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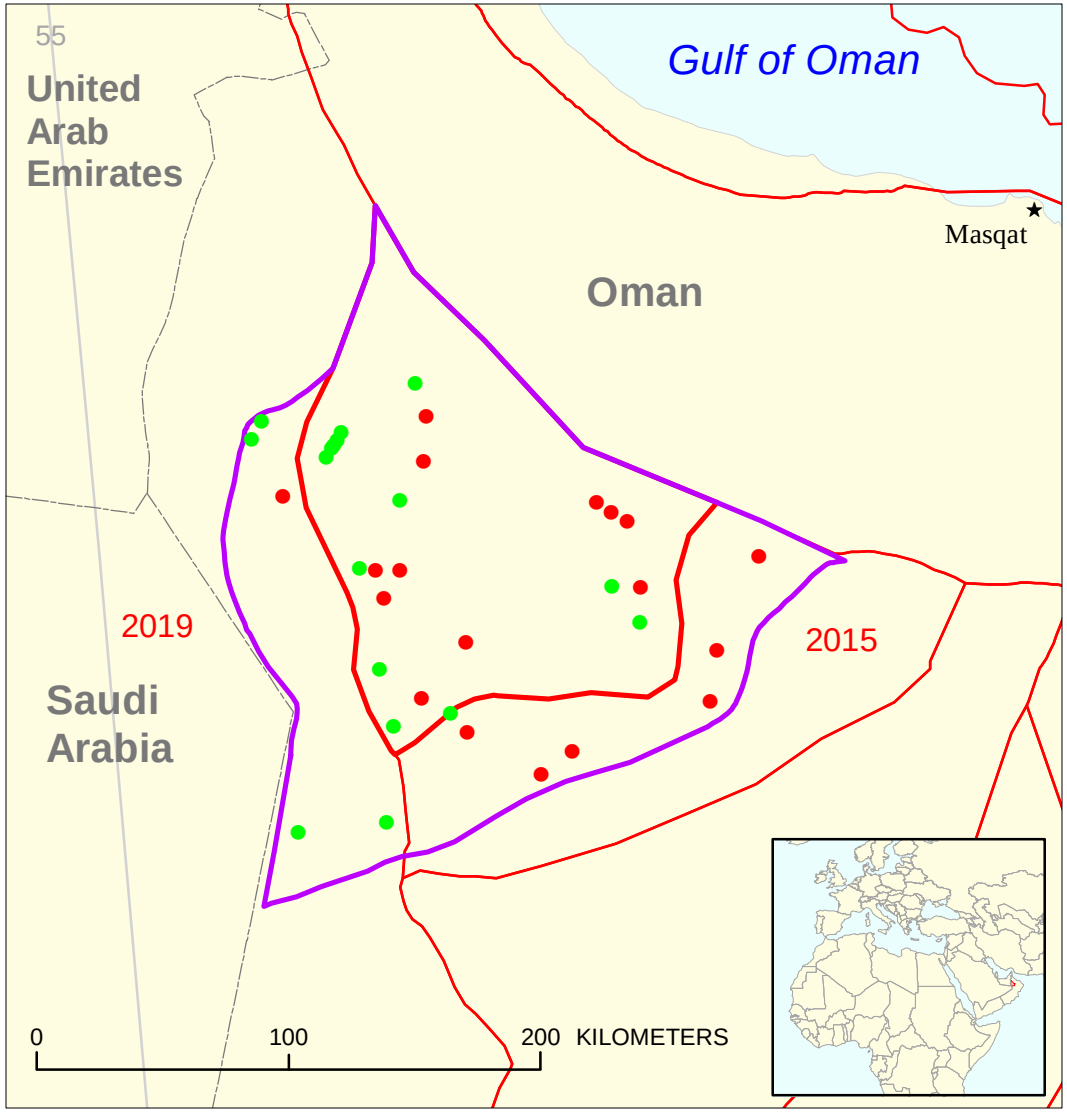
Fahud-Huqf Combined Structural Assessment Unit 20160101



Fahud-Huqf Combined Structural Assessment Unit 20160101
Fahud Salt Basin Geologic Province 2014
Other geologic province boundary

Geologic Summary

Detailed map of this assessment unit

Exploration/Discovery-History Data

- Plots of Known Field Sizes
- Plots of Grown Resources
- Tables

Assessment Input Data

Assessment Results

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

USGS PROVINCE: Fahud Salt Basin (2016)–Petroleum system is centered in the Fahud Salt Basin but extends onto the northwestern half of the Central Oman Platform province (2015) and a small portion of the eastern Rub ‘al Khali Basin province (2019).

GEOLOGIST: R.M. Pollastro

TOTAL PETROLEUM SYSTEM: North Oman Huqf-Shu’aiba (201601)

ASSESSMENT UNIT: Fahud-Huqf Combined Structural (20160101)

DESCRIPTION: Assessment unit lies entirely in Oman and is defined mostly by the underlying Cambrian Ara Salt. Assessment unit is structurally bounded to the north-northeast by the Oman Mountains, to the east-southeast by the Makarem-Mabrouk high (an extension of the Central Oman Platform), to the west-southwest by the Rub ‘al Khali Basin and foreland bulge of the Oman Foredeep. Fields of the Fahud Salt Basin are structurally complex, salt-induced anticlines and domes.

SOURCE ROCKS: Source rocks are a multiple of carbonate and shale units in the Infracambrian Huqf Supergroup, most associated with the Cambrian Ara Salt. Huqf source rocks contain structureless, Type I and Type II oil-prone organic matter. The Shuram Formation contains a thick (about 450 m), laterally extensive carbonate source unit in North Oman that averages about 2 weight percent TOC. Huqf-type oils correlate well with Huqf source rock extracts and have high sulfur (1.5 to 2.0 weight percent) content, with a geochemical character of the so-called “X”-branched compounds. Commonly, light (~40° API gravity), mature, low-sulfer, 'Q-type' oils sourced from within the salt of the Ghaba and Fahud Salt basins are also recognized in this assessment unit.

MATURATION: Early minor stage oil generation occurred in Middle and Lower Huqf source rocks during the Early Silurian. Peak oil generation occurred during Late Permian/Early Triassic (~250 Ma). Gas generation began during the Cretaceous (~110 Ma). Gas expelled from Huqf sources charged structures across the Fahud Salt Basin and reached the Makarem high during a period ranging from 80 Ma to present day.

MIGRATION: Migration is both vertical and lateral into multiple, often stacked, reservoirs ranging in age from Infracambrian to Cretaceous. Long-distance (100 km), lateral migration of intrasalt-generated ‘Q-type’ oils occurred southward along regional Permian Khuff seal and into Gharif reservoirs.

RESERVOIR ROCKS: Reservoirs include clastics and carbonates ranging in age from Infracambrian to Cretaceous. However, the Lower Cretaceous Shu’aiba and middle Cretaceous Natih limestones account for most production in the Fahud Salt Basin with about 50 percent of the basin’s production from porous, fractured Shu’aiba limestones in Yibal field. Deep gas is produced mainly from Middle Cambrian to Lower Ordovician clastics of the Haima Supergroup. Oil and gas is produced from sandstones of the Permo-Carboniferous Haushi Group with some production from the overlying Permian Khuff Formation. Future gas reservoirs may include the Infracambrian Buah limestone of the Huqf Supergroup.

TRAPS AND SEALS: Traps vary and are structurally complex, salt-induced anticlines and domes that have been broken up into several fault blocks by crestal collapse features. Multiple regional and intraformational seals occur throughout the section. Primary regional seals are the shales of the Cretaceous Nahr Umr and Fiqa Formations, and Ordovician Mabrouk Shale Member and Permian Khuff carbonates.

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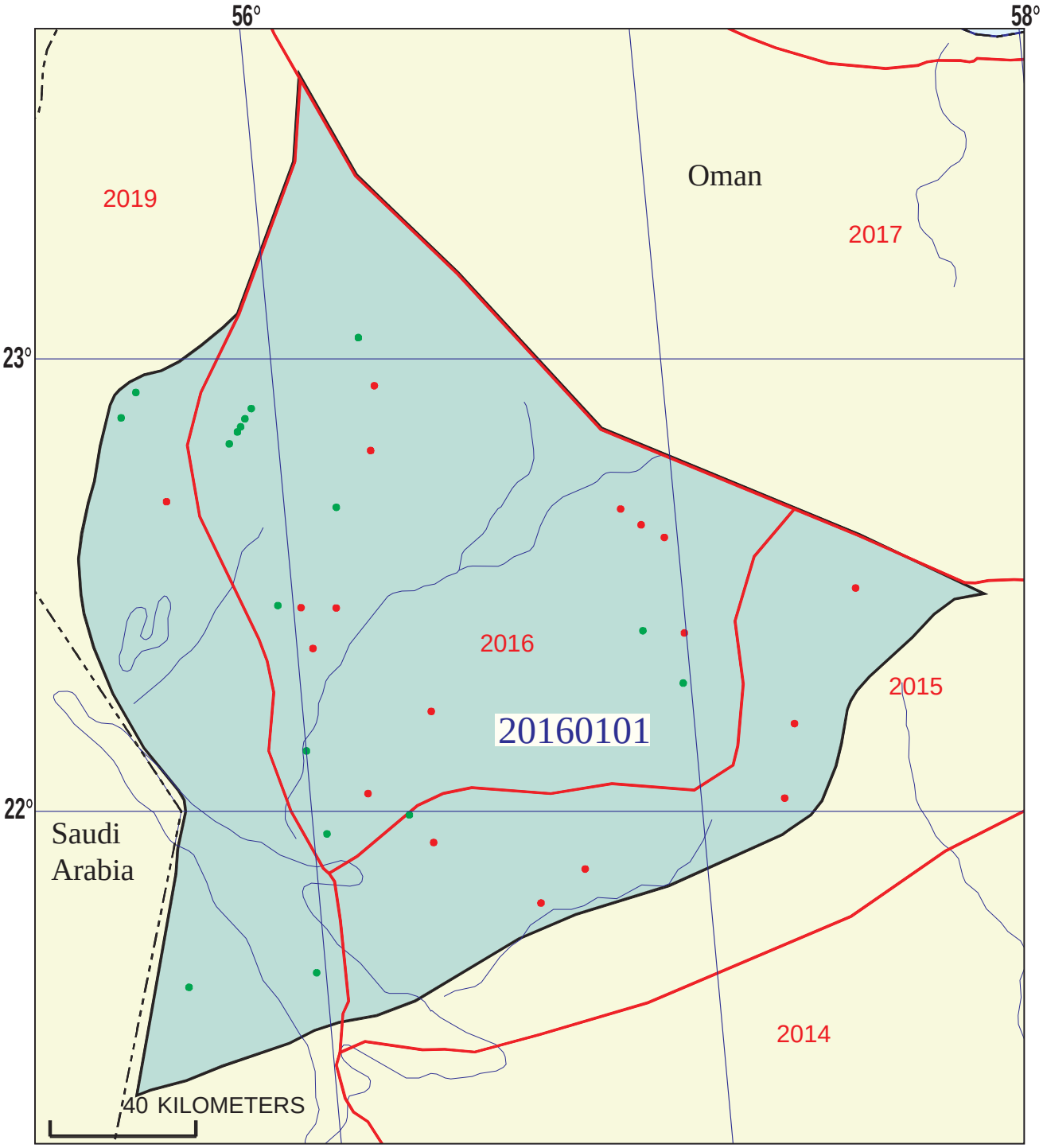


Fahud Huqf Combined Structural Assessment Unit - 20160101

EXPLANATION

- Hydrography
- Shoreline
- 2016 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 20160101 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	10/7/98		
Assessment Geologist:……..	R.M. Pollastro		
Region:……..	Middle East and North Africa	Number:	2
Province:……..	Fahud Salt Basin	Number:	2016
Priority or Boutique……	Priority		
Total Petroleum System:……	North Oman Huqf-Shu'aiba	Number:	201601
Assessment Unit:……..	Fahud-Huqf Combined Structural	Number:	20160101
* Notes from Assessor			

CHARACTERISTICS OF ASSESSMENT UNIT

Oil (<20,000 cfg/bo overall) **or** Gas (≥20,000 cfg/bo overall):… Oil
*Yibal 25% of Oman's Production
What is the minimum field size?……. 4 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: 16 Gas: 17
Established (>13 fields) X Frontier (1-13 fields) _____ Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 174 2nd 3rd 13.6 3rd 3rd 29.6
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 350 2nd 3rd 350 3rd 3rd 107

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.	25	max no.	60
Gas fields:……min. no. (>0)	5	median no.	25	max no.	60

*Approximately 20 undrilled structures

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

						*(1/2 Yibal)
Oil in oil fields (mmbo)……	min. size	4	median size	20	max. size	1500
Gas in gas fields (bcfg):……	min. size	24	median size	150	max. size	3000

Assessment Unit (name, no.)
Fahud-Huqf Combined Structural, 20160101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	1000	1500	2000
NGL/gas ratio (bngl/mmcfg)……	30	35	40

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	25	35	45
Oil/gas ratio (bo/mmcfg)……			

SELECTED ANCILLARY DATA FOR UNDISCOVERED FIELDS

(variations in the properties of undiscovered fields)

Oil Fields:			
API gravity (degrees)……	21	40	52
Sulfur content of oil (%)……	0.8	1	1.2
Drilling Depth (m) ……	800	2500	4000
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……	15	45	75
CO_2 content (%)……			
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	2000	4500	6000
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Fahud-Huqf Combined Structural, 20160101

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

1. Province 2016 represents 56 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		56	
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):...		56	
Portion of volume % that is offshore (0-100%).....		0	

2. Province 2015 represents 22 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		22	
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):...		22	
Portion of volume % that is offshore (0-100%).....		0	

3. Province 2019 represents 22 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		22	
Portion of volume % that is offshore (0-100%).....		0	

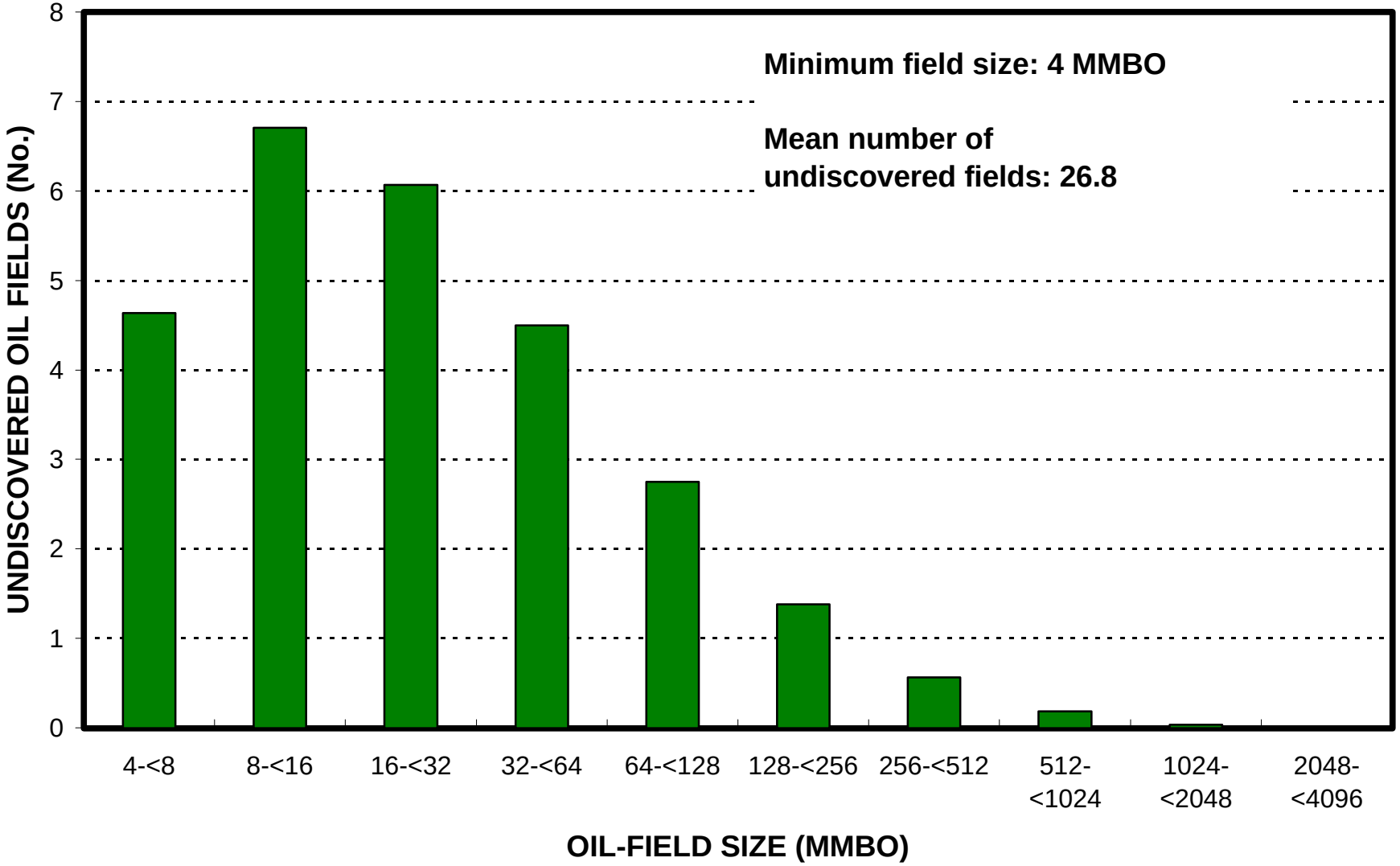
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		22	
Portion of volume % that is offshore (0-100%).....		0	

4. Oman represents 100 areal % of the total assessment unit

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

Fahud-Huqf Combined Structural, AU 20160101
Undiscovered Field-Size Distribution



Fahud-Huqf Combined Structural, AU 20160101
Undiscovered Field-Size Distribution