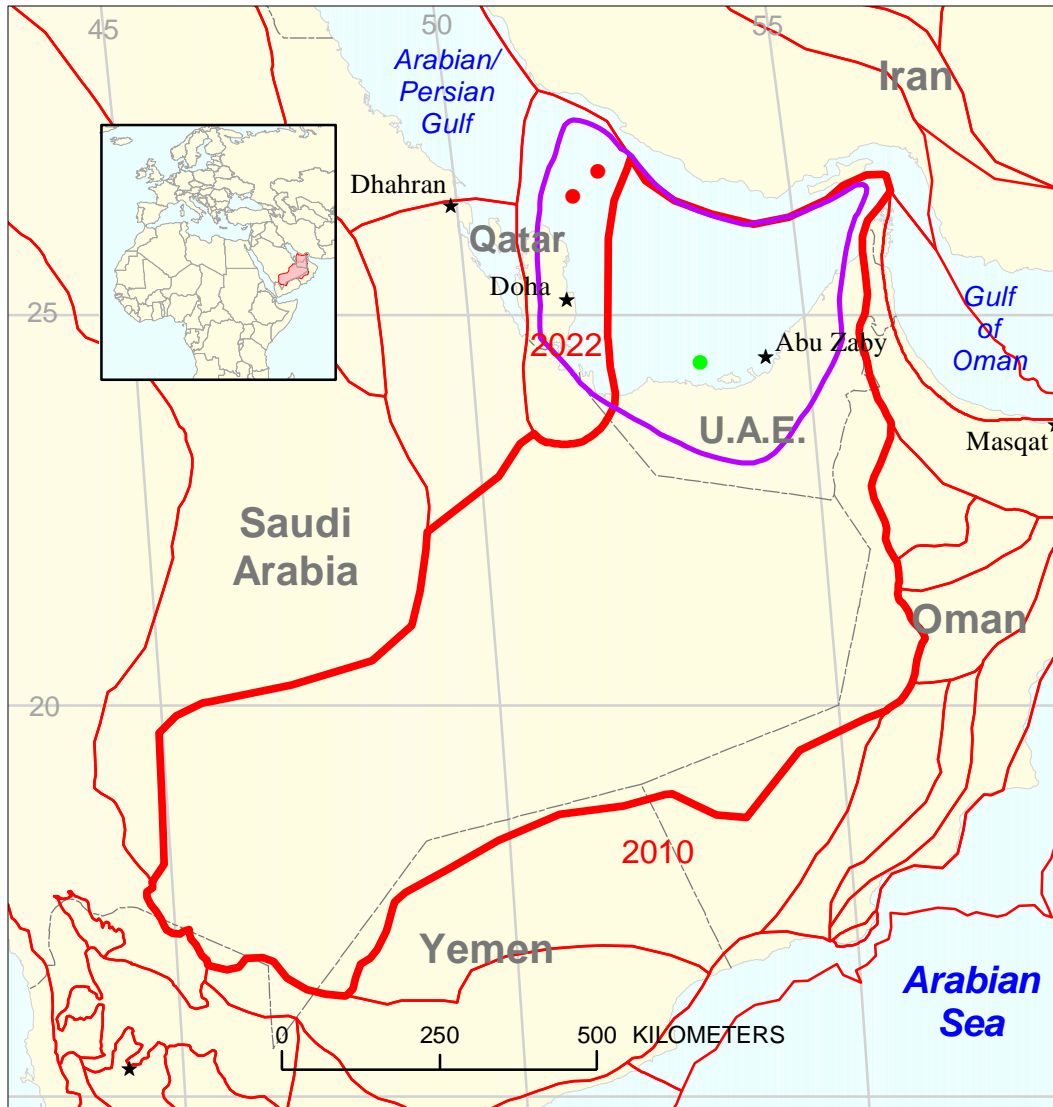# Khuff Carbonates in Salt Structures
Assessment Unit 20190301

Khuff Carbonates in Salt Structures Assessment Unit 20190301

Rub Al Khali Basin Geologic Province 2019

Other petroleum system boundary

USGS PROVINCE: Rub Al Khali Basin (2019)   **GEOLOGIST:** C.J. Schenk

TOTAL PETROLEUM SYSTEM: Silurian Qusaiba (201903)

ASSESSMENT UNIT: Khuff Carbonates in Salt Structures (20190301)

DESCRIPTION: This assessment unit encompasses the northeastern Rub al Khali Basin where shelf carbonate reservoirs of the Upper Permian Khuff Formation are the predominant reservoirs in salt-related structures of the Infracambrian Hormuz Salt Basin.

SOURCE ROCKS: Source rocks are hot shales of the basal Qusaiba Member of the Lower Silurian Qalibah Formation, which occurs throughout the Rub al Khali Basin. The basal Qusaiba is as thick as 75 m, with TOC values as high as 20 percent.

MATURATION: Qusaiba mudstones in this assessment unit have passed the oil window and are in the dry gas window over much of the area of the assessment unit.

MIGRATION: Migration of Qusaiba hydrocarbons in this assessment unit was mainly from the east up regional dip into the crestal portion of the Qatar Arch, forming the supergiant North and South Pars fields. Vertical migration occurred along the flanks of the numerous salt structures.

RESERVOIR ROCKS: Reservoirs are mainly shelf carbonate grainstones and reef carbonates of the Upper Permian Khuff Formation.

TRAPS AND SEALS: Traps are mainly structural, and are related to salt domes and other salt structures of the Infracambrian Hormuz Salt Basin, which encompasses this area of the southern Arabian Gulf. Seals are predominantly anhydrites within the Permian Khuff interval.

REFERENCES:
Al-Jallal, I.A., 1994, The Khuff Formation–its regional reservoir potential in Saudi Arabia and other Gulf countries; depositional and stratigraphic approach, *in* Al-Husseini, M.I., ed., Geo '94; The Middle East Petroleum Geosciences, Volume I, Gulf PetroLink, Bahrain: p. 103-119.
Cole, G.A., Abu-Ali, M.A., Aoudeh, S.M., Carrigan, M.J., Chen, H.H., Collig, E.L., Gwathney, W.J., Al-Hajii, A.A., Halpern, H.I., Jones, P.J., Al-Sharidi, S.H., and Tobey, M.H., 1994, Organic geochemistry of the Paleozoic petroleum system of Saudi Arabia: Energy and Fuels, v. 8, p. 1425-1442.
Jones, P.J., and Stump, T.E., 1999, Depositional and tectonic setting of the Lower Silurian hydrocarbon source facies, central Saudi Arabia: American Association of Petroleum Geologists Bulletin, v. 83, p. 314-332.
Milner, P.A., 1998, Source rock distribution and thermal maturity in the southern Arabian peninsula: GeoArabia, v. 3, p. 339-356.
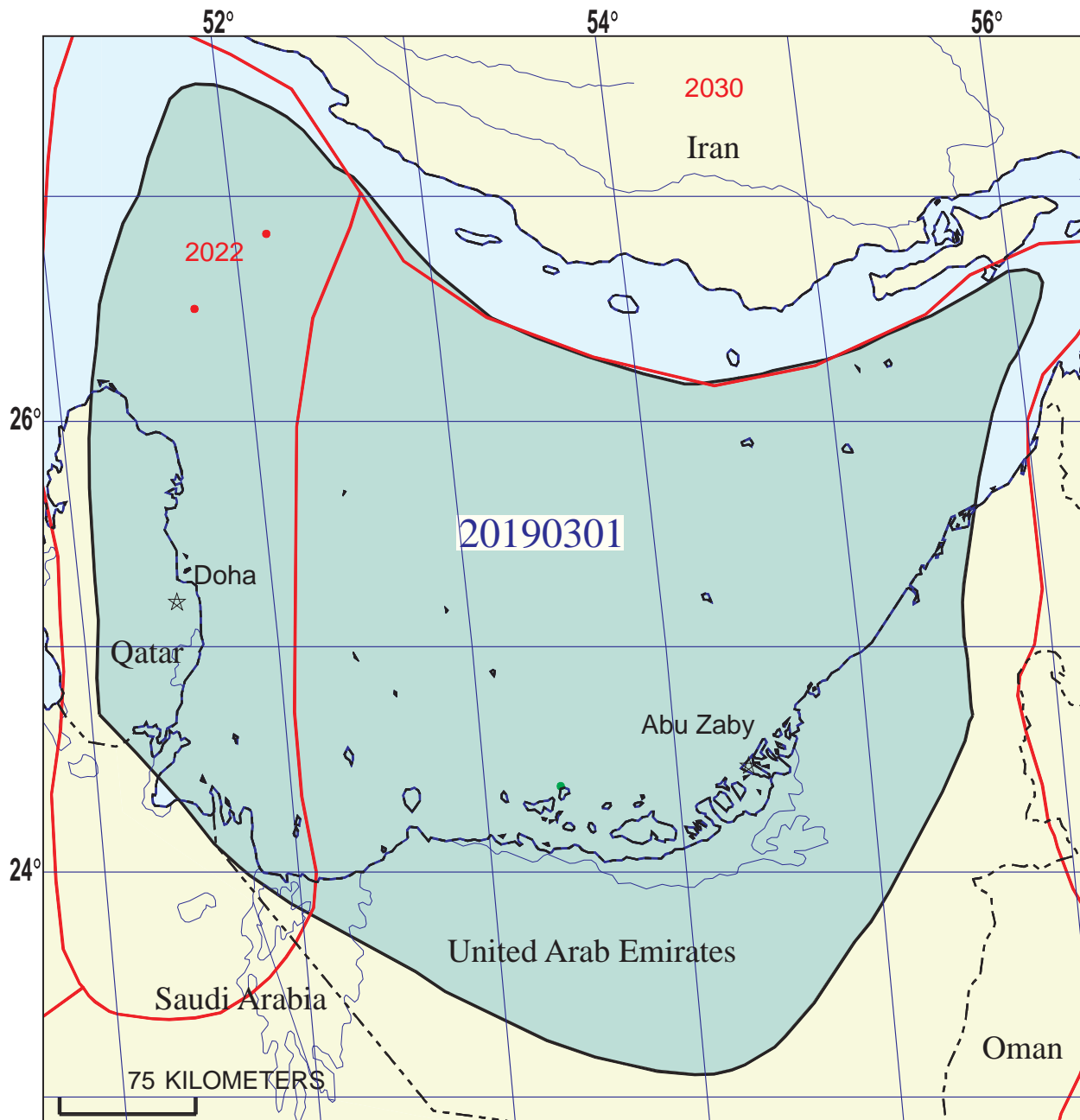
Khuff Carbonates in Salt Structures
Assessment Unit - 20190301

EXPLANATION

— Hydrography

— Shoreline

2019 —— Geologic province code and boundary

- - - Country boundary

• Gas field centerpoint

• Oil field centerpoint

20190301 —— Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

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

Date:…………………….. 12/8/99

Assessment Geologist:…….. C.J. Schenk

Region:……………………. Middle East and North Africa   Number: 2

Province:…………………… Rub Al Khali Basin   Number: 2019

Priority or Boutique…………. Priority

Total Petroleum System:…… Silurian Qusaiba   Number: 201903

Assessment Unit:………….. Khuff Carbonates in Salt Structures   Number: 20190301

* Notes from Assessor   Lower 48-all growth function. This is an assessment of Permian reservoirs

separately from other reservoirs), recognizing possible overlap of Jurassic

and Cretaceous. Inert gas is N_2.

CHARACTERISTICS OF ASSESSMENT UNIT

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

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: 1   Gas: 2

Established (>13 fields)   Frontier (1-13 fields)   X   Hypothetical (no fields)

Median size (grown) of discovered oil fields (mmboe):

1st 3rd   2nd 3rd   3rd 3rd

Median size (grown) of discovered gas fields (bcfg):

1st 3rd   2nd 3rd   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)   median no.   max no.

Gas fields:………………………………min. no. (>0)   5   median no.   50   max no.   110

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   median size   max. size

Gas in gas fields (bcfg):……………………min. size   60   median size   180   max. size   15000

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS
(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)…………………….…..………			
NGL/gas ratio (bngl/mmcfg)………………....…..			

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)………………….………….			
Sulfur content of oil (%)……………………...….			
Drilling Depth (m) ………….…...………………..			
Depth (m) of water (if applicable)………….....….			

Gas Fields:	minimum	median	maximum
Inert gas content (%)………………….……....……	1	6	12
CO_2 content (%)……………….……………......…	1	2	4
Hydrogen-sulfide content (%)………………..….….	1	2	5
Drilling Depth (m)…………….………………………	1000	3000	6500
Depth (m) of water (if applicable)………………….	0	25	100

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

1. United Arab Emirates   represents   55   areal % of the total assessment unit

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

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……….…..…			
Volume % in parcel (areal % x richness factor):…		55	
Portion of volume % that is offshore (0-100%)……		60	

2. Qatar   represents   20   areal % of the total assessment unit

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

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%)……		100	

3. Iran   represents   25   areal % of the total assessment unit

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

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……….…..…			
Volume % in parcel (areal % x richness factor):…		25	
Portion of volume % that is offshore (0-100%)……		100	

4. Province 2019   represents   82   areal % of the total assessment unit

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

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……….…..…			
Volume % in parcel (areal % x richness factor):…		82	
Portion of volume % that is offshore (0-100%)……		72	

5. <u>Province 2022</u>   represents   <u>18</u>   areal % of the total assessment unit

<u>Oil in Oil Fields:</u>

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

<u>Gas in Gas Fields:</u>

	minimum	median	maximum
Richness factor (unitless multiplier):……….…..…			
Volume % in parcel (areal % x richness factor):…		18	
Portion of volume % that is offshore (0-100%)……		100	

Khuff Carbonates in Salt Structures, AU 20190301
Undiscovered Field-Size Distribution

Minimum field size: 60 BCFG

Mean number of undiscovered fields: 52.1

UNDISCOVERED GAS FIELDS (No.)

GAS-FIELD SIZE (BCFG)

48-<96 | 96-<192 | 192-<384 | 384-<768 | 768-<1536 | 1536-<3072 | 3072-<6144 | 6144-<12288 | 12288-<24576