



MINISTRY OF ENERGY AND MINERAL RESOURCES

# OIL & GAS EXPLORATION OPPORTUNITIES IN JORDAN 2021





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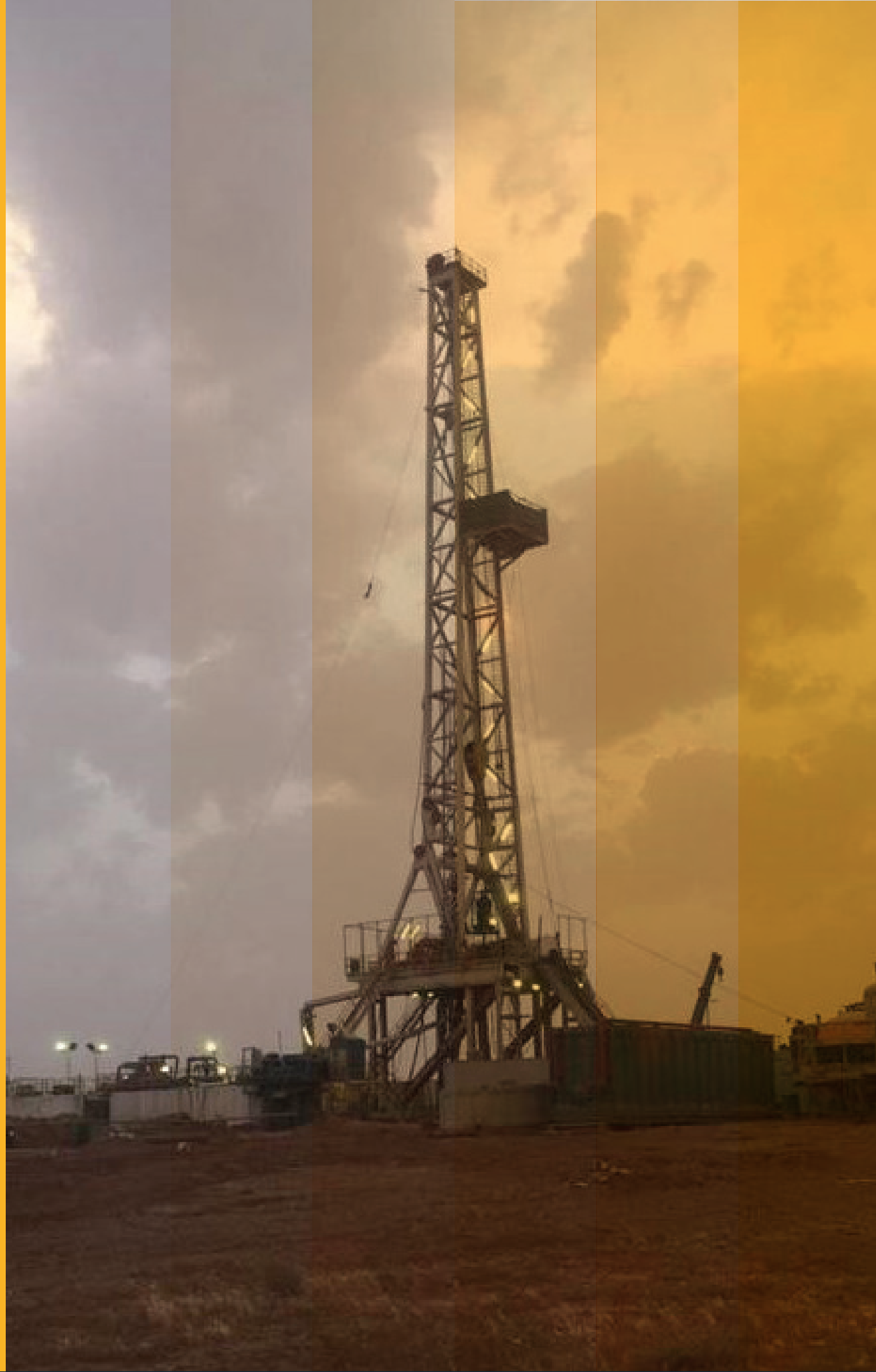


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# INTRODUCTION



Jordan is located in the northwestern part of the Arabian Plate within a producing sedimentary basin. Since the start of exploration in Jordan in 1947 by the Iraqi Petroleum Company, two fields have been discovered so far: Hamza oil field and Risha gas field. A discovery is reported in the WS-4 well (Sirhan Development area).

Production in Jordan has started in 1984 of crude oil and in 1989 of dry gas which is used locally to generate electricity. The existence of the Hamza oil field and the Risha gas field proves the presence of two working petroleum systems in Jordan.

Previous exploration studies that were conducted in Jordan had identified leads/anomalies structures across Jordan based on various seismic lines, gravity/magnetic data or satellite data, and several wells that had been drilled, minding that the prospectivity of oil and gas in Jordan is not limited to these structures.

Hydrocarbon occurrences within neighboring countries include the Akkas gas field in Iraq, the Turaif tight gas development in Saudi Arabia are located to the south of the Risha and East Safawi areas, and the Golan Heights discovery.

The Risha Field shares a similar geological history to the Akkas Field; both of these are recognized along with the Turaif tight gas development. It is considered to be potential for tight gas availability in the eastern deserts of Jordan. The light oil discovery at WS-4 well could also be the southwestern continuation of the Mudawwara system.

In this promotion bulletin, the main exploration areas that are open for oil and gas exploration are defined and presented to clarify their prospectivity and the potential leads and anomalies that were identified by various companies who worked in each area within the available data.



# OIL & GAS EXPLORATION HISTORY



The Iraqi Petroleum Company (IPC) was the first company to start exploring for oil in 1947 and had accomplished some geological mapping, gravity and magnetic surveys.

Edwin Pauly/Phillips acquired a license between 1955 and 1961 where geological and geophysical works were conducted, in addition to the drilling of six wells (Safra-1, Halhoul-1, Ramalla-1, Suwileh-1, Jordan Vally-1, Lisan-1).

The period 1964-1978 has witnessed some activities by John Mecom, INA, Total, Filon, Fuyo and Natural Resources Authority "NRA" where 14 wells were drilled, in addition to limited seismic, gravity and magnetic surveys.

In 1981-1996, the Jordanian Government decided to increase oil exploration efforts funded through the National Budget where 83 wells were drilled in addition to acquiring about 34,030 Km of 2D seismic lines. These efforts resulted in the discovery of oil in Hamzeh Field/Azraq area in 1984 and the discovery of the commercial gas in Risha area in 1987, close to the Iraqi borders.

In parallel, foreign oil companies have worked in different blocks of Jordan for certain limited exploration activities under Memoranda of Understanding (MOU) or Production Sharing Agreement (PSA) terms or through Technical Assistance Programs.

## Oil & Gas Exploration Areas

The Kingdom is divided into twelve areas for oil and gas exploration (Conventional and Unconventional Resources), two of them are development areas (Hamza Development Area and Sirhan Development Area).

The open areas for exploration in Jordan are:

1. Azraq
2. Sirhan
3. Sirhan Development
4. Jafr
5. West Safawi
6. Dead Sea
7. North Highlands
8. Petra
9. Rum

## Current Oil & Gas Agreements

**1. Risha area:** Risha area was awarded to the National Petroleum Company “NPC” through a concession agreement for a period of (50) years since 1996.

**2. East Safawi area:** The East Safawi area was awarded to the National Petroleum Company” NPC” in 2014 through a Production Sharing Agreement.

**3. Hamza Field:** The Ministry of Energy and Mineral Resources in cooperation with the National Petroleum Company “NPC”, are undertaking the field assessment activities.

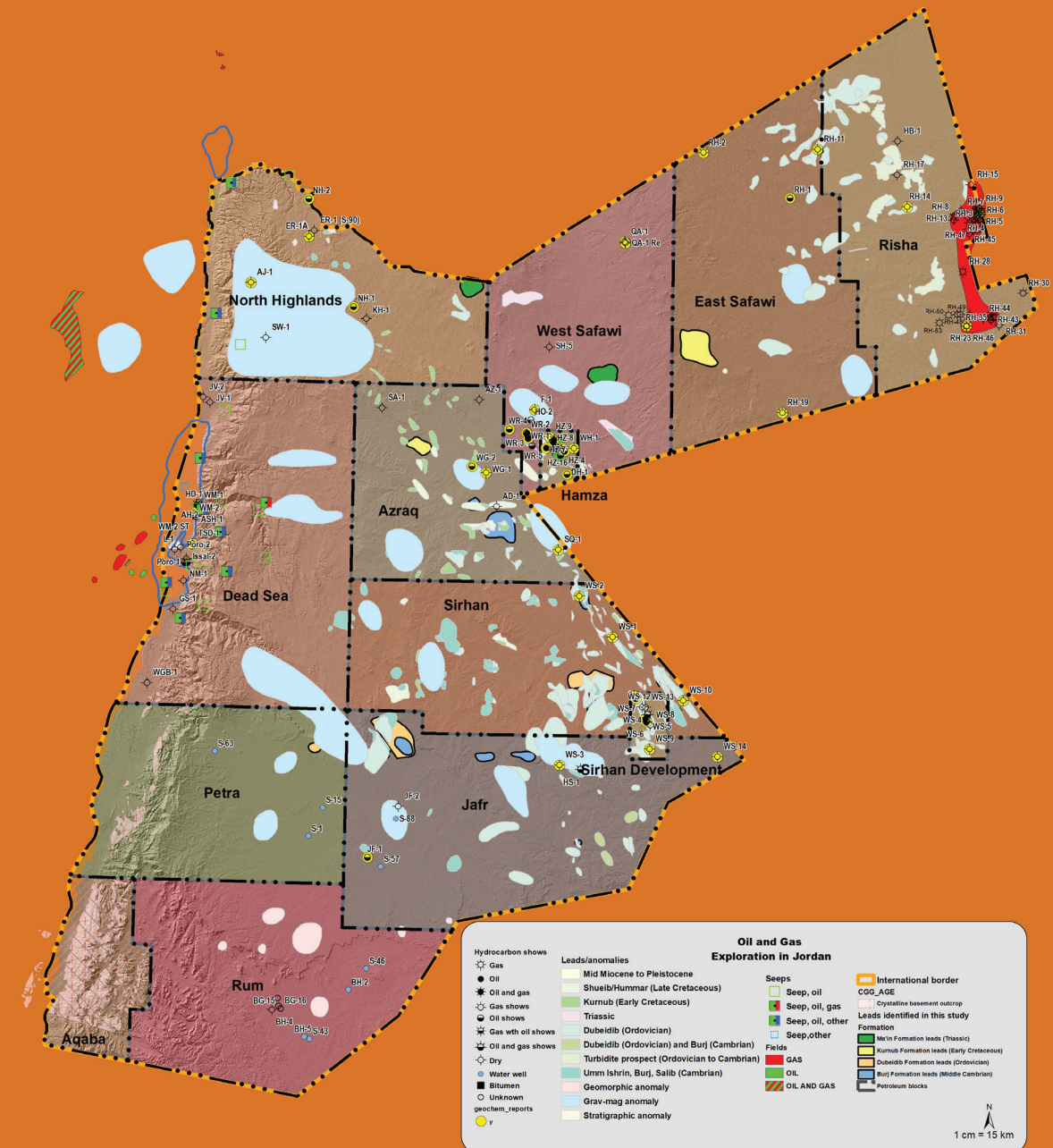
## Oil & Gas Exploration Investments

oil and gas exploration projects shall encounter official procedures within the laws and legislations in force in the Kingdom. The Jordanian Government represented by the Ministry of Energy and Mineral Resources”MEMR, adopts an approach for conventional and unconventional oil and gas exploration investment projects through contracting with qualified companies who are capable of carrying out exploration activities and developing oil and gas production projects based upon the following two tracks that the Government may embrace:

1. Launching international bid rounds, to explore certain open petroleum exploration areas and to select the qualified company according to certain evaluation standards and criteria indicated in the terms of reference of the bid which are mainly based on the experience, technical and financial capabilities of the company.

2. Direct negotiation with the interested Companies in investing in oil and gas exploration in the open areas, where companies will be evaluated according to special standards and criteria for the evaluation and qualification, based on their experience, technical and financial capabilities.

A memorandum of understanding” MOU” will be signed with the qualified company in order to study and evaluate oil and gas potentials in the area of interest and to develop an exploration program for oil and gas exploration and extraction before moving to signing official procedures of a Production Sharing Agreement “PSA “.





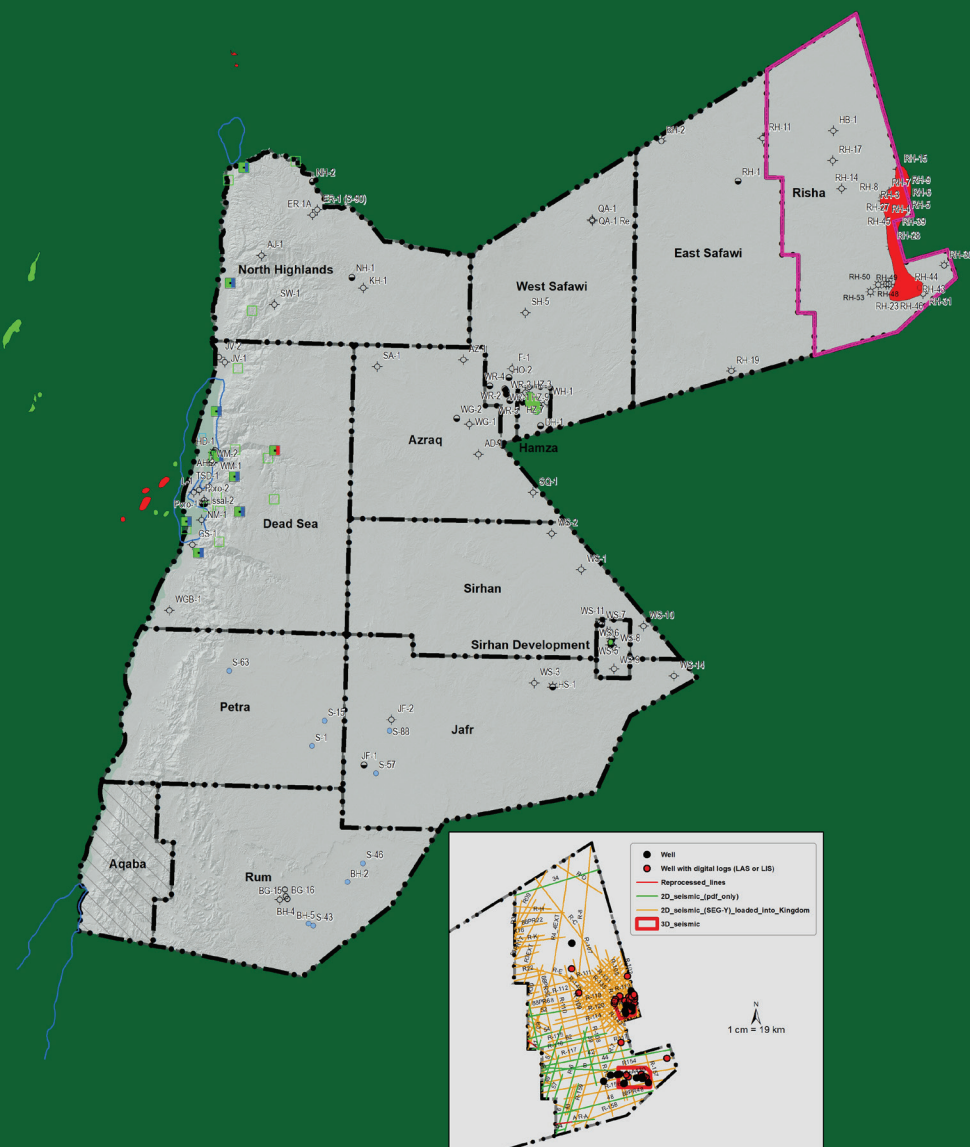
## Jordan Hydrocarbon Production

### 1. The Risha Gas Field

The Risha gas field lies in northeast Jordan, along its eastern edge close to the border of Jordan with Iraq. Fifty three wells have been drilled so far in this area with an average production of 27 mmcf/day by the end of 2020 that are supplied to a power station in the site.

The cumulative production since 1989 to 2019 is about 223.8 BCF. Drilling of more wells is recommended to improve the overall recovery at Risha.

The Risha gas field is part of the Palaeozoic Qusaiba/Akkas/Abba/Mudawwara petroleum system which is proven in Risha and in the WS-4, a light oil discovery in southeast Jordan, at the Akkas oil, gas and condensate field in western Iraq and most recently, in the Jalamid gas discovery in northern Saudi Arabia.



### 2. Hamza Oil Field

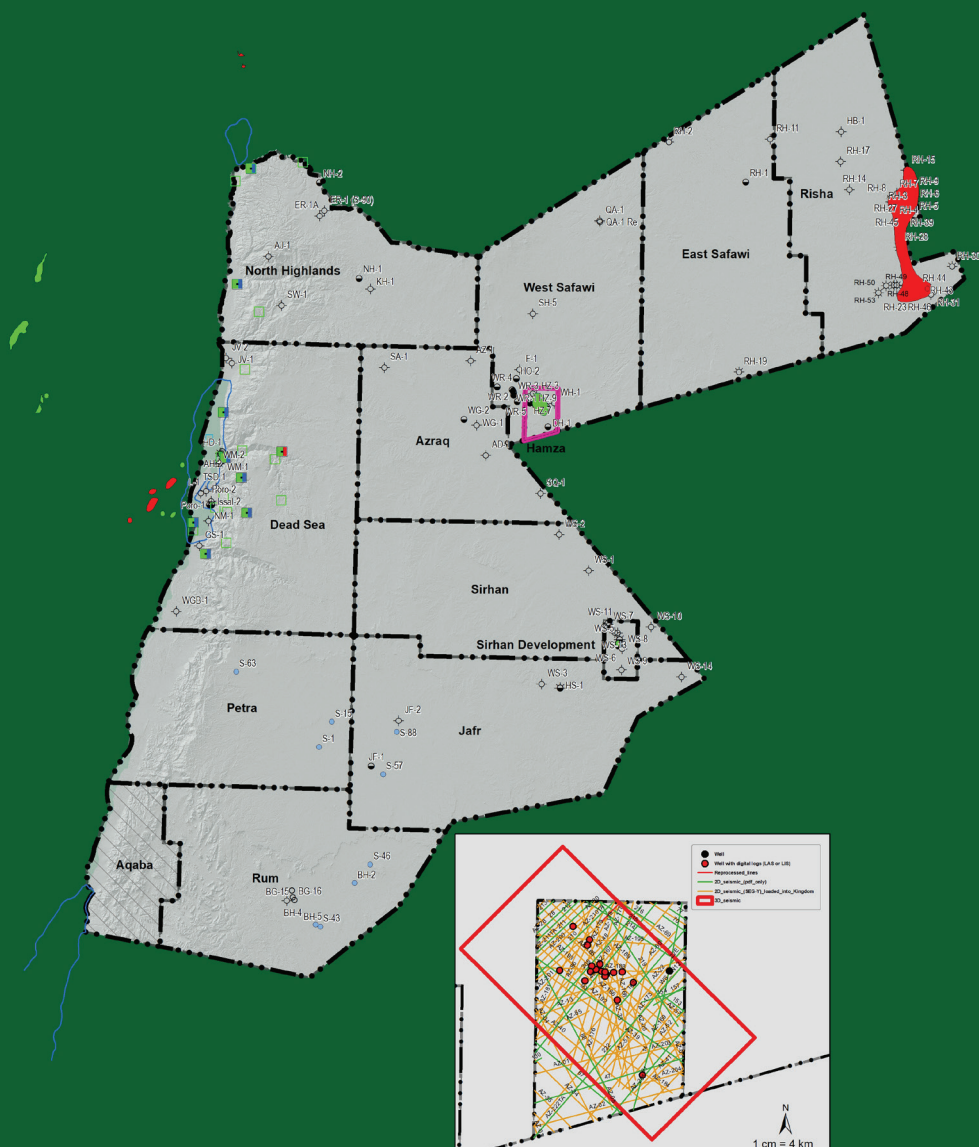
The Hamza Oil Field is located in the north part of Jordan and covers 363 km<sup>2</sup> and produces oil from two fractured reservoirs which enhances production of a medium gravity, low Sulphur oil from four wells in the field, there are 19 wells in the area. The Hamza Field produces from several geological formations.

The Hamza oil field in the Azraq district has produced more than one million barrels.

The area is covered with 2D of 1040 Lkm and 3D Seismic of 440 Km<sup>2</sup> and has the full information and reports of the 19 drilled wells in the area.

Several leads/anomalies have been identified by previous companies who worked in the area:

Tracs (2010) identified 4 leads, Sonoran report (2010) identifies 11 leads and the NRA and PCSB (1995) report identifies three leads.





## Jordan Hydrocarbon Shows & Surface Indications

Oil shows and occurrences in Jordan were identified in:

### - The Sirhan Development Area

Light oils (42° API) were discovered in well WS-4, it is estimated that approximate reserves are in order of 20-40 MMBO. This discovery represents the southwestern extension of the Mudawwara petroleum system proven at Risha, which is a component of the Widyan Basin-Interior Platform Province, that also exists in northern Saudi Arabia and western Iraq. This area displays similar stratigraphy to the Jafr area.

### - The North Highlands Area

Seven wells were drilled in the North Highlands area during the years 1959 to 1990. There are oil shows in the Salib Formation (Cambrian) at the NH-1 well. A significant discovery of oil and gas was found in the Golan Heights (at Jordan north borders) and to the north of the North Highlands area.

### - The Dead Sea Area

Twenty wells were drilled in the Dead Sea area during the years 1988 to 2005. There are numerous oil and gas shows in several formations in the area. The Ain El Hammar discovery (1993) flowed oil to surface. Oil seeps and Bitumen-impregnated sands have been known to occur along the eastern shoreline, together with floating asphalt blocks as reported in ancient times.

Surface Hydrocarbon indications in Jordan were identified as:

- **Oil Seepages:** In 1889 Blake described oil seeps at Ain Al-Hammar, situated on the east side of the Dead Sea, some of these occurrences have been famous since the early history. Geochemical data indicate that the source rock for this oil is most likely the Cretaceous oil shale buried deeply in the graben area. Other seepages were encountered along the Eastern and Western sides of the Dead Sea and Jordan River.

- **Asphalts:** Asphalt occurs in and near the Dead Sea as blocks or as concretions, veins, cavities and fissure fillings or as Ozocerite veins. Historically large blocks of Asphalt were occasionally found floating on the surface of the Dead Sea waters, of variable size, some of the blocks have been reported to be as large as 150 cubic meters in volume.

The Asphalt is very pure and has a high luster on a fresh face and specific gravity of 1.118.

- **Gas:** which analysis issuing with Sulphur depositing spring water at the Lisan area on the Dead Sea shorelines indicates heavy hydrocarbon fractions in these gases.

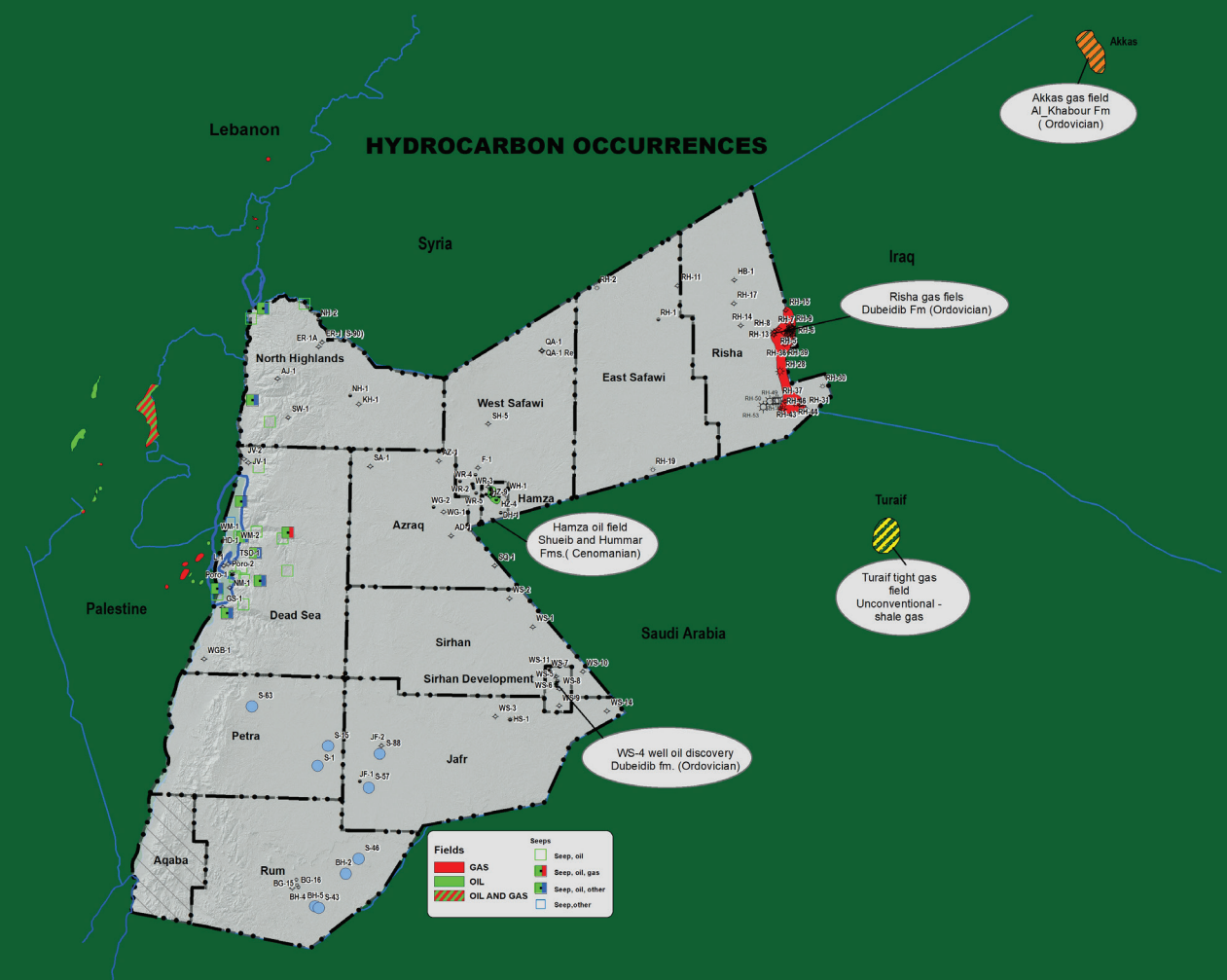
- **Tar Sand:** The known outcrops of Tar Sand in Jordan are located in Wadi Issal, Wadi Aheimir and Ed Dhira along the high cliff east of Lisan Peninsula overlooking the Dead Sea. The twenty drilled wells revealed that the deposit reserve is 40 million metric tons. The recoverable tar is estimated to be (3.6%) of total rock volume.

Sixteen wells have been drilled in East Issal and one well in Aheimir Issal areas.

Tar Sand was originated from the organic maturation of Bituminous Marly Limestones of Ghareb Formation that was deeply buried in the Dead Sea Basin.

- **Oil shale:** Oil shale is defined as a sedimentary rock (mostly Carbonates; Chalk Marl and Shale) whose solid immature organic content is insoluble in organic solvents, but forms liquid oil-like hydrocarbons when exposed to pyrolysis process at temperatures up to 500-600°C.

The Jordanian Oil Shale is Kerogen-rich, Bituminous, argillaceous Limestone that was deposited in shallow marine during the Maestrichtian- Paleocene. The origin of the kerogen are the dead plants and animals that were found in the ancient seas and lakes during the Upper Cretaceous period.



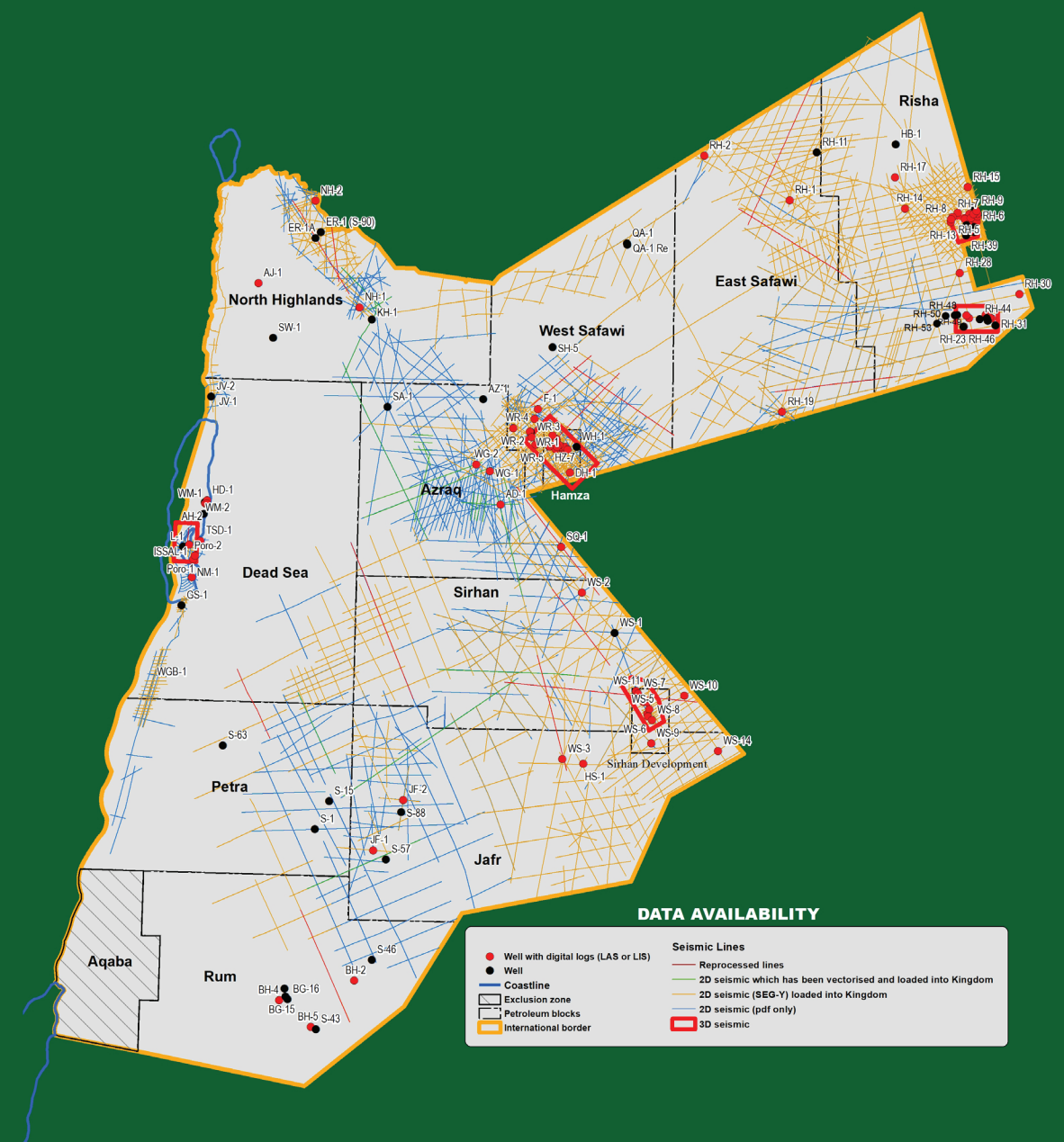


# HYDROCARBONS IN JORDAN



## Petroleum Database.....

MEMR available database includes geological, geophysical, drilling, completion development and production data on about 132 wells and 26670 km of 2D-Seismic line data. A coverage of 5951 km<sup>2</sup> 3D seismic is available and restricted to Lisan Peninsula of the Dead Sea, Hamza development area, Sirhan development area and some parts of Risha area.





# AZRAQ AREA

## Area

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The Azraq area is located close to the central part of Jordan with an area of 6311 km<sup>2</sup>.

## Existing Wells & Available Information

- 2D seismic lines of 1256 Lkm.

- Six exploration wells were drilled during the period 1957-1991, one well (WG-2) has shown weak evidence of oil and Bitumen presence.

Well	Depth(m)	Hydrocarbon Shows	Composite & Master Logs	Lithologic al Logs	Electrical Well Logs	Well Logs LAS & LIS	Geological Report
AD-1	1784	Dry	/	/	A	A	A
AZ-1	1299	Dry	/	/	/	/	/
SA-1	2583	Dry	/	/	A	/	/
SQ-1	1850	Dry	A	/	A	A	A
WG-1	3207	Dry	A	/	/	A	/
WG-2	3740	Weak oil staining and Bitumen	A	A	A	A	A

A:Available

## Potential Leads & Anomalies

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Several leads/anomalies had previously been identified by the companies who worked in the area through specific limited exploration studies and activities.

- Nineteen leads were identified by NRA in 1982 in Azraq area, two leads have been considered as the main leads in the area, however, NRA drilled well” WG-2 “in 1983.

- Six leads were defined by AMOCO in 1986 and drilled the AD-1 well in 1988.

- JNOC in 1990 had identified 37 leads in this area and drilled SQ-1 well in 1991.

- Shell in 1990 had identified one lead in the area.

- CGG GeoConsulting had identified three structural leads in 2016. In summary, one lead has 193 MMBO in place, the second lead has 55 MMBO in place and third lead has 405 MMBO in place.

## Potential Investment Opportunity

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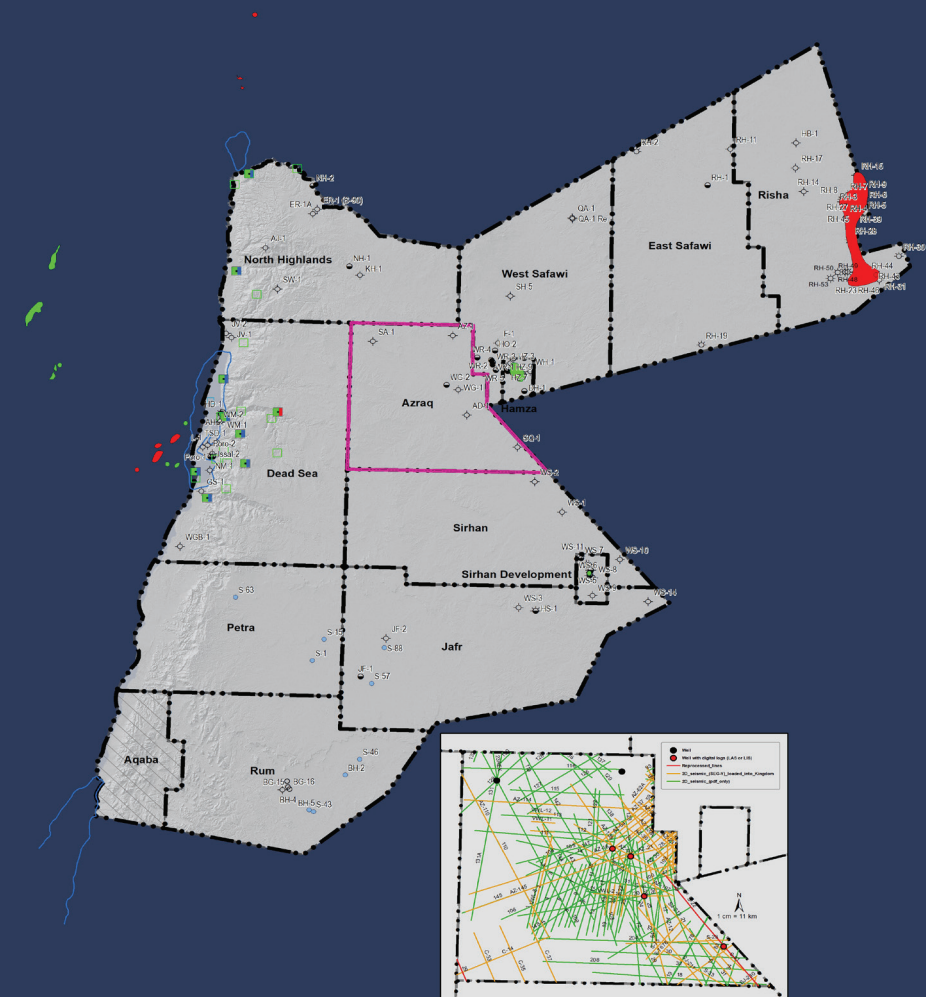
- **Hydrocarbon shows:** WG-2 well has oil stains and Bitumen in the Wadi Essir Formation (Turonian) and oil stains in the Naur Formation (Cenomanian).

- **Key reservoirs:** Lower Amman, Shueib and Hummar (Cenomanian), Kurnub (Early Cretaceous), Ma'in (Early Triassic) and Dubeidib (Ordovician) Formations.

- **Key source rocks:** Wadi Essir Formation, however, immature in the west. Mudawwara Formation. (early to late Llandovery) is considered the main source rock in the south.

There are no oil discoveries or fields in this area so far, it is worth indicating that this area is very close to the Hamza Field to the northeast which produces oil, still the area needs to be sufficiently studied in order to verify the oil potential in the area. The Hamza Field produces oil from the same formations that do exist in Azraq area. A number of potential leads and anomalies had been identified but that does not necessarily indicate the absence of other indicators which could be confirmed by the extensive exploration studies in the future.

## Azraq Location Map & Available Information



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## Area

The West Safawi contract area is located in the north of Jordan and covers an area of 7695 km<sup>2</sup>.

## Exisiting Wells & Available Information

- 2D seismic lines of 235 Km.
- Eleven wells were drilled in the area and six wells of them encountered oil shows.

Well	Depth (m)	Hydrocarbon Shows	Composite & Master Logs	Lithological Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
F-1	2665	Dry	A*		A	A	A	A			
HO-1	1569	Oil Shows	A*		A	A		A			
HO-2	3367	Oil Shows	A*	A	A	A		A			
QA-1	2823	Dry	A*		A		A		A		
QA-1 Re	4016	Dry	A*		A		A			A	
SH-5	1405	Dry									
WR-1	3076	Oil	A*				A				
WR-2	3510	Oil Shows	A*	A	A	A		A			
WR-3	2810	Oil Shows	A*	A	A	A**		A			
WR-4	3105	Oil Shows	A*	A	A	A**		A			
WR-5	3133	Oil Shows	A*	A	A	A		A			

A: Available

A\*:Computed by CGG in 2016

A\*\*;Digitized Scanned Logs i2016

## Potential Leads & Anomalies

This area of Jordan is characterized by Basaltic flows. A number of structural leads have previously been identified by companies who worked in the area.

NRA and PCSB (1995) identified a lead. The Tracs study (2010) identified nine leads, four within the adjacent Hamza Field Development area and five just outside the West Safawi area itself. Sonoran (2010) identified 16 leads, six in the Hamza Field area and five within the West Safawi contract area.

AMOCO (1986) identified a large closure. Global Petroleum Limited (2010) identified two leads. A report that was prepared in (1986) identified three large anomalies. One of these was drilled by HO-2 and F-1 wells. The HO-2 well, drilled in 1986 and encountered oil shows.

CGG GeoConsulting has identified one lead. There are eleven wells in the area and further 19 wells in the adjacent Hamza Development area. Oil shows are found in the WR-2, WR-3 and WR-4 wells. This area may not be limited only to one structure; it is an example of a potential trap within the area.

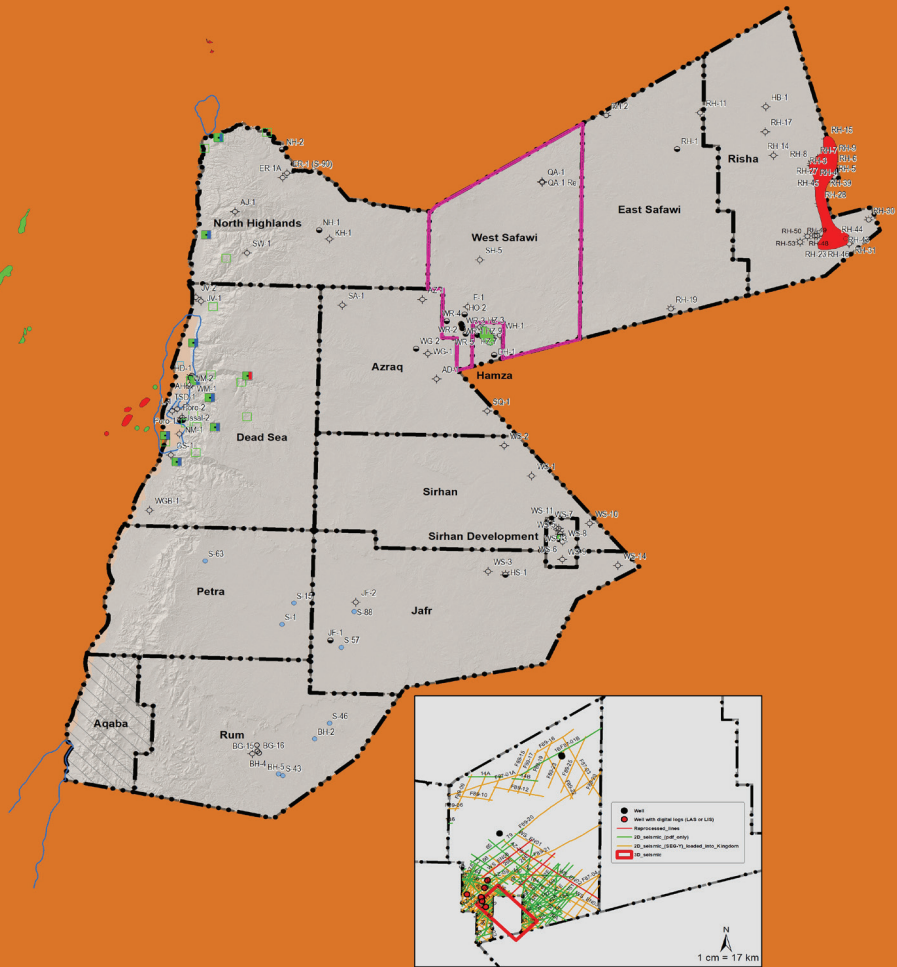
## Potential Investment Opportunity

A working petroleum system is proven by the Hamza Field in the far southwest of the West Safawi area. A number of structural leads have been identified by companies who worked in the area through limited exploration activities. New seismic coverage may reveal further leads and further information.

- **Hydrocarbon shows:** Oil shows in the Wadi Essir and Amman Formations (both Late Cretaceous) in wells WR-2, WR-3 and WR-4.
- **Key reservoirs:** Dubeidib (Ordovician), Kurnub (Early Cretaceous), Ma'in (Early Triassic) and Shueib/Hummar (Cenomanian) Formations. Further potential in the Lower Amman (Azraq Sandstone) (Campanian to Santonian), Iraq Al-Amir (Middle Triassic), Umm Sahm (Early Ordovician), Burj (Cambrian, Series 3) and Salib (Cambrian, Terreneuvian) Formations.
- **Key source rocks:** Wadi Essir Formation (Turonian), minor contributions from the Shueib and Naur Formations (both Cenomanian). Also further potential from Triassic to Cambrian sediments, especially north of the Azraq Graben.

Identifying a number of potential leads and anomalies does not mean that there are no other indicators which could be confirmed by conducting further exploration studies in the future to verify the oil potential.

West Safawi Location Map & Available Information





Area

The Dead Sea area is located along the western edge of Jordan and covers 10841 km<sup>2</sup>.

Exisiting Wells & Available Information

- 2D Seismic lines of 800 LKm.
- 3D Seismic lines (SEG-Y) of 75 Km<sup>2</sup>.
- There are numerous oil and gas shows within some geological formations in 11 wells of the 20 wells that were drilled in the area.

Well	Depth (m)	Hydrocarbon Shows	Composite & Master Logs	Lithologic al Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
AH1	260	Oil and Gas						A			
AH2	1471	Oil	A	A	A	A	A	A		A	
ASH1	1390	Strong Oil and Gas Shows	A		A	Digitized	A		A	A	
Carn2	506	Unknown	A		A	A					
Carn4	506	Bitumen							A		
GS1	2783	Dry					A				
HD1	575	Oil Shows	A	A	A	A	A		A	A	
Issal1	3315	Oil Shows	A		A	A			A	A	
Issal2	2870	Strong Oil and Gas Shows	A		A	Digitized		A	A	A	
JV1	1100	Dry	A		A	Digitized	A		A		
JV2	1417	Dry	A					A			
L1	3655	Dry	A		A	Digitized					
NM1	2900	Dry	A	A	A	A	A	A		A	A
Porol	2703.4	Dry	A			A	A		A	A	
Porol	4190	Dry/Gas pocket	A	A		A			A	A	
TSD1		Dry	A		A	A				A	
WGB1	3203.4	Dry	A		A	Digitized		A	A		
WM1	627	Good Oil and Gas Shows	A	A	A	A		A	A		
WM2	1360	Oil Shows	A		A	Digitized	A		A		
WM2/ST	439	Gas with Oil Shows									
TS-21		Unknown								A	

A: Available Digitized: Digitized Scanned Logs in 2016

Potential Leads & Anomalies

The Dead Sea area is considered to be an active petroleum system. Several leads/anomalies had previously been identified by companies who worked in the area through specific limited exploration studies and activities. The “AH1 well” discovery in 1993 flowed oil to surface, and also oil seeps and Bitumen-impregnated sands have been known to occur along the eastern shoreline, with floating Asphalt blocks as reported in ancient times.

Leads/anomalies that been identified by companies, Western Atlas (1994) identified six leads at the edge of the Dead Sea. Shell (1990) identified two leads. These leads are located on the eastern edge of the area bordering the Sirhan area. The presence of oil seeps within the Dead Sea area indicates that some hydrocarbons which was generated have been lost to the surface.

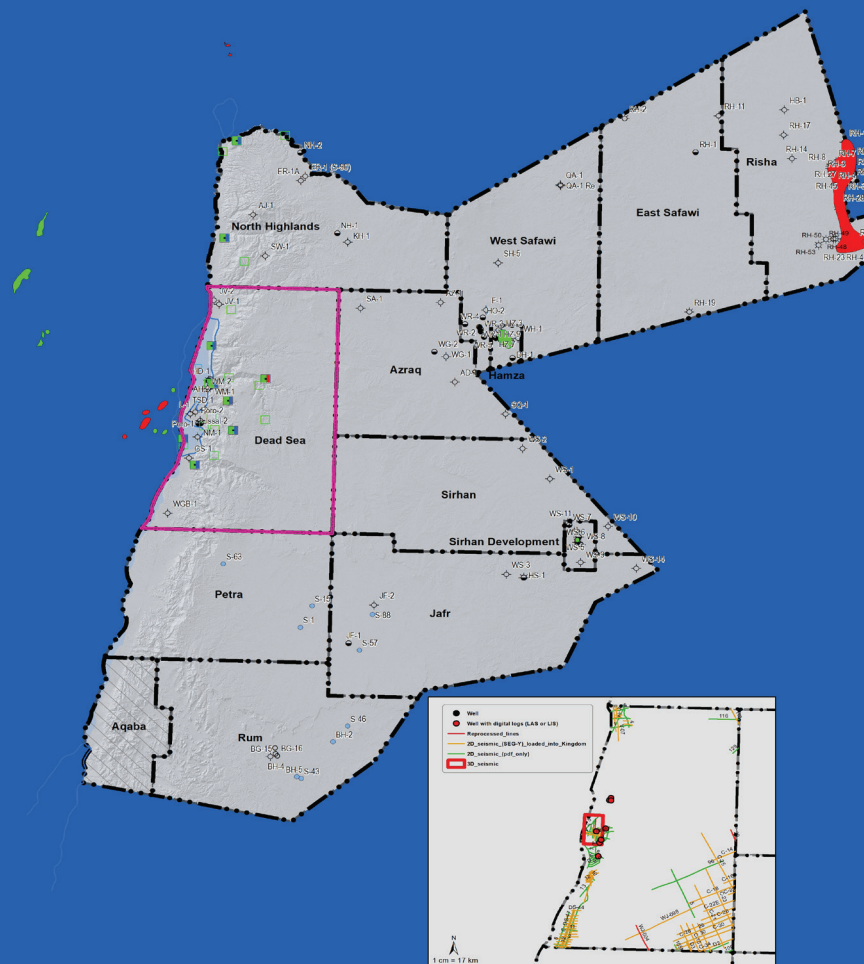
Potential Investment Opportunity

- Hydrocarbon shows:** Numerous oil and gas shows across 11 of the 21 wells drilled in this area, within Late Cretaceous and Cambrian formations.
- Key reservoirs:** Kurnub (Early Cretaceous), Burj (Cambrian, Series 3) and Salib (Cambrian, Terrenewian) Formations, there may also be potential plays in post-salt reservoirs (Pleistocene).
- Key source rocks:** Ghareb Fm. (Maastrichtian), potential source may also exist within the Ma’in (Triassic) and Huni (Jurassic) Formations.

There is no substantial discovery of oil and gas in the Dead Sea area, the potential leads and anomalies are located on the eastern edge of the contract area bordering the Sirhan area and require further investigations in order to be sufficiently studied. Some formations are expected to have reached the required maturity for petroleum generation and some formations have been identified as the main reservoir targets and to be the main contributing source rock for the Asphalt and oil seeps found in the Dead Sea area.

The area needs more exploration activities and investigations in order to enrich the area with the necessary technical information that are required to verify the oil potential.

Dead Sea Location Map & Available Information



Area

The Jafr area is located in south of Jordan and covers an area of 10662 km<sup>2</sup>.

Exisiting Wells & Available Information

- 2D Seismic lines of 2118 LKkm.
- There are oil and gas shows within some geological formations in 3 wells of the 7 wells that were drilled in the area. HS-1 well has oil and gas shows. JF-1 well has oil shows. S-57 well has weak oil shows.
- Al Jafr area lies to the south of the Sirhan Development area where there is light oil discovery at WS-4 well.

Well	Depth (m)	Hydrocarb on Shows	Composite & Master Logs	Lithological Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
HS-1	2243.3	Oil and Gas	A	A	A	A	A	A			A
JF-1	4047.7	Oil	A	A	A	A	A	A			
JF-2	1302	Dry	A	A	A	A		A			
S-57	1243	Water Well									A
S-88	803	Water Well									
WS-14	2181	Dry	A	A	A	A		A	A		A
WS-3	4530	Dry	A	A	A	A	A	A	A	A	

A: Available

Potential Leads & Anomalies

Several leads / anomalies were previously identified by companies who worked earlier in the area through specific limited exploration studies and activities.

In the Hanbo Energy (1993) report, 13 leads were identified in this area. NRA and PCSB “PETRONAS Carigali Sdn. Bhd.”in (1995) identified five leads in this area. Shell (1990) identified four leads. Sonatrach and NRA (1998) reported five leads. OMV (1990) identified five leads.

Zarubezhneft et al. (2011) identified one anomaly in the south of the area. The HS-1 well was drilled in 1993 and is located over two of the Shell (1990) leads, a Hanbo Energy (1993) lead. The well encountered oil and gas shows.

CGG GeoConsulting has identified seven structural leads in 2016, the leads have in place of 207 MMBO, 112 MMBO, 44 MMBO, 33 MMBO, 3 MMBO, 1376 MMBO and 160 MMBO.

Potential Investment Opportunity

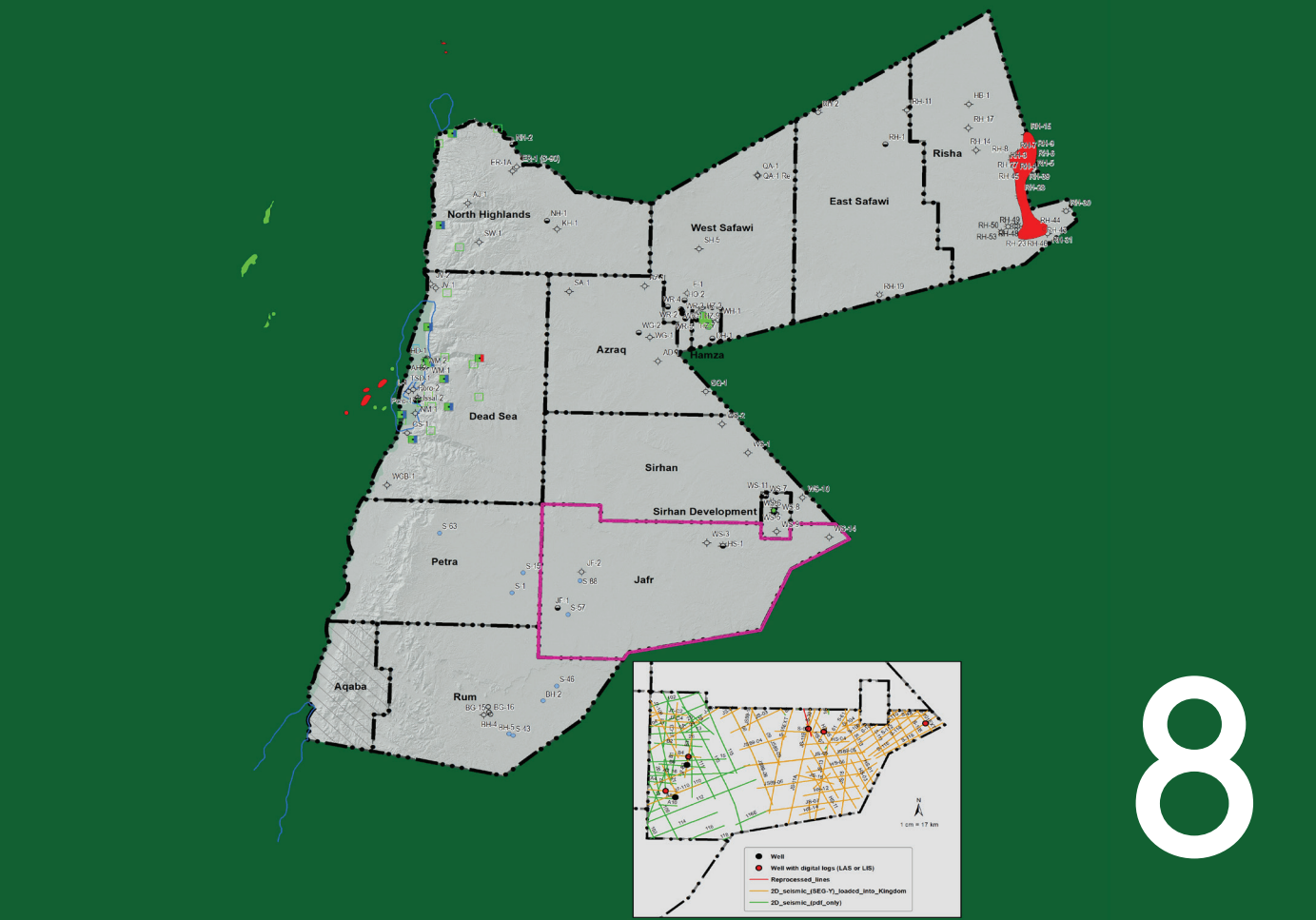
- **Hydrocarbon shows:** Oil and gas shows in Dubeidib (Ordovician) and Salib Formations (Cambrian), Hiswa Formation. (Ordovician), Khish-Sha /Mudawwara Formations (Silurian) and in Early Cretaceous.
- **Key reservoirs:** Kurnub (Early Cretaceous) and Dubeidib (Ordovician) Formations. The Azraq sandstones (Amman Formation, Late Cretaceous), Disi (Early Ordovician) and Salib (Cambrian) Formations may also have potential.
- **Key source rocks:** Mudawwara (early to middle Llandovery) with further potential from the Dubeidib, Hiswa (Ordovician) and Burj (Cambrian) Formations, or through migration from adjacent kitchens.

The petroleum systems of Saudi Arabia and North Africa contain similar stratigraphy and structures to those within Jafr (Dauntless Energy, 1999).

The Jafr area is located to the south of the Sirhan Development area where there are nine wells, one of which (WS-4) is a discovery; another three wells in the area have oil and gas shows.

There is a need to conduct further exploration activities and studies in order to enrich the area with the necessary technical information that are required to verify the oil potential.

Jafr Location Map & Available Information





## Area

The Sirhan area is located in the eastern part of Jordan with an area of 7970 km<sup>2</sup>.

## Exisiting Wells & Available Information

- 2D Seismic lines of 2419 LKm.
- Three wells, WS-1, WS-2 and WS-10, were drilled in the Sirhan area during the period 1971 - 1989. The WS-1 well encountered oil shows in a certain formation and there was weak presence of hydrocarbons in the test within another formation in the WS-2 well. In the adjacent area of” Sirhan Development Area”, nine wells were drilled, one of which (WS-4) was a discovery from the same formation. Three wells had oil and gas shows within the same formation.

Well	Depth (m)	Hydrocarbon Shows	Composite & Master Logs	Lithological Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
WS-1	1800	Dry	A				A			A	
WS-10	4285	Dry	A*	A	A	A	A		A	A	
WS-2	3330	Dry	A*		A	A		A	A		A

A: Available

A\*Computed by CGG in 2016

## Potential Leads & Anomalies

Several leads/anomalies were previously identified by companies who worked earlier in the area through specific limited exploration activities.

PCIAC and NRA (1989) identified one lead. Sonatrach and NRA (1998) highlighted four leads in this area. OMV (1990) identified one lead. Hanbo Energy (1993) identified six leads. NRA and PCSB (1995) identified four leads. JNOC (1990) identified 46 leads on several horizons.

Shell (1990) identified 36 leads. One of the leads was drilled by the WS-2 well in 1982. The well had a weak presence of hydrocarbons in a certain tested interval.

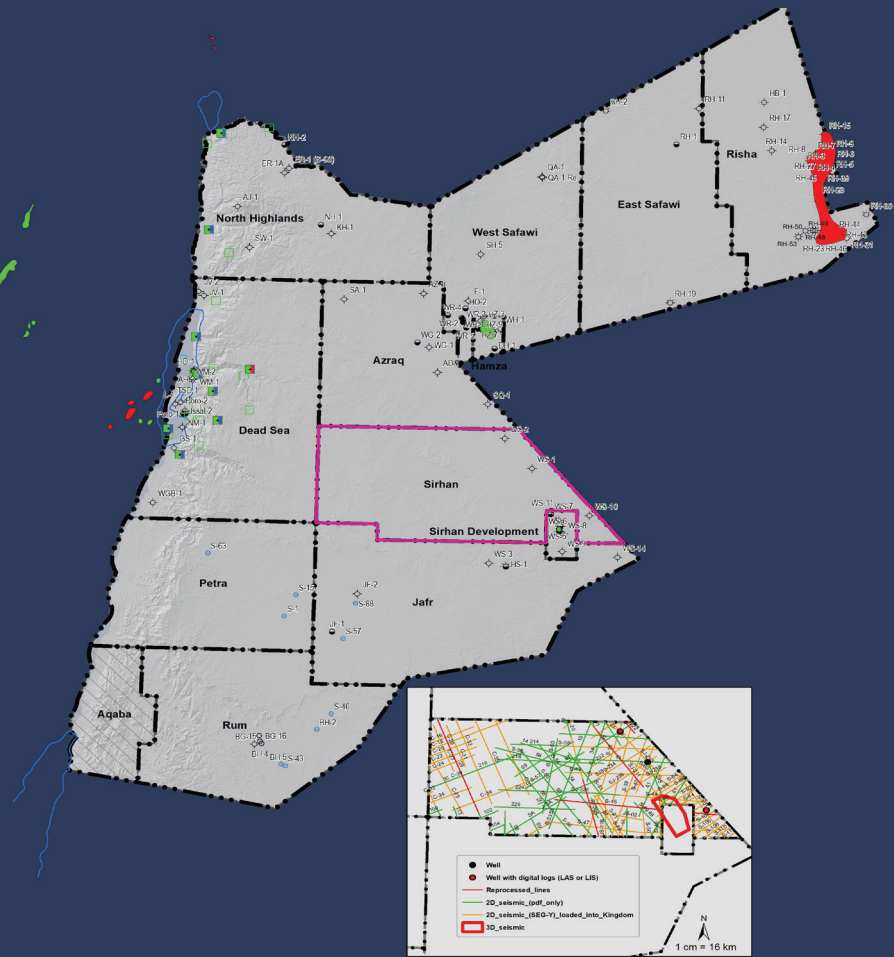
CGG GeoConsulting identified six leads in 2016, one of the leads has resource in place of 870 MMBO. Other resources in place range from 5 MMBO to 80 MMBO, and that does not mean these resources are limited to these six structures; they are examples within the area.

## Potential Investment Opportunity

- **Hydrocarbon shows:** Oil shows in the Dubeidib Formation (Ordovician) at WS-1 and WS-2 wells.
- **Key reservoirs:** Kurnub (Early Cretaceous) and Dubeidib (Ordovician) with further potential from Umm Sahm (Early Ordovician), Disi (Early Ordovician) and Burj (Cambrian, Series 3) Formations.
- **Key source rocks:** Mudawwara Formation (early to late Llandovery) with potential input from the Dubeidib, Hiswa (Ordovician), and Burj (Early Cambrian) Formations.

The defined leads and anomalies do not necessarily indicate the absence of other indicators which will be confirmed by extensive exploration studies in the future. Further exploration activities and investigations are required in order to support the area with the sufficient information that are required to verify the oil potential.

Sirhan Location Map & Available Information





## Area

The Sirhan Development area is located close to the south eastern part of Jordan within the Sirhan area with an area of 443 km<sup>2</sup>.

## Existing Wells & Available Information

- 2D Seismic lines of 327 LKm.

- 3D Seismic of 217 Km<sup>2</sup>.

- There are nine wells in this area, one of which is an oil discovery (WS-4) of 42 API. Three wells have oil and gas and Bitumen shows.

Well	Depth (m)	Hydrocarbon Shows	Composite & Master Logs	Lithological Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
WS-4	1790	Oil	A*	A	A	A	A	A	A	A	A
WS-5	1542	Oil & Gas Shows	A*	A	A	A		A	A	A	
WS-6	1531	Oil & Gas Shows	A*	A	A	A			A		
WS-7	1525	Oil Shows	A*	A	A	A			A		A
WS-8	1582	Dry	A*	A	A	A			A	A	
WS-9	1700	Dry	A*	A	A	A	A		A		A
WS-11	1660	Dry	A*	A	A	A		A	A		
WS-12	1700	Dry	A*	A	A	A			A		
WS-13	1650	Dry	A*	A	A	A			A		

A: Available

A\*Computed by CGG in 2016

## Potential Leads & Anomalies

- Several Leads/anomalies had been previously identified by companies who worked in the area.

- Shell (1990) identified two leads in this area, the WS-4 well which was drilled on this structure encountered oil. The second lead was drilled by WS-9.

- PCIAC and NRA (1989) also identified two leads in the same location as Shell (1990).

- Hanbo Energy (1993) identified three leads which are located close to the previous leads but have not been drilled.

## Potential Investment Opportunity

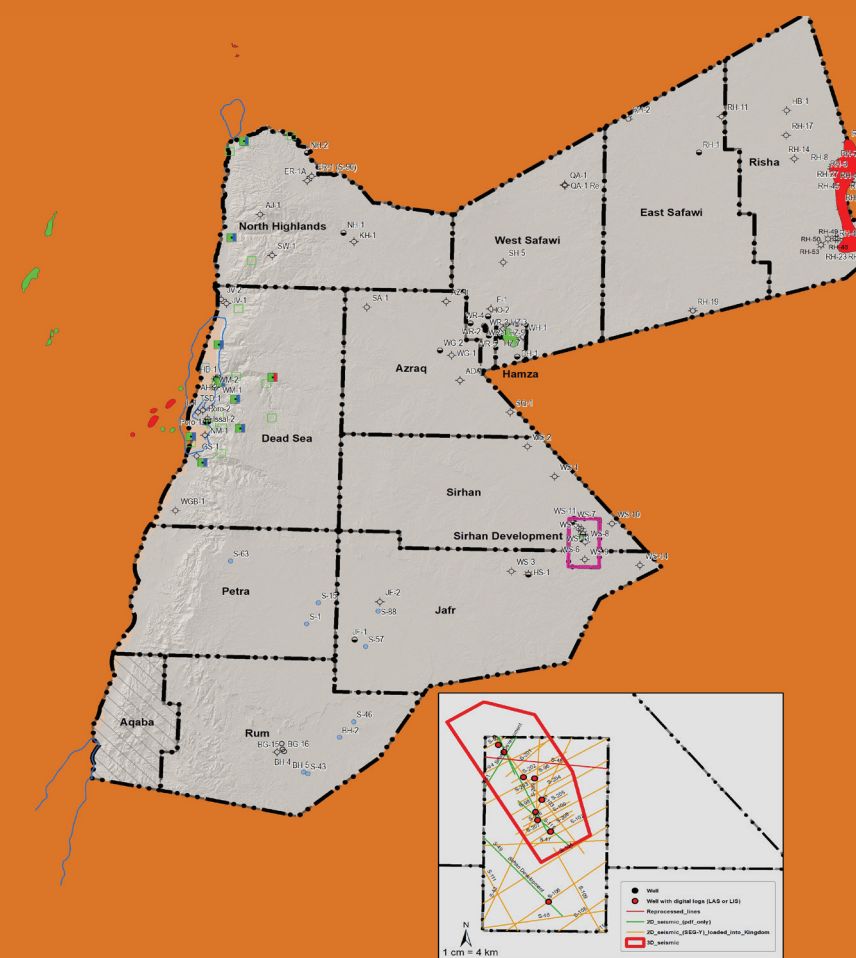
- **Hydrocarbon shows:** Oil discovery in the Dubeidib Formation (Ordovician) at WS-4 well. Three other wells have oil and gas shows in the Dubeidib Formation and bitumen in the Mudawwara Formation (early to late Llandovery).

- **Key reservoirs:** Kurnub (Early Cretaceous) and Dubeidib Formations with further potential from Umm Sahm (Early Ordovician), Disi (Early Ordovician), Burj (Cambrian, Series 3) and Salib (Early Cambrian, Terreneuvian) Formations.

- **Key source rocks:** Mudawwara Formation, with potential from the Dubeidib, Hiswa (Ordovician) and Burj (Cambrian) Formations.

A number of potential leads and anomalies had been identified but that does not necessarily indicate the absence of other indicators which could be confirmed by the extensive exploration studies in the future. The area needs more exploration activities and studies to verify the oil potential.

### Sirhan Development Location Map & Available Information





## Area

The North Highlands area is located in the far northwest part of Jordan and covers an area of 7908 km<sup>2</sup>.

## Existing Wells & Available Information

- 2D seismic lines of 1106 Lkm.

- Seven wells were drilled in the area, two were reported to have minor oil and gas shows.

Well	Depth (m)	Hydrocarbon Shows	Composite & Master Logs	Lithological Logs	Electrical Well Logs	Well Logs LAS & LIS	Drilling & Completion Reports	Drilling Report	Geological Report	Geological & Geochemical Reports	VSP Report
AJ-1	3796.5	Dry	A*	A	A	A			A	A	
WR-1(S-90)	a2753	Dry		Y-S-90	Y-S-90		Y-S-90			Y-S-90	
ER-1A	2753	Dry		A	A				A	A	
KH-1	1333.3	Dry					A		A	A	
NH-1	4016	Oil Shows	A*	A	A	A	A	A	A	A	A
NH-2	3722.5	Oil Shows	A*	A	A	A	A	A	A	A	A
SW-1	2327.7	Dry	A*	A	A	*Digitized	A		A		

A: Available

A\*Computed by CGG in 2016

\*Digitized: Digitized Scanned Logs in 2016

## Potential Leads & Anomalies

The North Highlands area is located to the south of the Golan Heights where significant quantities of oil and gas were found in two recently drilled exploration wells by Genie Energy, in very close proximity to the Jordan border. The discovery in the Golan Heights nearby area suggests an active source down dip from the North Highlands area, heated and matured by an increased heat flow due to the presence of volcanics.

Several leads and anomalies had previously been identified by companies working in the area through limited exploration activities including NRA (1986), INA Naftaplin (2007) and NRA and PCSB "PETRONAS Carigali Sdn. Bhd."(1995).

NRA (1982) identified six leads. INA Naftaplin (2007) identified nine leads. NRA and PCSB (1995) identified one lead in this area.

## Potential Investment Opportunity

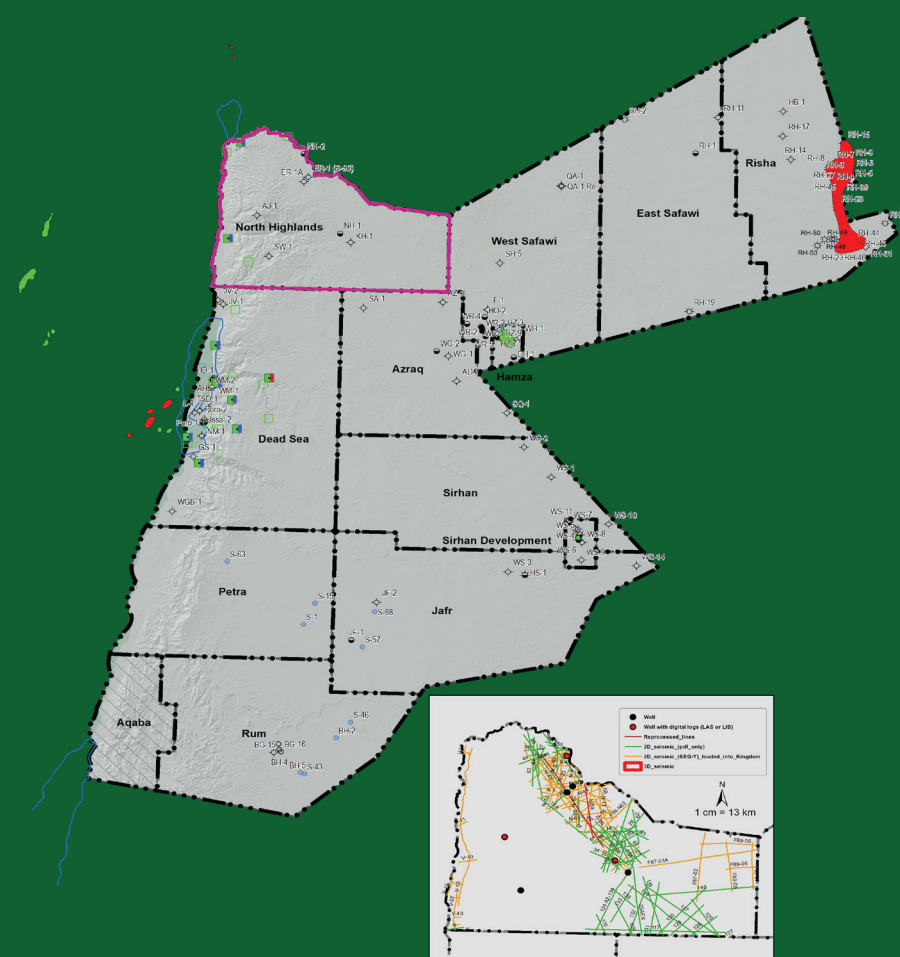
- **Hydrocarbon shows:** Minor oil and gas shows in the Huni (Jurassic) and Salib (Early Cambrian) Formations.

- **Key reservoirs:** Kurnub (Early Cretaceous) and Ma'in (Early Triassic) Formations, with further potential from the Disi (Early Ordovician), Burj (Cambrian, Series 3) Salib (Cambrian, Terreneuvian) Formations.

- **Key source rocks:** Huni (Early Jurassic), Abu Ruweis (Late Triassic), Iraq Al-Amir (Middle Triassic), Mukheiris (Middle Triassic), Ma'in (Early Triassic) and Hudeib (Permian) Formations. Potential for migration from kitchens from the north is recognized.

There can be further indicators for oil potential in the area, thus, more exploration activities and investigations are recommended in order to enhance the area with the necessary technical information that are required to verify the oil potential.

### North Highlands Location Map & Available Information









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