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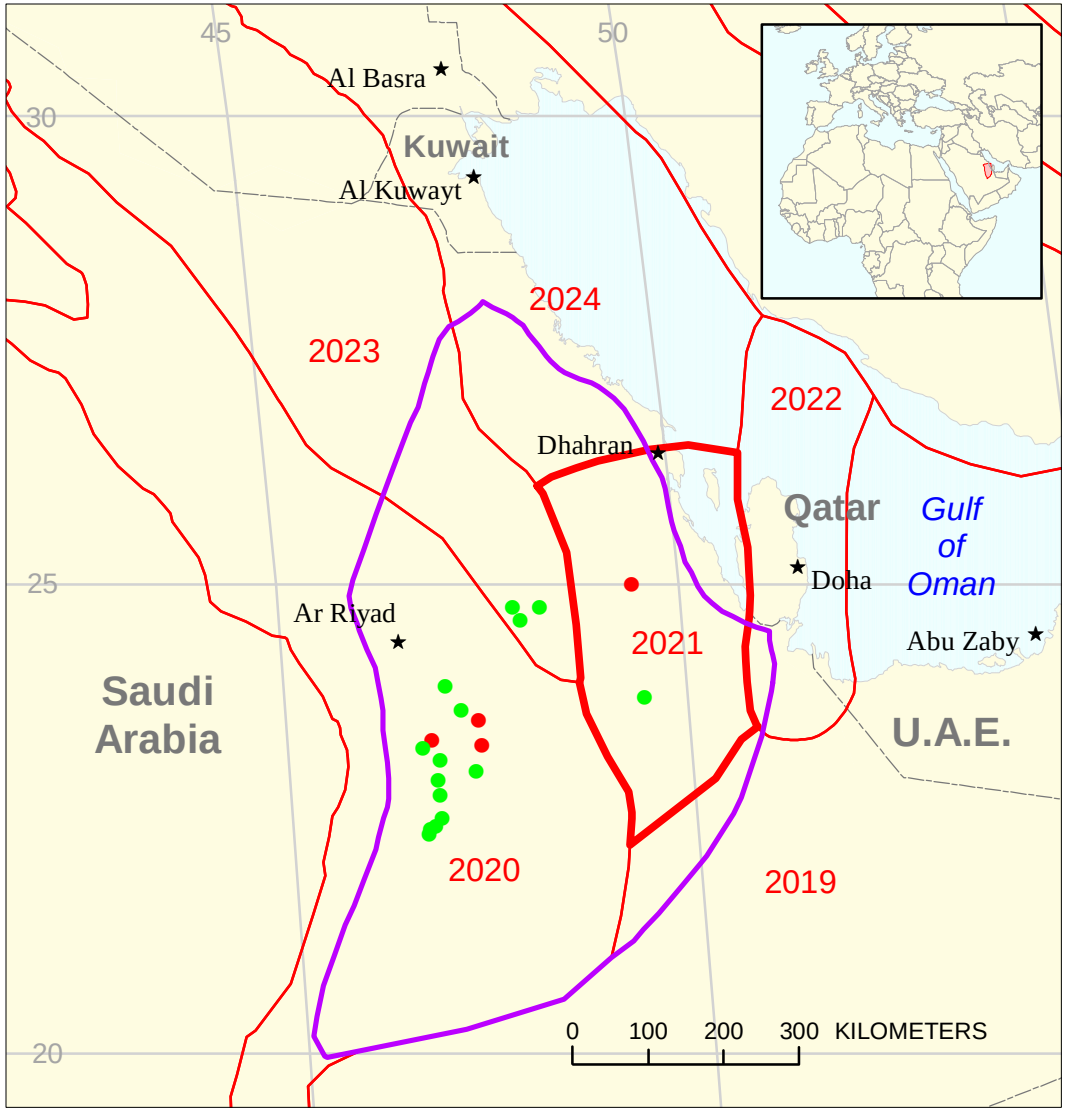
Central Arch Horst-Block Anticlinal Oil and Gas Assessment Unit 20210101



Central Arch Horst-Block Anticlinal Oil and Gas Assessment Unit 20210101
Greater Ghawar Uplift Geologic Province 2021
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: Greater Ghawar Uplift (2021)–Petroleum system is centered at Greater Ghawar but extends over parts of provinces 2019-Rub 'al Khali; 2020-Interior Homocline-Central Arch; 2022-Qatar Arch; 2023-Widyan Basin-Interior Platform; and 2024-Mesopotamian Foredeep.

GEOLOGIST: R.M. Pollastro

TOTAL PETROLEUM SYSTEM: Central Arabia Qusaiba Paleozoic (202101)

ASSESSMENT UNIT: Central Arch Horst-Block Anticlinal Oil and Gas (20210101)

DESCRIPTION: Assessment unit lies entirely in Saudi Arabia and covers the onshore portion of Central Arabia. It is structurally bounded to the north-northeast by the Arabian-Persian Gulf Salt Basin, to the east by the Qatar Arch, the west by the uplifted monocline outcrop belt along the eastern edge of the Arabian Shield, and limited to the north by erosion of the source-rock facies. Assessment unit is characterized by a primary north-south structural grain formed by basement fault blocks that resulted from island arc accretion during the Idsas (Precambrian) Orogeny and by a secondary northwest-southeast Najd rift trend. Anticlines formed by draping of sediments over horst blocks having subsequent movement.

SOURCE ROCKS: The primary source rock is the “basal hot shale” in the lower part of the Qusaiba Member of the Lower Silurian Qalibah Formation. The basal hot shale ranges from 3 to 75 m in thickness and occurs throughout most of central Arabia and Rub 'al Khali basins including the north and west Arabian-Persian Gulf Salt Basins. The source rock is eroded along the Central Arabian Arch.

MATURATION: The basal hot shale is immature along the outcrop belt in the far southwest corner of the assessment unit but mature for oil in most of the western half where it produces in a series of wrench-faulted fields. The basal hot shale is mature for gas in the eastern half of the assessment unit at Ghawar and to the east and south.

MIGRATION: Migration is mainly vertical into Paleozoic reservoirs. However, light, sweet oil with high (44 to 52° API) gravities has migrated westward from more mature eastern source areas of the central Arabian Basin into these westernmost fields (for example, Hawtah, Layla).

RESERVOIR ROCKS: Reservoirs are primarily Paleozoic clastics and include the aluvial-fluvial sandstones of the Lower Permian Unayzah Formation, shallow marine shelf sandstones of the Jauf Formation, and some Ordovician sandstones. Basal transgressive marine sandstones and cyclic dolomitic shelf carbonates of the Lower Permian Khuff Formation are reservoirs for gas and oil in the eastern part of the unit.

TRAPS AND SEALS: Traps are mainly structural and most are anticlinal (crest and flank) formed from draping of sediments over basement horst blocks having subsequent movement. Some drape and drag traps formed by wrench faulting. Minor updip pinch-out stratigraphic traps have been recognized

in the Unayzah. The primary regional seal is the basal Khuff Formation (shales, tight carbonates, and 'D' anhydrite). Local intraformational seals are also found within each of the reservoir units.

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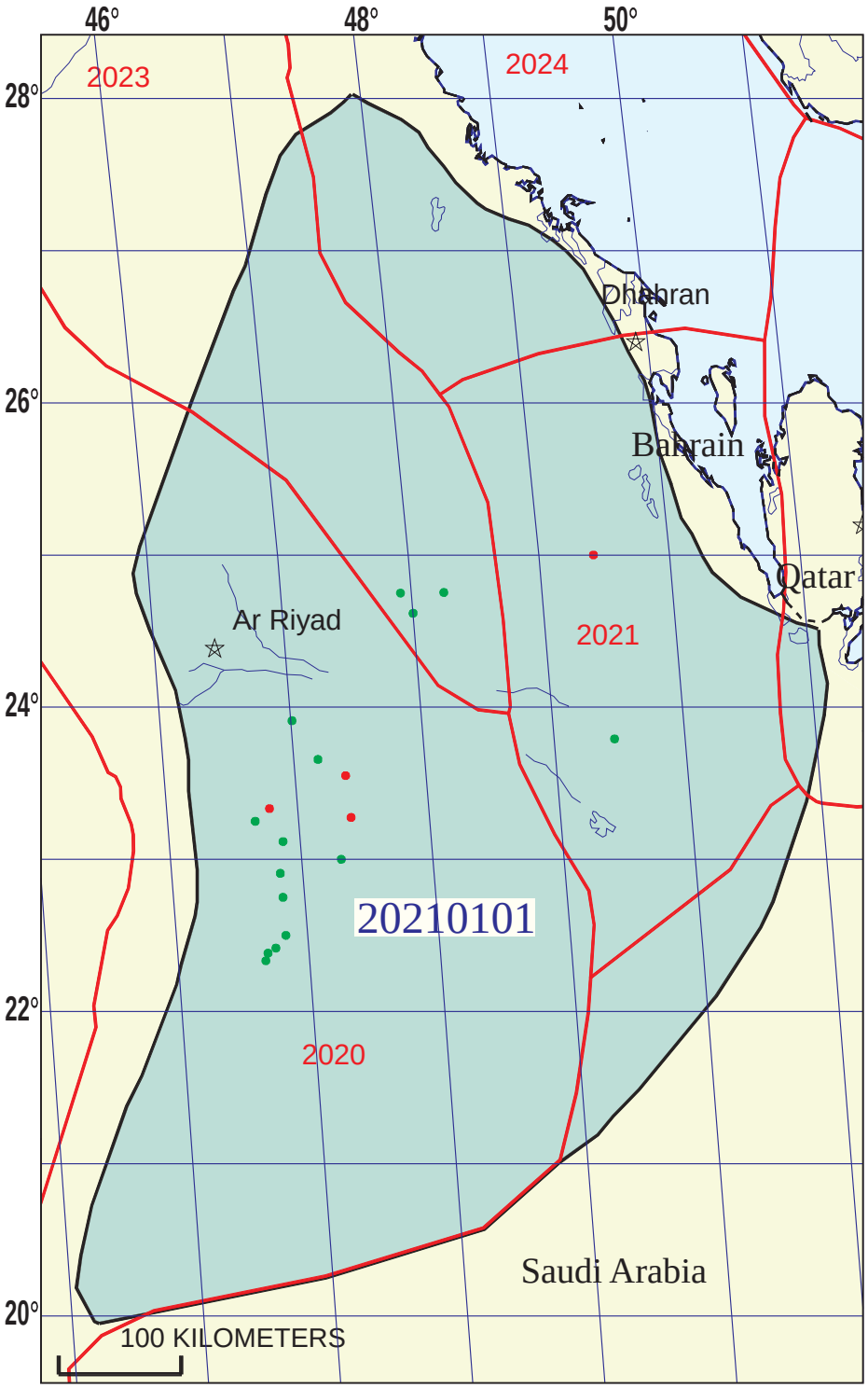


Central Arch Horst-Block Anticlinal Oil and Gas Assessment Unit - 20210101

EXPLANATION

- Hydrography
- Shoreline
- 2021 — Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 20210101 — Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:……..	5/13/99		
Assessment Geologist:……..	R.M. Pollastro		
Region:……..	Middle East and North Africa	Number:	2
Province:……..	Greater Ghawar Uplift	Number:	2021
Priority or Boutique……..	Priority		
Total Petroleum System:……	Central Arabia Qusaiba Paleozoic	Number:	202101
Assessment Unit:……..	Central Arch Horst-Block Anticlinal Oil and Gas	Number:	20210101
* Notes from Assessor	Lower 48 growth factor. Assessment unit involves 6 priority provinces.		

CHARACTERISTICS OF ASSESSMENT UNIT

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

What is the minimum field size?……. 20 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: 14 Gas: 4
Established (>13 fields) X Frontier (1-13 fields) _____ Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 760 2nd 3rd 976 3rd 3rd 539
Median size (grown) of discovered gas fields (bcfg):
1st 3rd 1691 2nd 3rd 2032 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)	15	median no.	90	max no.	180
Gas fields:……min. no. (>0)	20	median no.	120	max no.	220

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	20	median size	100	max. size	5000
Gas in gas fields (bcfg):……min. size	120	median size	700	max. size	50000

Assessment Unit (name, no.)
Central Arch Horst-Block Anticlinal Oil and Gas, 20210101

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	60	90

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	60	80	100
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)……	35	46	55
Sulfur content of oil (%)……	0.02	0.07	0.9
Drilling Depth (m) ……	1000	2000	5000
Depth (m) of water (if applicable)……			

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……			
Hydrogen-sulfide content (%)……			
Drilling Depth (m)……	1500	2800	6000
Depth (m) of water (if applicable)……			

Assessment Unit (name, no.)
Central Arch Horst-Block Anticlinal Oil and Gas, 20210101

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

1. Saudi Arabia 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	

2. 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):...		2	
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	

3. Province 2020 represents 50 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):.....			
Volume % in parcel (areal % x richness factor):...		65	
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):...		41	
Portion of volume % that is offshore (0-100%).....		0	

4. Province 2021 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):...		10	
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):...		30	
Portion of volume % that is offshore (0-100%).....		0	

5. Province 2022 represents 1 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		0	
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):…		1	
Portion of volume % that is offshore (0-100%)……		0	

6. Province 2023 represents 14 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		20	
Portion of volume % that is offshore (0-100%)……		0	

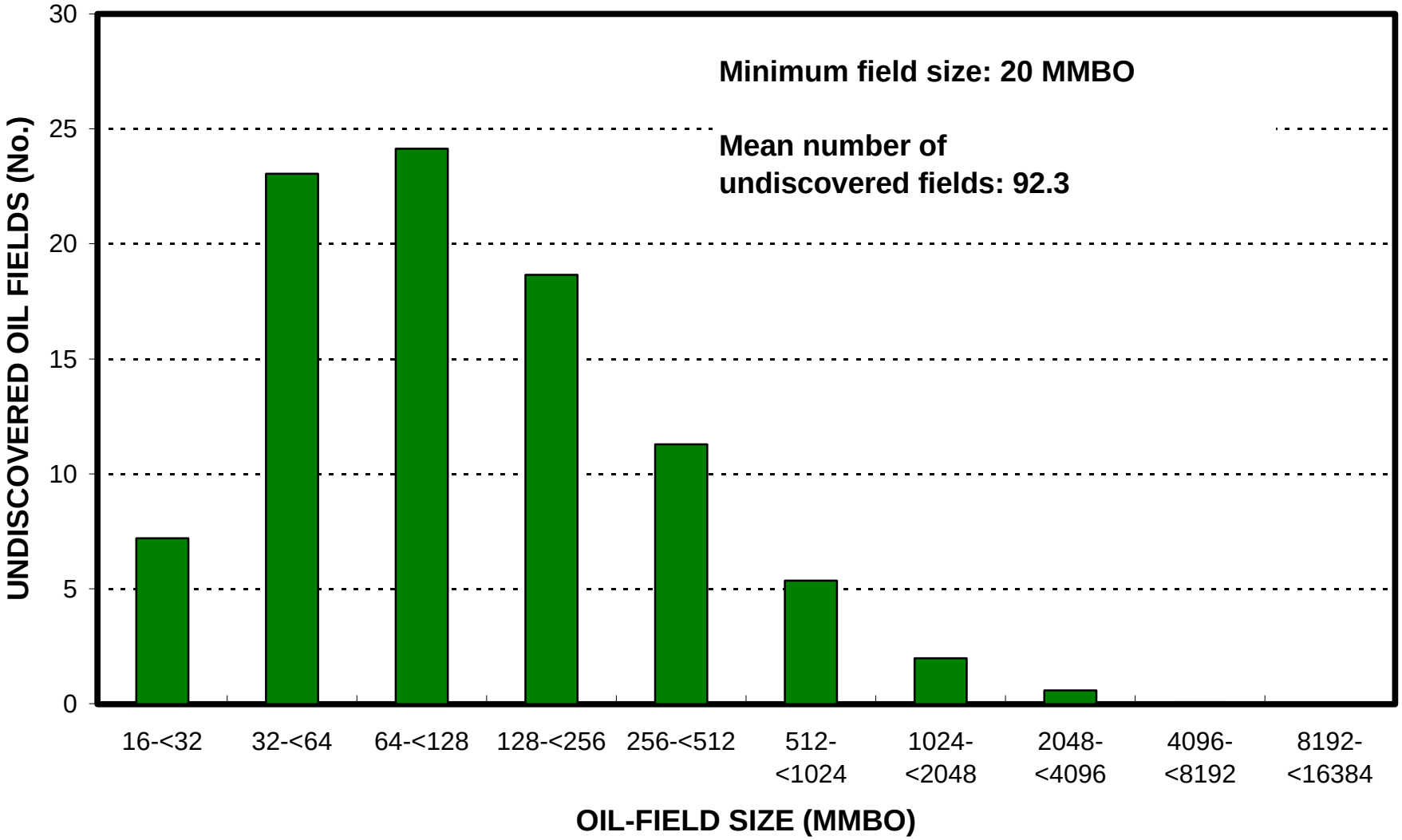
Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		20	
Portion of volume % that is offshore (0-100%)……		0	

7. Province 2024 represents 8 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	

Central Arch Horst-Block Anticlinal Oil and Gas, AU 20210101
Undiscovered Field-Size Distribution



Central Arch Horst-Block Anticlinal Oil and Gas, AU 20210101
Undiscovered Field-Size Distribution