS OF MYANMAR

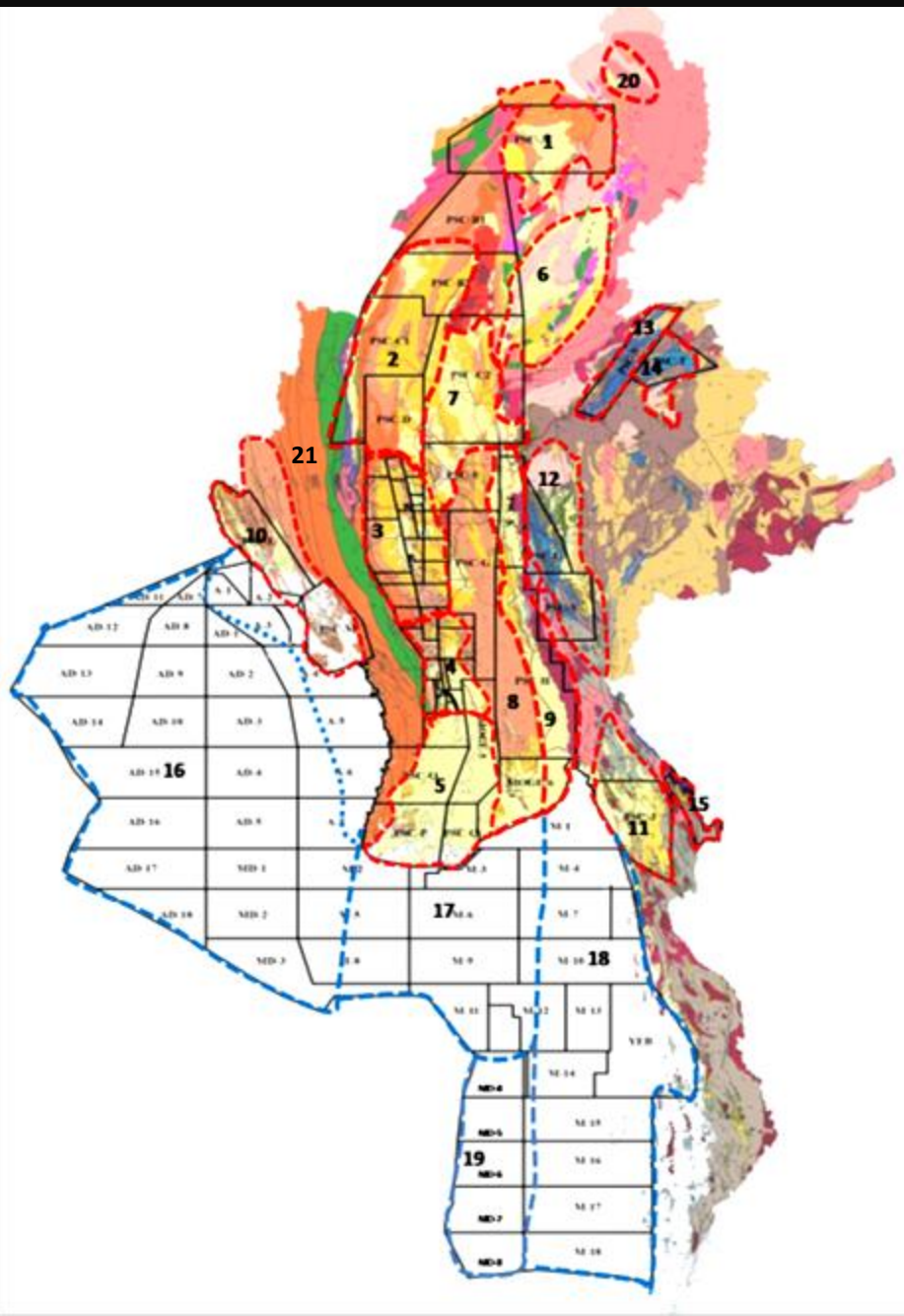
- A total of twenty two sizable sedimentary basins are identified in Myanmar.
- The western coastal and offshore province is represented by Rakhine deepwater basin and coastal/ shallower basin.
- The western fold belt is an accretionary basin which is southern segment of Chittagong Fold Belt in Bangladesh, and Tripura-Cachar Fold and Disang Flysch belts in India.
- Central Myanmar Lowland is a Tertiary fore-arc and back-arc basin complex which comprises of five fore-arc basins (Hukaung, Chindwin, Salin, Pyay Embayment, Ayeyarwady) and four back-arc basins (Myitkyina-Katha, Shwebo-Monywa, Bago Yoma, Sittaung) separated by central volcanic arc.
- Three Tertiary (Putao, Mawlamyine, Mepale) and three pre-Tertiary intermontane basins (Hsipaw-Lashio, Namyau, Kalaw) are developed on the Eastern Highlands.
- The Andaman Sea province is a seaward continuation of Central Myanmar Lowland and also characterized by a fore-arc and back-arc basin complex which includes one fore-arc basin (West Moattama) and three back -arc basins (East Moattama, Tanintharyi and East Andaman).

SEDIMENTARY BASINS OF MYANMAR

PLATE	GEOTECTONIC PROVINCE	SEDIMENTARY BASIN	BASIN CLASSIFICATION
INDIA	Rakhine Deepwater	Rakhine Deepwater	Foredeep
BURMA	Rakhine shallow water and coastal	Rakhine shallow water and coastal	Accretionary prism
	Western Fold Belt (Rakhine, Chin, Naga)	Not identified yet	Accretionary prism
	Central Lowland (Sagaing, Magway, Bago, Ayearwaddy region)	Hukaung Chindwin Salin Pyay Embayment Ayeyarwaddy Myitkyina-Katha Shwebo-Monywa Bago Yoma Sittaung	Fore-arc Fore-arc Fore-arc Fore-arc Fore-arc Back-arc Back-arc Back-arc Back-arc
	West Andaman Sea	West Moattama East Moattama West Andaman (Indian Territory) Andaman Island (Indian Territory)	Fore-arc Back-arc Fore-arc Island arc (Accretionary prism)
SUNDA	East Andaman	East Andaman Taninthary	Strike slip Terrace
	Southern Peninsula (Kayin-Tanntharyi)	Not define yet	
EURASIA	Eastern Highlands (Kachin,-Shan- Kayar- Kayin-Mon)	Putao Hsopaw-Lashio Namyau Kalaw Mawlamyine Mepale	Intermontane Intermontane Intermontane Intermontane Intermontane Intermontane

SEDIMENTARY BASINS OF MYANMAR

A total of twenty one sedimentary basins are identified in Myanmar.



FORE-ARC	<i>Hukawng(1), Chindwin(2), Central Myanmar(3), Pyay Embayment(4), Ayeyarwady Delta(5), West Moattama Offshore(17)</i>
BACK-ARC	<i>Myitkyina-Katha (6), Shwebo-Monywa(7), Bago Yoma (8), Sittaung (9), East Moattama Offshore(17), Tanintharyi Offshore(18) East Andaman (19)</i>
FOREDEEP	<i>Rakhine Coastal(10) , Rakhine Offshore(16)</i>
INTERMONTANE	<i>Mawlamyine(11), Kalaw (12), Mepale(15), Hsipaw-Lashio (13), Namyau (14), Putao(20)</i>
ACCRETIONARY PRISM	<i>Western Fold Belt(21)</i>

PETROLEUM SYSTEMS OF MYANMAR

GEOLOGICAL AGE	Petroleum system Element	SOURCE				RESERVOIR				REGIONAL SEAL				TRAP FORMATION				
		PLATE	I	B	E	S	I	B	E	S	I	B	E	S	I	B	E	S
Holocene																		
Pleistocene																		
Pliocene			★				●		●	■	■		■	★	★			★
Miocene	L	★			★	●	●		●	■	■		■	★	★			★
	M				★	●	●		●	■	■	■	■	★				★
	E	★	★		★	●	●		●	■	■		■	★				★
Oligocene	L		★		★	●	●		●	■	■		■		★			★
	E				★	●	●		●	■			■					
Eocene	L	★	★		★	●	●		●	■			■		★			
	M	★	★			●	●			■								
	E		★														✦	
Paleocene	L		★															
	E		★															
Cretaceous	L	★	★	★									■		★			
	E						●										✦	
Jurassic	L						●										✦	
	M			★			●											
	E			★			●					■						
Triassic	L			★			●					■					✦	
	M			★														
	E						●											
Permian	L						●											
	E			★			●					■						
Carbonaceous	L						●											
	E						●											
Devonian	L			★									■					
	M			★														
	E																	
Silurian	L																	
	E																	
Ordovician	L																	
	M																	
	E																	
Cambrian	L																	
	M																	
	E																	

- In petroleum geological point of view, Myanmar has three petroleum systems; Tertiary, Mesozoic and Palaeozoic.
- Up to present, petroleum exploration and production in Myanmar are confined only in the Tertiary.

I – India Plate
 B- Burma Plate
 E- Eurasia Plate
 S- Sunda Plate

- In petroleum geological point of view, Myanmar posses three petroleum systems; Tertiary, Mesozoic and Paleozoic.
- Up to present, petroleum exploration and production in Myanmar are confined only in the Tertiary petroleum system.

Proven Tertiary Hydrocarbon Basins

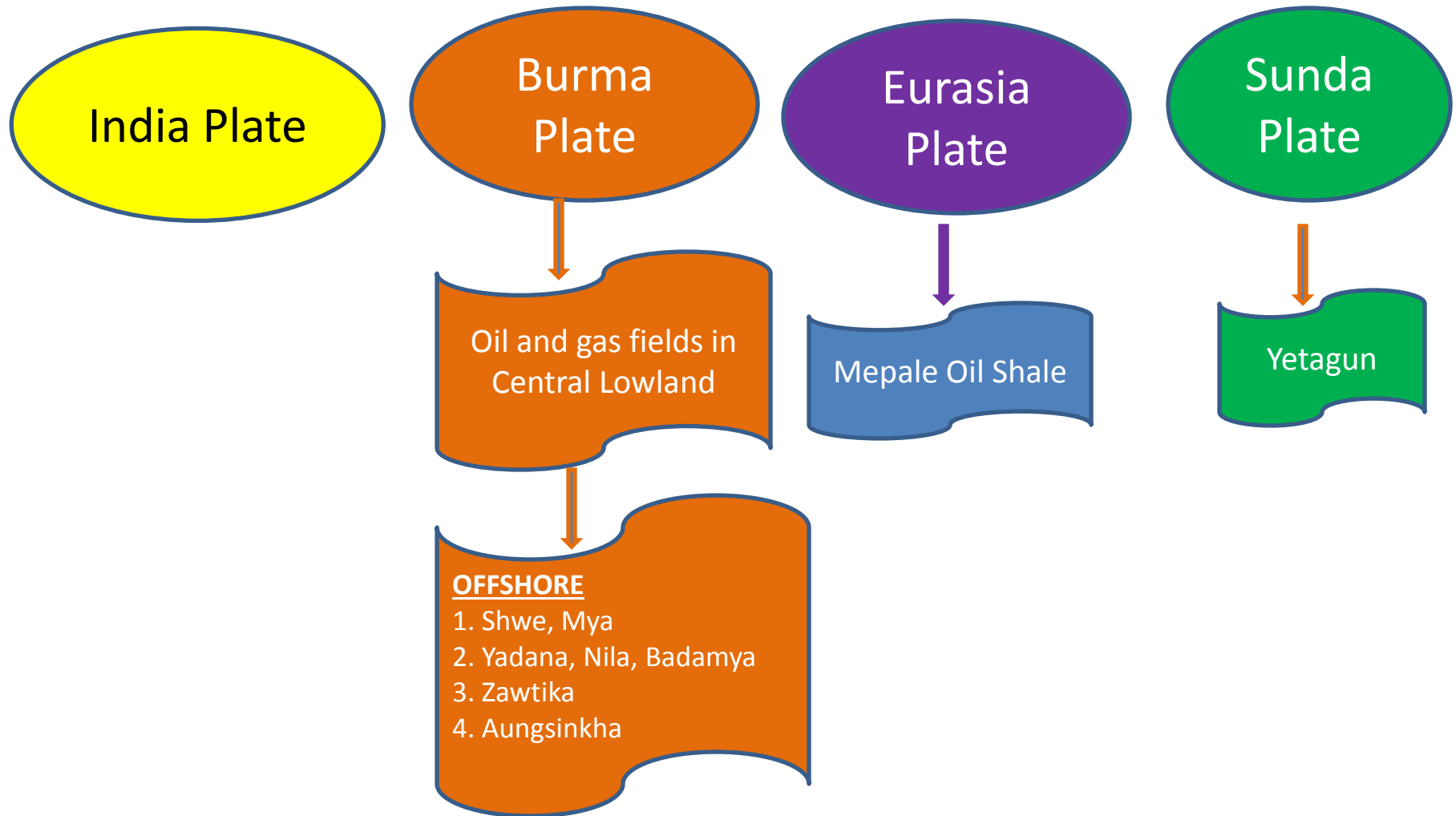
Onshore

1. Central
2. Chindwin
3. Pyay Embayment
4. Ayeyarwady
5. Bago Yoma
6. Rakhine Coastal

Offshore

1. Rakhine
2. Moattama
3. Tanintharyi

HYDROCARBON OCCURENCES IN MYANMAR PLATE MOSAIC



OIL AND GAS DISCOVERIES

- So far oil and gas discoveries could be made only in Tertiary petroleum system.
- A total of thirty six Tertiary hydrocarbon discoveries (25 for oil and 11 for gas) were made to date, of which ten were discovered by foreign oil companies and the rest twenty six were discovered by the efforts of national geoscientists.
- The age of the proven Tertiary hydrocarbon reservoirs ranges from Pleistocene to Eocene and lithologies are sandstones, carbonates and volcanoclastics. Both biogenic gas and thermogenic gas are discovered in Tertiary petroleum system. Biogenic gas is trapped in Plio-Pleistocene sediments, while oil and thermogenic gas are reservoirized in Miocene to Eocene sediments.

Tertiary Oil and Gas Discoveries in Myanmar

Basin /High	Oil/Gas Field	Geological Age			
		Plio-Pleistocene	Miocene	Oligocene	Eocene
Chindwin	Yenan				●
	Indaw		● ●		
22 Degree High	Letpando			●	●
	Kyaukkwet			●	●
	Patolon			●	●
	Ayadaw			●	
Salin	Thargyitaung/Sabe			●	
	Chauk			●	
	Yenangyaung		●	●	
	Mann		●	●	
	Htaukshabin/ Tabin/ Kanni/ Peppi		● ●	●	
	Ngahlaingdwin			●	● ●
	Yenanma			●	
	Dahatpin			●	
	Pyay Embayment		●		
	Pyalo		●		
Pyay Embayment	Natni		●		
	Padaukpin		●	●	
	Sakangyi		●		
	Pyay	●	● ●		
	Myanaung		● ●		
	Shwepyitha		● ●		
	Htantabin (Carbonate)		●		
	Payagon (Volcani-clastics)		● ●		
	Kyakite	●			
	Hteinkyun		●		
Ayeyarwady	Apyauk		●		
	Nyaungdon		●		
	Ma U Bin	●			
	Indaing	●			
	Shwegu				
Rakhine Coastal	Baronga Islands		●		
	Ledaung			●	●
Rakhine	Shwe	●			
Moattama	Yadana (Carbonate)		●		
	Badamya		●		
	Aung Sin kha (Carbonate)		●		
	Zawtika	●	●		
Tanintharyi	Yetagun		●		

● Biogenic Gas

● Oil

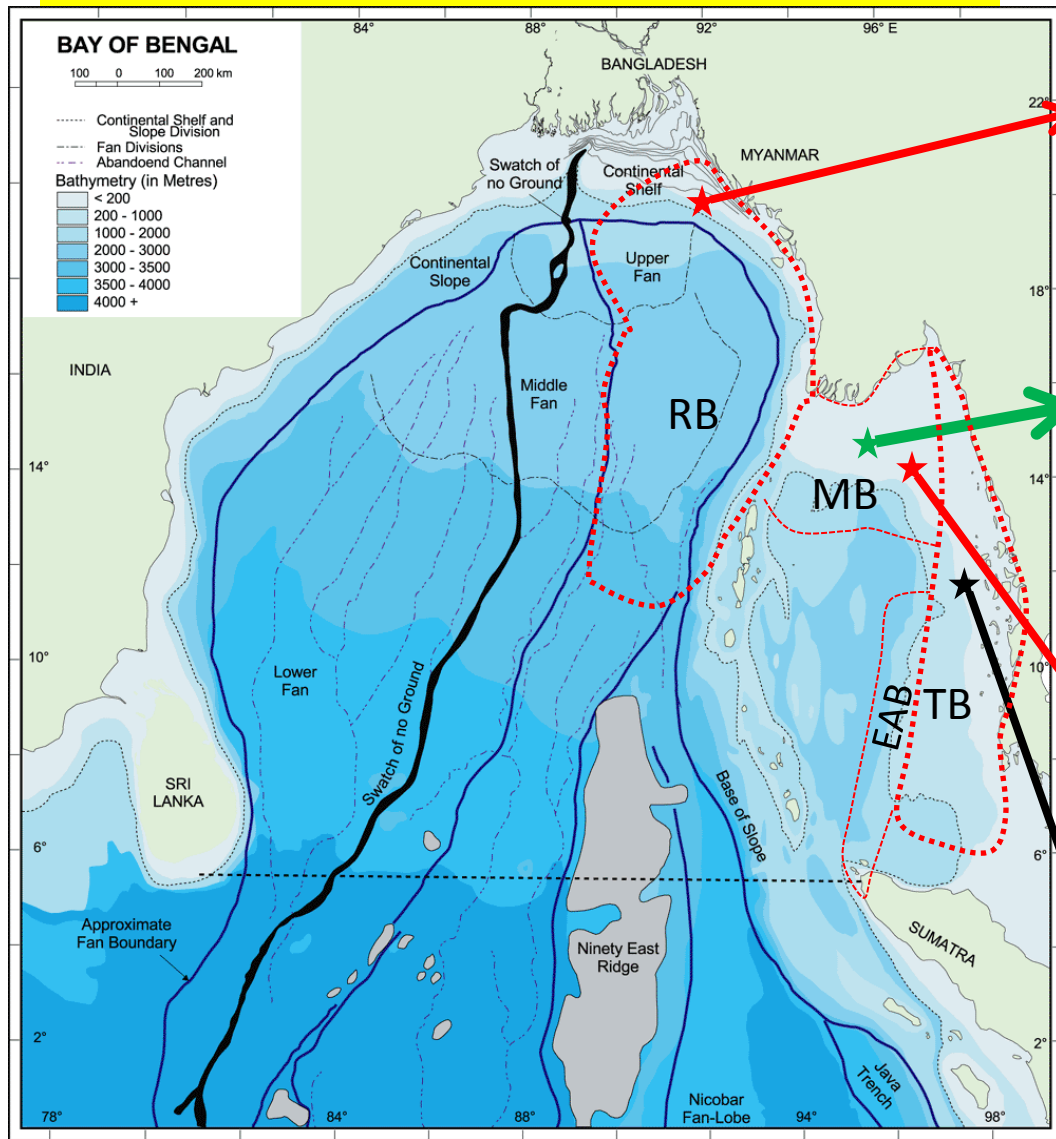
● Thermogenic Gas

CURRENT DAILY OIL AND GAS PRODUCTION OF MYANMAR



Sr. No	Name of Oil/Gas Field	Discovery Year	Daily Average Production	
			Oil (BOPD)	Gas (MMSCFD)
1	Yenangyaung (Goldpetrol)	1887	1,702	0.3000
2	AYADAW	1893	1	1.6267
3	Chauk/Lanywa(Goldprtrol)	1902	1,456	0.2020
4	Myanaung (MPRL)	1964	36	0.2583
5	Pyay (MPRL)	1965	83	0.1010
6	Shwepyithar (Petronas)	1967	88	0.0400
7	Mann (MPRL)	1970	1,422	2.0042
8	LETPANDO	1974	1,501	0.1270
9	PEPPI	1976	-	0.2024
10	HTAUKSHABIN	1978	526	0.8331
11	KANNI	1985	579	-
12	APYAUK	1991	17	7.5713
13	KYAUKKWET	1995	22	11.0574
14	NYAUNGDON	1999	206	9.5539
15	THARGYITAUNG/SABE	2001	158	2.5820
16	MAUBIN(SOUTH)	2006	75	11.1636
17	HTANGAING/DAHATPIN	2007	16	-
	Onshore Total		7,887	47.6229
18	YADANA	1982	-	516.2440
19	YETAGUN	1992	4,707	224.1090
20	SHWE	2004	-	409.6720
21	ZAWTIKA	2007	-	171.2180
	Offshore Total		4,707	1,321.2430
	Grand Total		12,594	1,368.8659

EXPORT GAS FIELDS IN MYANMAR OFFSHORE



Field

Shwe/Mya
 Yadana, Zawtika
 Yetagun

Basin

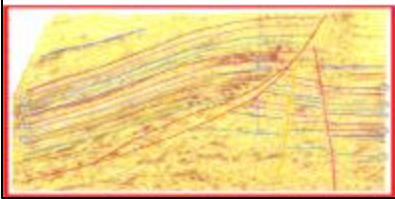
Rakhine Offshore Basin (RB)
 Moattama Offshore Basin (MB)
 Tanintharyi Offshore Basin (TB)

PROVEN TRAPPING GEOMETRIES

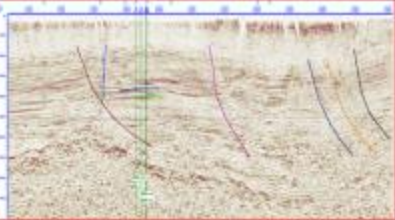
- **The proven trapping geometries in onshore Tertiary petroleum system include thrust related anticlines, inversion anticline, shoal limestone, wedgeout, extension faults, wrench related faults and basement related highs. The trapping geometry of onshore commercial oil fields are thrust related anticline. The trap types of large scale onshore gas fields are basement related high and extensional fault blocks.**
- **The proven commercial Tertiary offshore trap geometries are reefal carbonate build up, extensional fault trap, tilted fault blocks and submarine basin floor turbidites fan.**

PROVEN TERTIARY TRAP GEOMETRIES

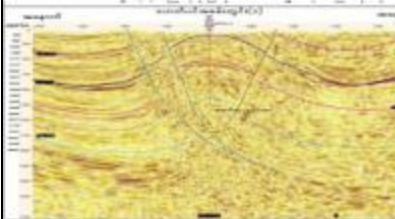
**Chauk Oil Field , Salin Basin
Miocene Compressive Anticline**



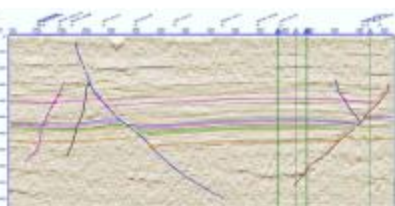
**Apyauk Gas Field , Ayeyarwady Basin
Basement Related High**



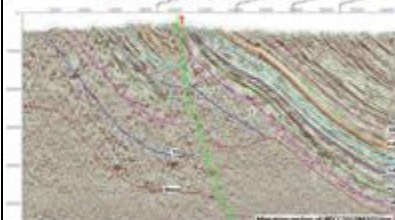
**Dahutpin Oil Field , Salin Basin
Pleistocene Inversion Anticline**



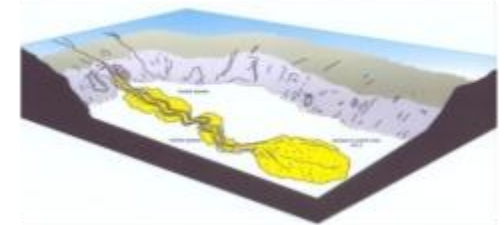
**Nyaungdon Gas Field , Ayeyarwady Basin
Normal Fault related two ways closure**



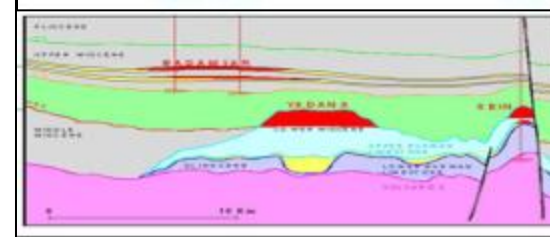
**Wedgeout Trap in Block PSC-F
West Flank of Salin Basin**



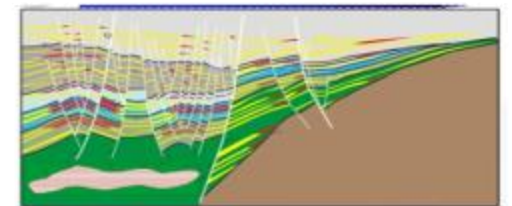
**Pliocene submarine turbidites basin floor fan
Shwe Gas Play (A-1), Rakhine Offshore**



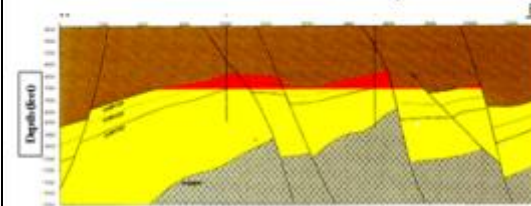
**Yadana reefal build up and Badamya
channel sandstone , Moattama Basin**



**Zawtika Gas Field , Moattama Basin
Extensional Fault Trap**



**Yetagun Gas Field , Tanintharyi Basin
Tilted Fault Block Trap**



Estimated Tertiary Hydrocarbon Resources in Myanmar

Source: U Kyaw Kyaw Aung MOGE (MOGEC 2015)

ONSHORE

As at 1-4-2015

Sedimentary Basin	OOIP (mmstb)	OGIP (bscf)	Cumulative Production		EFRR	
			Oil (mmstb)	Gas (bcf)	Oil (mmstb)	Gas (bcf)
Chindwin	50.000	11.014	1.200	0.002	8.800	8.808
Shwebo-Monywa	3,255.000	-	-	-	-	-
Central Myanmar	1,824.766	894.399	566.241	620.812	85.122	130.203
Pyay Embayment	145.002	483.987	40.652	304.531	5.173	89.599
Bago Yoma	-	29.034	-	2.399	-	20.828
Ayeyarwaddy delta	12.126	1,130.946	2.975	652.058	2.847	194.758
Rakhine Coastal	4.500	-	0.009	-	0.881	-
Total (7) Basins	2,036.394	2,549.380	611.077	1,579.802	102.823	444.196

OFFSHORE

As at 1-4-2015

Sedimentary Basin	Offshore Field	Operator	Initial Recoverable Cds (mmstb)	OGIP (tcf)	Initial Recoverable Gas	Cumulative Production		EFRR	
						Cds (mmstb)	Gas (tcf)	Cds (mmstb)	Gas (tcf)
Moattama	Yadana	TEPM	-	6.942	5.893	-	3.686	-	2.207
Taninthari	Yetagun	PCML	84.600	4.166	3.167	48.723	1.917	35.877	1.250
Rakhine	Shwe	Daewoo	-	5.353	4.531	-	0.179	-	4.352
Moattama	Zawtika	PTTEP	-	1.756	1.400	-	0.085	-	1.315
(3) Basins	(4) Fields	(4) Co.,	84.600	18.217	14.991	48.723	5.867	35.877	9.124

AREAS HAVING UNTAPPED HYDROCARBON POTENTIAL

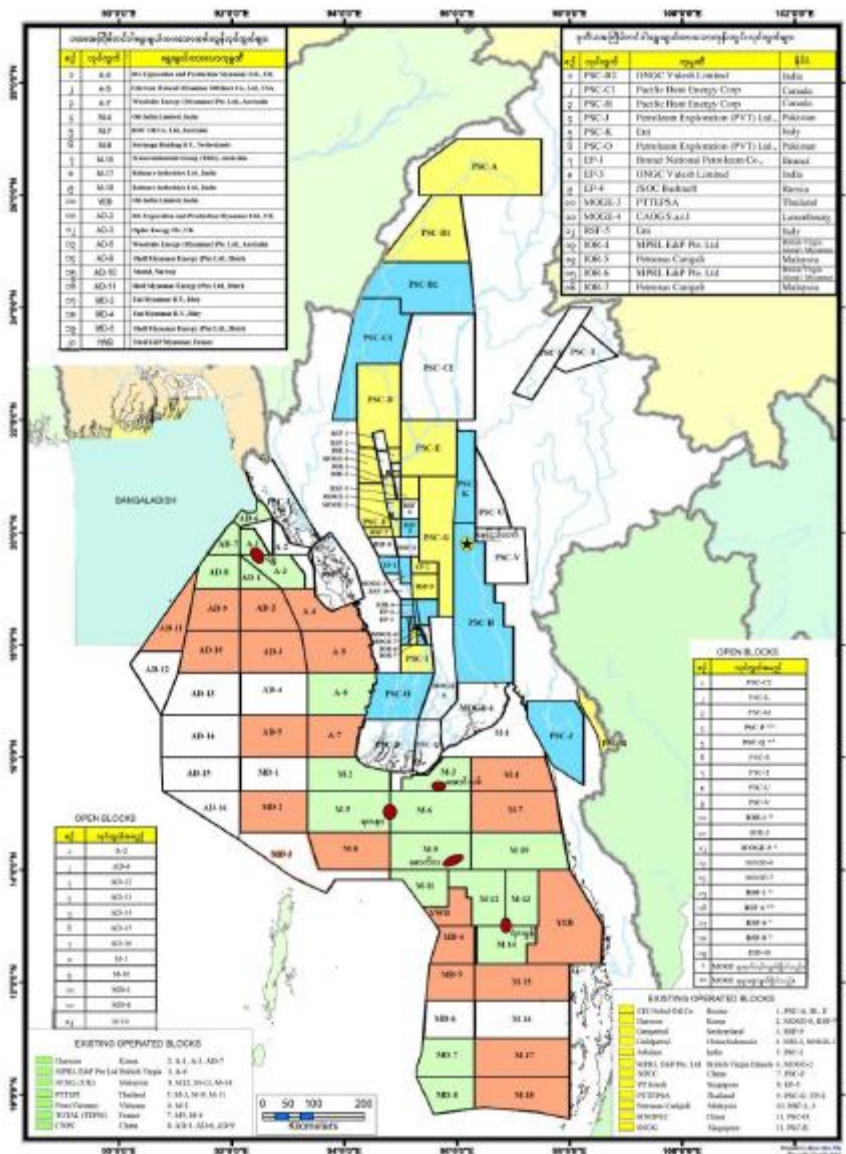
ONSHORE

- **7 Tertiary basins**
(Putao, Hukawng, Shwebo-Monywa, Myitkyina-Katha, Sittaung, Mawlamyine, Mepale)
- **3 Pre-Tertiary basins**
(Hsipaw-Lashio, Kalaw, Namyau)
- **Cross Basinal Highs (24°, 22°, 20°)**
- **Western Fold Belt**

OFFSHORE

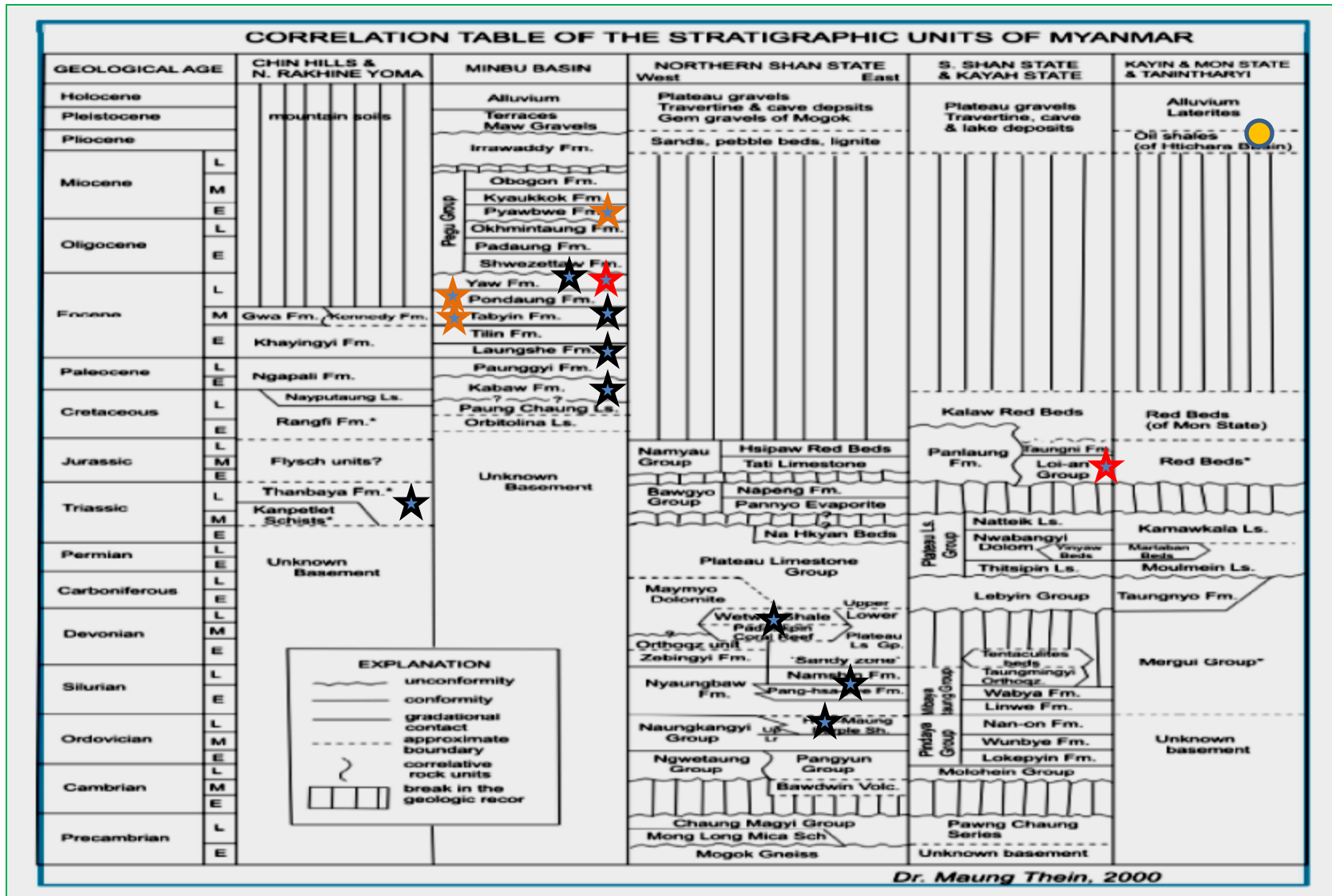
- **Deepwater areas**
(Rakhine Offshore, Moattama Offshore, East Andaman Basin)

PETROLEUM CONCESSION S MAP OF MYANMAR



ONSHORE - 53 BLOCKS
 OFFSHORE - 51 BLOCKS

STRATIGRAPHIC POSITION OF EXTRACTABLE UNCONVENTIONAL HYDROCARBON RESERVOIRS



OIL SHALE



SHALE GAS



CBM



TIGHT GAS

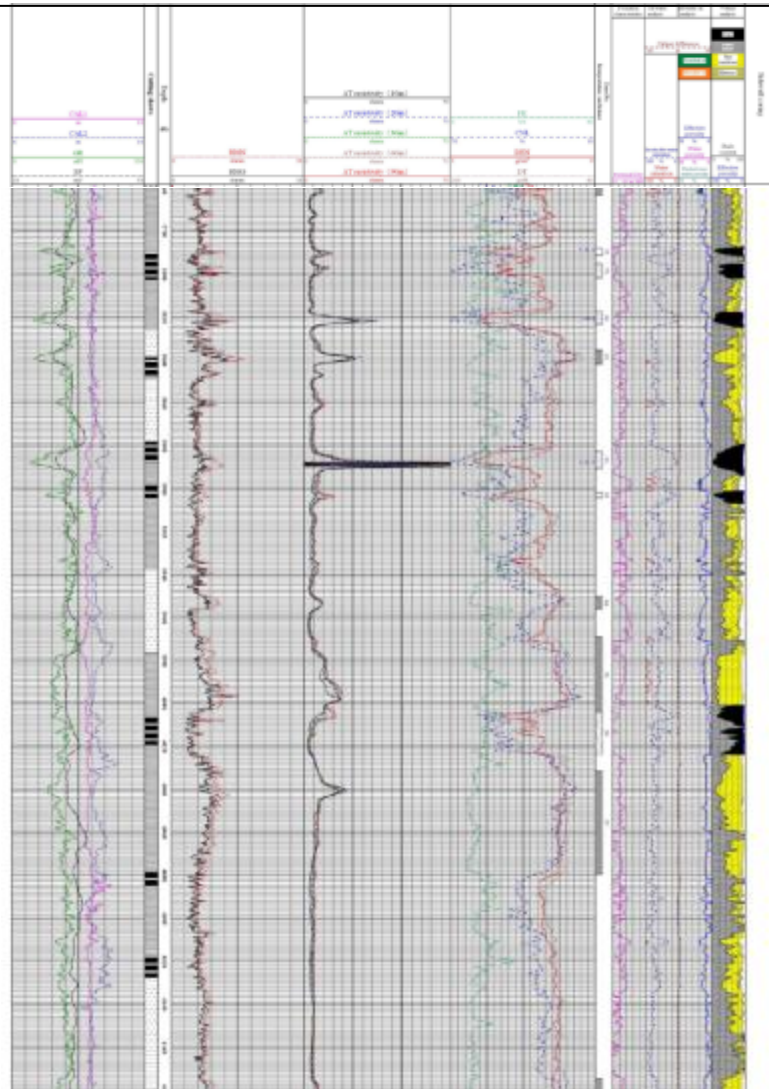


COAL BED METHANE PROSPECT IN PSC-F

Coal Beds in Yaw Formation



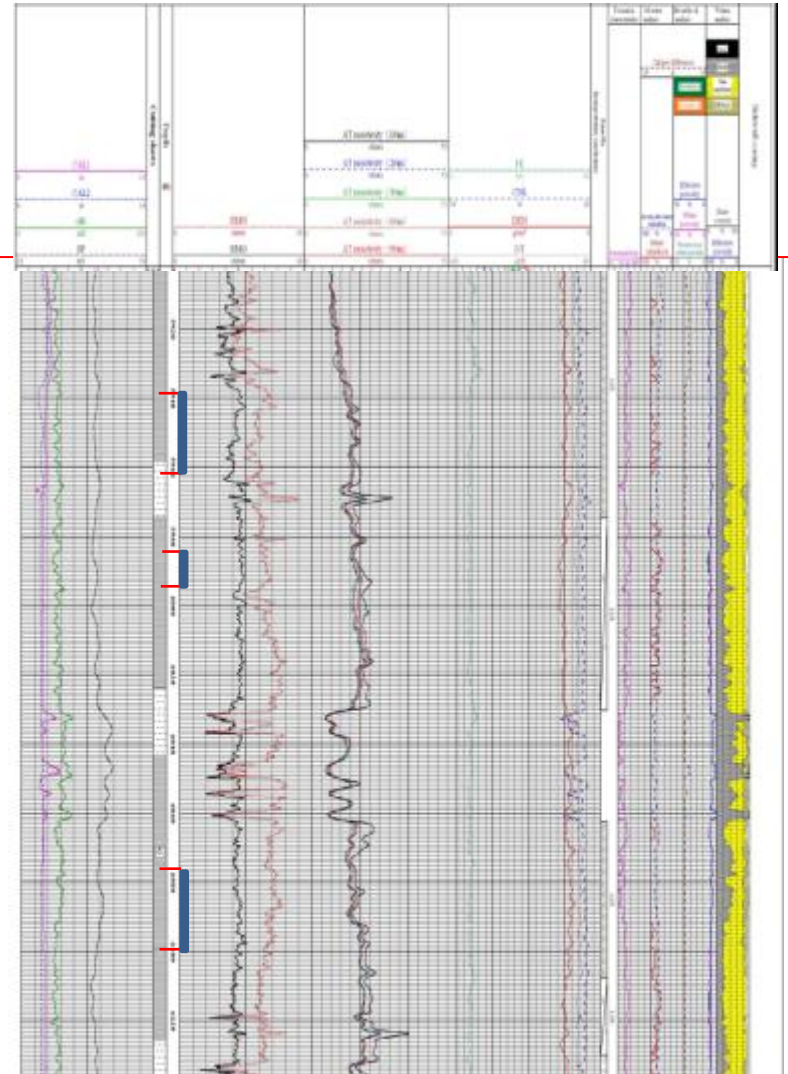
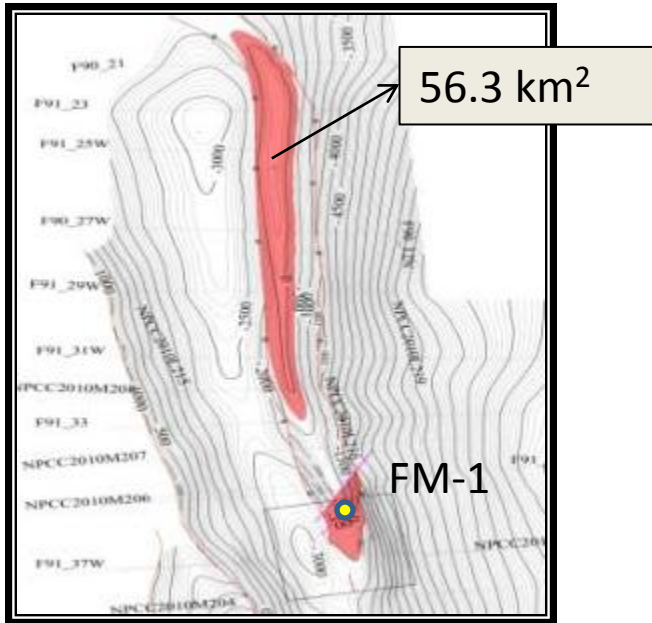
Well FM-1 Log Interpretation Results showing coal beds in Yaw Formation Ngahlaingdwin Anticline



Flaring gas flowed from Yaw Formation while drilling in well FM-3, PSC-F



PONDAUNG TIGHT GAS SANDSTONE RESERVOIR TESTED IN WELL FM-1 , PSC-F, WEST FLANK OF SALIN BASIN



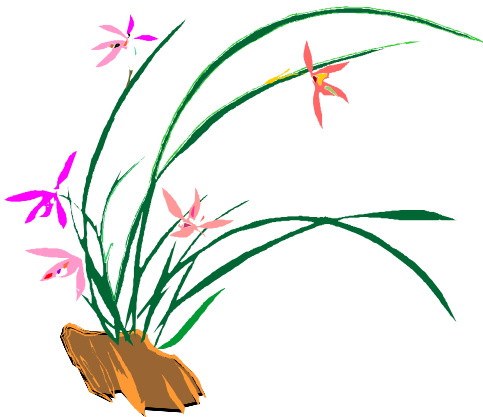
2009年3月12日FM-1井试气点火场景

Gas flowed after shut in for one month

CONCLUSION

- Tertiary and Pre-Tertiary petroleum systems of Eastern Highlands and Southern Peninsular province are yet to explore.
- Tertiary and Pre-Tertiary petroleum systems of Rakhine deepwater areas are not tested yet.
- Exploration in deepwater area of Andaman sea is in progress.
- Western Fold Belt can be considered as secondary exploration target.
- At least 60 percent of Tertiary petroleum system is not fully explored.
- Myanmar has huge amount of untapped oil and gas reserves.
- Realistic hydrocarbon potential of Myanmar is still unknown.
- Should start study of unconventional hydrocarbon potential (Shale oil, shale gas, coalbed methane, tight gas and gas hydrates).

THANK FOR YOUR ATTENTION



Q & A