



Exploration Opportunities in the Middle East

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Finding Petroleum Middle East Forum

Tuesday 16th May 2017 The Geological Society, London

Agenda

- ▶ What defines the Middle East?
- ▶ Regional Considerations
- ▶ Exploration Frontiers
- ▶ Conclusions

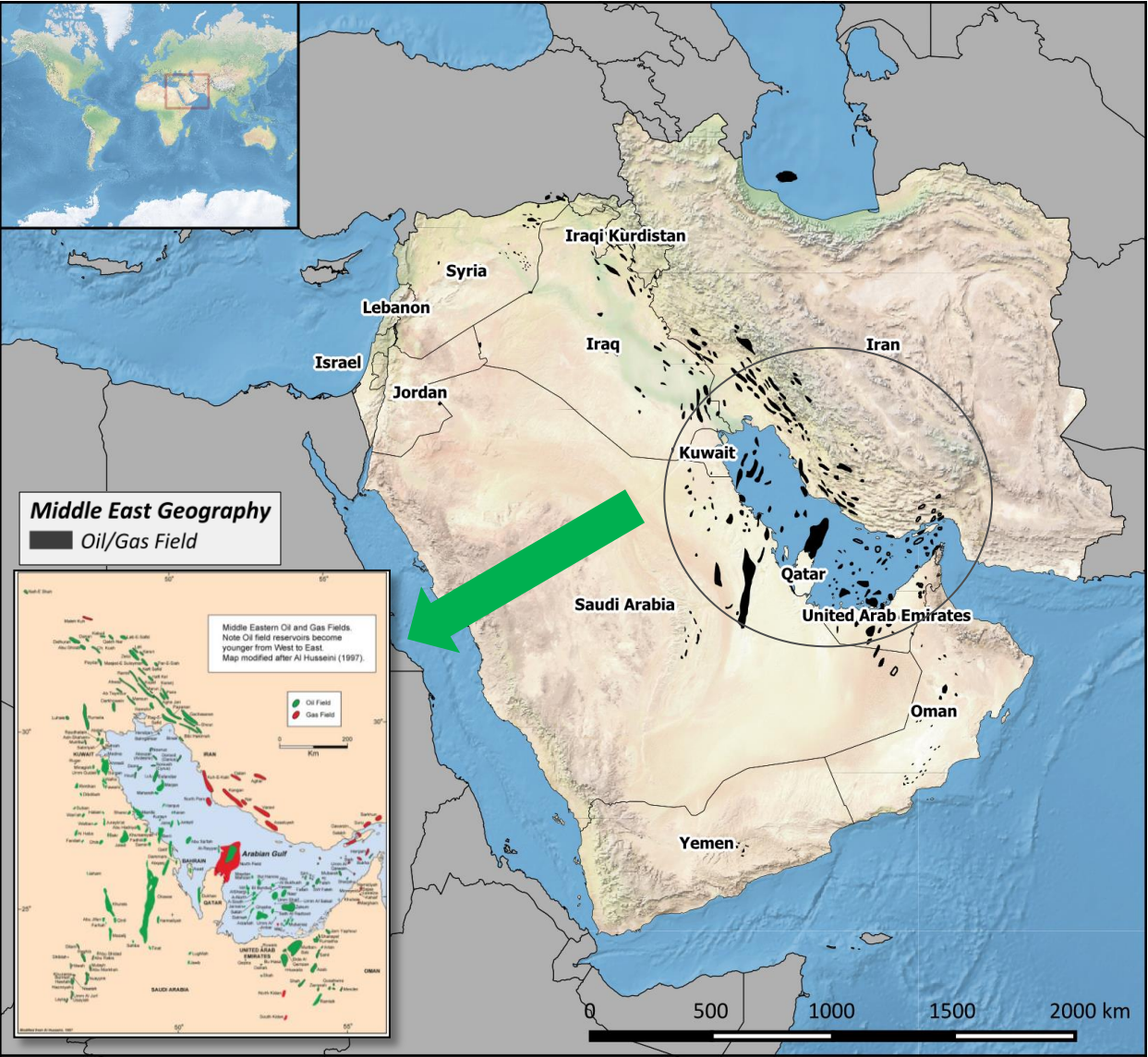
Grateful acknowledgement of support from:



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Middle East Geography



Source: REP2017, field locations are approximate.

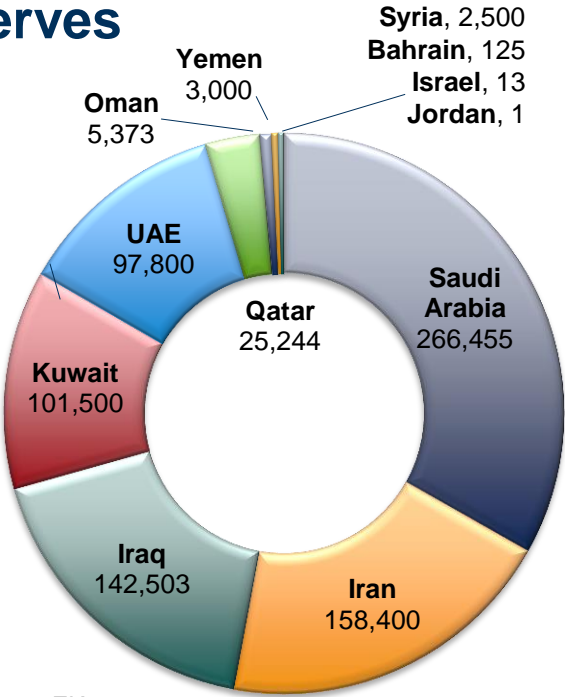
OPEC Countries

Iraq
Iran
Saudi Arabia
Kuwait
UAE
Qatar

Non-OPEC Countries

Yemen
Oman
Jordan
Syria
Lebanon
Israel

Proven Reserves (mmbbl)



Source: EIA 2017

The Middle East is the Largest Petroleum Province in the World



BP Statistical Review of World Energy, 2016

The Middle East in 2015 –

OIL

47% of the world's reserves and 33% of world production

R/P 73 years (world average 50 years)

GAS

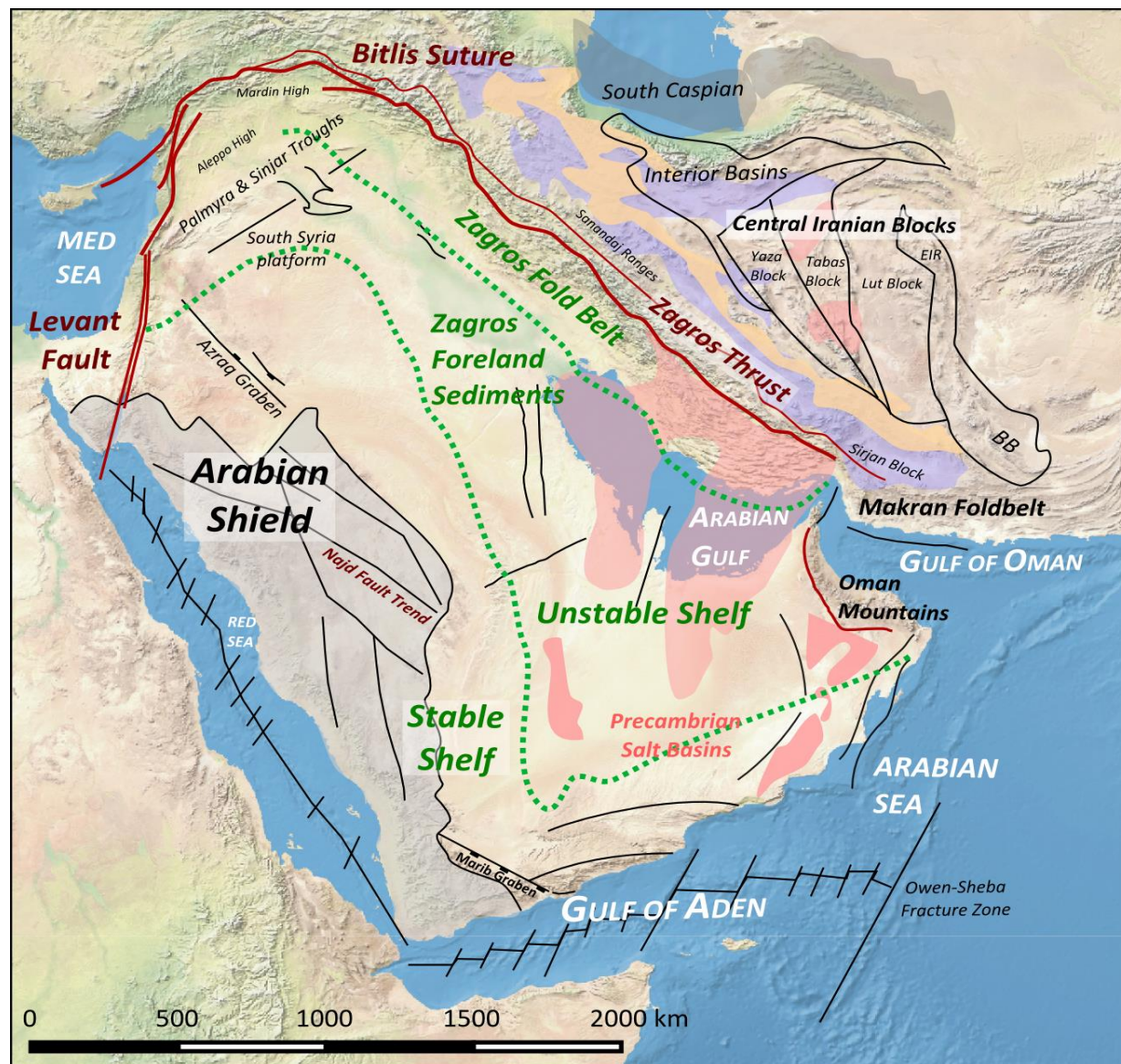
43% of the world's reserves and 17% of world production

R/P 130 years

Exploration has been very successful – why?

Why the Middle East Fields May Produce Oil Forever (Mahfoud and Beck, Offshore, Jan 1995)

Middle East – Regional Setting



Source: REP2017, adapted from multiple sources

Palaeozoic

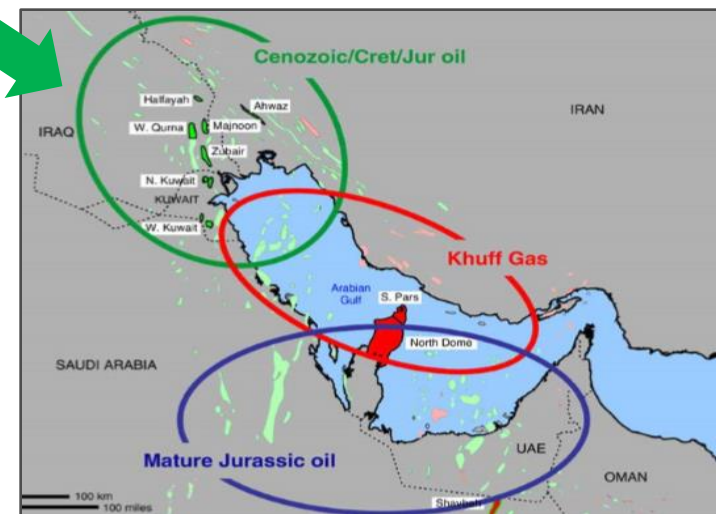
- Early Palaeozoic - Arabia stable subsiding passive margin
- Hercynian orogen and uplift from Devonian
- Permian rifting, deposition of the Khuff formation

Mesozoic

- Mesozoic formation of structural highs and lows
- Regional extension from breakup of Gondwana, rifting along Zagros belt
- Middle Jurassic - Early Cretaceous inversion (central Arabian arch)

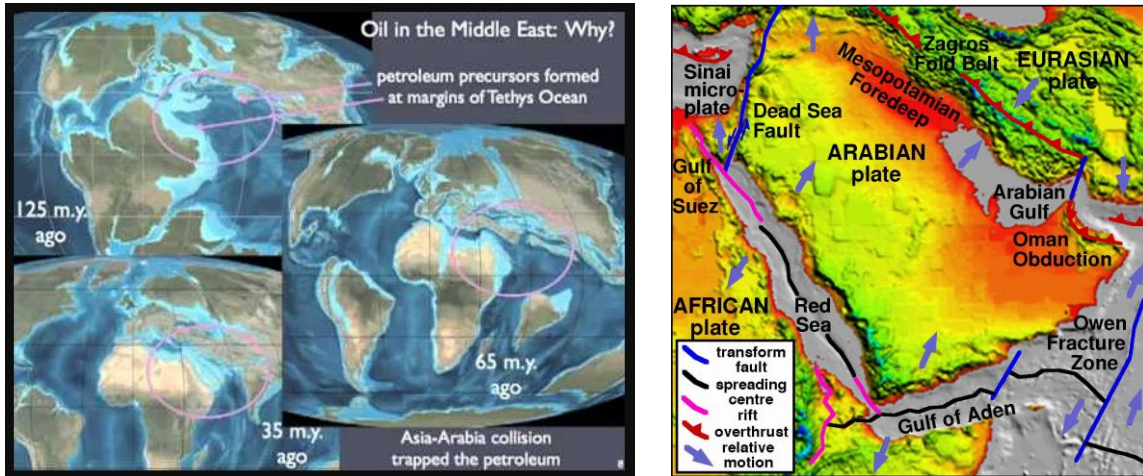
Cenozoic

- Mid Tertiary formation of Zagros foreland basin
- Continued rifting and subsidence



Middle East – Why is There So Much Oil and Gas?

- Tethys Setting



- ▶ Long-lived extensive passive margin through Palaeozoic-Mesozoic, overlain by Tertiary Zagros Foldbelt
- ▶ Multiple petroleum systems with excellent source rocks and reservoirs, mainly carbonates
- ▶ Evaporites provide major regional seals, fold belt detachments and structures
- ▶ Large structures – regional arches inherited from Hercynian, salt-related structures and Zagros folds

- Source and Reservoirs

Mid Cretaceous - Oligocene

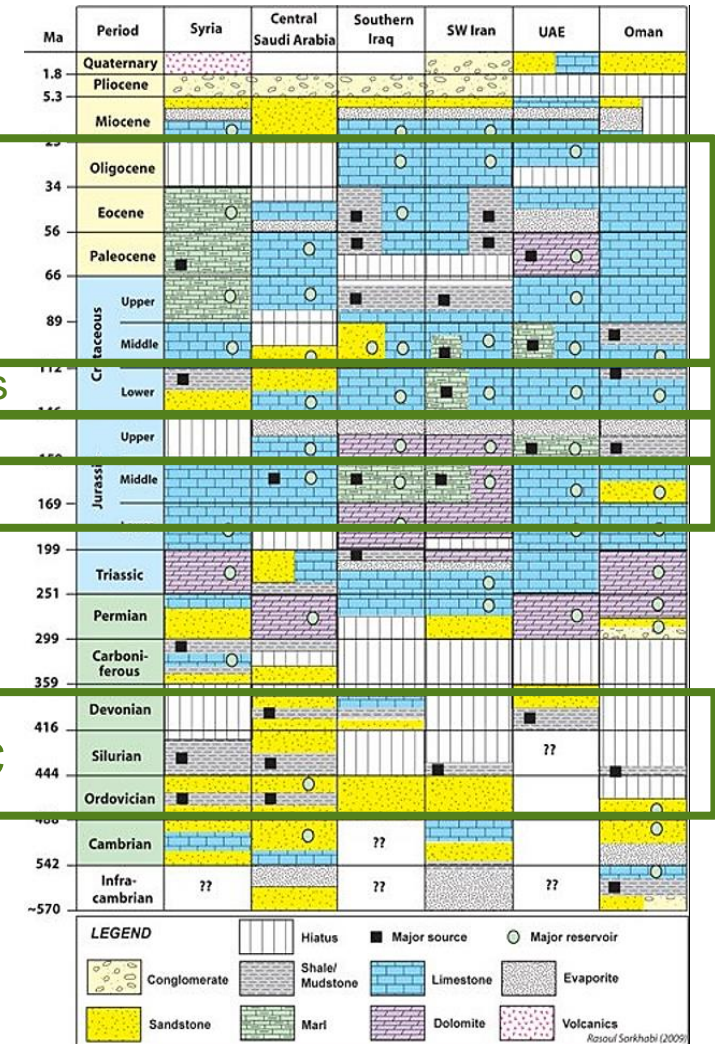
Early Cretaceous

Late Jurassic

Mid Jurassic

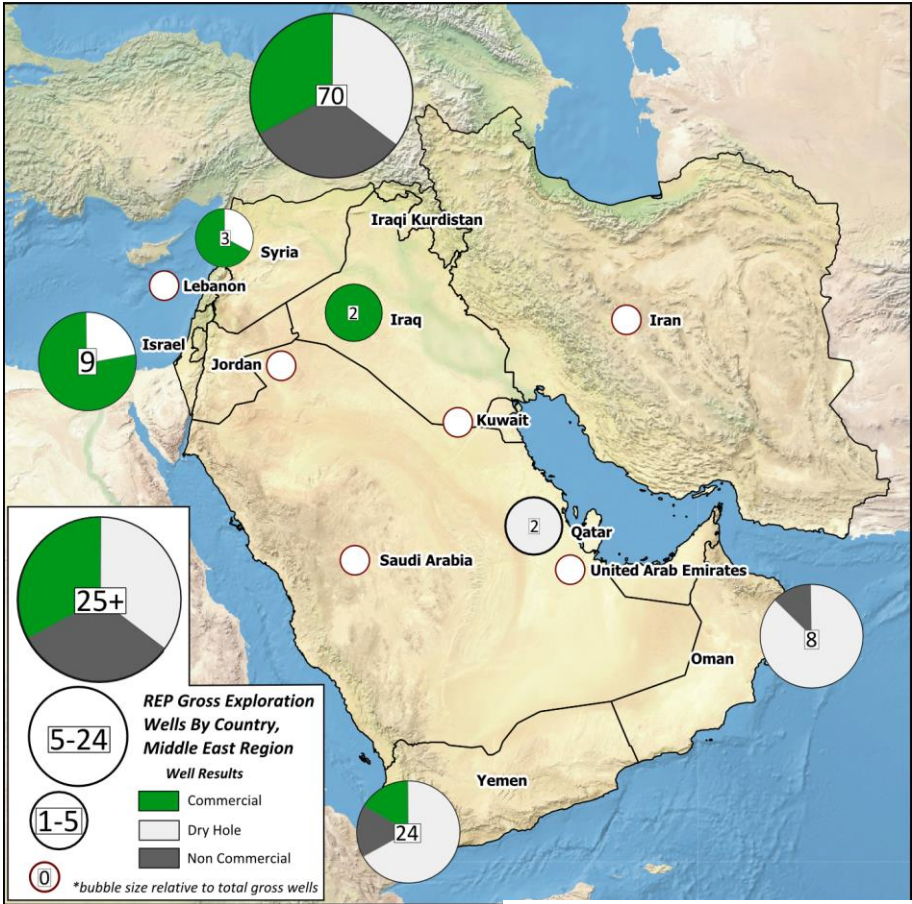
Palaeozoic

MAJOR PETROLEUM SYSTEMS



Middle East Exploration 2008 – 2017

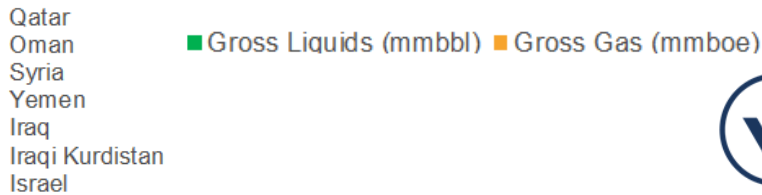
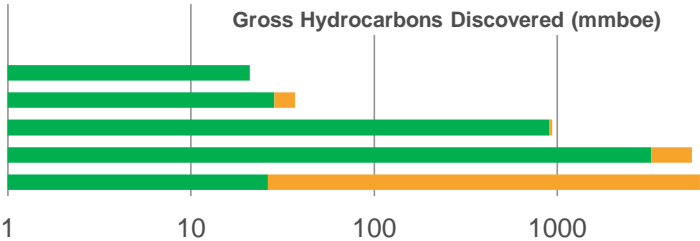
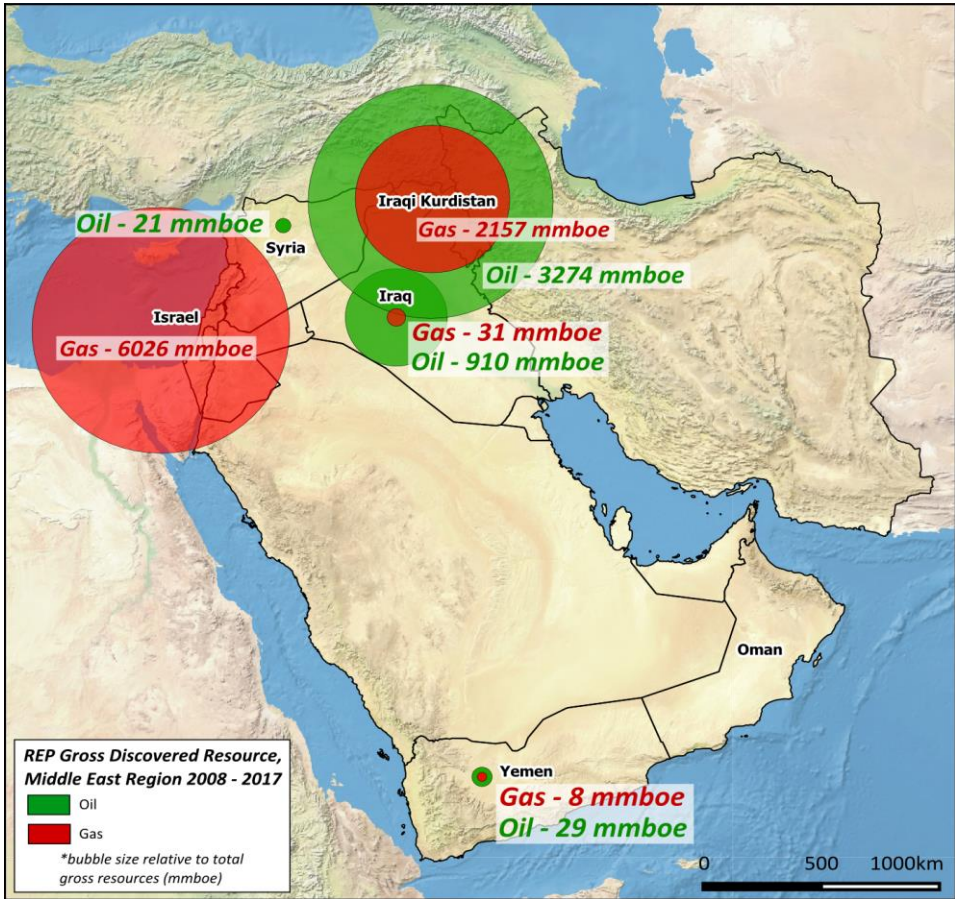
Gross Exploration Wells



Source: REP 2017

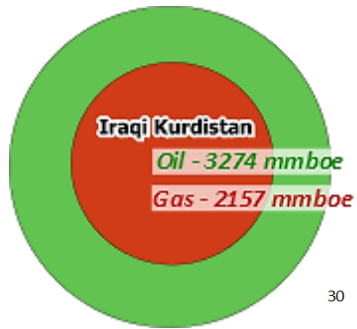
Wells database not including Saudi Arabia, UAE, Kuwait & Iran discoveries 2008 -2017

Gross Resource Discovered



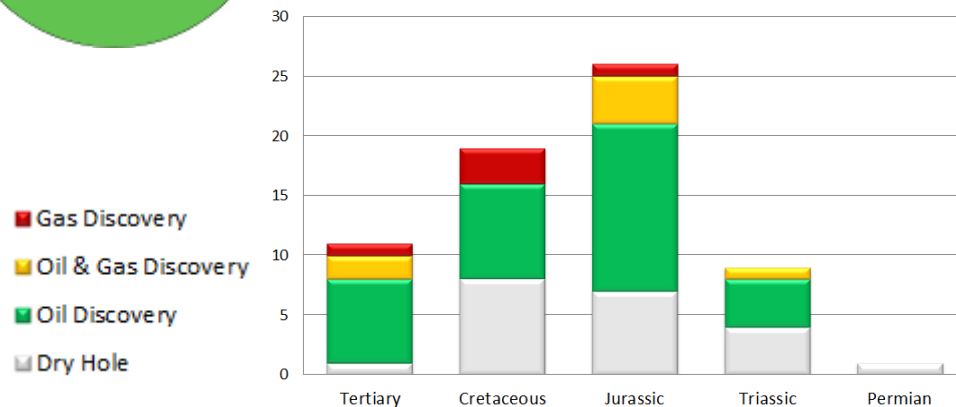
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Iraq - Kurdistan

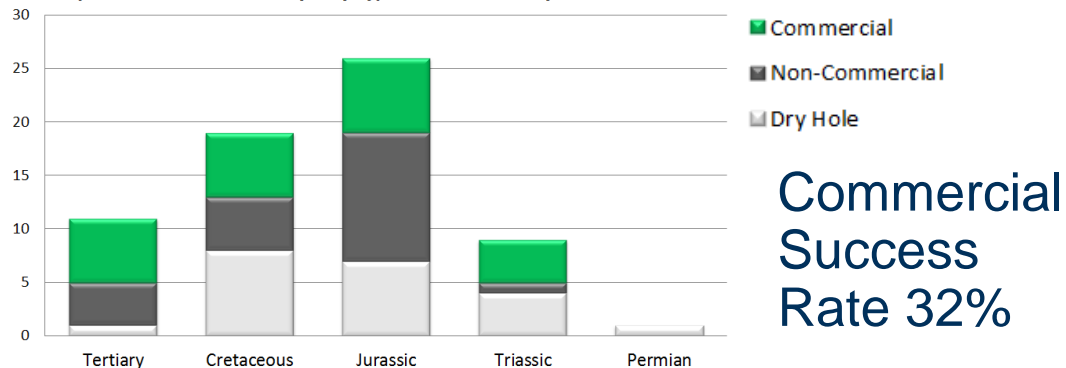


Discovered Volumes 2008 - 2017

Iraq Kurdistan Gross Wells by Play Type & Result, 2008 - 2017

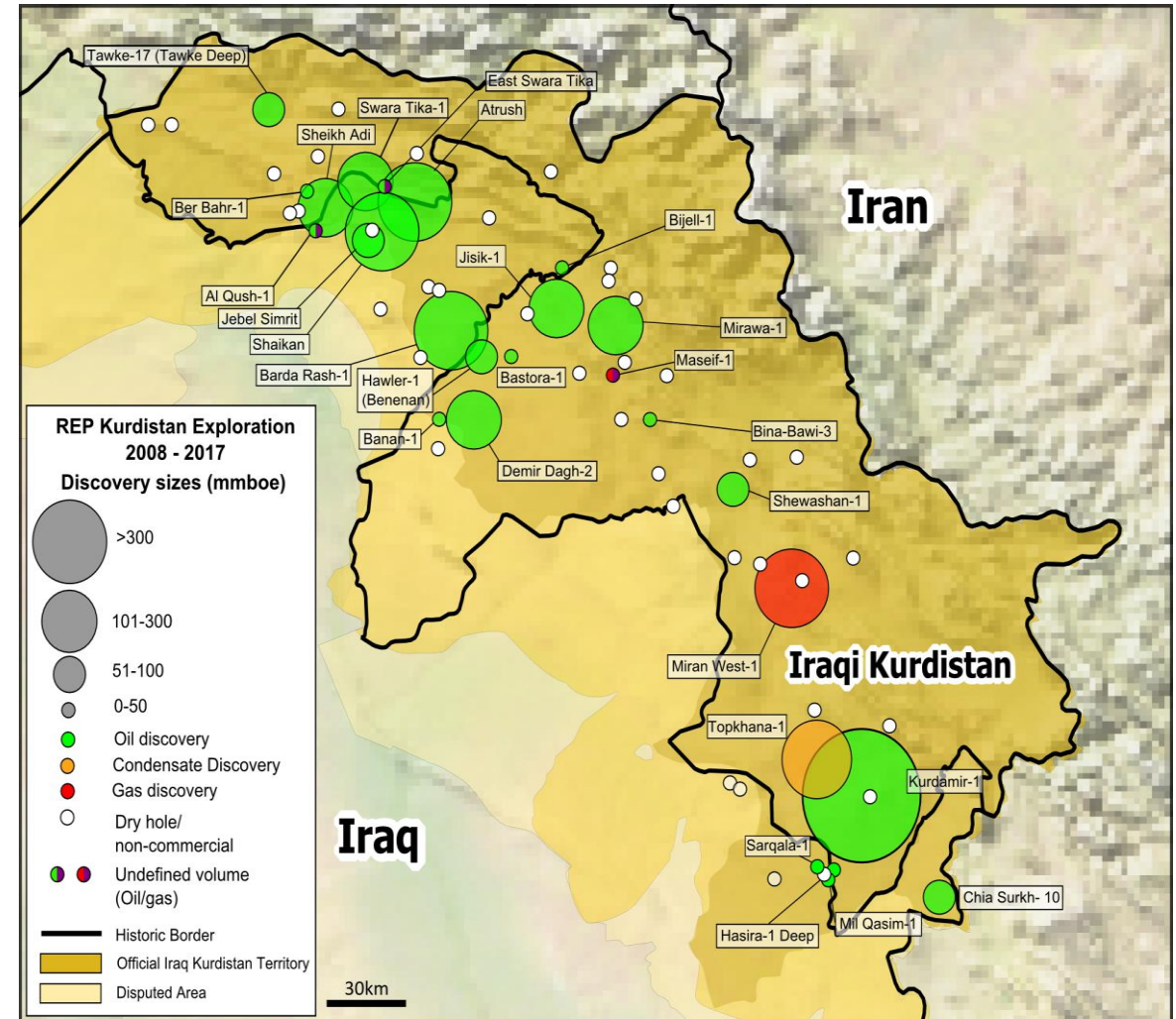


Iraq Kurdistan Gross Wells by Play Type & Commerciality, 2008 - 2017



Commercial Success Rate 32%

Source: REP 2017



Source: REP 2017, adapted from Western Zagros February 2017 map



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Iraq – Kurdistan Challenges

Challenges

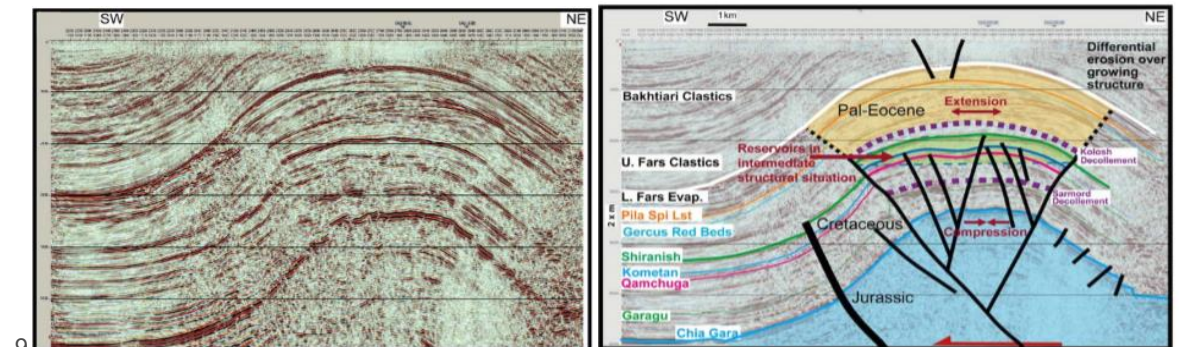
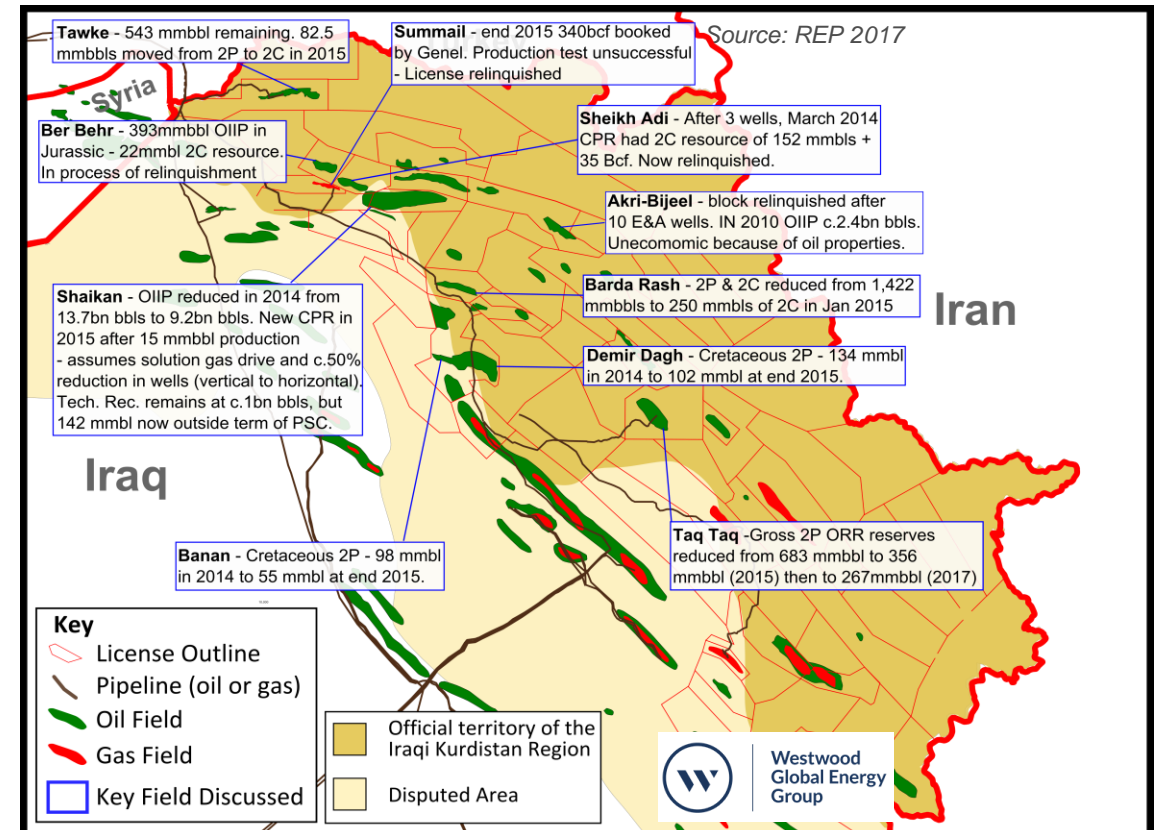
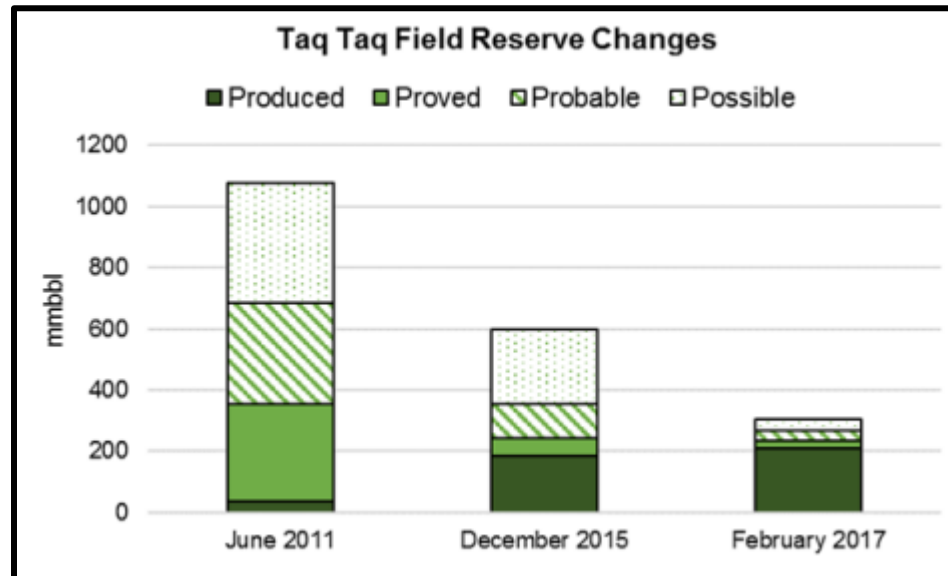
- Fractured reservoirs – write downs
- Oil export and sales / Payments

Remaining opportunities

- Tertiary reservoirs - better matrix poroperm, located in south where gas more predominant

Taq Taq - Downgrades

- 2015 Genel Taq Taq downgrade from 683 – 356mmbbl
- 2017 downgrade to 267mmbbl
- 9 years after first oil!



Offshore Iraq

Iraq plans Offshore Oil and Gas Exploration

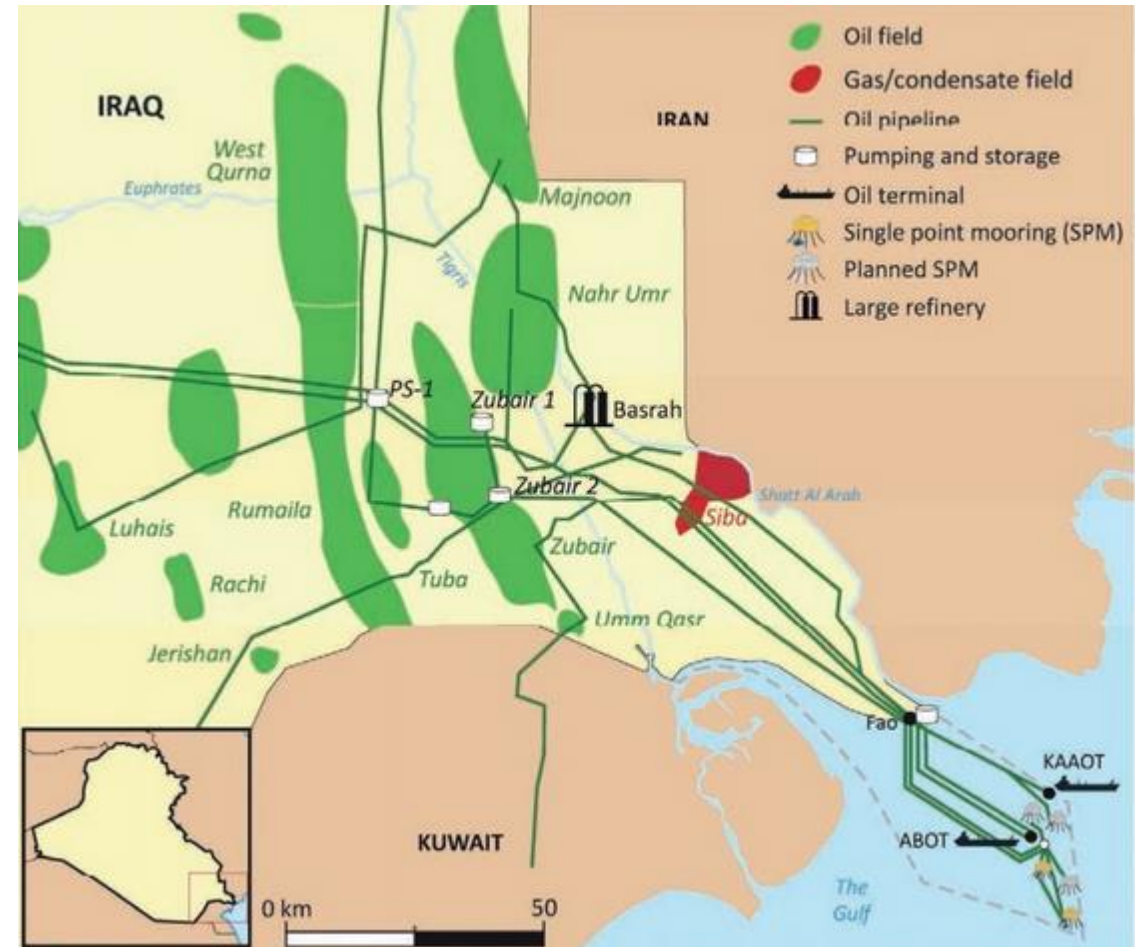


February 28, 2017 in Iraq Oil & Gas News

By John Lee.

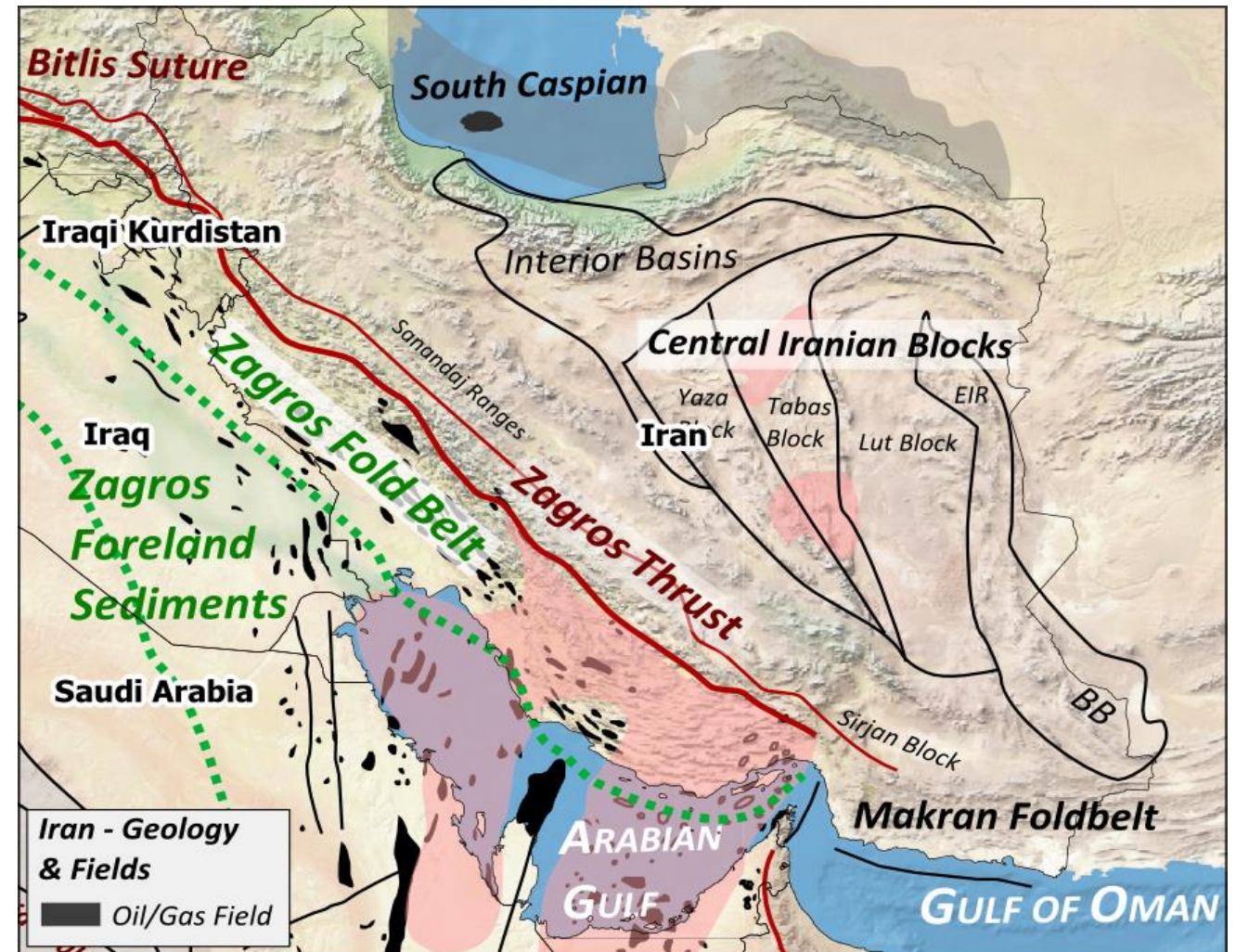
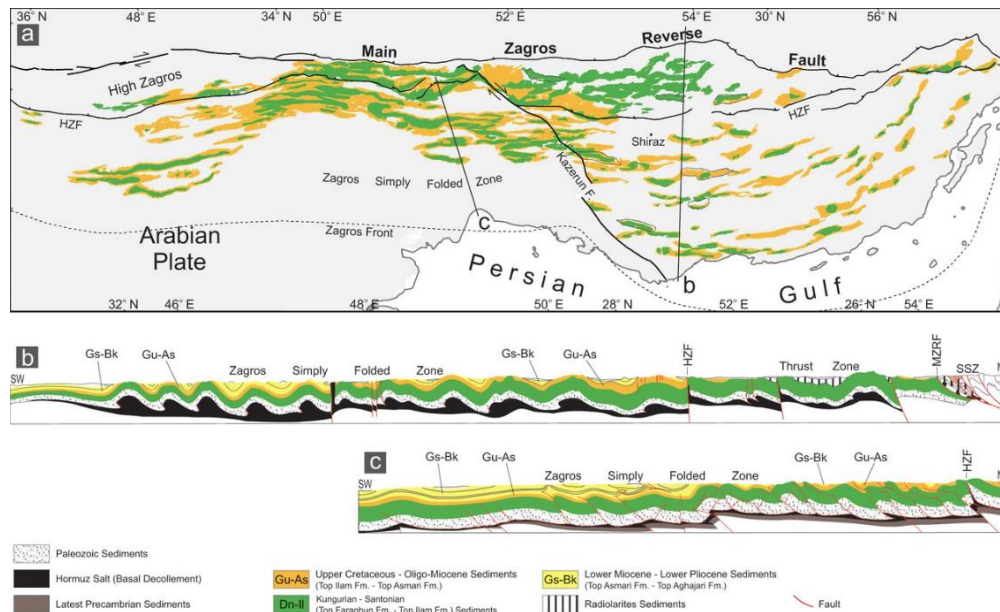
Iraqi oil minister Jabar Ali al-Luaibi [Allibi] has directed the **Iraqi Oil Exploration Company (OEC)** to start exploring Iraq's coastal waters for new oil and gas reserves.

Addressing an OEC conference, the Minister also emphasised the need to focus on areas bordering neighbouring countries.



Iran – Zagros Fold Belt

- ▶ Northwest: Lurestan Region
Extension of Kurdistan plays – Triassic & Jurassic reservoirs in NW, Cretaceous carbonates in SE
- ▶ Central Area – Dezful Embayment
Undrilled structures, sub-thrust targets, stratigraphic plays
- ▶ Southeast – Fars Region
Palaeozoic gas / Jurassic-Cretaceous oil



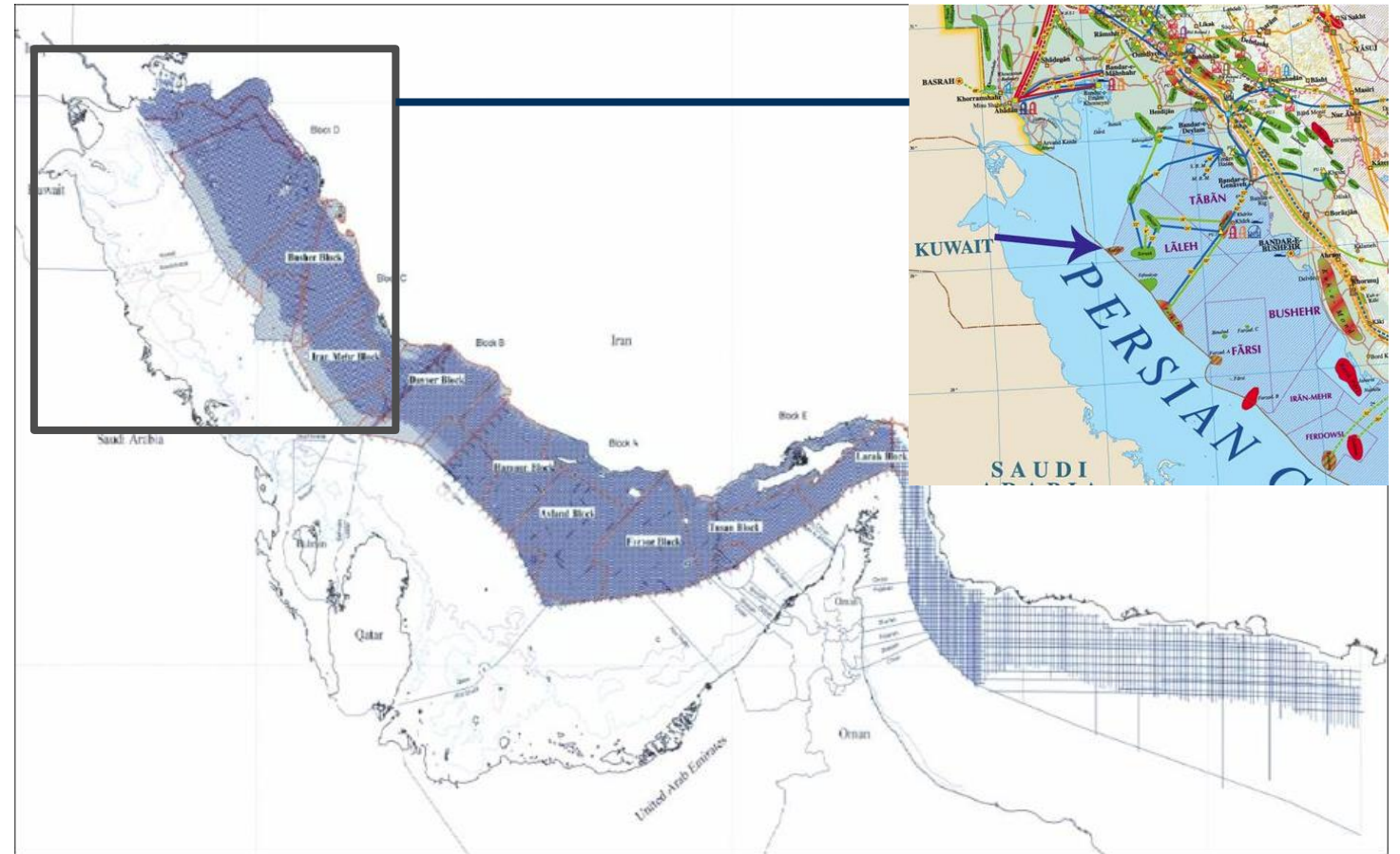
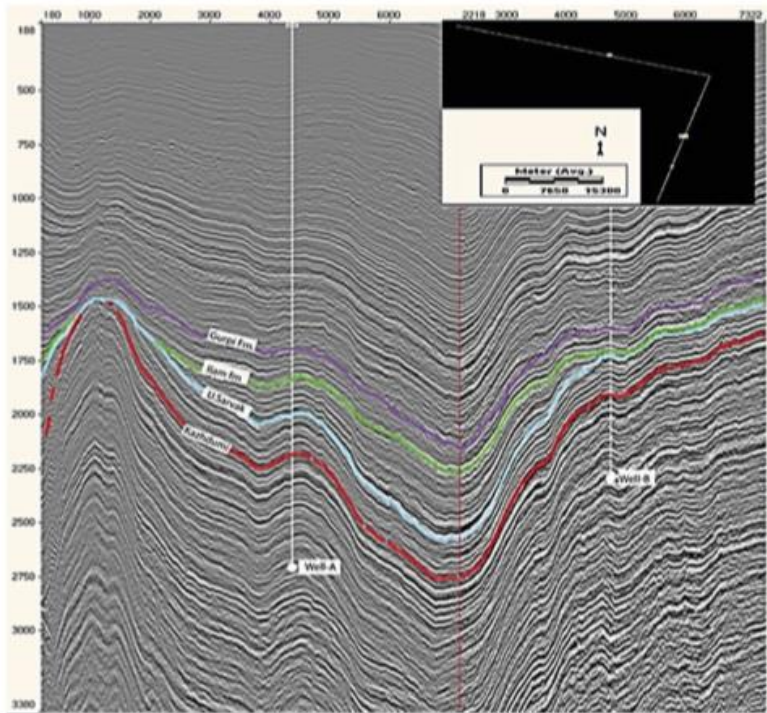
Source: REP2017, adapted from multiple sources

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Iran – Offshore Persian Gulf

- ▶ Significant heavy oil and gas discoveries in last decade – **Forroz**, **Madar**, **Ferdowsi**
- ▶ Ongoing exploration by NIOC (1 rig)
- ▶ Most structures now drilled – remaining stratigraphic potential

Amirkhani / Iranian Journal of Earth Sciences 7 (2015) /153-163

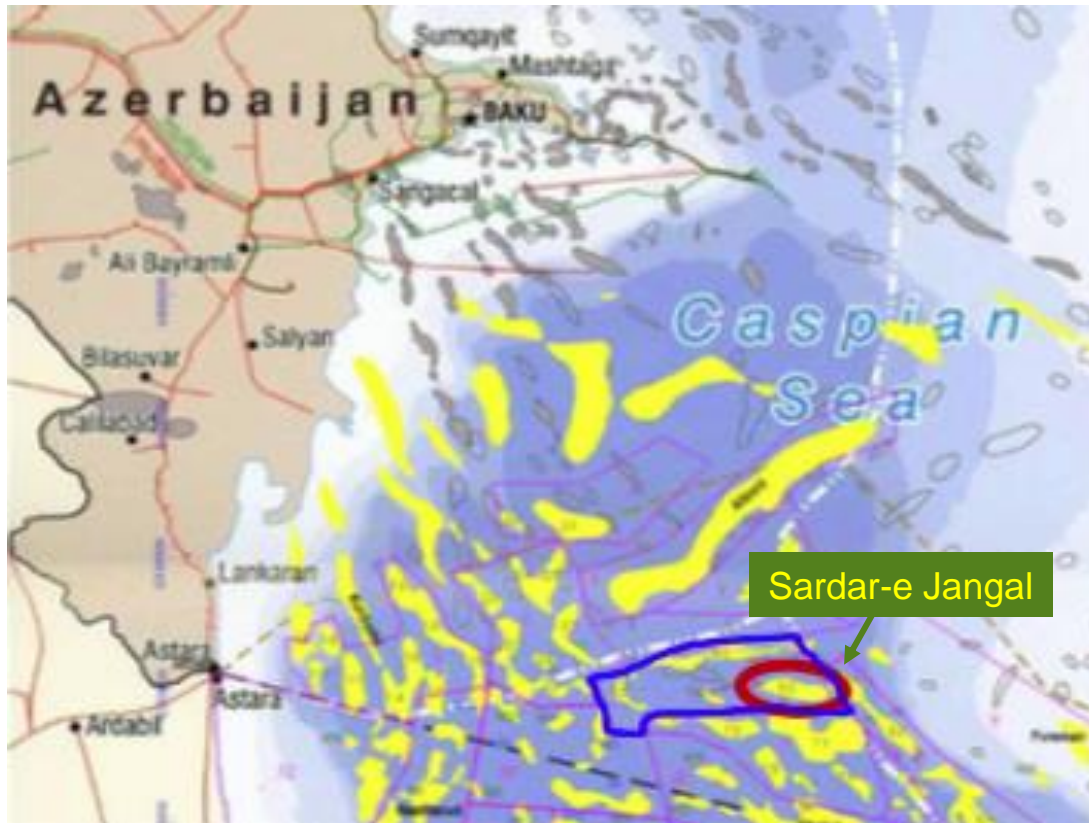


Source: Global Geo Services AS website

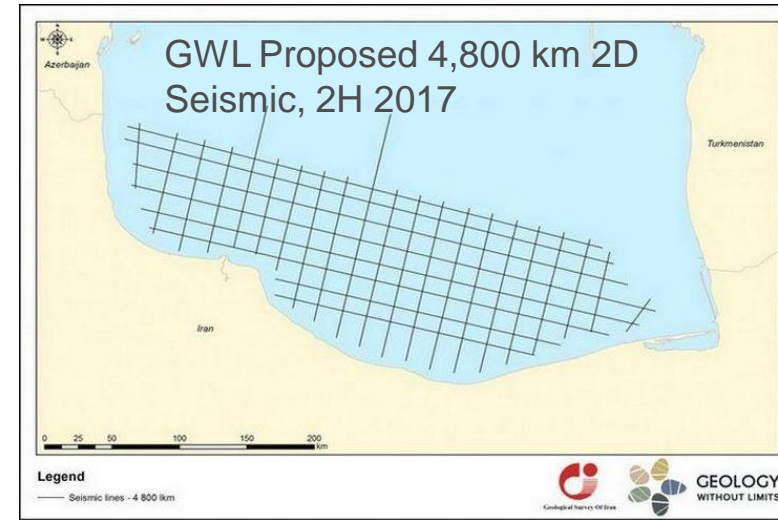
- ▶ Persian Carpet 2D Seismic 2000 – 106,000 km in Persian Gulf (2*2 km grid) and Oman Sea

Iran – South Caspian Sea

- 2011 Sardar-e Jangal Discovery in 700m W.D. 500 mmb/5 tcf reserves?
- Sardar-e Jangal and 3 exploration blocks offered for international co-operation
- Likely multi-billion boe potential



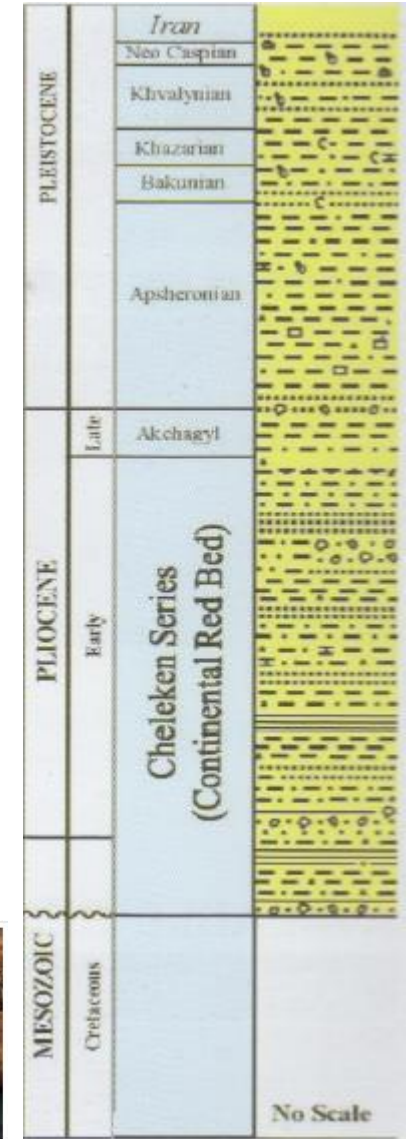
Source: NIOC



Amir Kabir
Semi-submersible
Rig

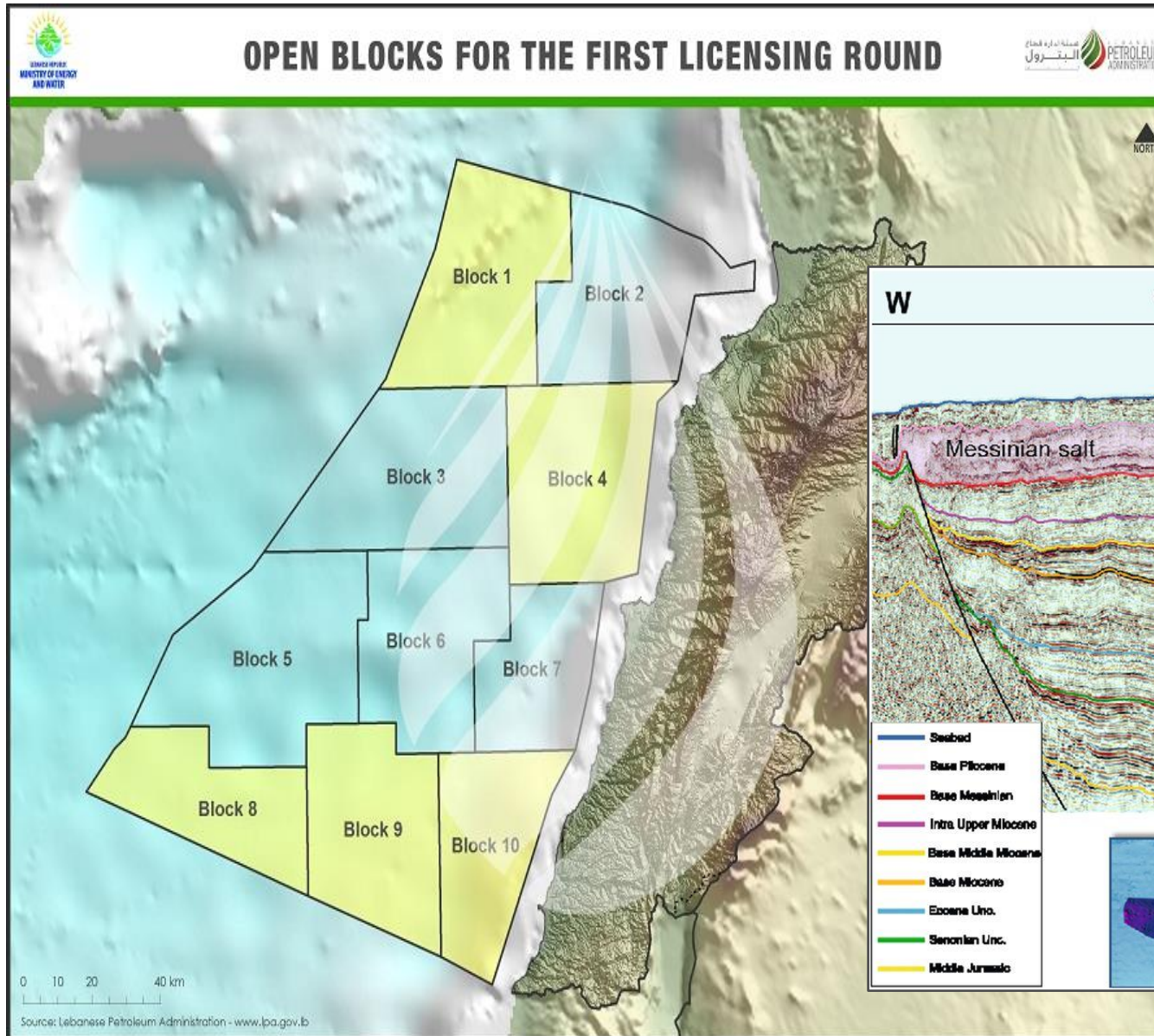


запасы нефти и газа на каспийском месторождении
Sardar-e Jangal подтвердились

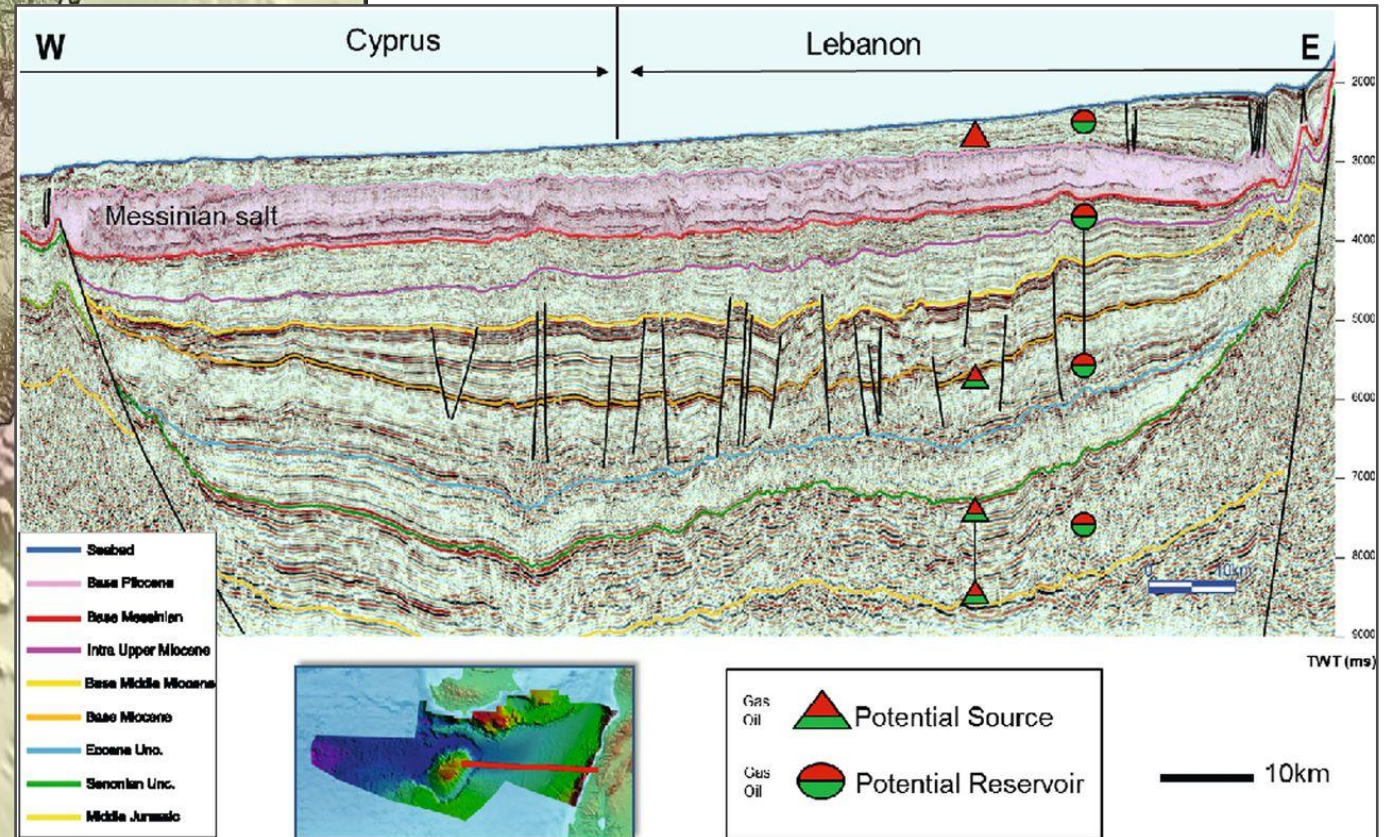


Source: NIOC

Lebanon – First Licencing Round



- 5 Blocks offered for bidding in January 2017
- Bid submission September 2017
- Prequalifiers eliminate “small players”



Source: Lebanon Petroleum Administration 2015

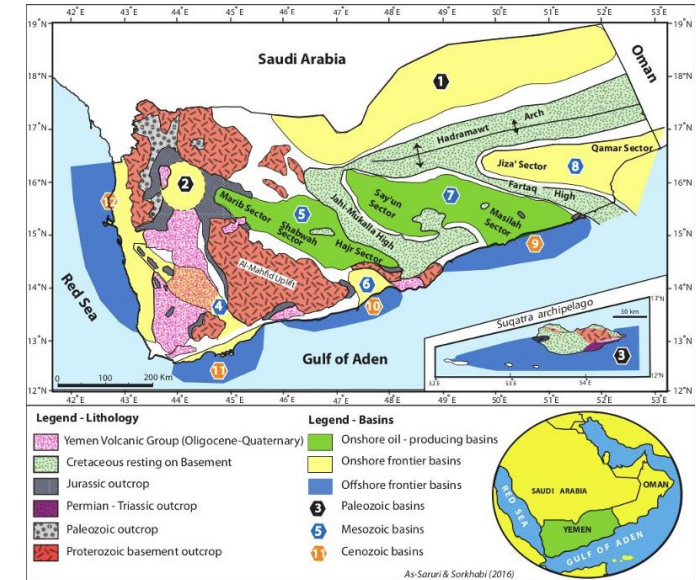
Finding Petroleum Middle East Forum, London, 16 May 2017

Other Conventional and Unconventional Plays

- ▶ Israel – 24 offshore blocks offered in 1st Licensing Round
Ministry report 6.6 bnbbbls oil and >70 tcf to find
- ▶ Yemen – 2 out of 12 basins are producing oil and gas today
Proven Late Jurassic – Early Cretaceous petroleum system in 2 well-explored Mesozoic basins
Less well-explored Jiza-Qamar Basin in east, Rub' Al Khali and offshore Oligocene rifts
- ▶ Iran – Interior basins: Oligo-Miocene source rocks

Abu Dhabi – Onshore Shale Potential

Yemen



Source: As-Saruri & Sorkhabi, GEOEXPro 2016

Figure 22. Shilaif Formation Oil Prospective Area

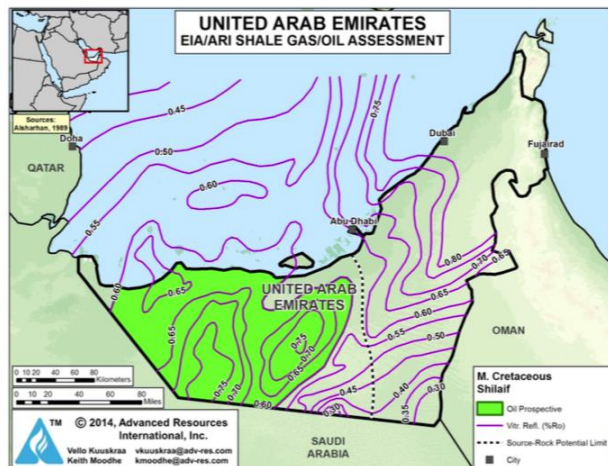
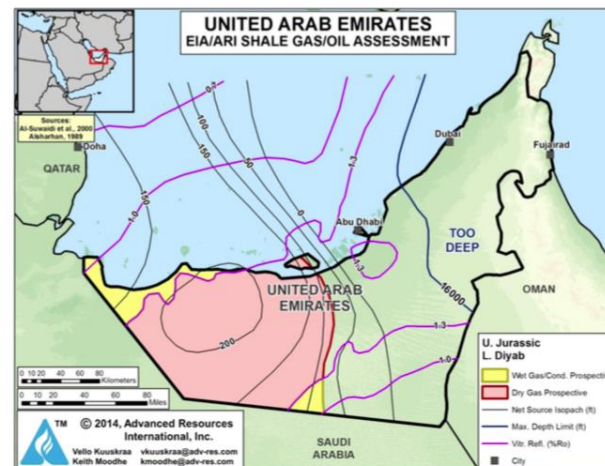


Figure 15. Prospective Areas of the Lower Member of the Diyab Formation



▶ Unconventional Plays

- Tight Gas: Oman, Iraq, Syria
- Qusaiba hot shale, Saudi Arabia: 600 tcf
- Jurassic and Cretaceous source rocks: UAE
- Upper Cretaceous Oil Shales: Jordan

Conclusions

- ▶ The Middle East has a multitude of exploration opportunities in established and new plays and has barely started to tap its unconventional potential.
- ▶ The barriers to successful exploration are less technical and more political, commercial and related to insecurity in the region
- ▶ Major Exploration Themes
 - Go Deeper: The Palaeozoic petroleum system is underexplored
 - Look Harder: New seismic and new ideas will unlock new discoveries in the established plays, including stratigraphic traps
 - Test the Frontier Geography: Deepwater Mediterranean, South Caspian
 - Unconventional Potential: lots of source rocks and tight rock! But does it compete on cost?



Questions