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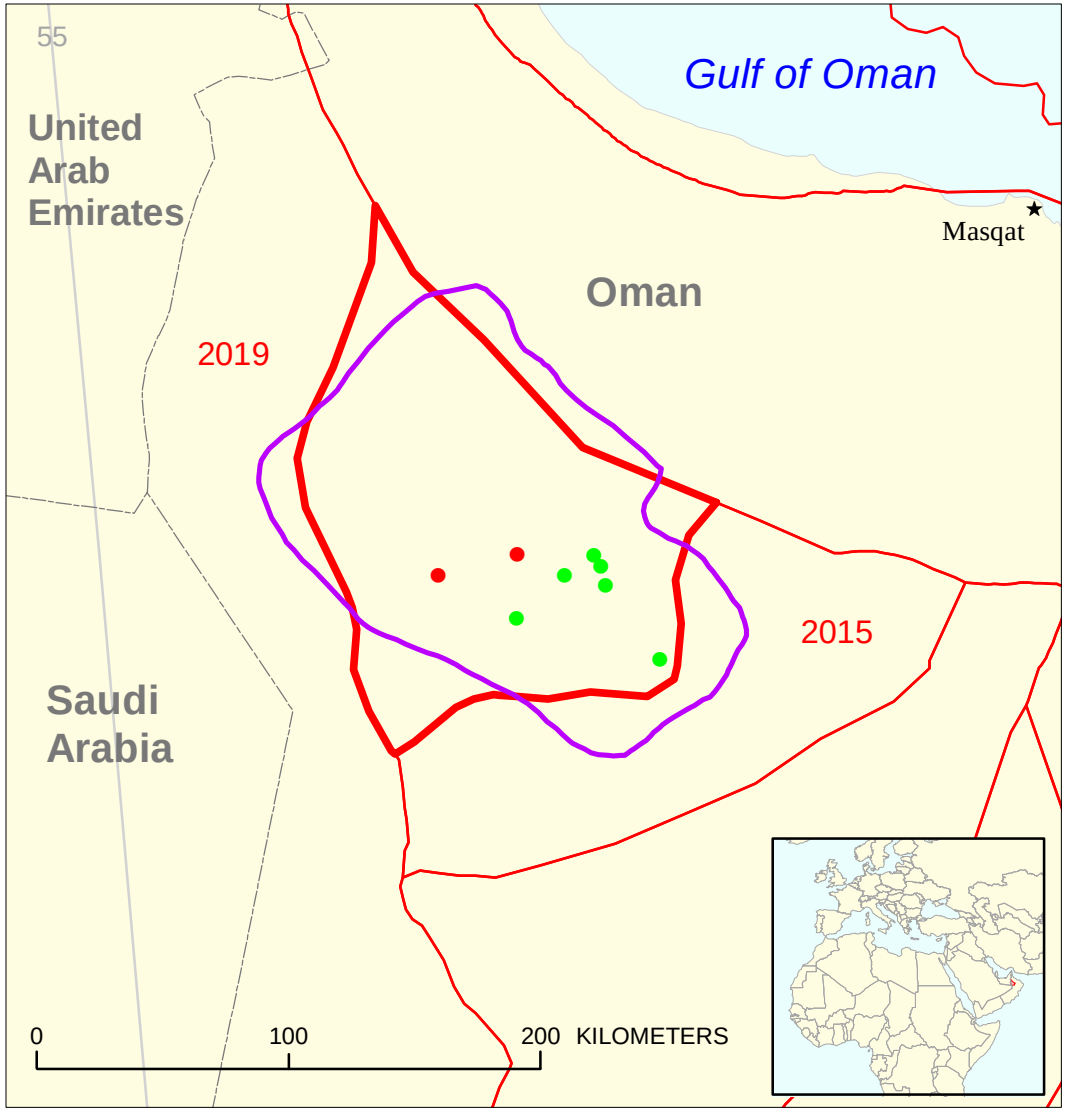
Natih-Fiqa Structural/Stratigraphic Assessment Unit 20160201



Natih-Fiqa Structural/Stratigraphic Assessment Unit 20160201
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 Central Oman Platform province (2015) and a small portion of the eastern Rub 'al Khali Basin (2019) and overthrust section of the Oman Mountains (2017) provinces.

GEOLOGIST: R.M. Pollastro

TOTAL PETROLEUM SYSTEM: Middle Cretaceous Natih (201602)

ASSESSMENT UNIT: Natih-Fiqa Structural/Stratigraphic (20160201)

DESCRIPTION: The middle Cretaceous Natih TPS is a small (about 20,000 km^2 in geographic extent) but highly efficient petroleum system. The Natih TPS is contained mostly within the Fahud Salt Basin Province with an estimated in-place resource volume of 9 BBOE. The petroleum system/assessment unit is bounded to east-northeast by the Oman Mountains, to the north by the Lekhwair-Safah arch, south-southeast by the Makarem-Mabrouk High, and to the west-southwest by the foreland bulge of the Omani foredeep.

SOURCE ROCKS: The 400 m-thick carbonate sequence of the Natih Formation is comprised of seven lithologic subdivisions designated A through G. Two organic-rich shaly intervals, the Natih "B" and "E" units, that are easily identified on well logs and of limited geographic extent, have sourced the hydrocarbons of the Natih TPS. In particular, the 50-m-thick Natih "B" unit is of excellent source rock quality, having TOC contents as high as 15 weight percent and averaging about 5 percent. These units contain structureless Type I/II organic matter.

MATURATION: Natih oils have an API gravity of about 32° and are distinctly different in geochemical composition than other oils in Oman. The Natih 'kitchen' is defined where the extent of the organic-rich facies is present in the deepest parts of the foreland basin. Models indicates only minor gas has been generated from Natih source rocks. A shallower extension of active source rock of lesser thermal maturity to the east of the Fahud and Natih faults and along the Maradi fault zone, which is an area of high (as much as 28 °C/km) geothermal gradient.

MIGRATION: The thickness of the massive Fiqa shale seal and modest folding and thrusting of the Oman Mountains forced lateral migration of Natih oils. Generation occurred in the Omani foredeep in the northern part of the assessment unit. Migration was initially south and west towards the foreland bulge and Ghaba Salt Basin but was interrupted by the formation of the Fahud fault during early development of the foreland basin. The fault created a shadow zone preventing migration of Natih oils to reach the foreland bulge and fields like Yibal.

RESERVOIR ROCKS: Reservoirs are porous skeletal grainstones and packstones of the Natih Formation (A, C, D, and E intervals), where freshwater leaching has enhanced porosities. Natih field, however, produces from heavily fractured, low permeability (0.5 to 10 mD) chalky limestones. Natih oils are also found in the Shu'aiba Formation in fault-dip structures of Natih and Fahud fields. Other

potential reservoirs include turbidite stratigraphic traps in the overlying Fiqa Formation and truncation traps below Lower Fiqa shales.

TRAPS AND SEALS: Most traps are structural and related to development of the foreland basin during the Late Cretaceous/Tertiary. These structures formed during two major stages of tectonics that built the Oman Mountains. Obduction and deformation during the first alpine event produced normal and strike-slip faults, while the second alpine event resulted in reactivation and inversion of earlier faults near the thrust front, most of which were enhanced by halokinesis. Specific common trap styles are faulted closures, dip closures, and faulted-dip closures. Individual Natih reservoirs are sealed by the intra-formational marls and shales. A thick shale sequence of the overlying Fiqa Formation forms a major regional seal for the Natih Formation.

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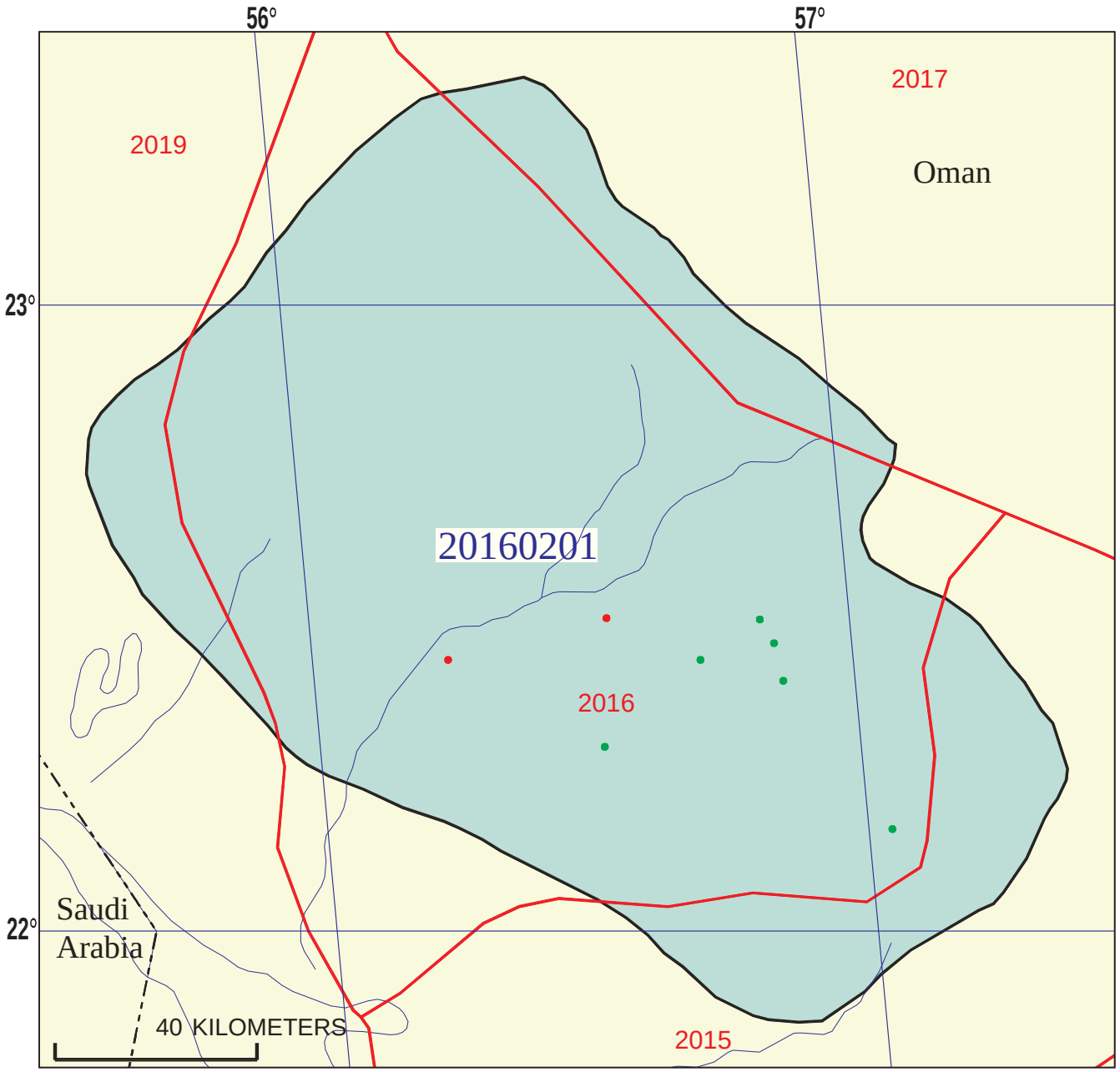


Natih-Fiqa Structural/Stratigraphic Assessment Unit - 20160201

EXPLANATION

- Hydrography
- Shoreline
- 2016 Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 20160201 Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	10/8/98		
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:……	Middle Cretaceous Natih	Number:	201602
Assessment Unit:……..	Natih-Fiqa Structural/Stratigraphic	Number:	20160201
* Notes from Assessor	L.A. Basin and Gulf Coast analogs.		

CHARACTERISTICS OF ASSESSMENT UNIT

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

What is the minimum field size?……. 1 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: 5 Gas: 2
Established (>13 fields) _____ Frontier (1-13 fields) X Hypothetical (no fields) _____
*Last field in 1980

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 754 2nd 3rd 34 3rd 3rd _____

Median size (grown) of discovered gas fields (bcfg):
1st 3rd 1570 *(1965) 2nd 3rd 1627 *(1966) 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)	1	median no.	15	max no.	40
Gas fields:……min. no. (>0)	1	median no.	4	max no.	10

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	1	median size	10	max. size	600
Gas in gas fields (bcfg):…… min. size	6	median size	20	max. size	1000

Assessment Unit (name, no.)
Natih-Fiqa Structural/Stratigraphic, 20160201

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	300	500	700
NGL/gas ratio (bngl/mmcfg)……	40	50	60

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	40	50	60
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)……	30	32	34
Sulfur content of oil (%)……	1.15	1.3	1.45
Drilling Depth (m) ……	800	1800	3000
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……			
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	800	1800	3000
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Natih-Fiqa Structural/Stratigraphic, 20160201

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

1. Province 2016 represents 78 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		78	
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):...		78	
Portion of volume % that is offshore (0-100%).....		0	

2. Province 2015 represents 11 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		11	
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):...		11	
Portion of volume % that is offshore (0-100%).....		0	

3. Province 2017 represents 6 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		6	
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):...		6	
Portion of volume % that is offshore (0-100%).....		0	

4. Province 2019 represents 5 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		5	
Portion of volume % that is offshore (0-100%).....		0	

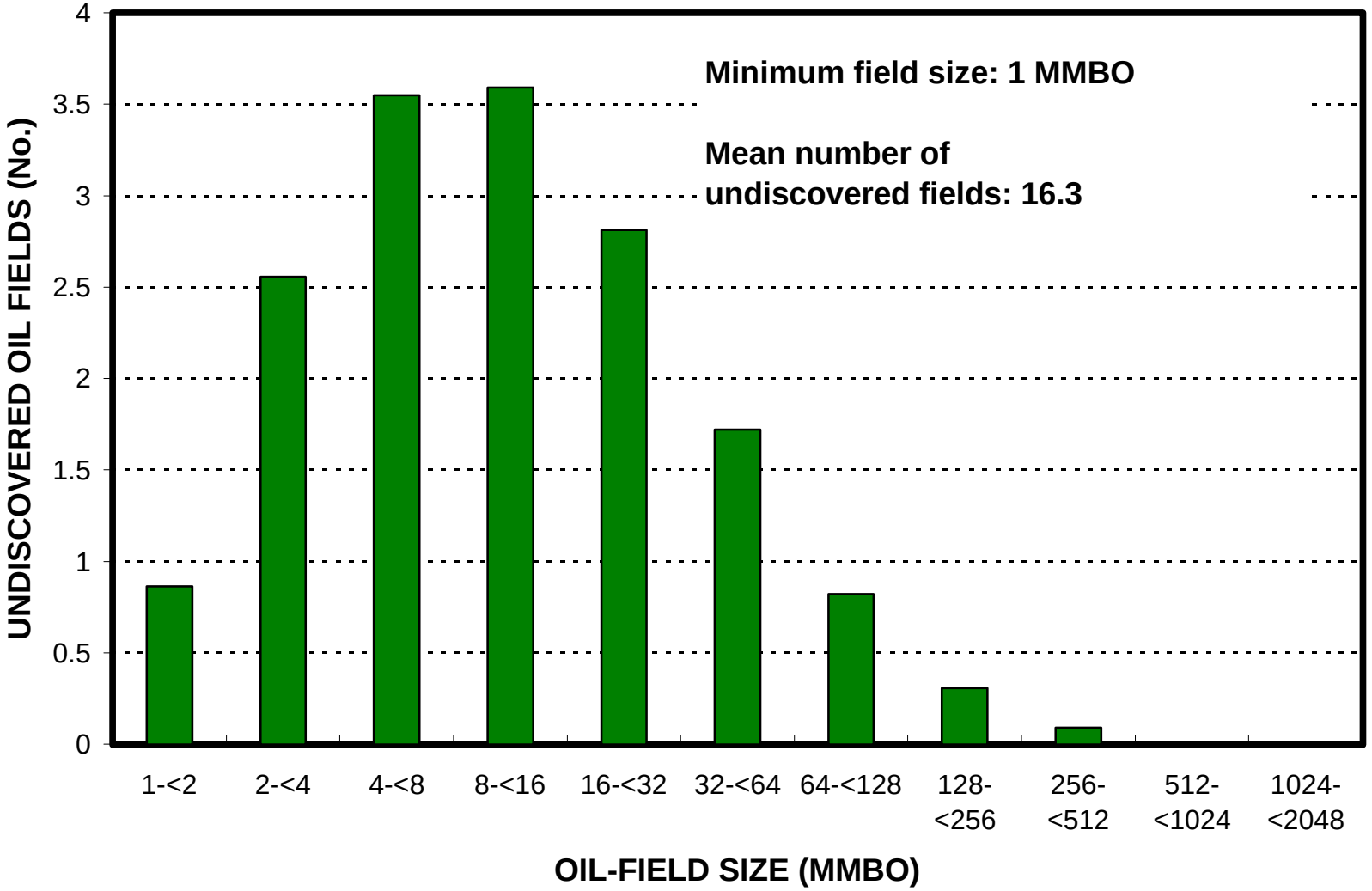
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		5	
Portion of volume % that is offshore (0-100%).....		0	

5. 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	

Natih-Fiqa Structural/Stratigraphic, AU 20160201
Undiscovered Field-Size Distribution



Natih-Fiqa Structural/Stratigraphic, AU 20160201
Undiscovered Field-Size Distribution