Construction of a collective database on the oil fields of 8 big producers

Progress report and results for Saudi Arabia : an update from Simmons

Flavien Rabas, Xavier Chavanne

June 2025

First question : **why ?**

From “*peakists*” to “*economists*” : a wide array of views and opinions.

YET

Oil was, is and will remain a major resource in the near term.

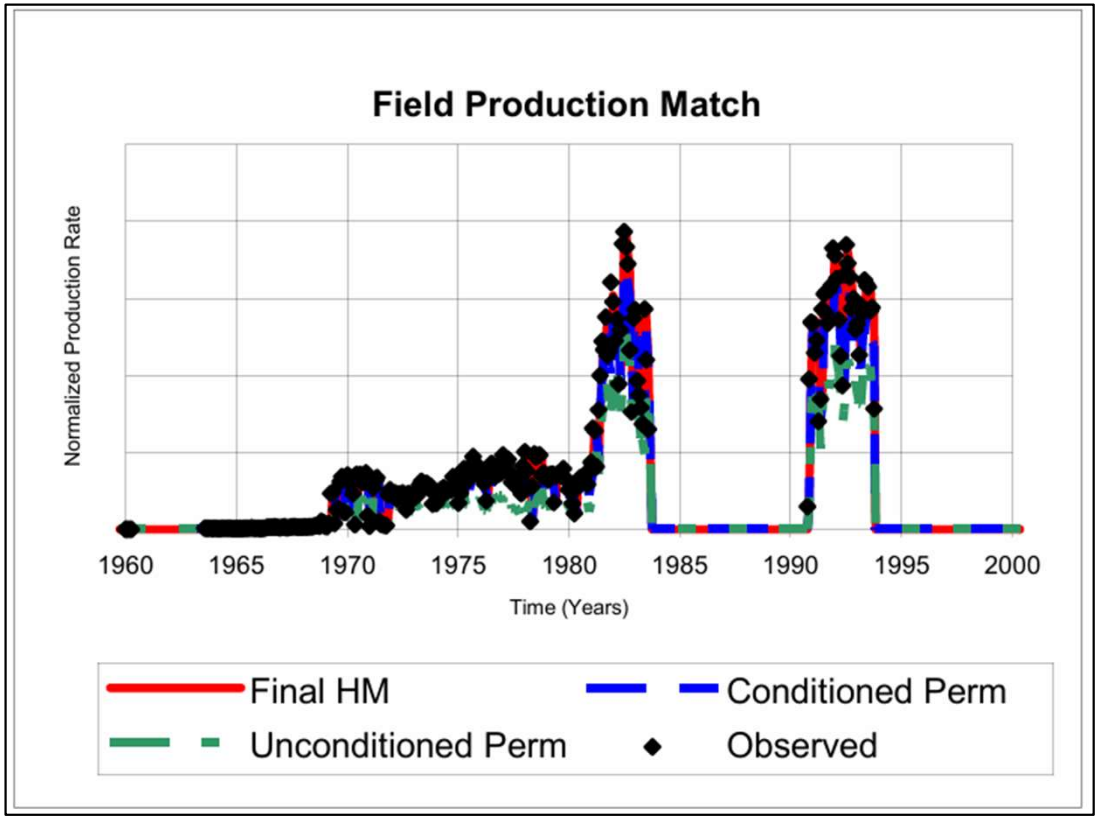
THE WORK : a bottom approach, from major oil fields to producer countries.

To do so : gathering, verification, organisation, analysis of datas for ~200 fields, **in a collective way.**

Second question : **how ?**

Data gathering :

- Press review (Reuters, O&G, NS Energy…).
- Scientific articles (Researchgate, Sciencedirect, Semantic scholar…).
- Geological reviews (AAPG, GeoExPro, Lyell…).
- SPE documents (access through OnePetro and sci-hub).



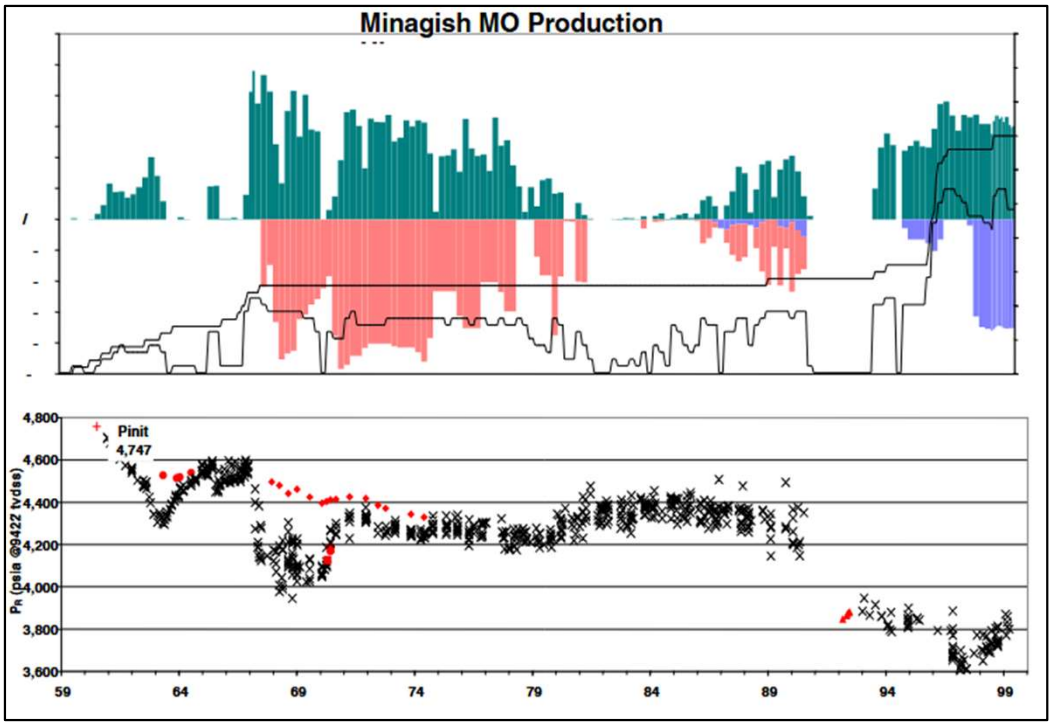
Field-wide production rate match for the ARAB-D reservoir in Khurais (SA). SPE 77743

Second question : **how ?**

Many challenges :

- lack of data, and when available :
- reliability questionable
- wide discrepancies
- Messy charts
- erased axis scales

"As of 31/12/2018, MSC at Zuluf was 825 kb/d. Proved liquids remaining reserves : 30.4 Gb. Original reserve : 43 Gb of crude [Aramco prospectus Dec 2019]. **So 13 Gb has been produced at 2018 end, or 820 kb/d over 43 years!!**"



Minagish MMO reservoir (Kuwait). SPE 70046

Second question : **how ?**

Data analysis :

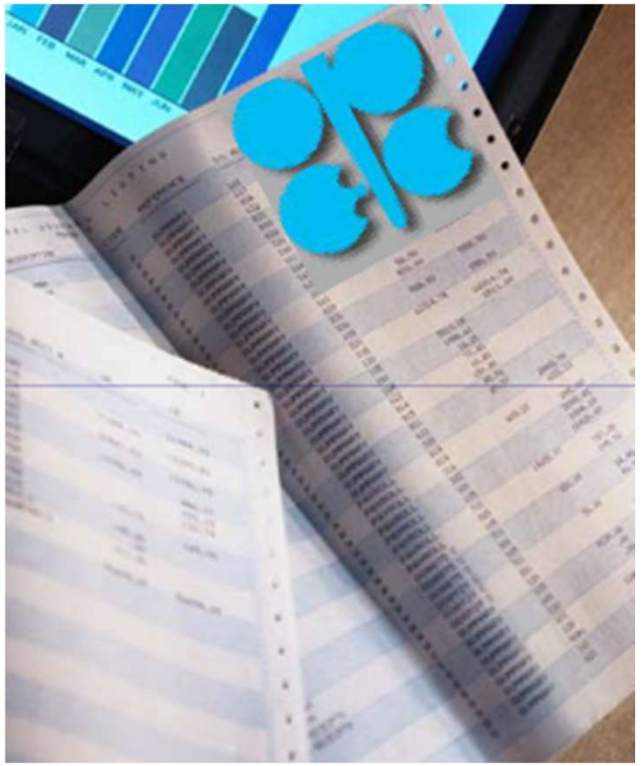
- Cross checking
- Comparison with other values

BUT, uncertainties remains : no one has a crystal ball.

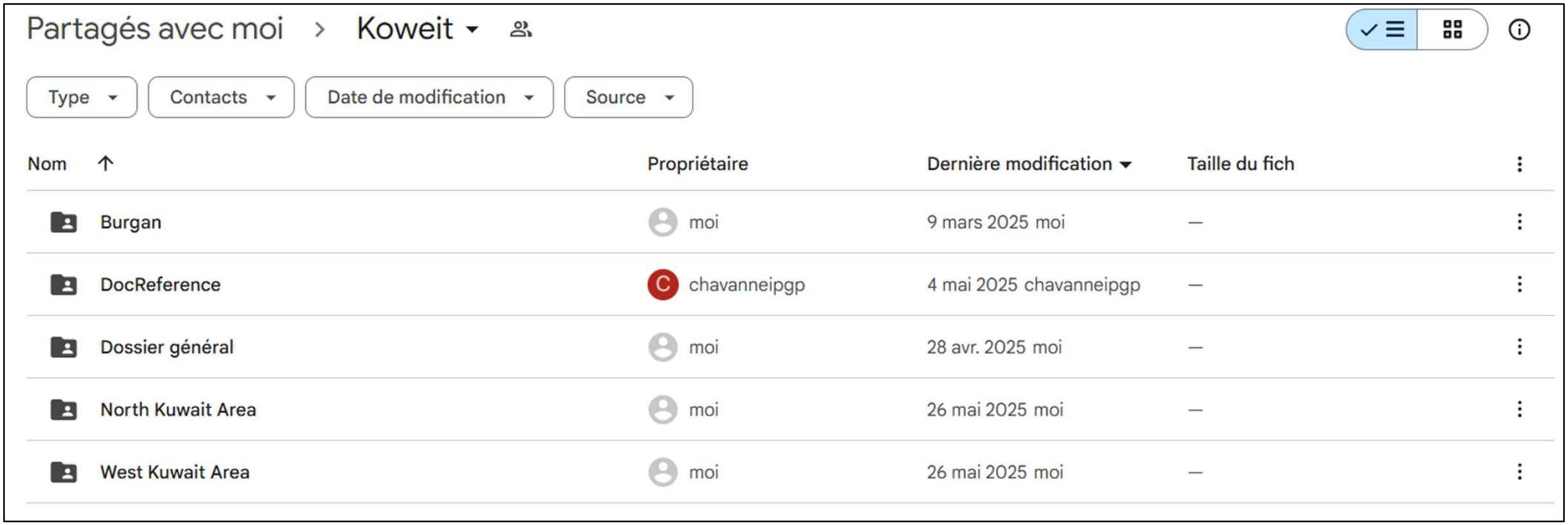
After analysis

Excel files & written reports added inside a Google drive database.

Google drive **shared** by P. Brocorens : accessible for members, enable community working.



Content & organization



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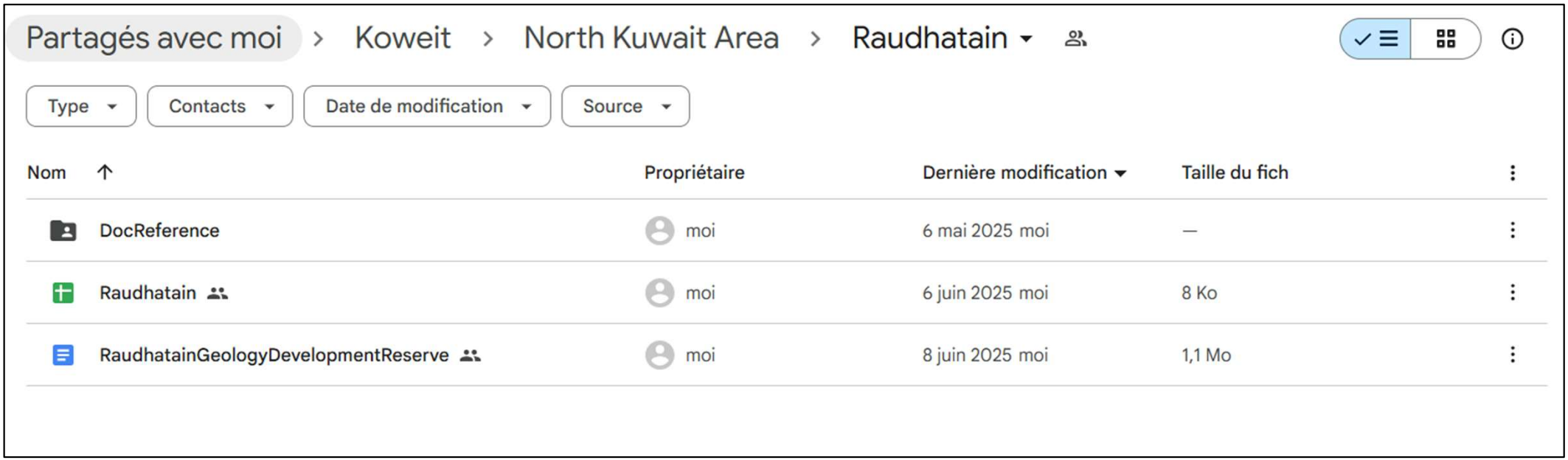

Content & organization

Kuwaiti Raudhatain field example, overview :

Raudhatain

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Partager

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Year	Raudhatain (a) kb/d	RAZU (b) kb/d	RAMA (c) kb/d	RAUB (d) kb/d	RALB (e) kb/d	ALL (f) kb/d		Cumul (a) Mb	Cumul (f) Mb		RR (a) Gb	RR (f) Gb			
2	1959	0	0,6		6,4	0	7			3		11,0	11,0			
3	1960	96	7,6		4,5	66	78		35	31		11,0	11,0			
4	1961	115	2,6		2,8	79	84		77	62		10,9	10,9			
5	1962	129	14,8	1,0	11,7	181	209		124	138		10,9	10,9			
6	1963	133	16,0	0,6	11,3	200	228		173	221		10,8	10,8			
7	1964	147	22,2	0,4	12,3	255	290		227	327		10,8	10,7			
8	1965	156	38,9	0,5	12,9	205	257		284	421		10,7	10,6			
9	1966	168	43,1	1,5	17,7	230	292		345	528		10,7	10,5			
10	1967	164	28,9	0,7	20,9	208	259		405	622		10,6	10,4			
11	1968	195	39,2	0,0	22,5	271	333		476	743		10,5	10,3			
12	1969	212	37,2	1,0	24,9	266	329		553	864		10,4	10,1			
13	1970	213	41,0	2,1	23,4	296	363		631	996		10,4	10,0			
14	1971	224	55,8	10,7	17,9	340	424		713	1151		10,3	9,8			
15	1972	230	46,4	9,8	19,9	340	416		797	1303		10,2	9,7			
16	1973	209	36,9	8,7	21,1	326	393		873	1446		10,1	9,6			
17	1974	200	27,1	5,8	11,9	200	245		946	1535		10,1	9,5			
18	1975	194	29,8	7,8	10,0	115	163		1017	1595		10,0	9,4			
19	1976	200	27,5	7,3	8,8	181	225		1090	1677		9,9	9,3			
20	1977	192	21,6	8,4	10,3	173	213		1160	1754		9,8	9,2			
21	1978	247	37,1	7,6	14,7	186	245		1250	1844		9,7	9,2			
22	1979	311	38,7	8,5	16,6	230	294		1363	1951		9,6	9,0			
23	1980	194	23,2	4,8	11,7	203	243		1434	2040		9,6	9,0			
24	1981	131	14,5	3,3	10,4	118	146		1482	2093		9,5	8,9			
25	1982	93	3,1	0,0	6,8	82	92		1516	2127		9,5	8,9			

Temporal data Reserves Charts

Location

The Raudhatain field lies within the Arabian basin in the northern part of Kuwait, encompassing a surface area of about 80 km2. The field produces from both clastic and carbonate reservoirs of the Early Cretaceous age. It was ranked as 18th among the largest known oil fields of the world by Halbouty et al. (1970) and 27th by Carmalt and St. John (1986).

Geology

Petroleum Systems: Middle and Lower Cretaceous systems.

Reservoirs:

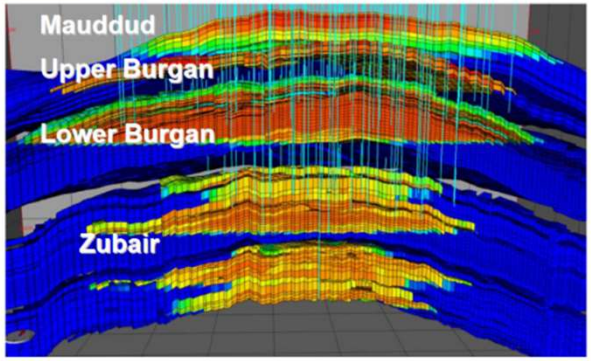


Fig 1 : Raudhatain reservoirs overview [4]

Reservoirs overview :
The producing interval in the Raudhatain field consists of two thick sections of oil-productive clastics, separated by a nonproductive section of marine carbonate and overlain by a second, oil-productive section of marine carbonate. The lower clastic section comprises the Zubair formation, overlain by the nonproductive carbonates of the Shuaiba formation. The entire interval from the base of Zubair to the top of Mauddud carbonate averages a thickness of 900 m and contains nine separate oil reservoirs, of which four are classified as containing major oil accumulations. Five of these nine reservoirs occur within the Zubair formation and two within the Burgan sand formation. These reservoirs are separated and capped by intraformational shale developments [1]. The Lower Burgan is the dominant reservoir, containing more than twice the in-place volumes of the other reservoirs combined (Tab 1).

Table-1 : Oil in-place volumes by formation [16].

Content & organization

Kuwaiti Raudhatain field example :

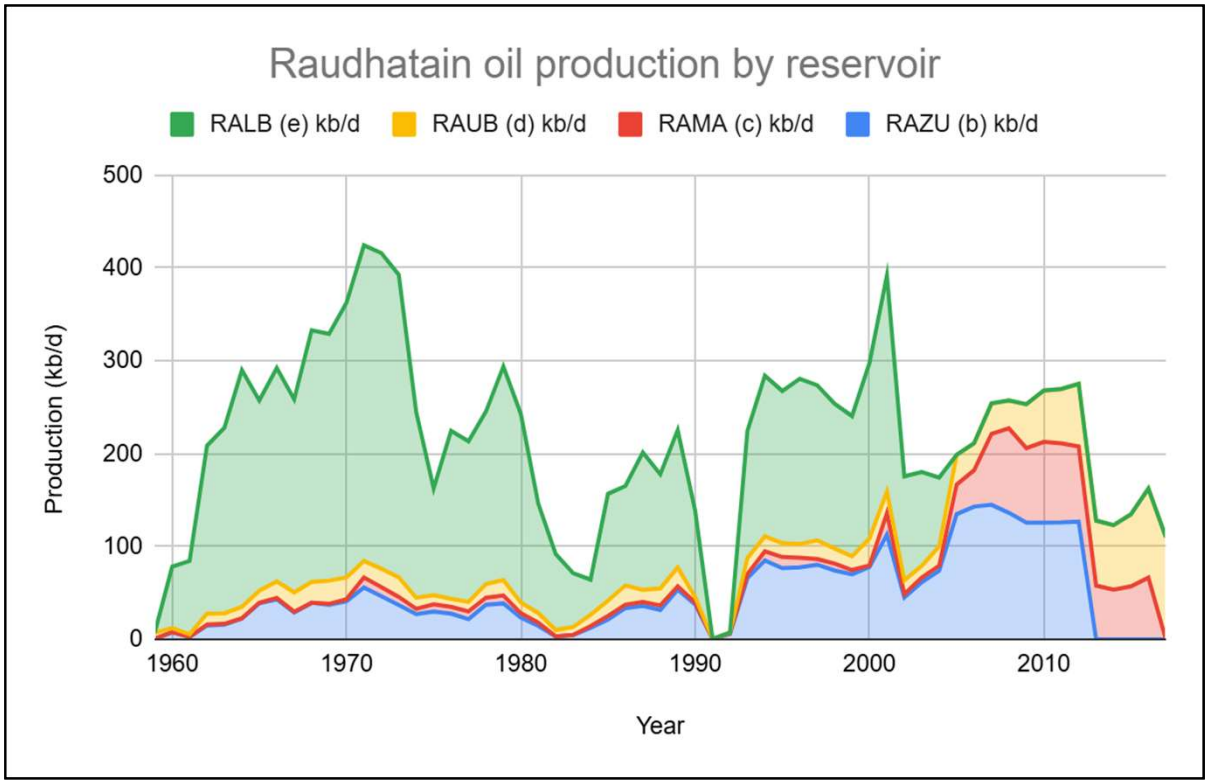
Reservoir	Zubair	L. Burgan	U. Burgan	Mauddud
Avg Por (%)	15.5-20	20-25	NA	16
Avg Perm (mD)	214-514	500-2000	NA	30
Gravity (API)	32.5-36.8	31	NA	30
GOR (scf/stb)	848-1109	NA	NA	550
Thickness (m)	NA	15-30	NA	110-120
Natural pressure support	Weak	Strong	Weak	No
OOIP (Gb)	**3.47**	**19.2**	**1.8**	**3.48**
Recovery factor (%)	50-60	NA	NA	35
Reserves (Gb)	1.7-2	Est	Est	1,2
Lithology	Sandstone	Sandstone	Sandstone	Carbonate

A few notes :

- RAZU OOIP underestimated
- RAMA RF based on Sabriyah value
- MA quoted as the biggest reservoir in NK, yet minor for RA
- RALB OOIP intriguing

Content & organization

Kuwaiti Raudhatain field example :



Chronology :

1956-60 : initial development, emphasis on RALB

1966-1981 : Gas injection in RAZU, no pressure support in the other reservoirs, limited offtake

1990-92 : facilities destroyed

End 90s-early 2000s : water injection dev in RAZU, RAMA & RAUB, rise of the offtake

2007 : Jurassic plays exploration (no prod yet)

Early 2010s : increase of the water support in RAMA and RAZU

Late 2010s-now : EOR projects dev for RAZU, RALB, RAMA (ASP, CO2…)

Progress so far : slow, tedious, but steady

TASK	PROGRESS	January	February	March	April	May	Jun	July	August	September	October	November	December
Project thinking	Done												
Database conception	Done												
Saudi Arabia	Done												
Kuwait	Done												
Irak	Ongoing												
UAE	Planned												
Iran	Planned												
Russia	Planned												
China	Planned												
Brazil	Planned												

Saudi Arabia : an update since Simmons

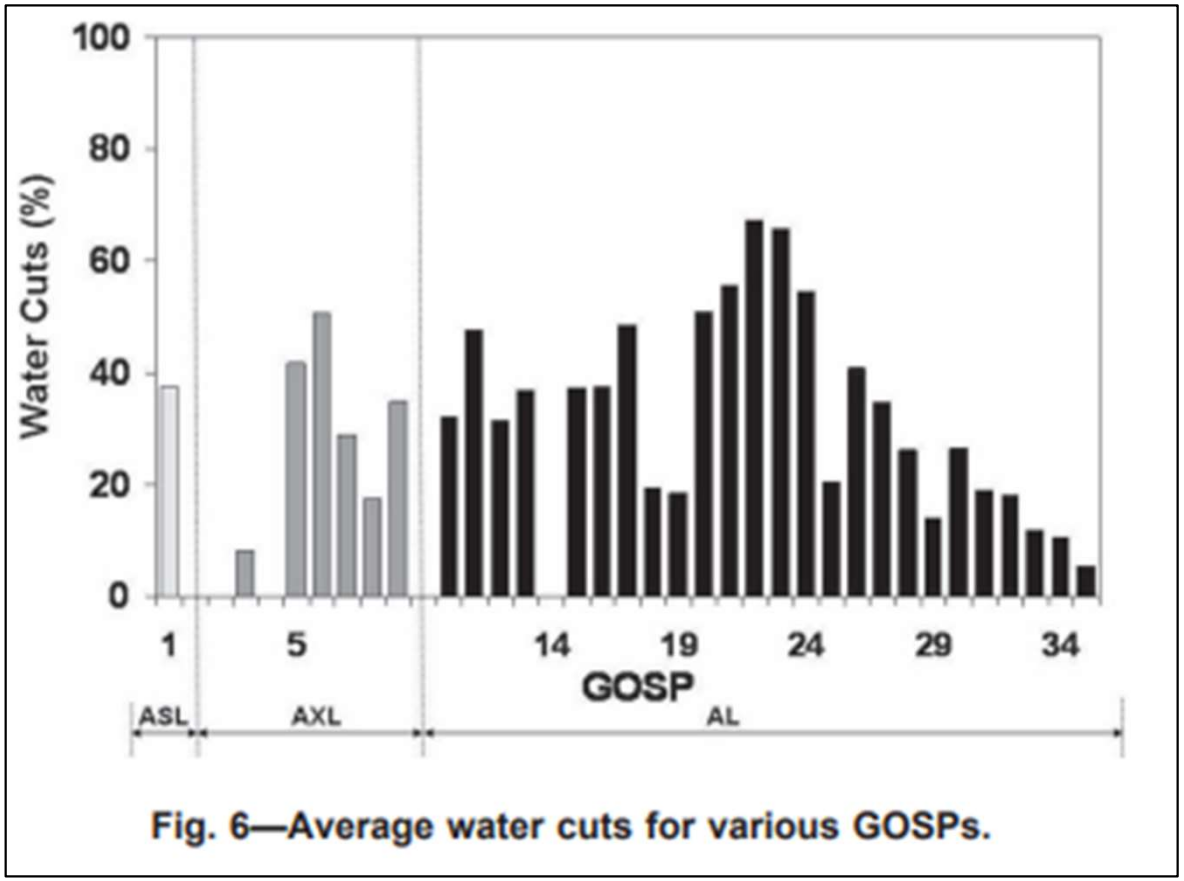


Fig. 6—Average water cuts for various GOSPs.

Saudi's GOSPs avg water cut by crude grade (2008).

ASL : Arab Super Light (Najd province fields)

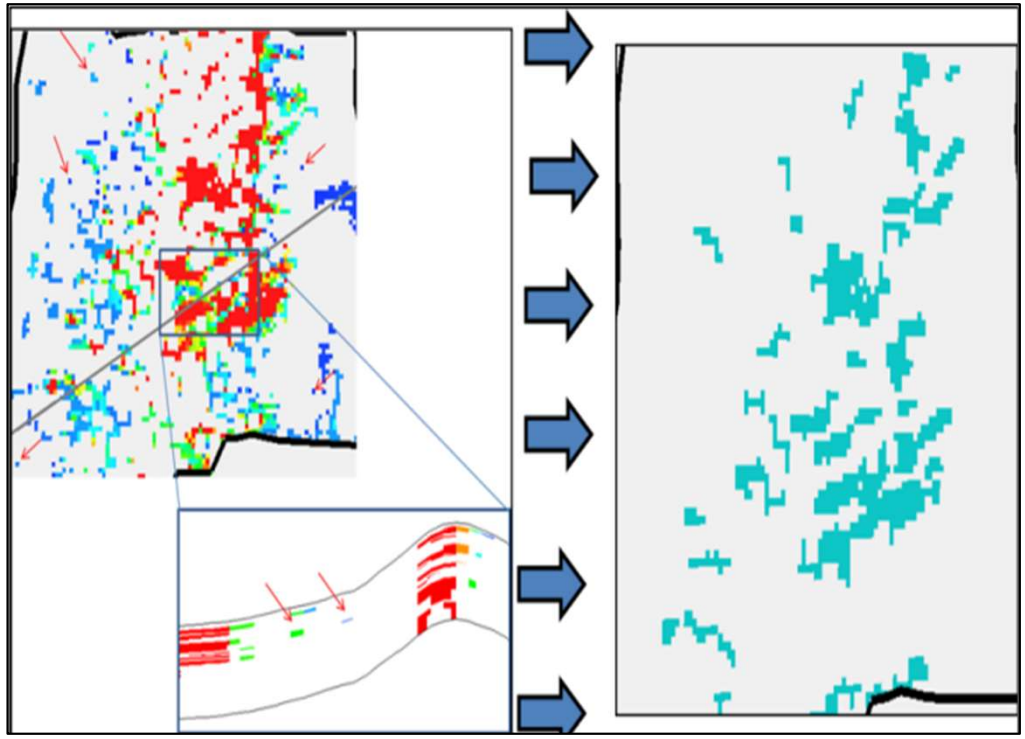
AXL : Arab Extra Light (Abqaiq, Shaybah, Berri)

AL : Arab Light (Ghawar, Qatif, Khursaniyah)

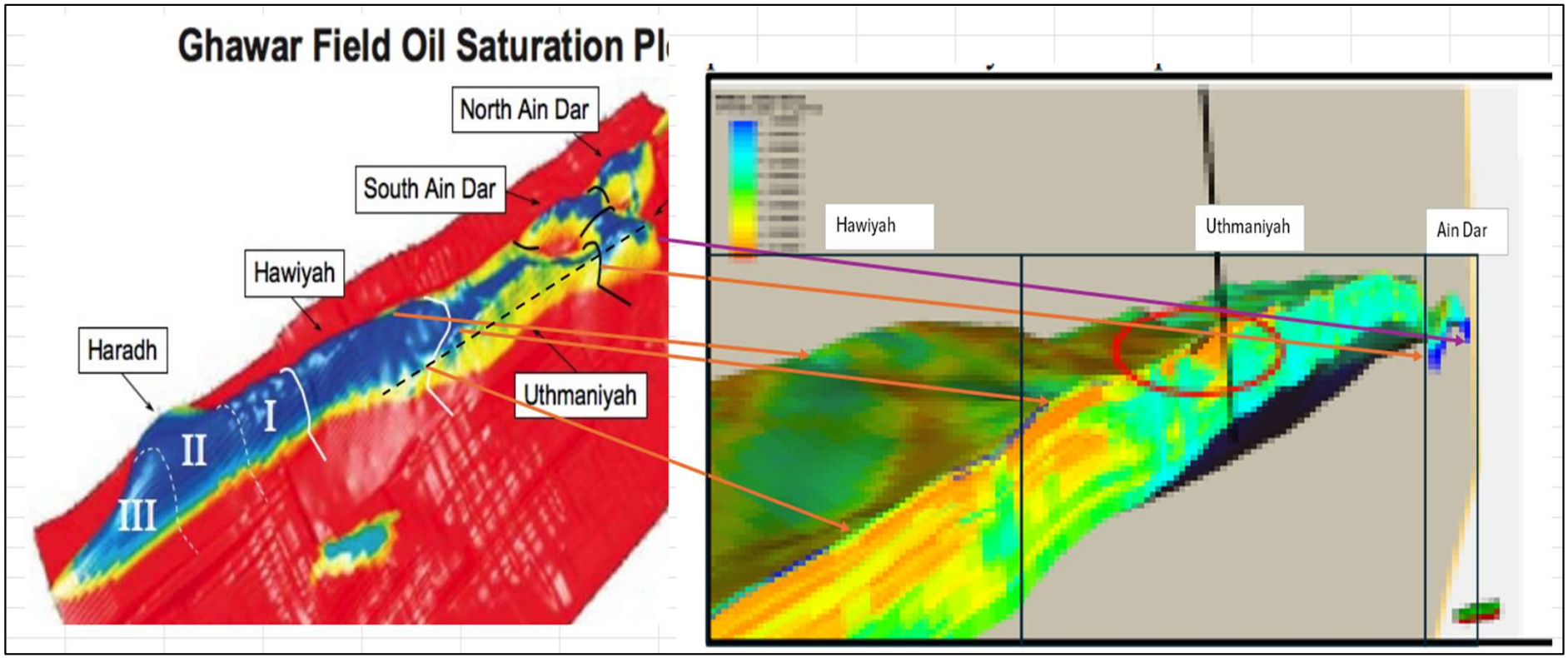
High quality crude-producing fields mature
Redev of mothballed medium&heavy producing fields : Manifa, Safaniyah, Zuluf

Ghawar

- 2006 : Sev vert wells cease to flow due to increase in water cut (30-80%). To revive them, several GOSPs had their operating pressure reduced from 150 to 120 psi, could not be lowered further due to limited gas handling capacities.
- Late 2000s : start of the development of the Arab-D zone 1 through infill drilling.
- Early 2010s : Unswept zones targeted through vertical wells sidetracking .
- 2025-Ongoing : Haradh-III expansion from 300 to 420 kb/d.



Ghawar


Ghawar Field Oil Saturation Pl
North Ain Dar
South Ain Dar
Hawiyah
Haradh
Uthmaniyah
I
II
III
Hawiyah
Uthmaniyah
Ain Dar

Abqaiq

- Production maintained throught horizontal drilling at the top of the Arab-D : « *attic oil* ».

- 2007 : Heavy oil accumulation [Above the Arab-D] development began. Hampered with technical difficulties related to artificial lift and the presence of a tar mat.

- 2009 : Oil accumulation discovered in the dome region (unknown formation).

- 2012 : Stratigraphically trapped accumulation [Below the Hanifa] development began. 1st dev well spudded & sidetracked as a 2900 ft lateral hz pilot producer. Put on production at a rate of 4000 STB/d. Carbonate reservoir, low perm : 0,1-2 mD : Require acidizing to flow.

- 2023-Ongoing : Debottlenecking of production facilities : optimize the production and hold the MSC at 350 kb/d.

Khurais

- 2009 : megaproject dev first oil : 232 oil producers, 119 water injectors, and 58 observation wells. Production capacity of 1200 kb/d **for the complex.**

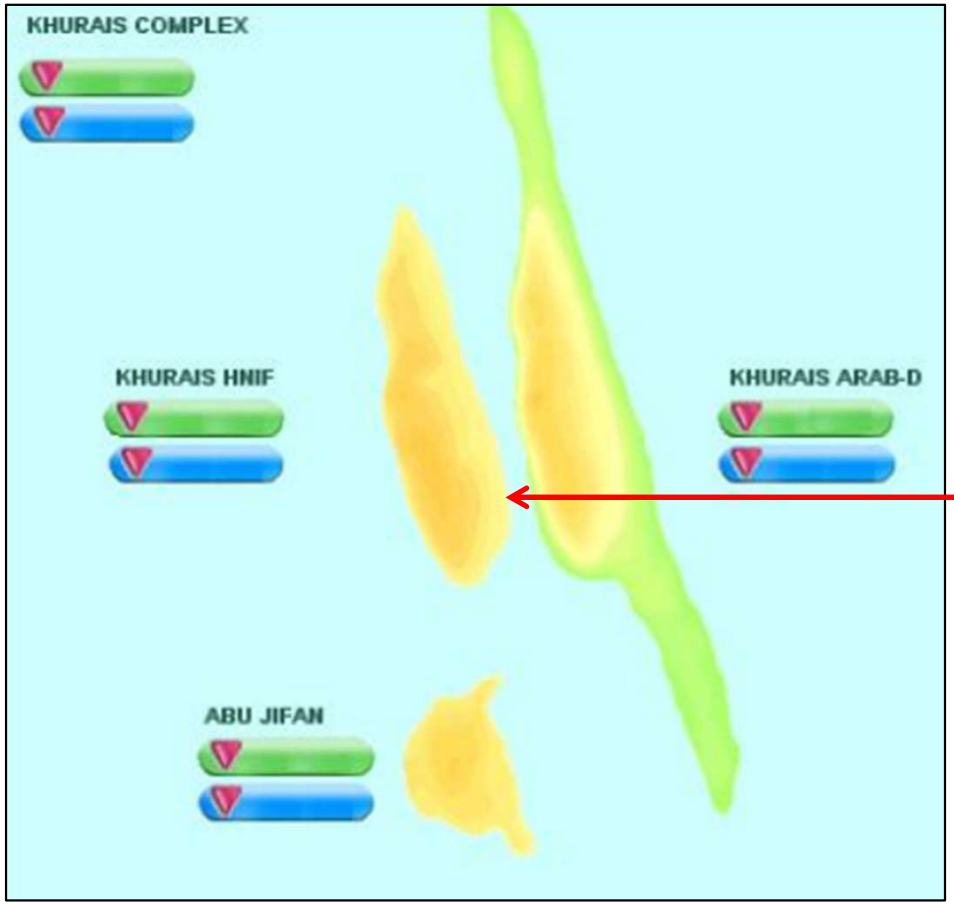
- 2010-2013 : Khurais reservoir has seen on avg a 35% increase in reservoir pressure due to water injection for production maintenance.

- **Unexpectedly** low water cut : 0–1% in 2009 to 5–8% in 2013 : had created deep troubles at the SWDP system.

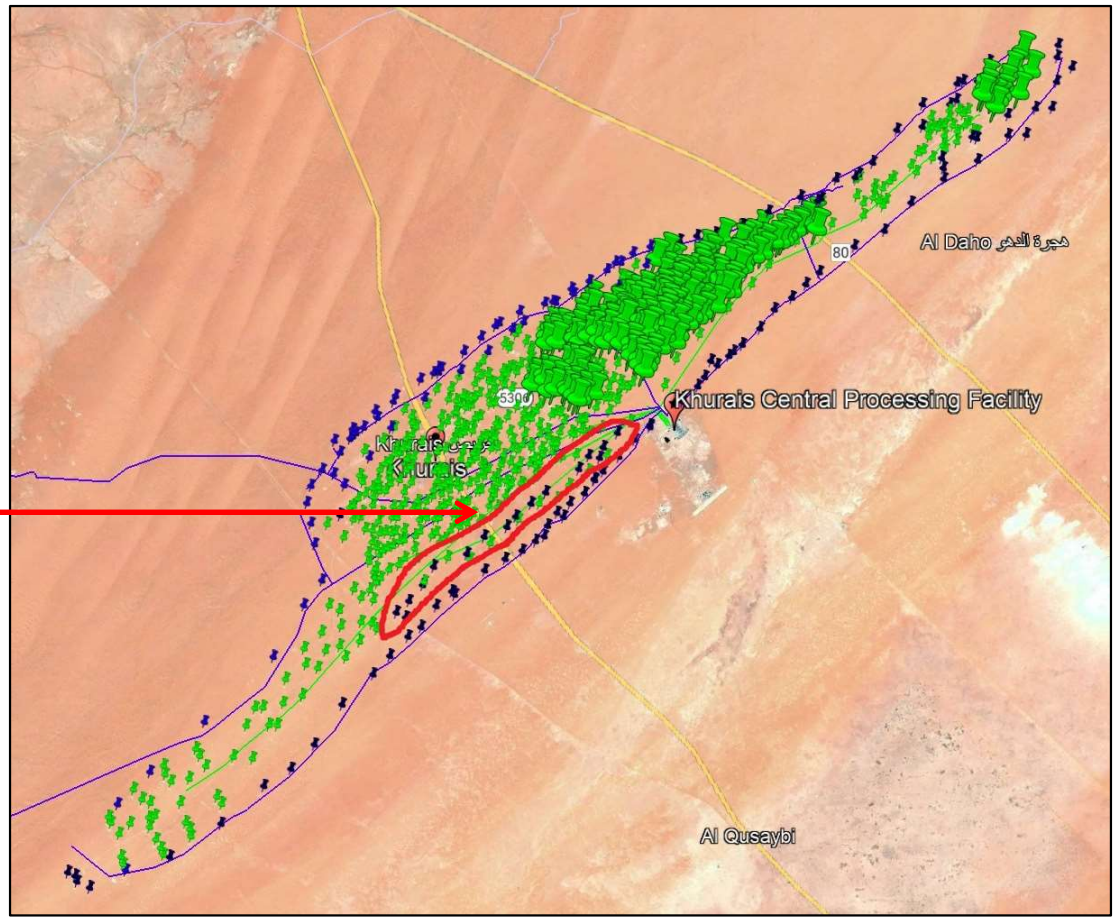
- 2017: expansion of Saudi Arabia's Khurais oilfield. Augmentation of the production capacity from 1.2 Mb/d to 1.5 Mb/d. Lower Fadhili dev began.

- 2024 : dev of a project to increase the capacity of the water handling facilities of Khurais from 750 kb/d to 1100 kb/d. 610 oil and observation wells, 165 water injectors (Google Earth counting) : 775 wells in total.

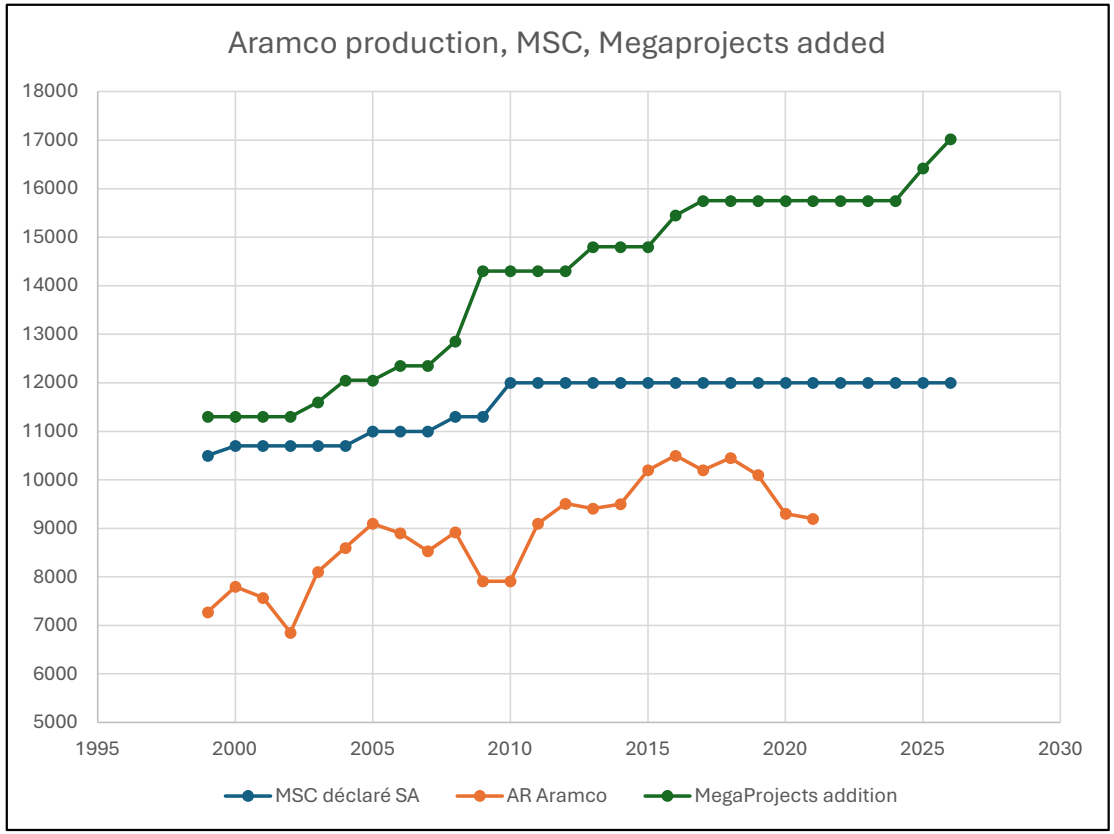
Khurais


KHURAIS COMPLEX
KHURAIS HNIF
KHURAIS ARAB-D
ABU JIFAN

?


Khurais Central Processing Facility
Al Daho
Al Qusaybi
80

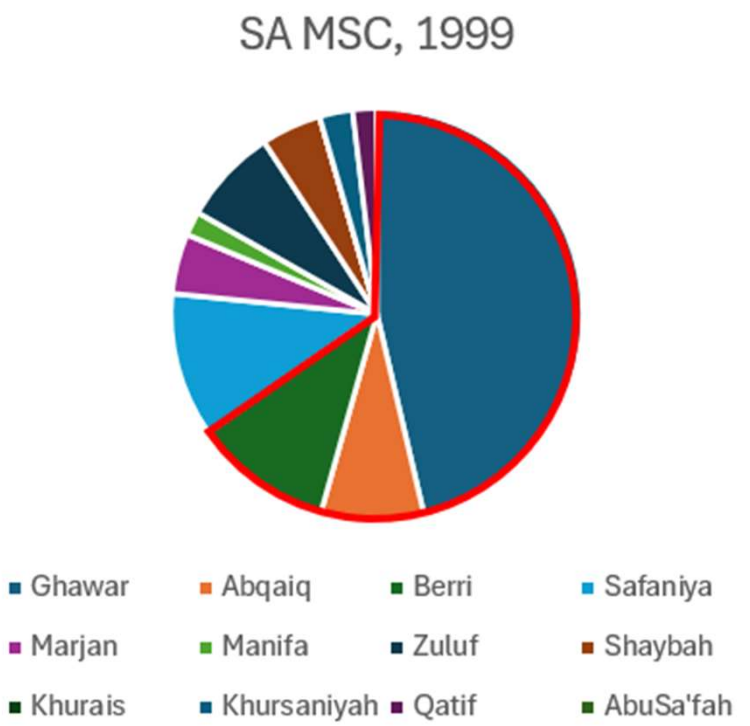
Saudi Arabia : MSC

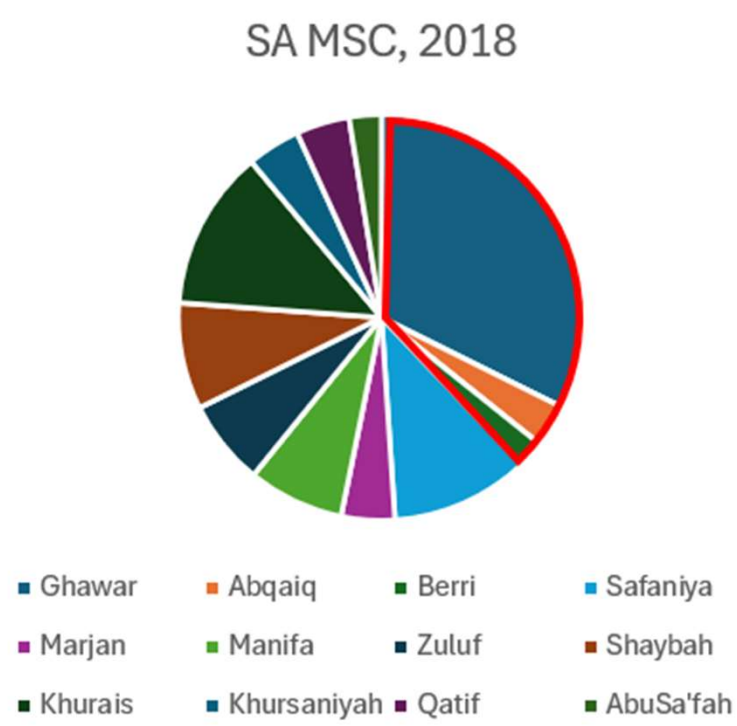


Berri MSC : 1150 kb/d to 250 kb/d
Abqaiq MSC : 850 kb/d to 350 kb/d (maybe less)
Ghawar MSC : 5000 kb/d to 3800 kb/d (maybe less)

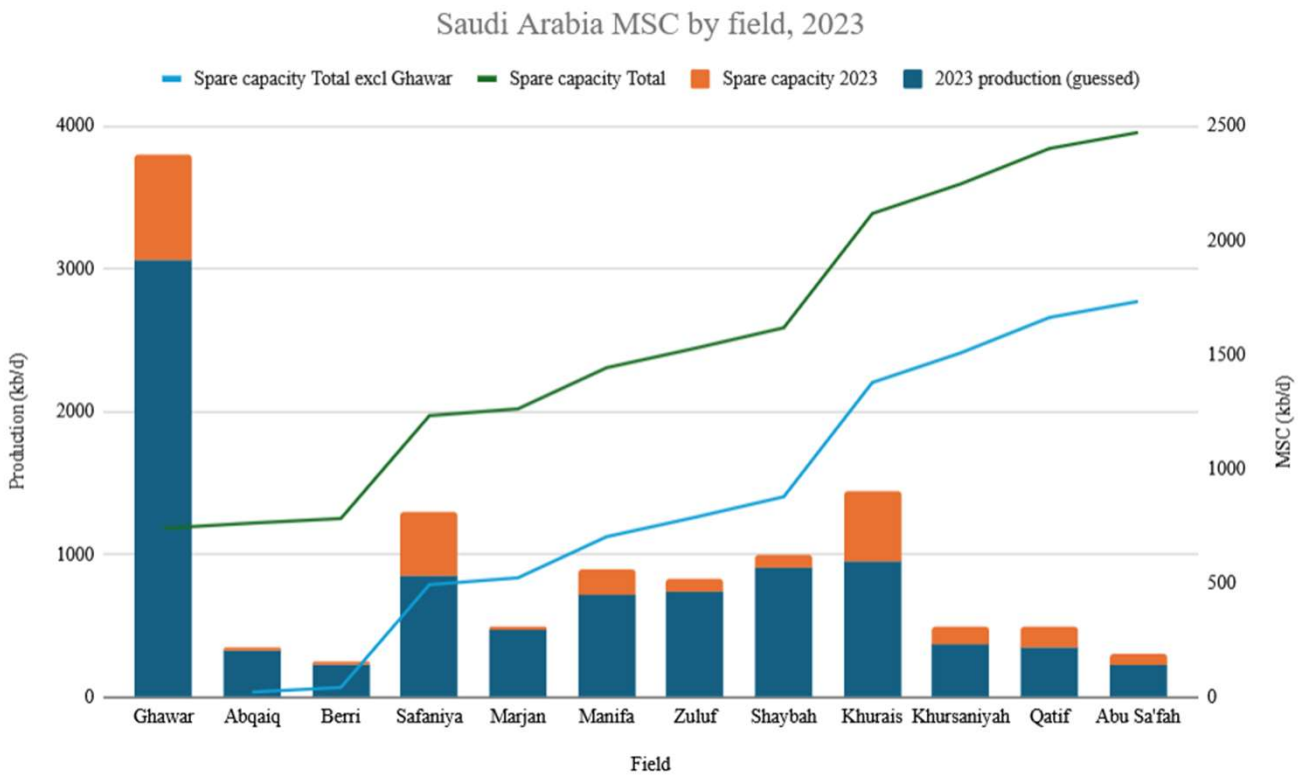
> Aging of the old high-quality high-productivity fields
Medium&Heavy refineries capacities expansion
Medium&Heavy producing fields expansion

Saudi Arabia : MSC





Saudi Arabia : MSC



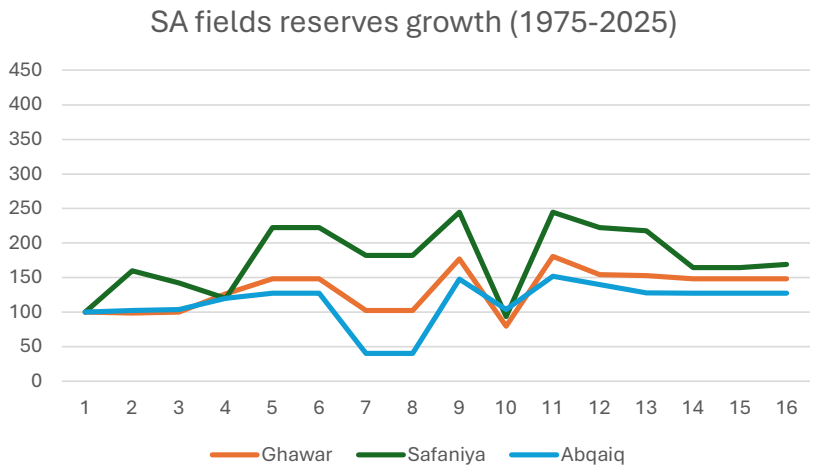
Before expansion of :
Marjan (300 kb/d)
Haradh-III (120 kb/d)
Dammam (50 kb/d, half in 2024, half in 2026)
Berri (250 kb/d)
Zuluf (600 kb/d)

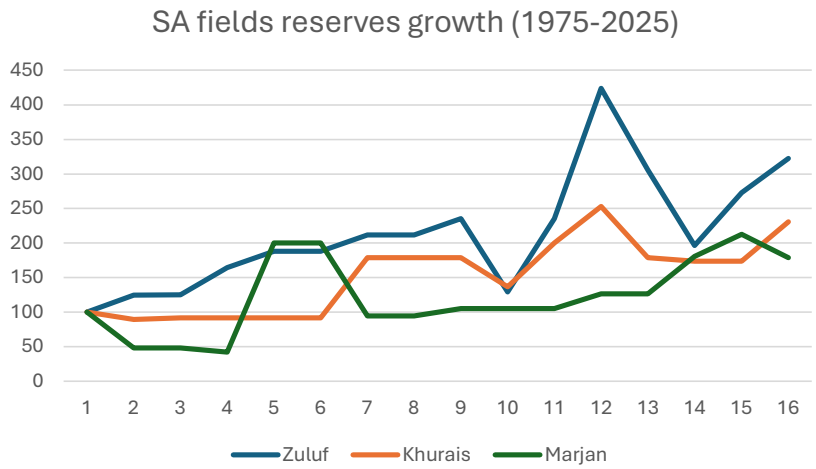
Aramco strategy :

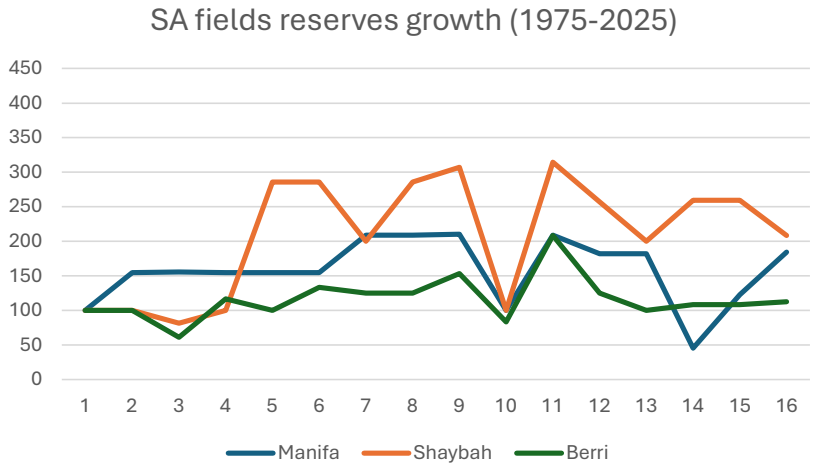
“To every oil producer, serving a GOSP area, is assigned a target rate and a production priority, high producing priority wells are on top of a list. This list, called production priorities, reflects the reservoir and production management strategy. These wells with top production priorities have to be flowed to meet the oil target rate of the GOSP area and limit produced water. Wells at the bottom of the list and beyond the GOSP target rate, are to be shut-in as standby wells or as alternatives to a shut-in high priority oil producer closed for well service jobs. To balance oil production with water injection, and to optimize drawdown on each well to sustain oil production and slow down water encroachment.”

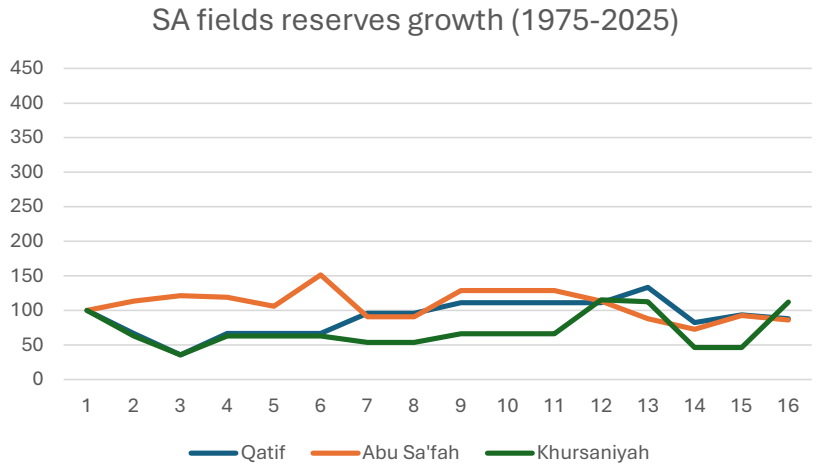
“A water injection target rate is assigned to every injector. Every well is equipped with a surface choke valve to allow adjusting to the assigned target rate. The injection target for every well is set such that a predetermined IPR is achieved for that well and area of the field. The objective is to balance the water injection with oil withdrawal while maintaining a healthy reservoir pressure and ensuring good oil sweep. ”

Saudi Arabia : Reserves

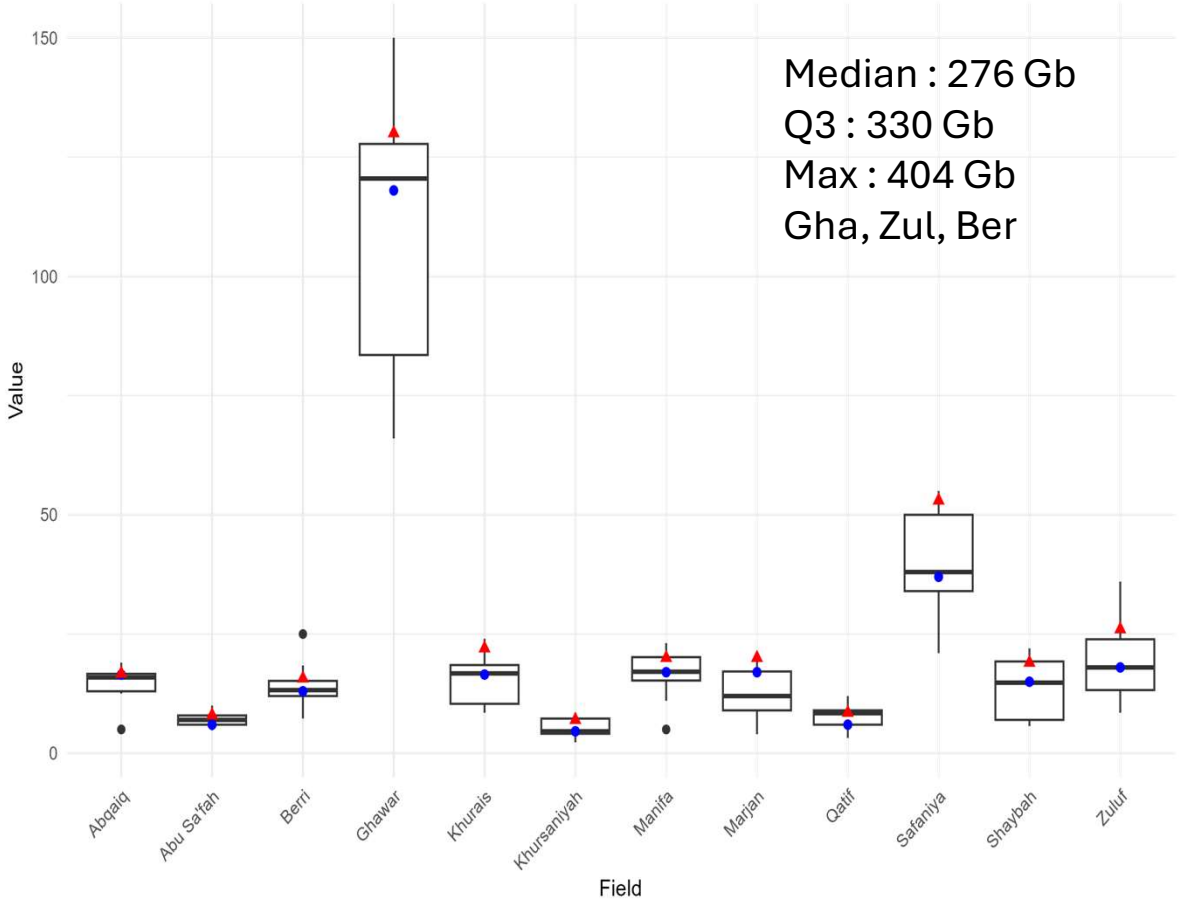








Saudi Arabia : Reserves



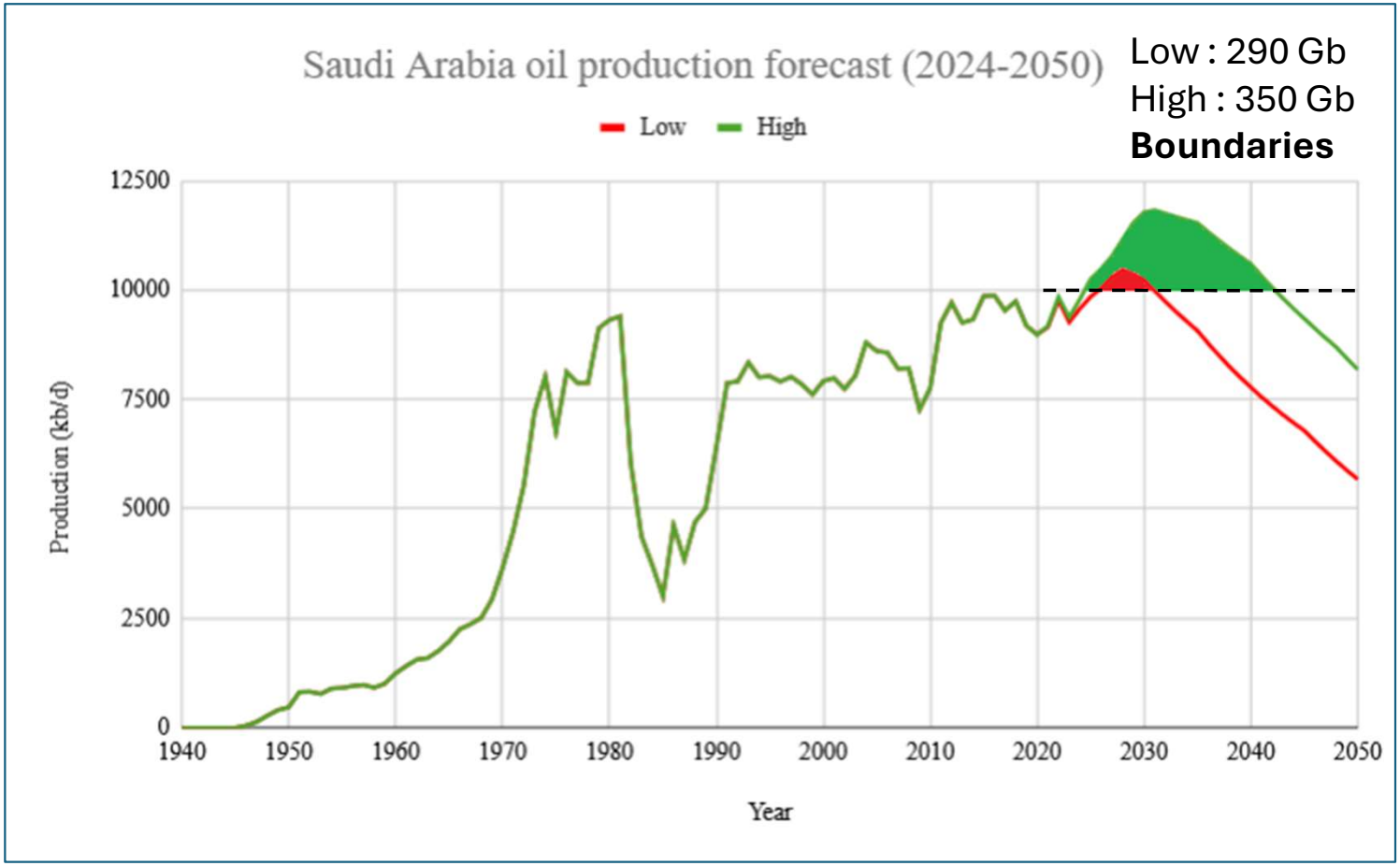
Don’t show the reserves increase over time, neither those for each estimation.

A few basic calculations :

Past cumul
Current prod
Forecasted expansion

Marjan < Manifa < Zuluf < Safaniyah

Saudi fields production forecast



High case assumption :
- full development of Safaniyah and Manifa

Low scenario :
decline in the 2030s

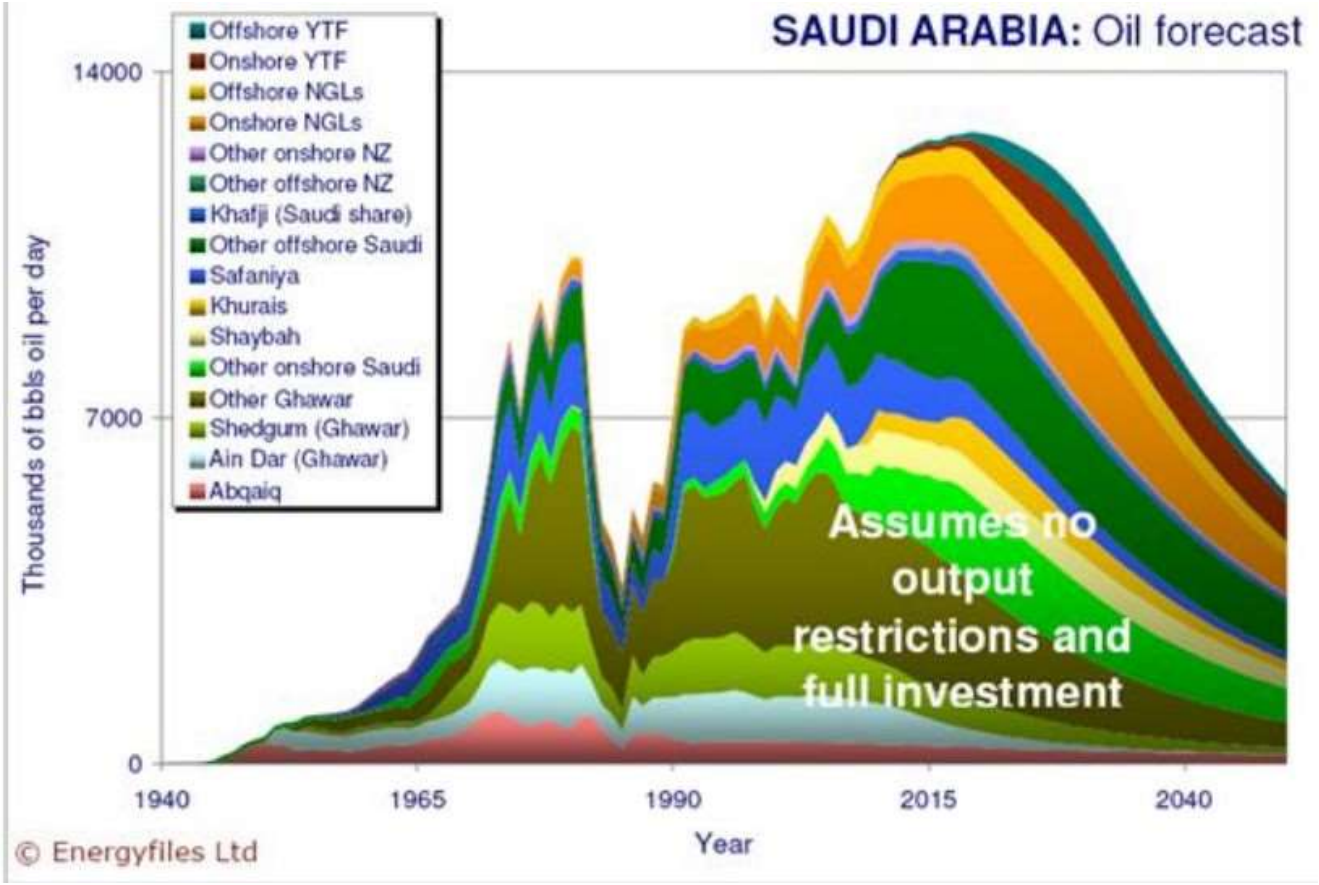
High scenario :
Peak close to 12 Mb/d, decline in the 2040s.

IF capped at 10 Mb/d :
Decline in 2045, or 2050 **BUT** with a stronger decline : few years gained
Green area : 7,15 Gb

Saudi Arabia : conclusion

Simmons work :
A rare glimpse into obscure data
too pessimistic
YET
Worries right for Ghawar, Abqaiq and Berri (to a lesser extent)

Uncertainties still present but :
Greatly reduced
Led to a « midpoint » view :
SA prod is not at a near-term collapse

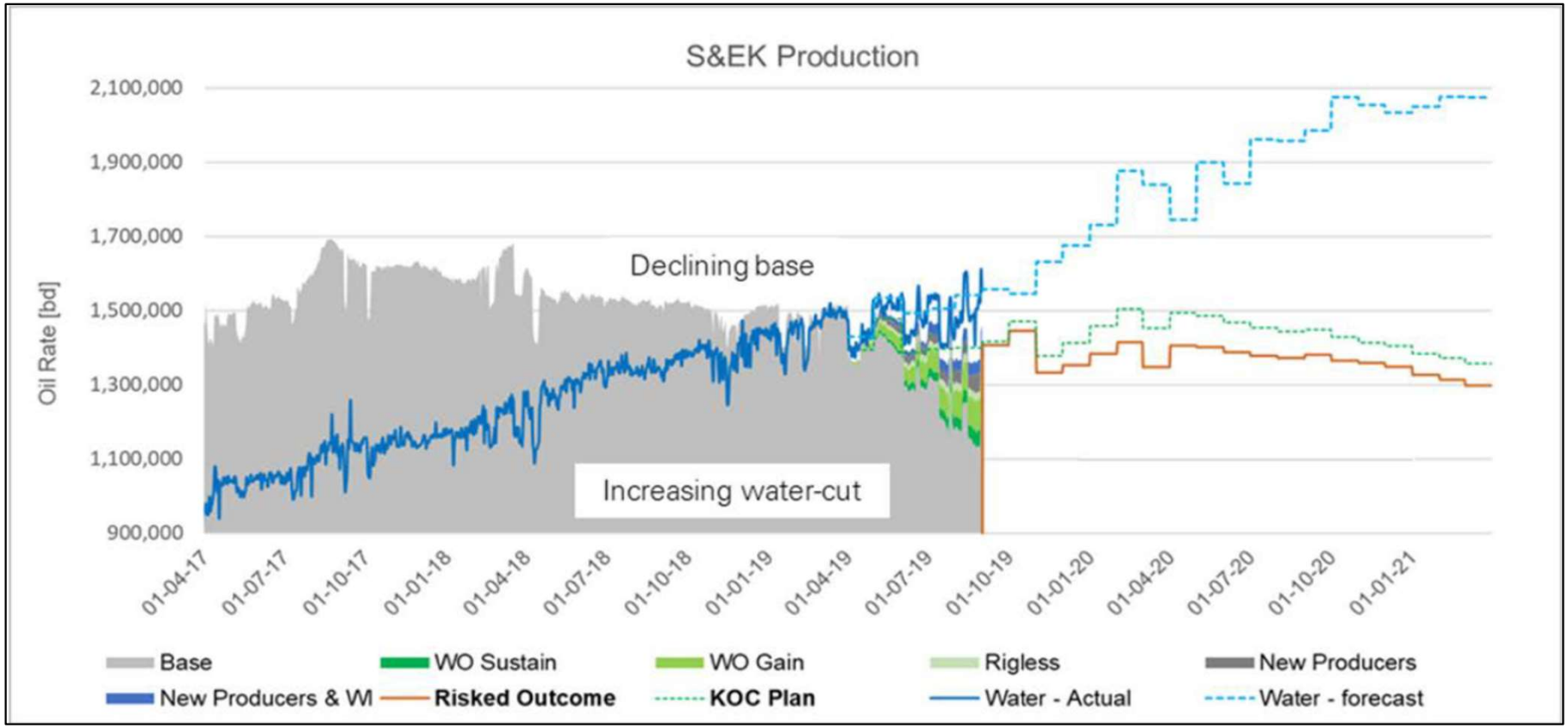


Kuwait, a quick insight

The Burgan supergiant field : a near-term « *watery* » problem, a long-term « *reserves* » problem.

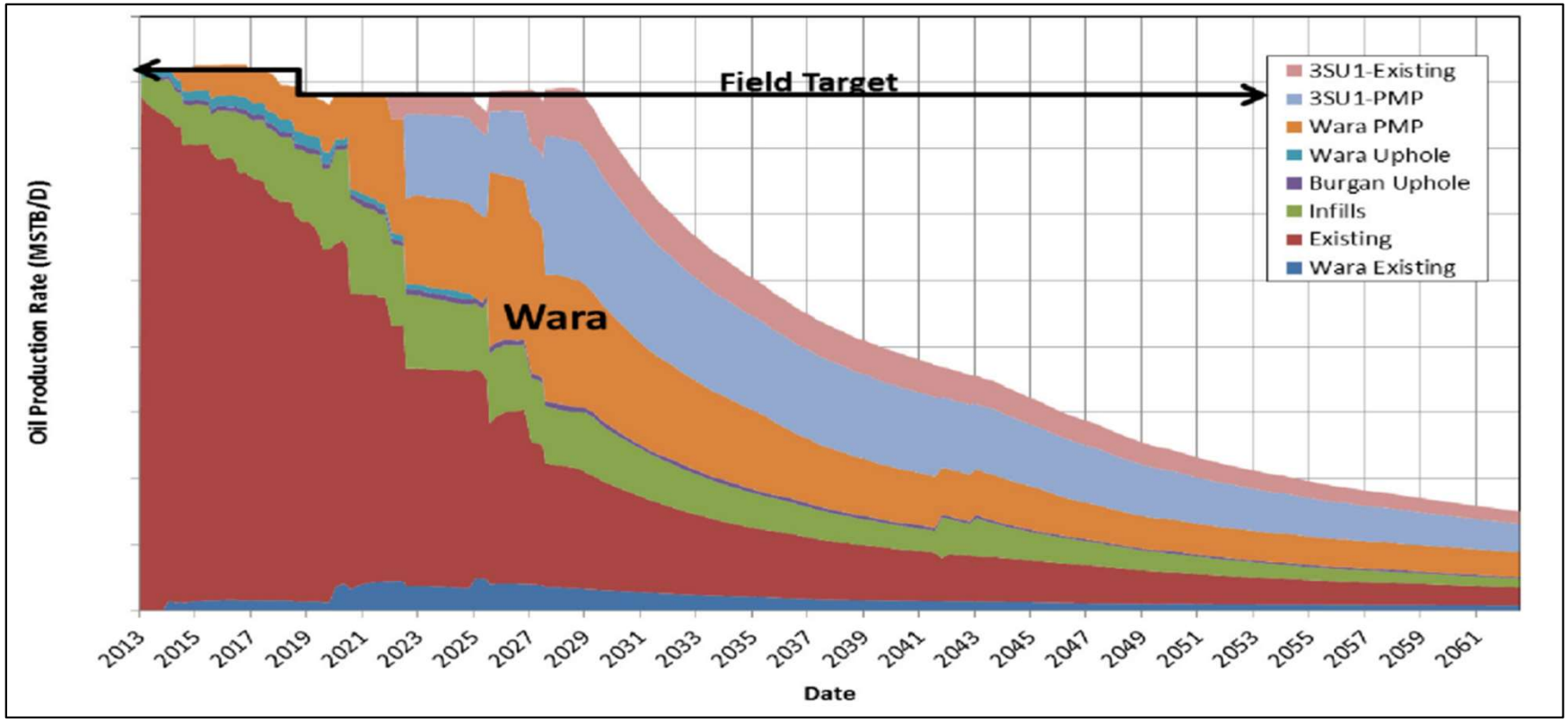
Burgan field, monthly crude production (1946-2013). SPE-175175-MS

Burgan field, a near-term « *watery* » problem.



Burgan field, production forecast (2019). Shaikha Al-kandari&al, "Water Management Challenges In Greater Burgan Field", AAPG

Burgan field, a long-term « *reserves* » problem.



Burgan field, production forecast (2015) by zone and completion type. SPE-175175-MS

A last personal thought :

Imagination of an interactive database similar to the Whalevis one.