

PS A Brief History of the Exploration History of the Gulf of Suez, Egypt*

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Abstract

The Gulf of Suez (GOS) is a failed rift located north of the triple junction formed by it and the Gulf of Aden and the Red Sea. It is one of the oldest known hydrocarbon provinces in the world with reports of natural seeps going back to Pharonic time. In the more modern era, oil was first discovered in 1868 by a French mining company while digging for sulfur. The first “true” exploration well (Gemsa D-1) was drilled by the Egyptian Government in 1886. Commercial oil was developed, later in 1908, by the Anglo Egypt Oil Company and the Egyptian Oil Trust with the establishment of Gemsa Field. By the end of 2015, more than 1545 exploration wells (including outpost and deeper/shallower pool) have been drilled in the GOS rift resulting in 170 fields with reserves of 12.7 bboe. In their comprehensive overview of GOS oil fields, published by The Egyptian General Petroleum Company (EGPC) in 1996, the exploration history of the basin was divided into six stages. The first phase extended from 1868 to 1921 and focused on the areas with known seeps around Gebel Zeit and Gemsa. Three fields were discovered during this time. The second stage extended from 1922-53 and witnessed the introduction of gravity, magnetics and seismic exploration methods. Also, during this time, rotary drilling was first used and five fields were discovered. From 1954-63 the first marine seismic surveys were acquired and eight more fields were brought on line. EGPC was established in 1956 to oversee petroleum operations in Egypt. The fourth stage from 1964-72 was the time when several international oil companies entered in to “participation” agreements with EGPC. Discoveries during this time, which included the giant El Morgan Field, increased the reserve base by more than three billion barrels. Stage five was from 1973-85 was a very active period of exploration with 365 wells drilled with 110 of them finding oil. During this time, the EGPC introduced the “Gas Clause” which allowed companies to economically search for natural gas. The second century of GOS exploration began in 1987 and since then the GOS has continued to be a major petroleum exploration venue. Modern exploration techniques continued to unlock the secrets of the rift and added to the discovered reserves. Today the basin is in its mature stage with many fields in decline and supported by enhanced recovery techniques; however, the GOS remains one of the world's important hydrocarbon provinces.

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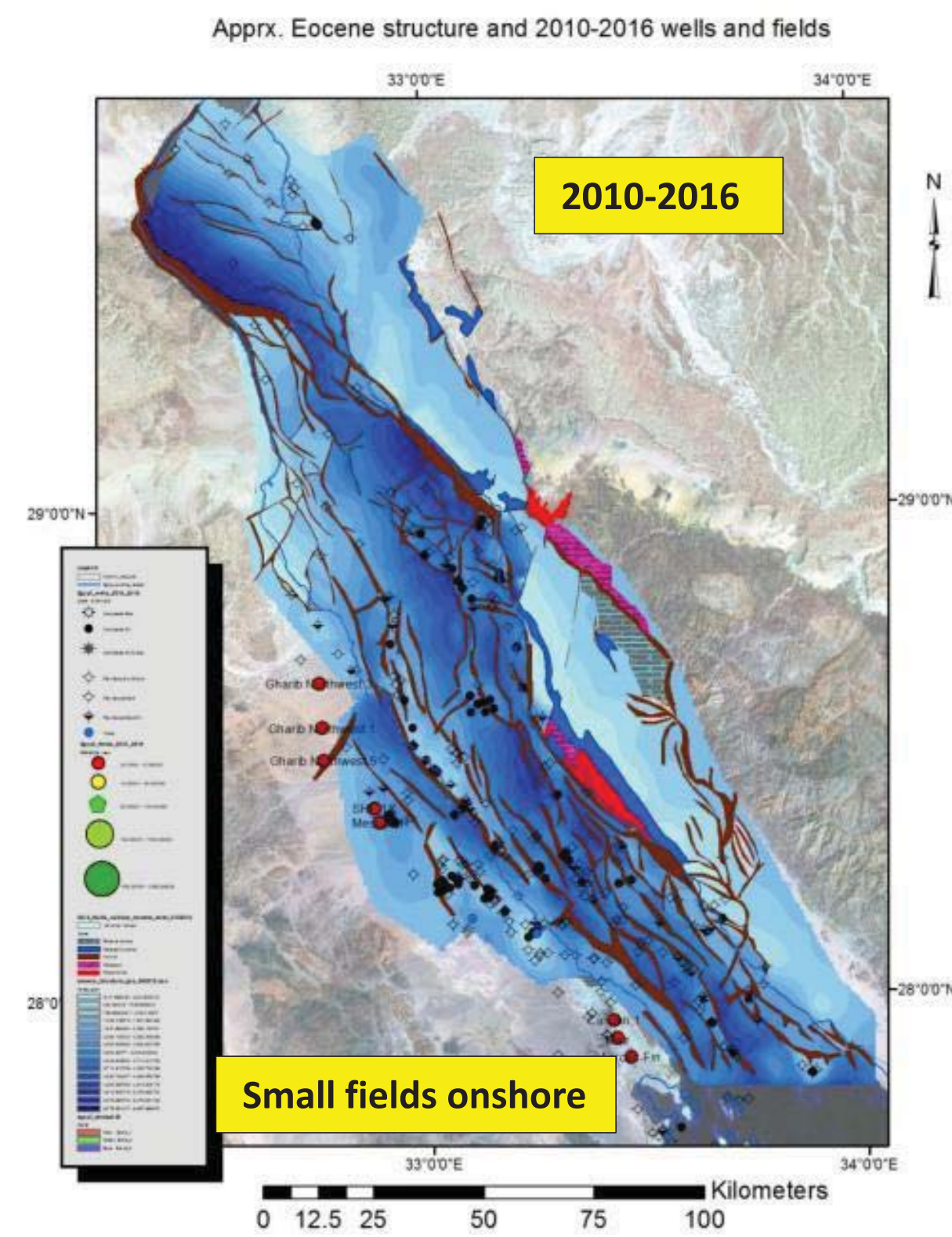
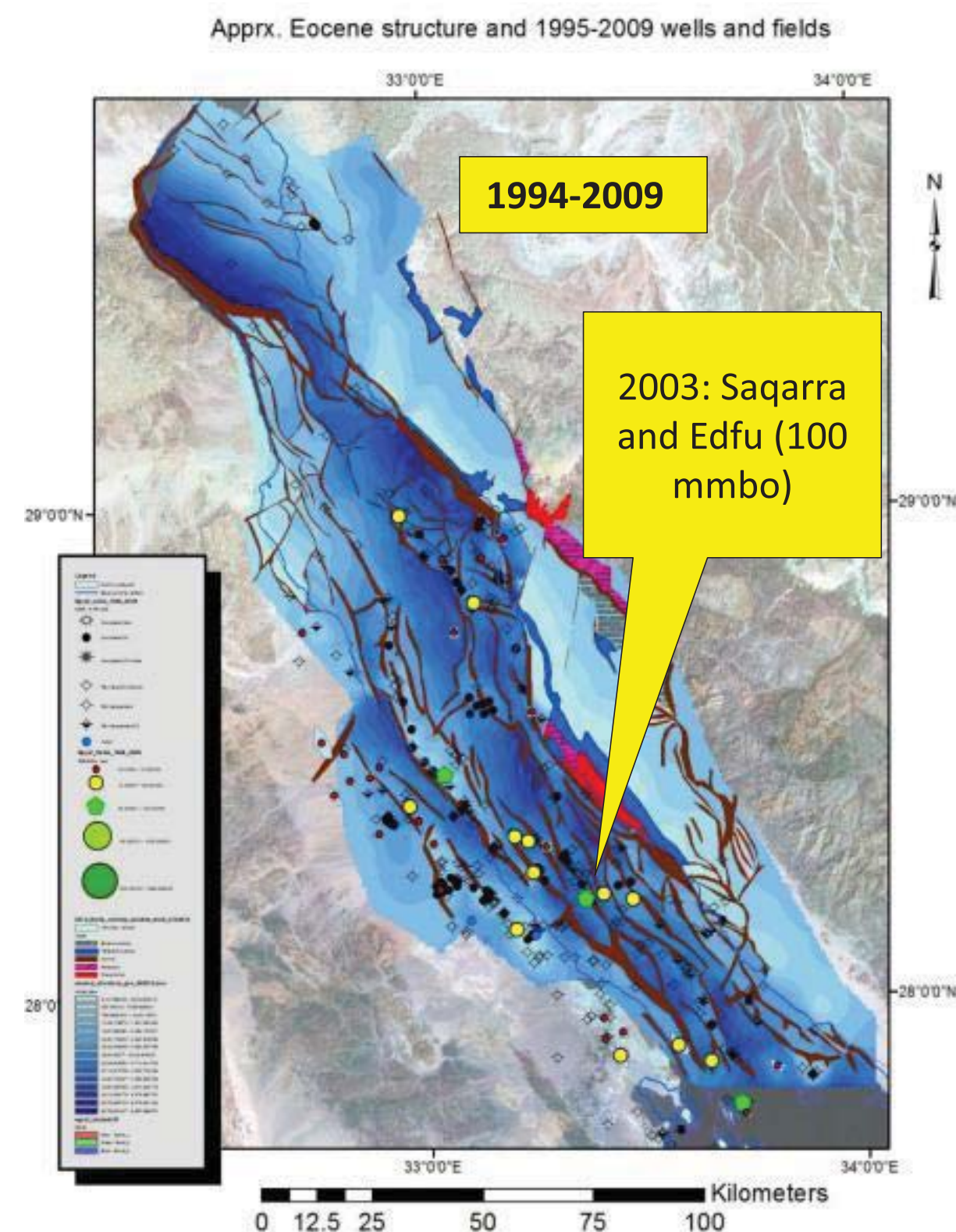
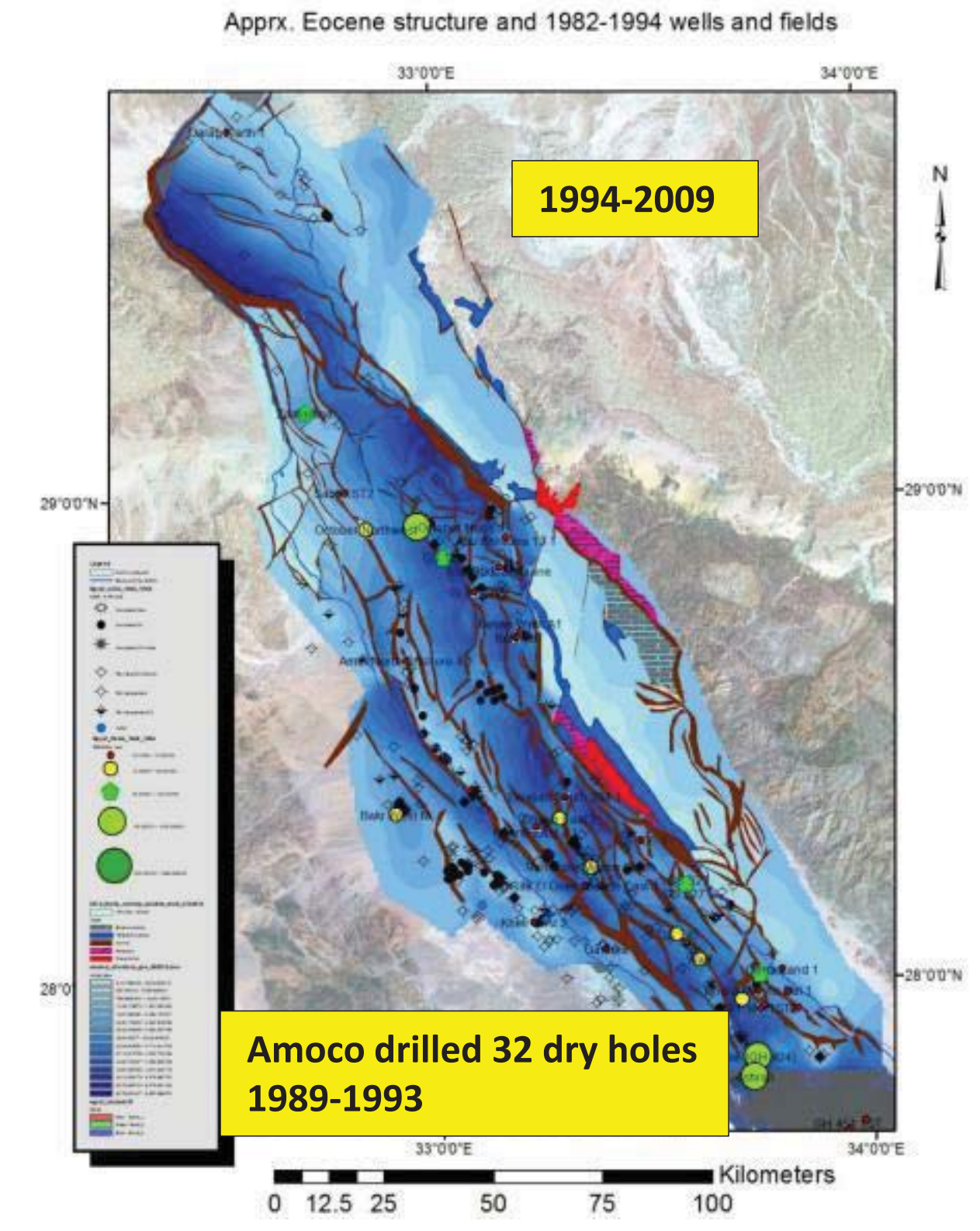
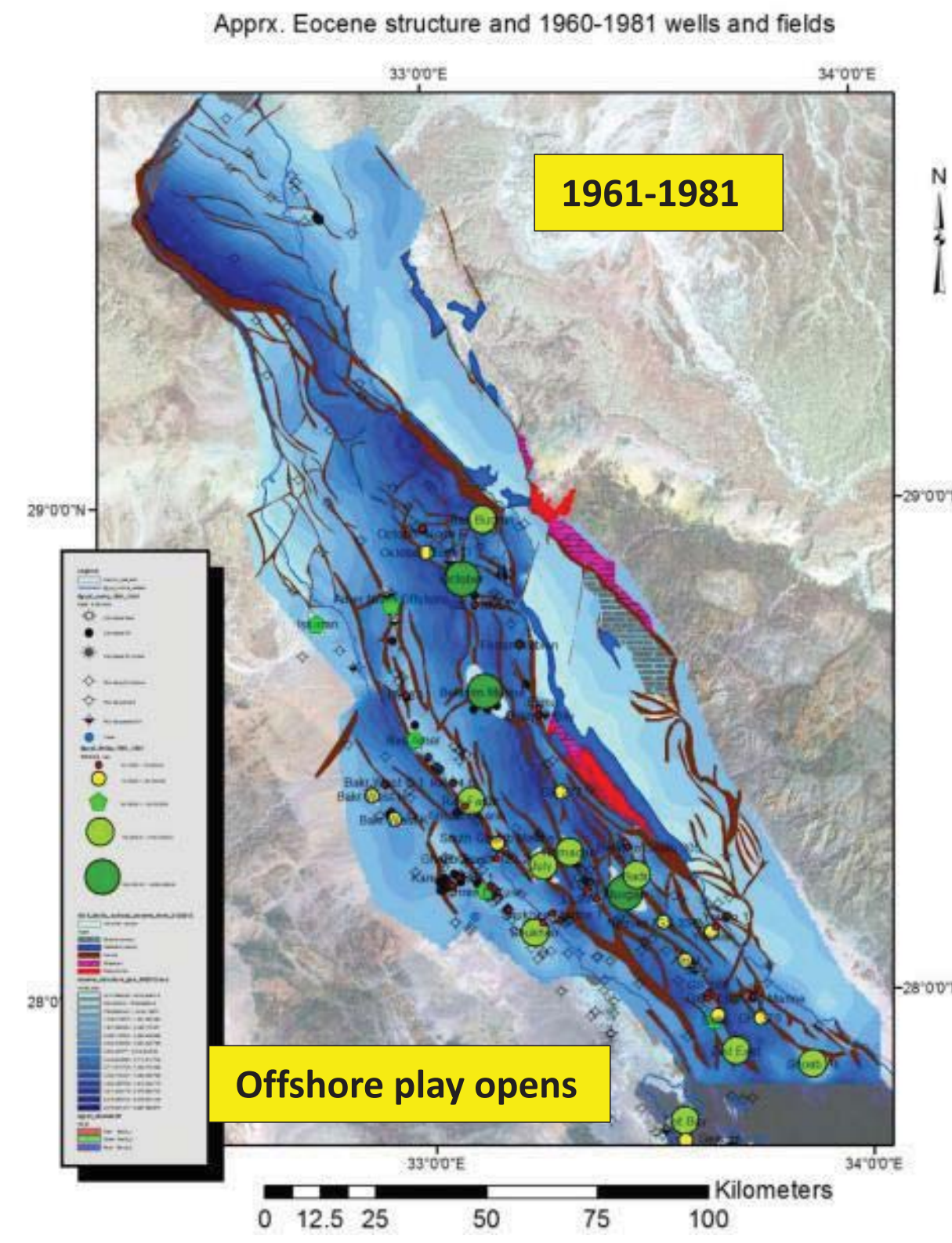
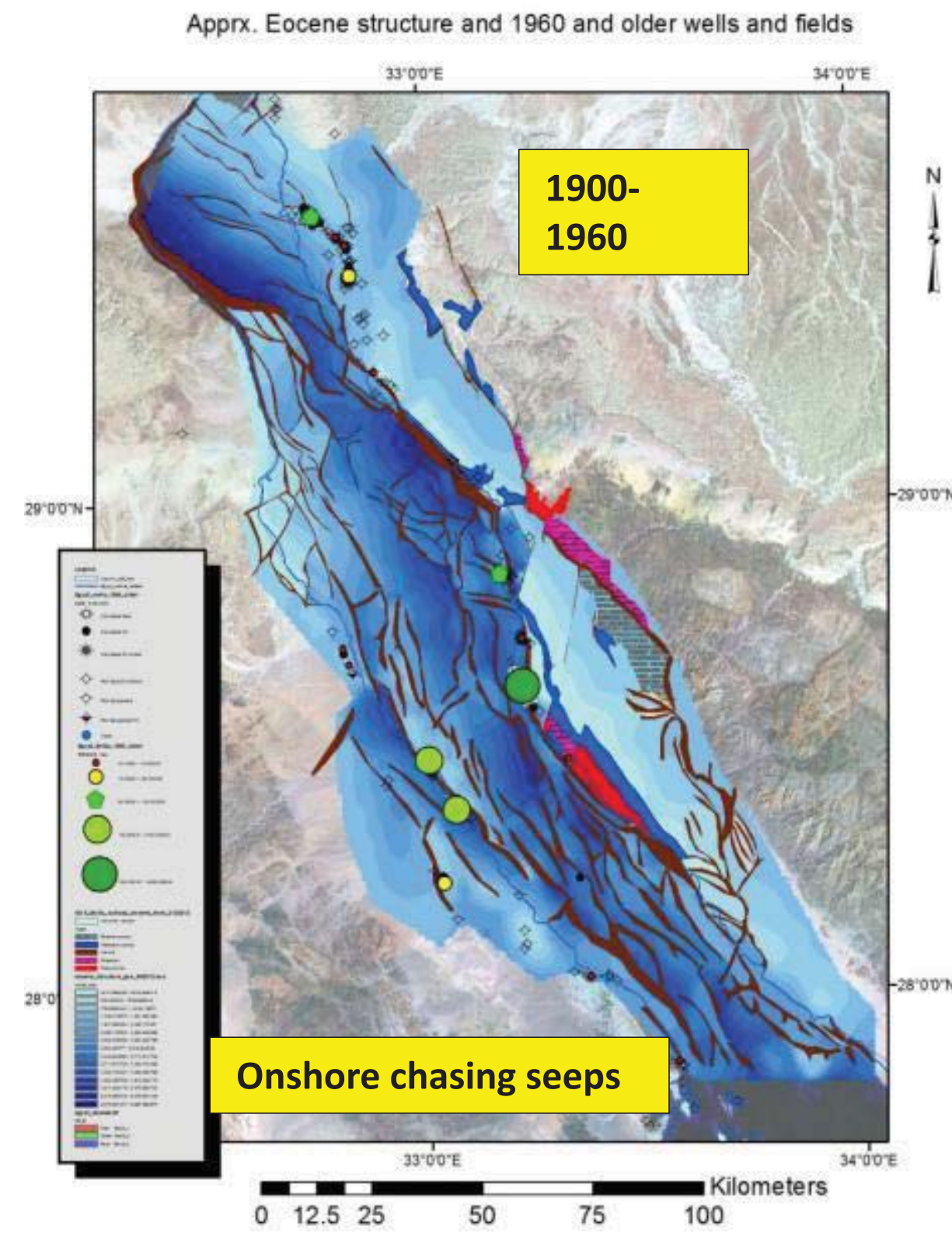
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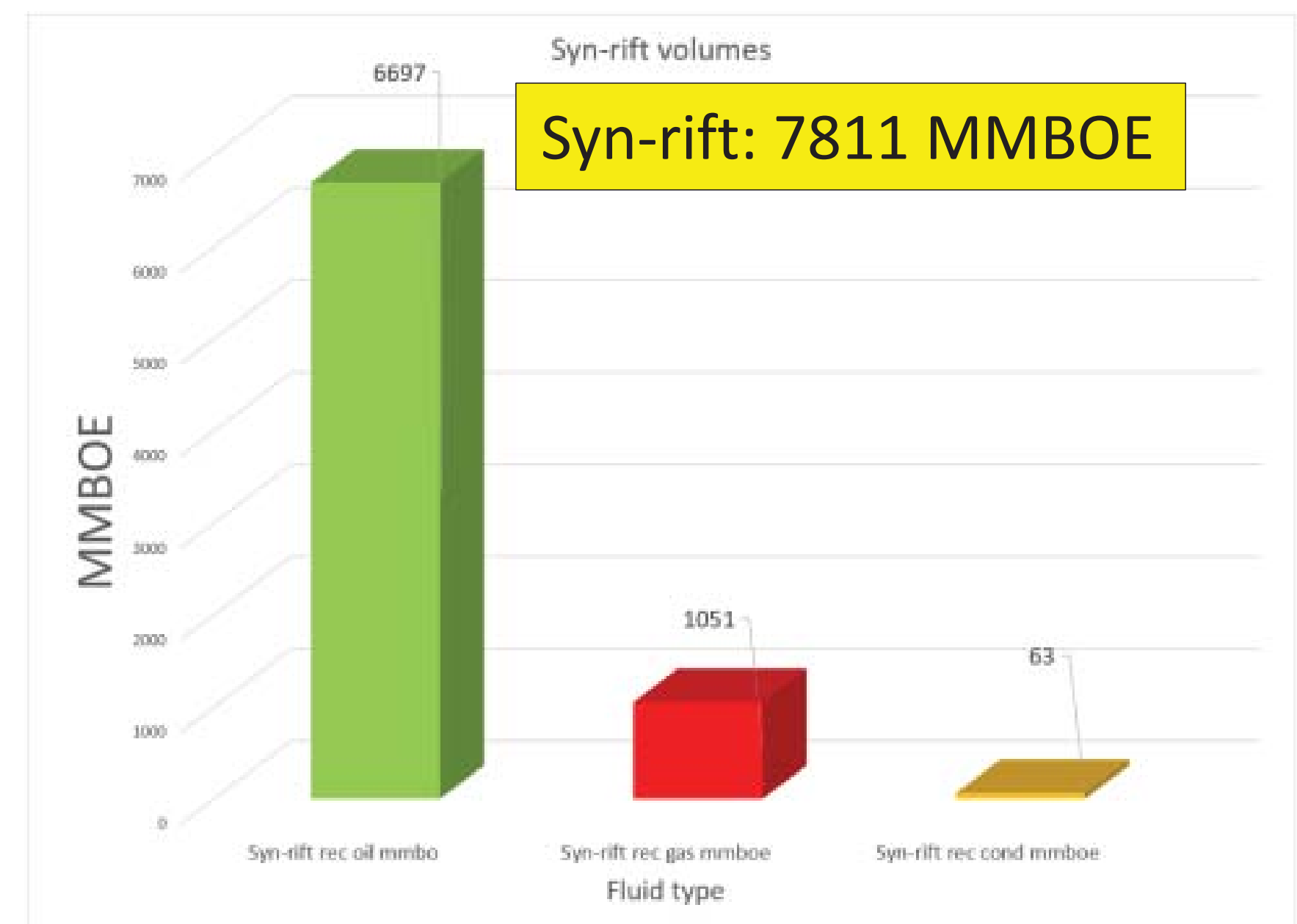
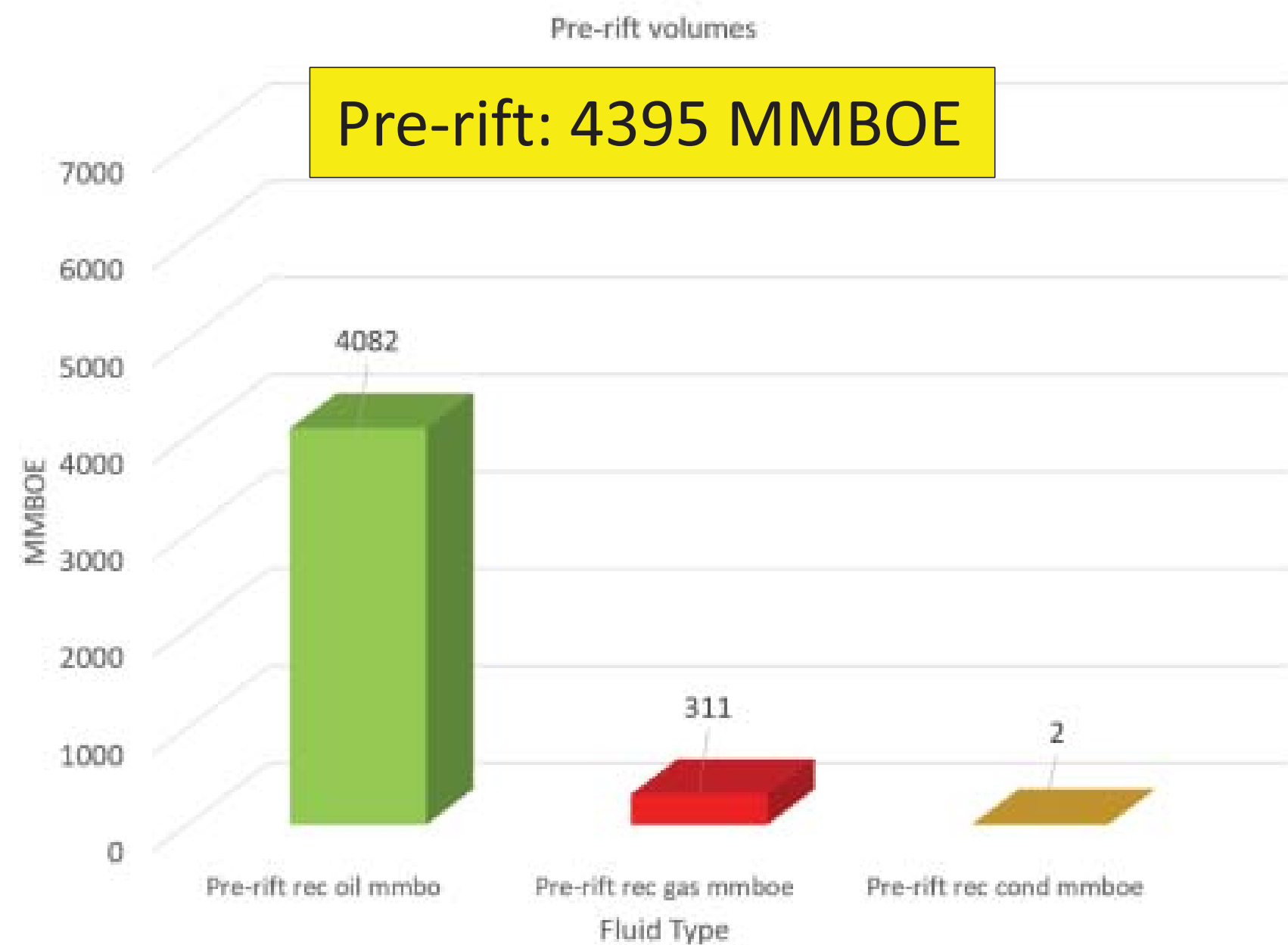
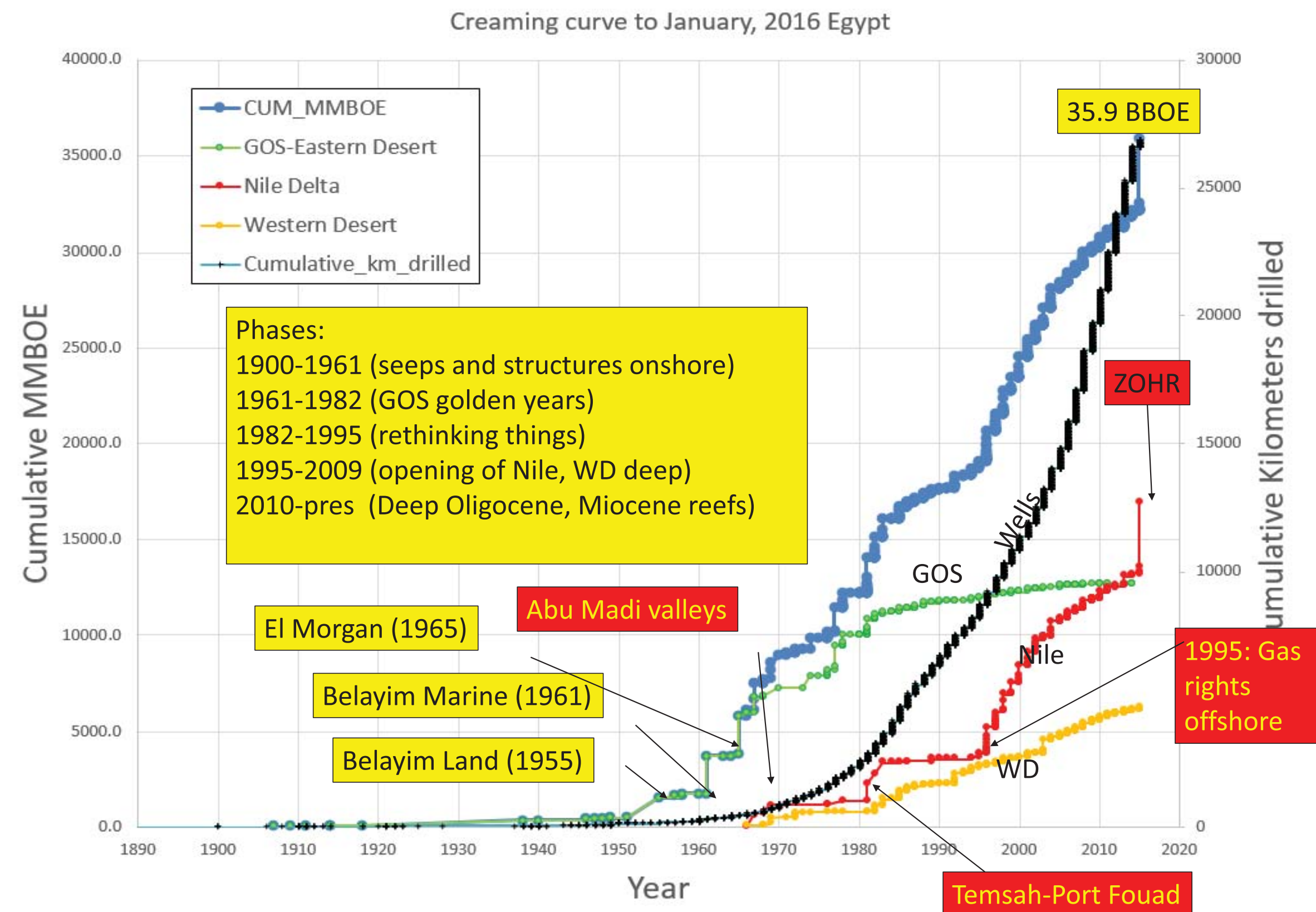
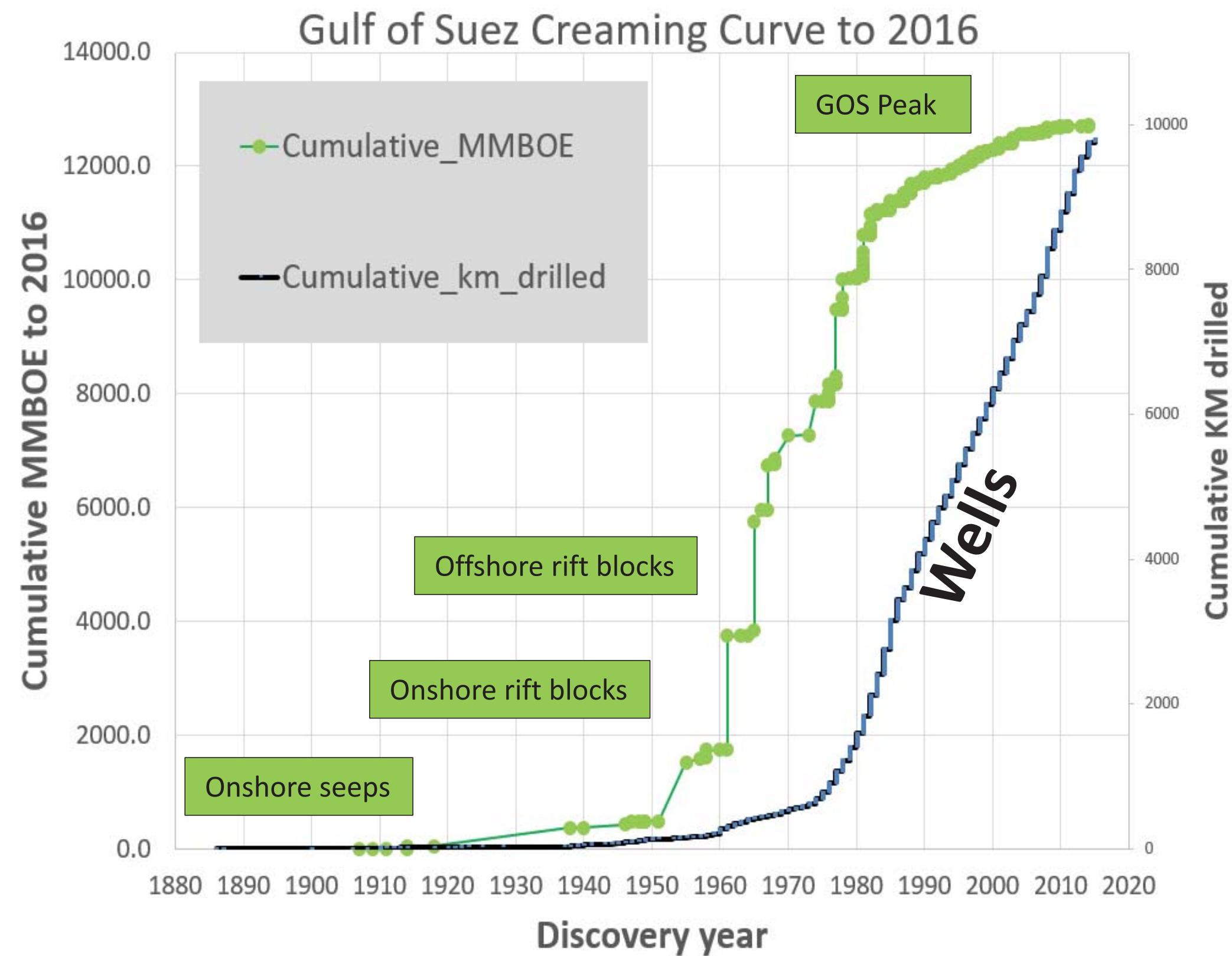


Drilling and Discoveries



Since 1955, the plays have remained the same: rift fault blocks and salt closures, but only smaller and smaller fields have been discovered.

GOS Exploration History



SEISMIC IMAGING DIFFICULTIES

MultiplesMultiplesMultiplesMultiplesMultiples

Stratigraphic column of the Gulf of Suez (Alsharhan and Salah, 1997)

RIFTING	ERA	TIME UNIT	GROUP	FORMATION Member	LITHOLOGY	TYPE SECTION	THICKNESS (m)
SYN - RIFT SEDIMENTS	CENOZOIC	POST MIOCENE		ZAAFARANA WARDAN			
		MIOCENE	Ras Maalab	ZEIT		Jabal Zeit-2	940
				SOUTH GHARIB		South Gharib-2	700
				Hamam Faraun			
				Feiran			
				Sidri		Belayim 112-12 Well	302
				Baba			
			Gharandal	KAREEM	Shagar Rahmi	Gharib N-2 Abu Zenima-1	461
				RUDEIS	Ayun Safra Yusr Bakr	Rudeis-2	780
				NUKHUL	Shoab Ali Ghara	Zeit Bay-1	427
				RED BEDS			
PRE - RIFT SEDIMENTS	MESOZOIC	OLIGOCENE	El Egma	THEBES		Luxor	423
		EOCENE		ESNA		Esna	60
		PALEOCENE		SUDR		Wadi Sudr	137
		LATE CRETACEOUS	Nezzazat	DUWI		Jabal Duwi	38
				MATULLA		Wadi Matulla	170
				WATA		Wadi Wata	64
				ABU QADA		Wadi Gharandal	25
		EARLY CRETACEOUS	El Tih	RAHA		Raha Scarp	120
				MALHA		Wadi Malha	149
		JURASSIC					
		TRIASSIC	Ataqa	OISEIB		Wadi Oiseib	44
		PERMIAN		ROD EL HAMAL		Wadi Rod El Hamal	274
		LATE CARBONIFEROUS		ABU DURBA		Jabal Durba	122
	PALEOZOIC	EARLY CARBONIFEROUS	Oibliat	UMM BOGMA		Jabal Nukhul	45
		CAMBRIAN-ORDOVICIAN		NAQUS		Jabal Naqus	410
			Oibliat	ARABA		Jabal Qubliat	133
		PRECAMBRIAN BASEMENT					

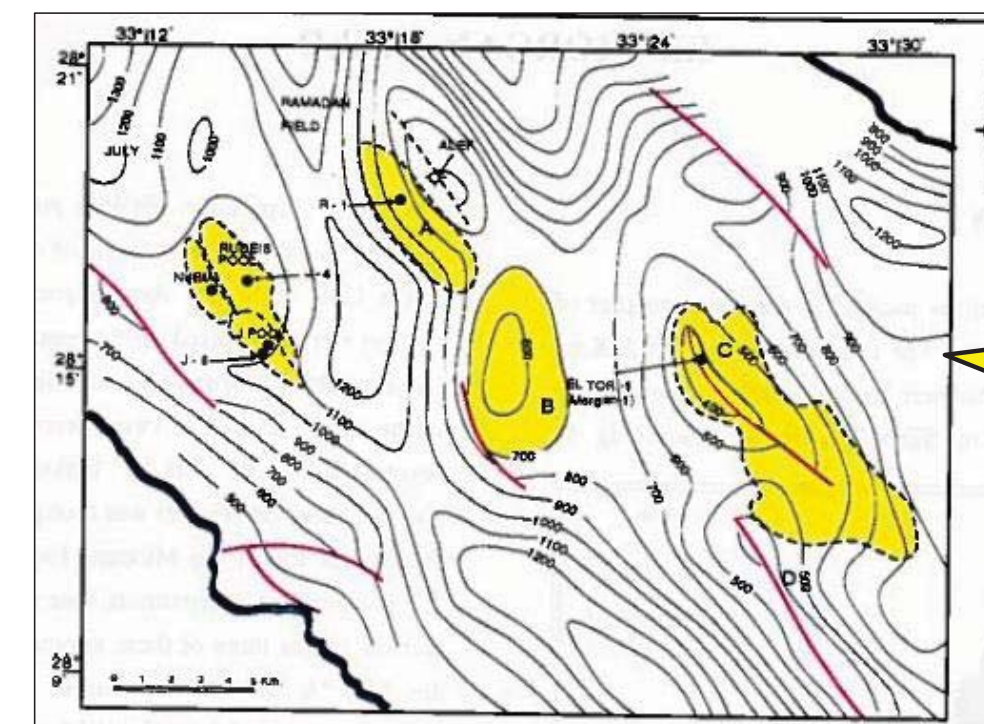
● Oil reservoirs

■ Source rocks

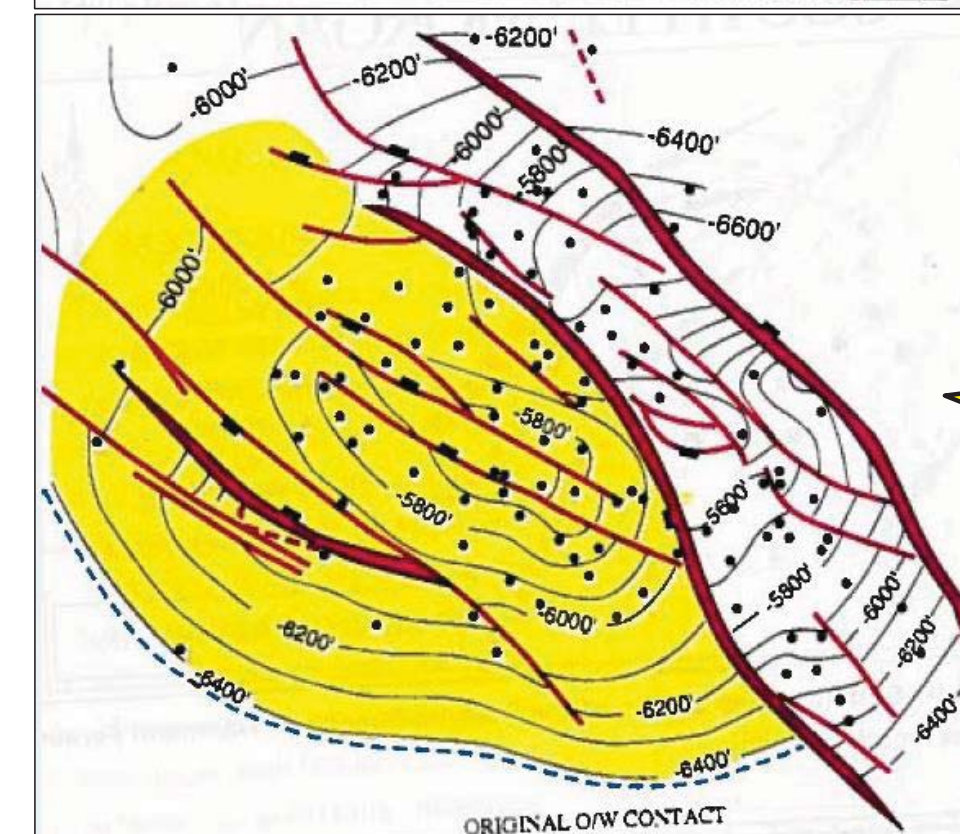
⊗ Seals

Thick salt beds in the Zeit Formation attenuate the seismic signal.

Interbedded anhydrites, carbonates and shales cause a train of peg leg multiples that totally obscure the seismic signal below the evaporites.



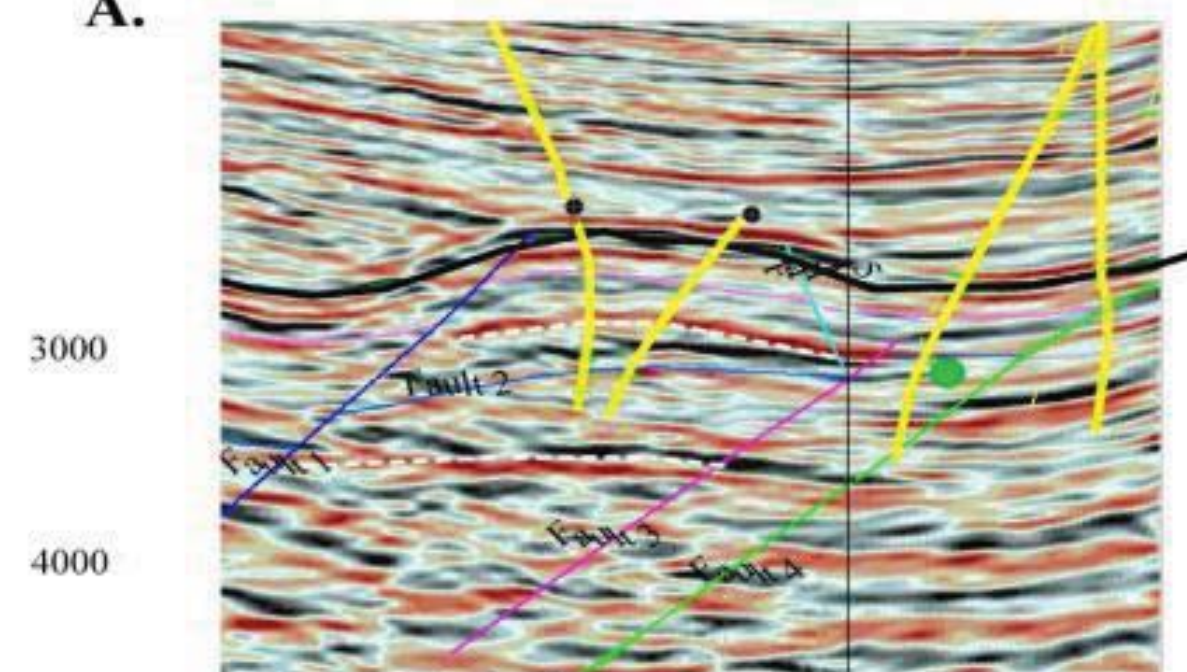
El Morgan prospect map 1965



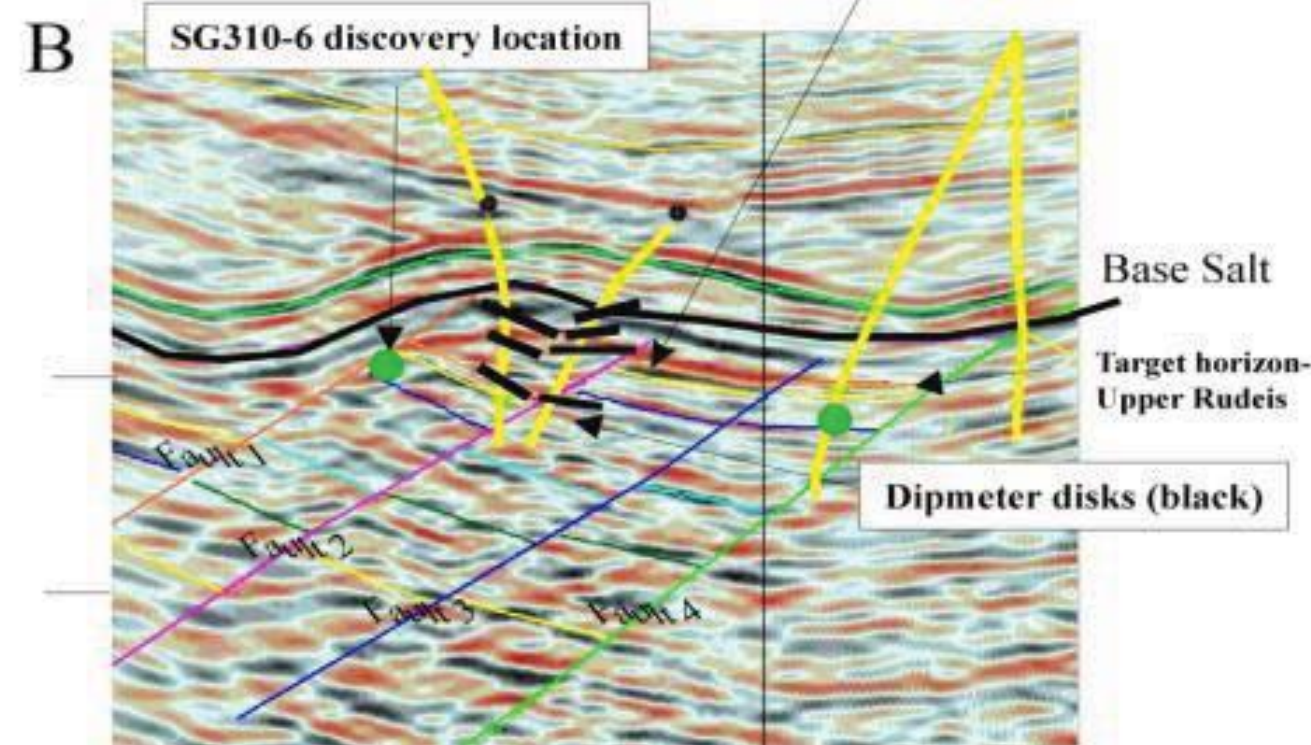
El Morgan field map 1990

Relative position of SG310-4 discovery

A.



B.



Pre (A) and post-drill (B) interpretation. Tilted fault blocks are not imaged on the predrill data. Only after adding dipmeter information Can the traps be interpreted (from Dolson and others, 2001).

THE DISCOVERY OF A GIANT

EL MORGAN FIELD ESTABLISHES THE GoS AS A MAJOR PETROLEUM PROVINCE

In 1963 Pan American UAR Oil Company (later Amoco Egypt Oil Company) acquired the right to explore offshore in the Gulf of Suez. In 1964 aeromagnetic and seismic surveys were conducted and several structural anomalies were recognized. During January 1965 the first of these anomalies, designated “C”, was tested by the El Tor No. 1 well (later called Morgan No.1). The well encountered oil in the Hammam Faraun sandstone in the Miocene Belayim Fm. at a depth of -5100’ and at -5600’ a very thick oil column was found in the Miocene Kareem Fm.

The field was declared commercial and Amoco and EGPC formed GUPCO as a joint venture company. Subsequent drilling established El Morgan as a giant oil field. By 1995 El Morgan had produced almost 1.25 billion barrels of oil!

Jim Vanderbeek was Amoco’s Managing Director in Egypt during the time of the El Morgan discovery. A story has been told, that after logging and testing the discovery well he took a set of logs and flew to Chicago to show the results to Amoco’s senior managers. As he unfolded the logs on the conference table he reportedly told everyone that they had logged four feet of pay; that is four feet of pay at 1:500, almost 2000’ of oil!*



James Wilson Vanderbeek

Other Vanderbeek Quotes:

“I figured if there was big oil in Saudi Arabia and big oil in Libya. There must be big oil somewhere in Egypt, ‘cause it was in between.”

Upon building a pipeline without corporate approval: “I figured if Egyptians could build the pyramids, they could do a pipeline.”

* Many versions of this story exist, with different log scales and numbers; regardless, he definitely understated the magnitude of the discovery with great dramatic effect.

FIELD GEOLOGY IN A BATTLE FIELD CAN BE **DANGEROUS!**

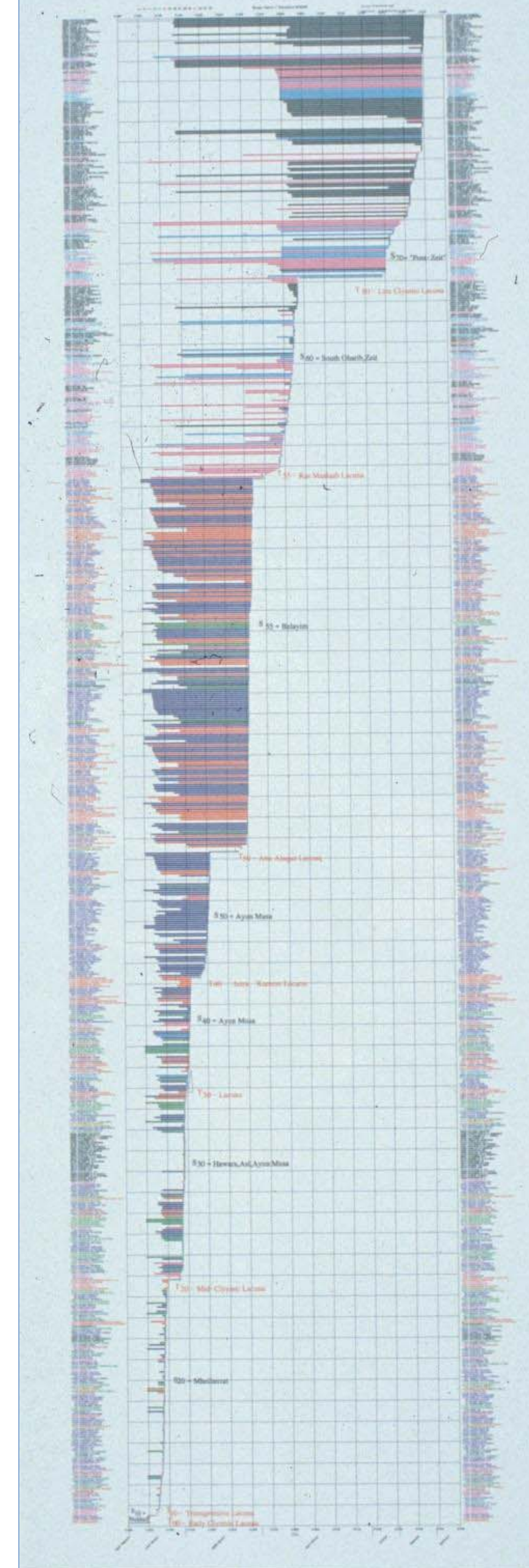
AN INCIDENT IN WADI ARABA

While measuring stratigraphic sections and collecting samples for microfossils for the purpose of building a Gulf of Suez Composite Standard, a group of geologists and paleontologists from Amoco and GUPCO were driving off road in the Wadi Araba area. Unbeknown to them, they drove into a mine field from the back side where it was not marked. Unfortunately they ran over an anti-tank mine which exploded and flipped the Land Rover. Everyone in the field party was injured and the driver was killed. One of the least injured men was able to back track safely out of the mine field and eventually make contact with authorities and the survivors were rescued.

Ultimately the composite standard was constructed and the detailed chronostratigraphic information derived from it was successfully applied by explorers for many years.



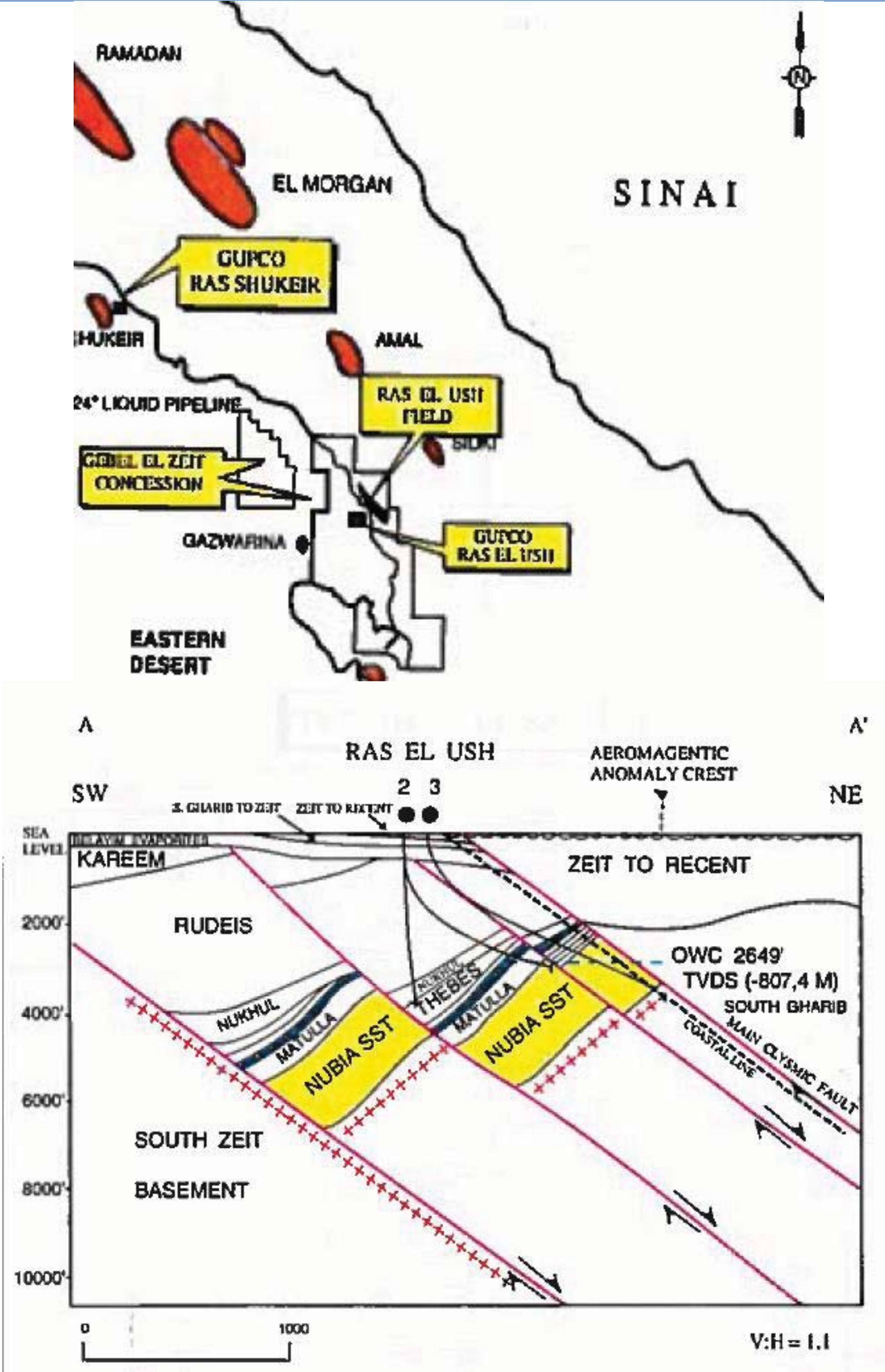
GoS Composite Standard



RAS EL USH FIELD

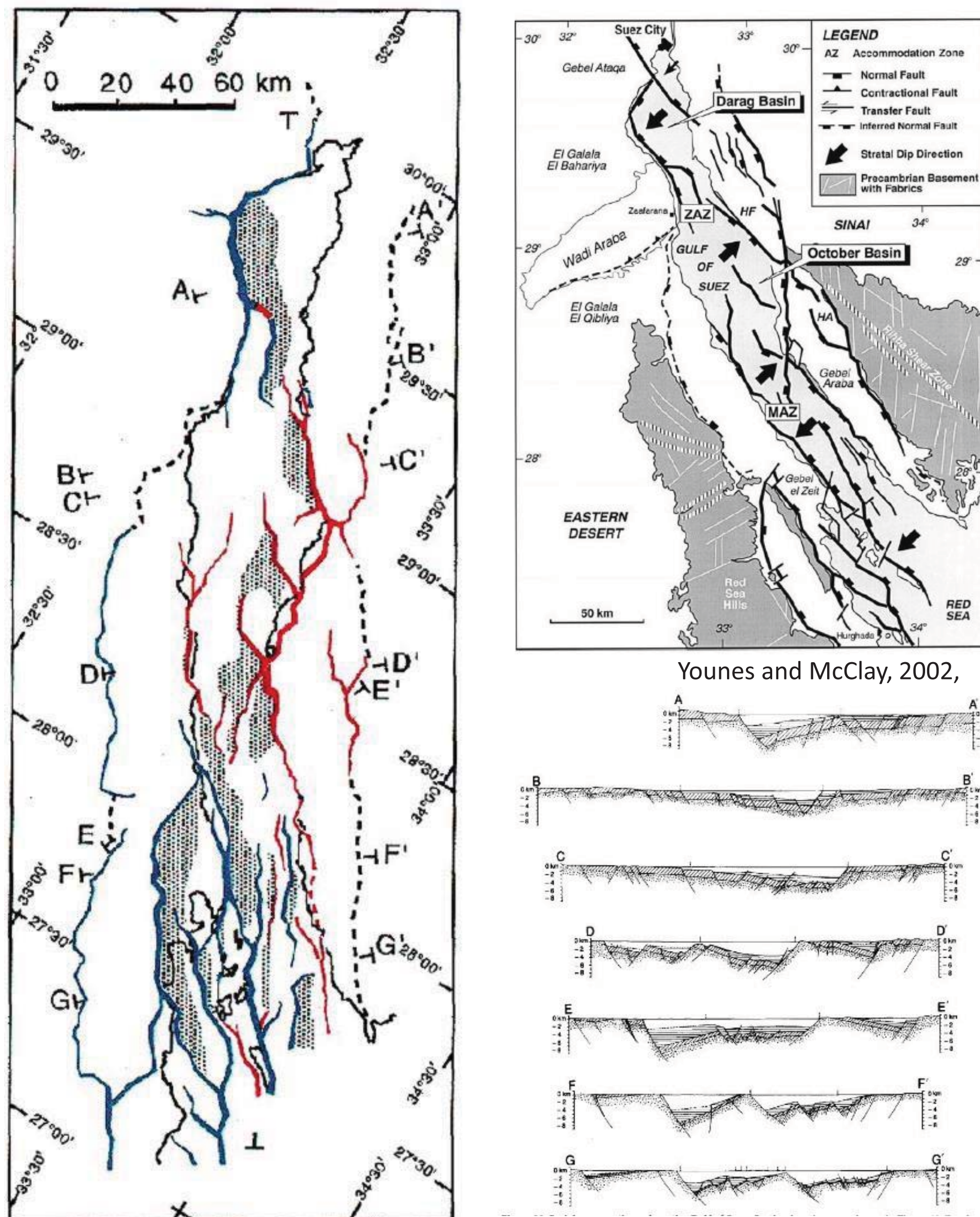
ENHANCED OIL RECOVERY IN A SUBSIDIZED ENVIRONMENT

Ras el Ush field was discovered by Marathon Oil in 1995. It was a relatively small three well field with 26.3 mmbo in place in the Nubia formation and 14.3 mmbo in place in the Matulla formation. Marathon later sold the field to an independent operator, who eventually took the field into an enhanced recovery project. This project required injecting diesel oil into the reservoir which mobilized some of the previously immovable and residual oil. For each barrel of diesel injected one plus barrel of hydrocarbons was recovered making this an effective methodology. It was especially economic since in Egypt the price of the diesel was subsidized by the government at well below world market price and the produced (reproduced?) oil was sold at free market prices!



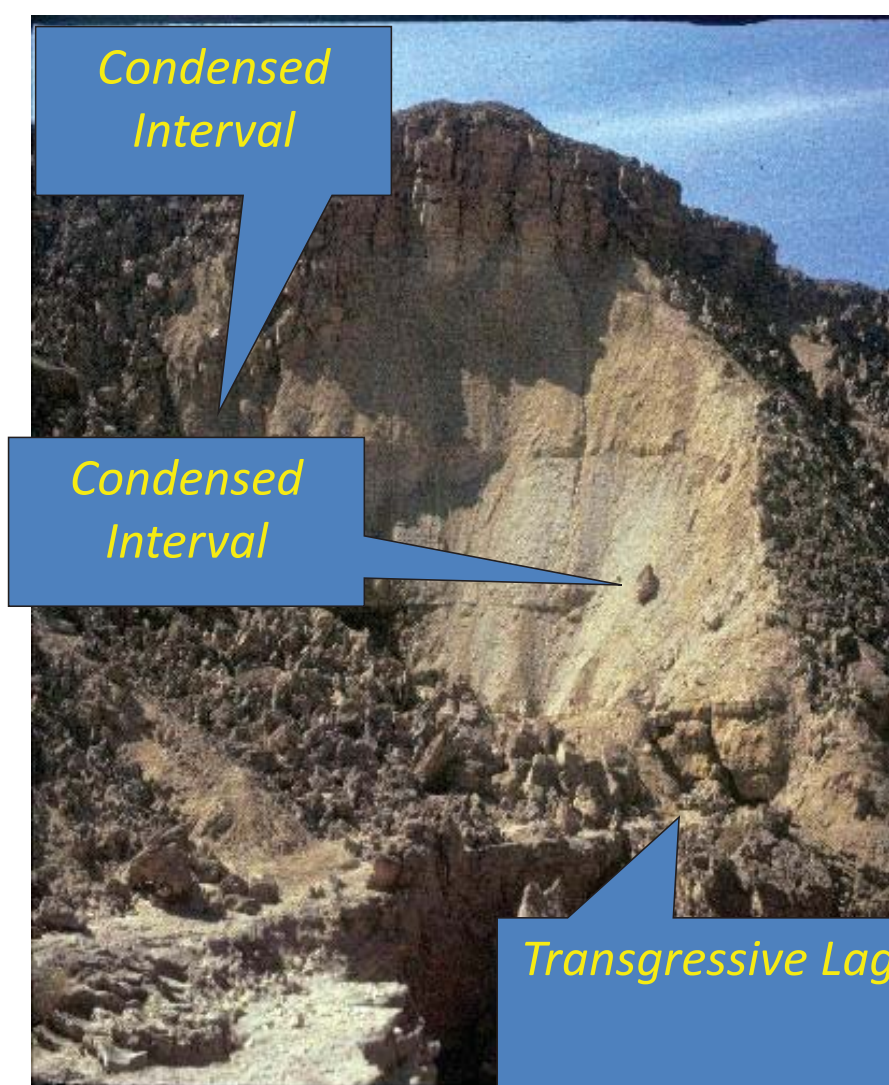
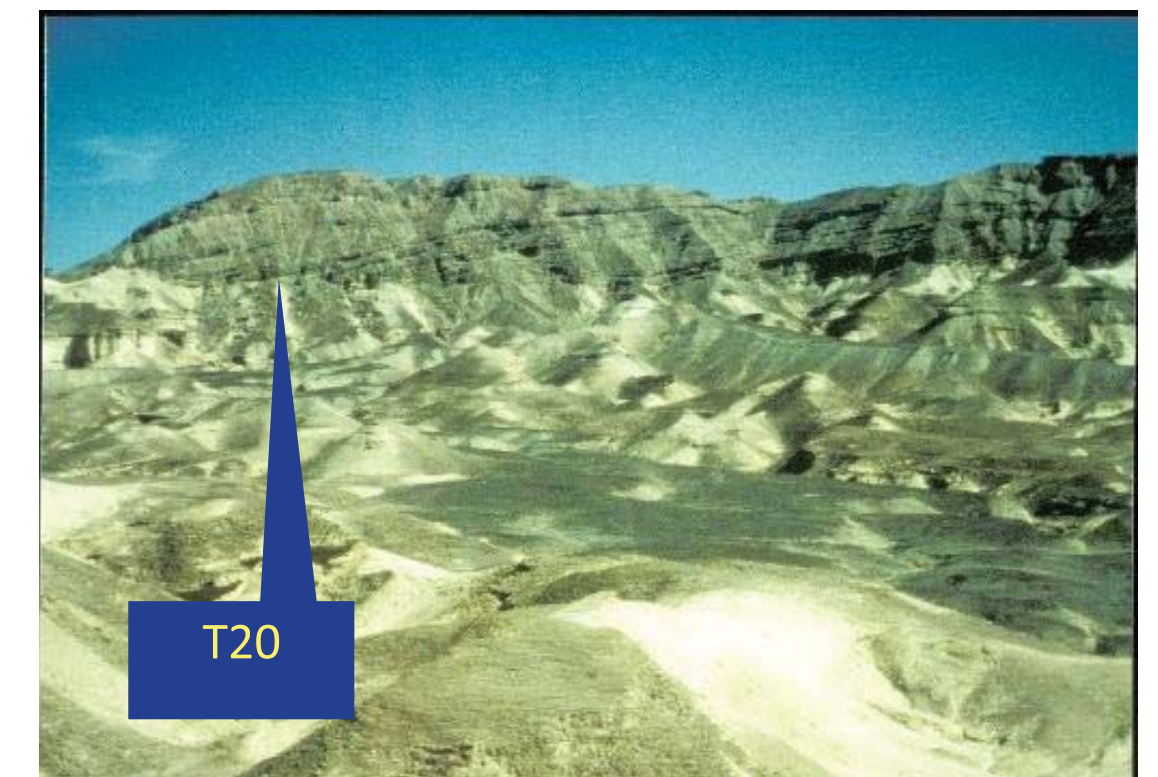
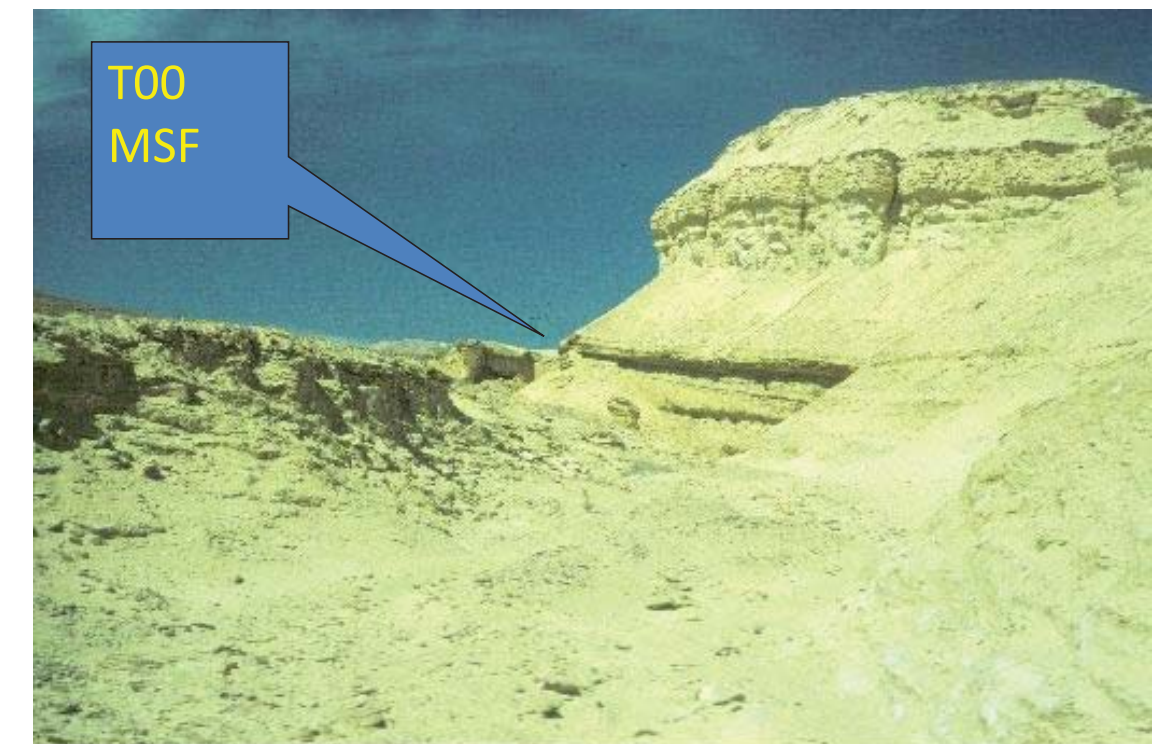
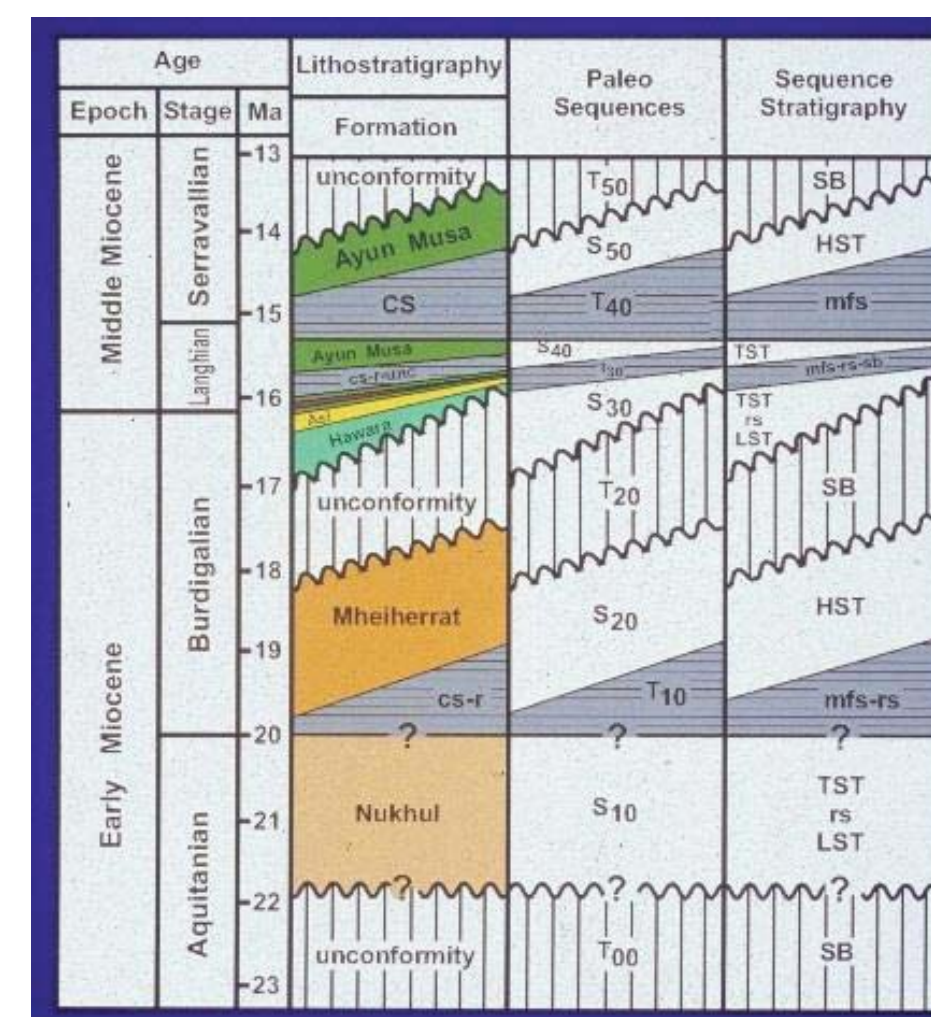
Gulf of Suez as a Field Laboratory for Rift Basins

Rift Basin Structure



Patton and others, 1994

Rift Basin Sequence Stratigraphy and Stratal Architecture



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