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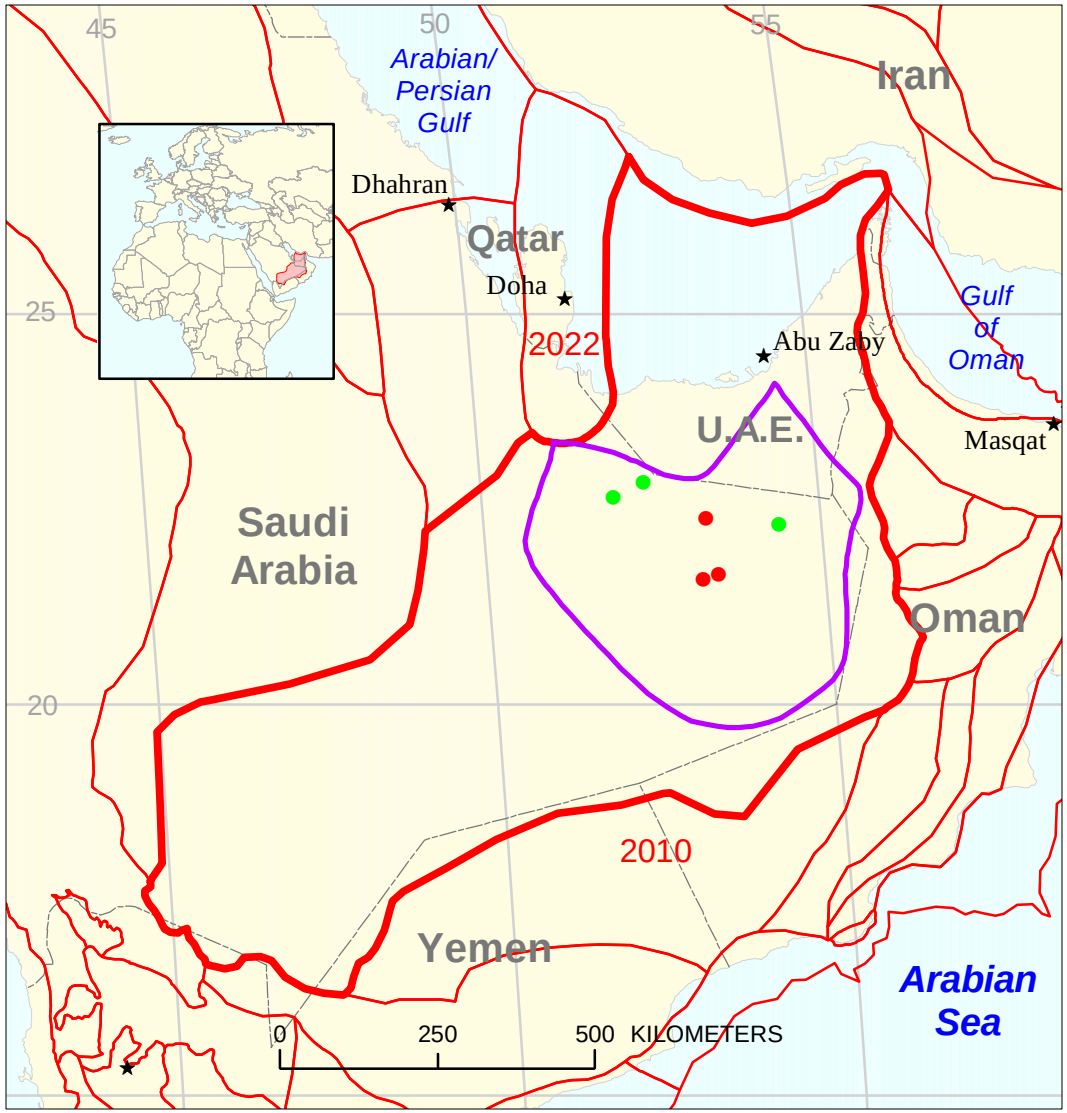
Jurassic Reservoirs in Northwest Desert Anticlines Assessment Unit 20190201



Jurassic Reservoirs in Northwest Desert Anticlines Assessment Unit 20190201

Rub Al Khali Basin Geologic Province 2019

Other petroleum system boundary

Geologic Summary

Detailed map of this assessment unit

Assessment Input Data

Assessment Results

- Assessment Unit Summary
- Detailed Assessment Results
- Undiscovered Field-Size Distributions

USGS PROVINCE: Rub Al Khali Basin (2019)–Petroleum system is centered along the basin's axis and extends over the eastern flank and crest of the Qatar Arch Province (2022). The system is limited to the south/southwest by organic-rich facies deposited in the Jurassic South Gulf intraplatform sub-basin.

GEOLOGIST: R.M. Pollastro

TOTAL PETROLEUM SYSTEM: Jurassic Hanifa/Diyab-Arab (201902)

ASSESSMENT UNIT: Jurassic Reservoirs in Northwest Desert Anticlines (20190201)

DESCRIPTION: The assessment unit is onshore Rub 'al Khali Basin and is defined paleogeographically by the Jurassic South Gulf sub-basin. It is bounded to the north by the Dibba transform fault and southern limit of the Hormuz Salt. It is structurally bounded by the Qatar Arch and Central Arabian Arch to the west. The unit is limited to the east by the geographic extent of source facies and pinch out of the primary Hith evaporite seal. The southern boundary is limited by the geographic extent of the Hanifa/Diyab basinal source-rock facies. A north-south structural grain is evident from basement controlled anticlines. Jurassic reservoirs are assessed separately recognizing possible overlap with Cretaceous and Paleozoic systems.

SOURCE ROCKS: The organic-rich, argillaceous limestone facies of the Late Jurassic Diyab/Hanifa Formations is the primary source rock. Secondary source rocks include organic-rich beds of the Middle Jurassic Araej/Dhruma Formaton and Early and Middle Jurassic Marrat, Hamlah, and Izhara Formations. The Diyab/Hanifa contains Type II organic matter and average TOC is about 2.0 to 3.0 weight percent. Some fields may produce Silurian-sourced gas from the Permo-Triassic Khuff Formation.

MATURATION: Hanifa/Diyab source rocks are presently in the mid-to-late-mature (Ro = 0.7 to 1.3 percent) oil window along the east, west, and south margins of the assessment unit. The north-central portion of the unit is in the main gas generation (Ro >1.3 percent) window. Mature oils of 40° API gravity are produced from fields along the western margin. Jurassic source rocks entered the oil window from Middle Cretaceous to Early Tertiary (100 to 50 Ma). Jurassic gas fields occur in the central portion of the unit.

MIGRATION: Both vertical and lateral migration has occurred in the assessed area. The occurrence of gas fields to the east/southeast of the main gas generation zone suggests some migration. Short vertical migration is from the Hanifa/Diyab source into mainly Arab reservoirs.

RESERVOIR ROCKS: Primary reservoirs in this assessment unit are the cyclic, shallow-water, carbonate grainstones and packstones of the Upper Jurassic Arab Formation (Arab A, B, C, D), also called the Qatar Formation in Qatar. Intraformational seals in the Arab pinch out to the east of the Hith seal, further limiting the eastern extent of the assessment unit. Some reservoirs also occur in the Araej Formation.

TRAPS AND SEALS: Traps are mainly structural and most are anticlinal (crest and flank traps) with combination structural/stratigraphic traps along a north-southeast trending, secondary leached shelfal limestone. Some anticlines drape basement horst blocks. Primary regional seal is the massive Upper Jurassic Hith Formation evaporites overlying the Arab Formation, however, the Hith pinches out to the east, limiting the assessment unit. Intraformational seals of carbonate/anhydrite cycles of the Arab Formation (A, B, C, D) and shales and tight carbonates of the Hanifa/Diyab and Araej Formations are important locally.

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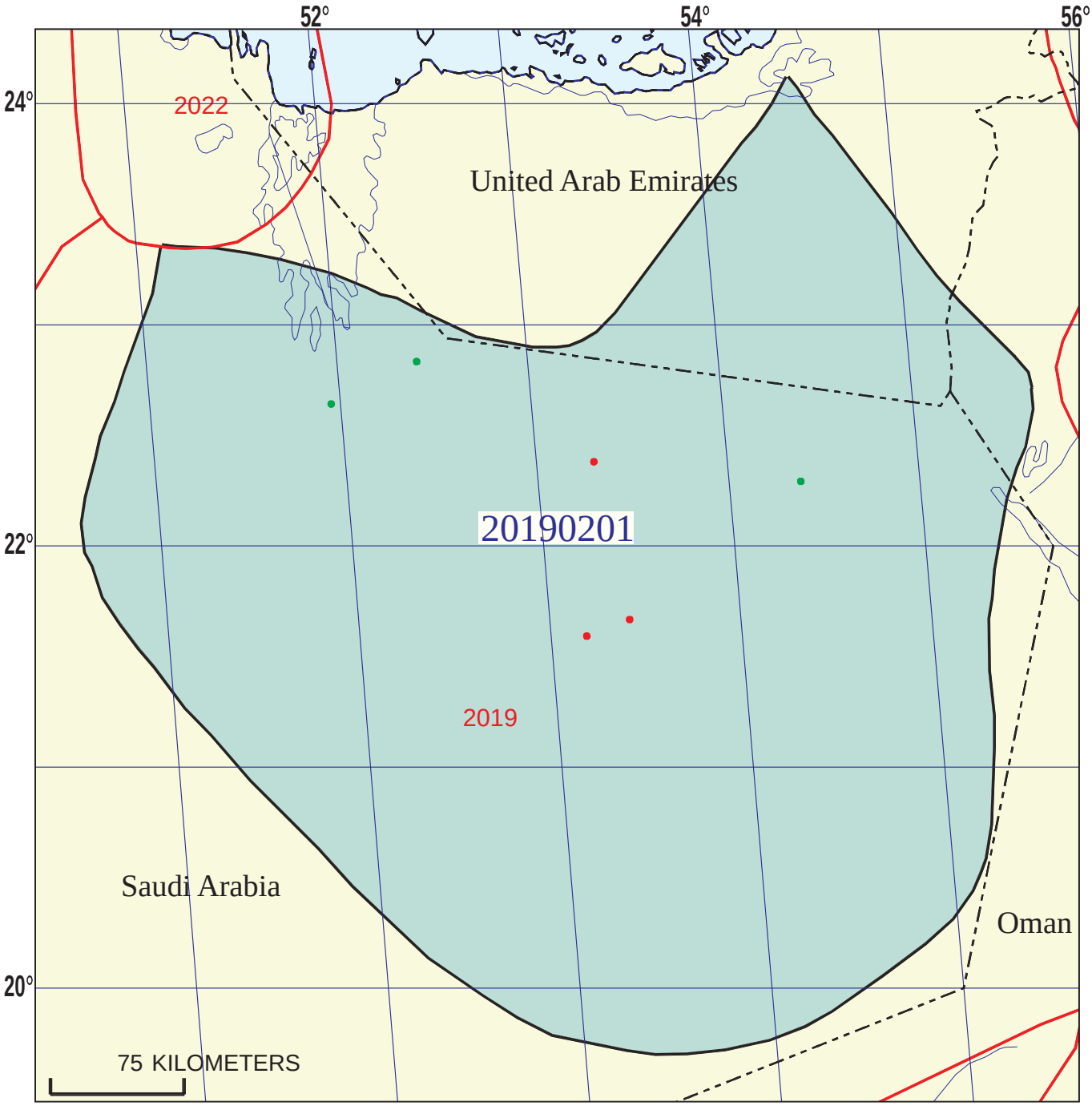


Jurassic Reservoirs in Northwest Desert Anticlines Assessment Unit - 20190201

EXPLANATION

- Hydrography
- Shoreline
- 2019 — Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 20190201 — Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

SEVENTH APPROXIMATION
NEW MILLENNIUM WORLD PETROLEUM ASSESSMENT
DATA FORM FOR CONVENTIONAL ASSESSMENT UNITS

Date:……..	12/7/99		
Assessment Geologist:……..	R.M. Pollastro		
Region:……..	Middle East and North Africa	Number:	2
Province:……..	Rub Al Khali Basin	Number:	2019
Priority or Boutique……	Priority		
Total Petroleum System:……	Jurassic Hanifa/Diyab-Arab	Number:	201902
Assessment Unit:……..	Jurassic Reservoirs in Northwest Desert Anticlines	Number:	20190201
* Notes from Assessor	Lower 48-all growth function. This is an assessment of Jurassic reservoirs (assessed separately from other reservoirs), recognizing possible overlap of Cretaceous and Paleozoic.		

CHARACTERISTICS OF ASSESSMENT UNIT

Oil (<20,000 cfg/bo overall) **or** Gas (≥20,000 cfg/bo overall):… Oil

What is the minimum field size?……. 10 mmboe grown (≥1mmboe)
(the smallest field that has potential to be added to reserves in the next 30 years)

Number of discovered fields exceeding minimum size:…… Oil: 3 Gas: 3
Established (>13 fields) _____ Frontier (1-13 fields) X Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 134 2nd 3rd 920 3rd 3rd _____
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 2073 2nd 3rd 4520 3rd 3rd _____

Assessment-Unit Probabilities:

Attribute	Probability of occurrence (0-1.0)
1. **CHARGE:** Adequate petroleum charge for an undiscovered field ≥ minimum size……	1.0
2. **ROCKS:** Adequate reservoirs, traps, and seals for an undiscovered field ≥ minimum size……	1.0
3. **TIMING OF GEOLOGIC EVENTS:** Favorable timing for an undiscovered field ≥ minimum size	1.0

Assessment-Unit GEOLOGIC Probability (Product of 1, 2, and 3):…….. 1.0

4. **ACCESSIBILITY:** Adequate location to allow exploration for an undiscovered field ≥ minimum size…… 1.0

UNDISCOVERED FIELDS

Number of Undiscovered Fields: How many undiscovered fields exist that are ≥ minimum size?:
(uncertainty of fixed but unknown values)

Oil fields:……min. no. (>0)	5	median no.	40	max no.	100
Gas fields:……min. no. (>0)	3	median no.	20	max no.	40

Size of Undiscovered Fields: What are the anticipated sizes (**grown**) of the above fields?:
(variations in the sizes of undiscovered fields)

Oil in oil fields (mmbo)……min. size	10	median size	80	max. size	10000
Gas in gas fields (bcfg):……min. size	60	median size	480	max. size	30000

Assessment Unit (name, no.)
Jurassic Reservoirs in Northwest Desert Anticlines, 20190201

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	1100	2200	3300
NGL/gas ratio (bngl/mmcfg)……	30	60	90

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	22	44	66
Oil/gas ratio (bo/mmcfg)……			

SELECTED ANCILLARY DATA FOR UNDISCOVERED FIELDS

(variations in the properties of undiscovered fields)

Oil Fields:	minimum	median	maximum
API gravity (degrees)……	34	36	42
Sulfur content of oil (%)……	0.2	1.2	3
Drilling Depth (m) ……	1500	2600	3500
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……			
Hydrogen-sulfide content (%)……	0.5	2	5
Drilling Depth (m)……	2500	3200	4000
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Jurassic Reservoirs in Northwest Desert Anticlines, 20190201

ALLOCATION OF UNDISCOVERED RESOURCES IN THE ASSESSMENT UNIT TO COUNTRIES OR OTHER LAND PARCELS (uncertainty of fixed but unknown values)

1. Saudi Arabia represents 85 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		85	
Portion of volume % that is offshore (0-100%).....		0	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		85	
Portion of volume % that is offshore (0-100%).....		0	

2. United Arab Emirates represents 12 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		12	
Portion of volume % that is offshore (0-100%).....		0	

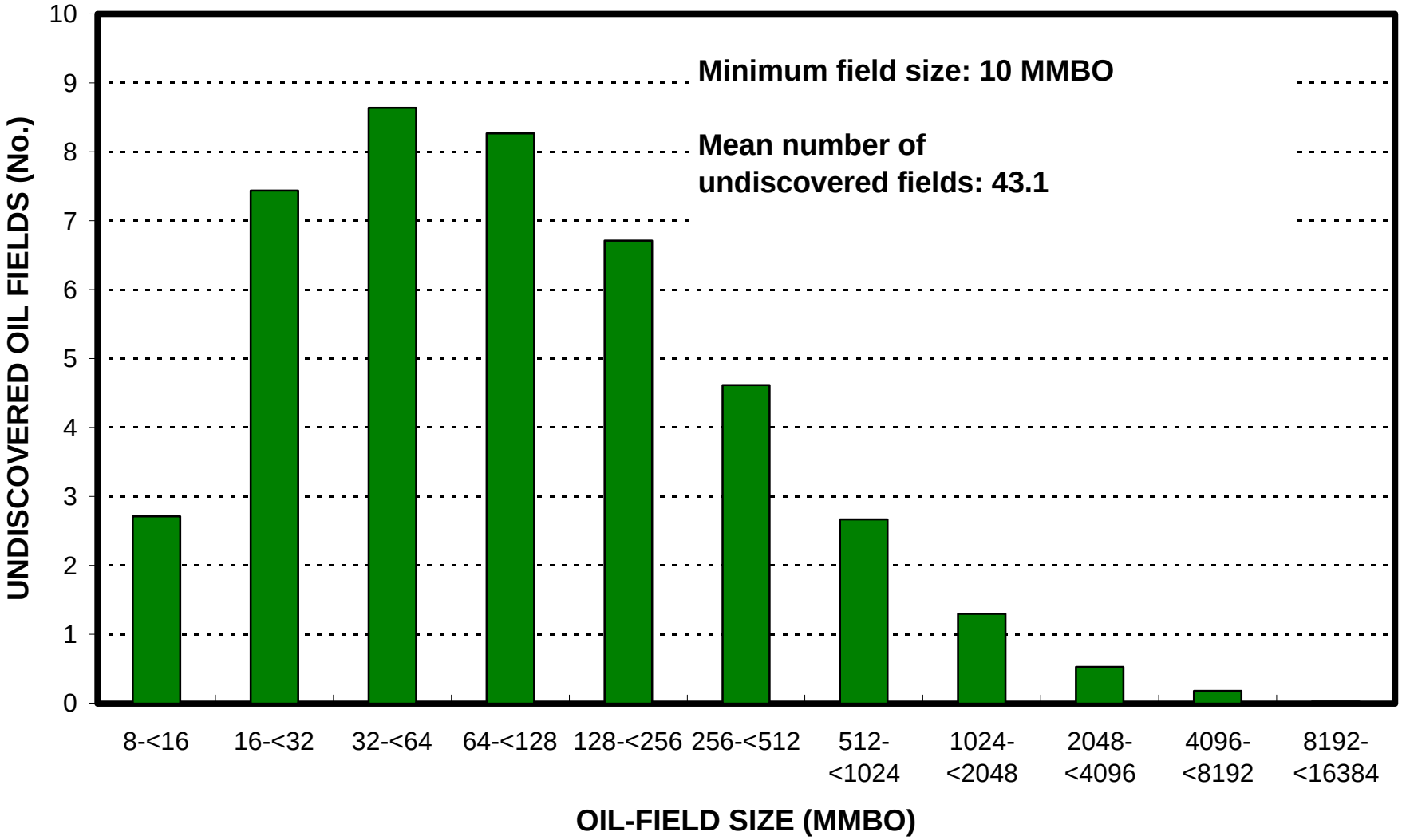
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		12	
Portion of volume % that is offshore (0-100%).....		0	

3. Oman represents 3 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		3	
Portion of volume % that is offshore (0-100%).....		0	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		3	
Portion of volume % that is offshore (0-100%).....		0	

Jurassic Resevoirs in Northwest Desert Anticlines, AU 20190201, Undiscovered Field-Size Distribution



Jurassic Resevoirs in Northwest Desert Anticlines, AU 20190201, Undiscovered Field-Size Distribution