De-risking Libyan Giant Oilfields for Subsurface Net Zero Transition

By: Mohamed El Gheriani [1,2]

Supervisors: Dr Neil Burnside[1] and Dr Jennifer Roberts [1]

1- Civil & Environmental Engineering Department - University of Strathclyde - Glasgow – UK , G1 1XJ

2- Geology Department - Faculty of Science - University of Tripoli - Tripoli - Libya , P.O.BOX: 13555

1- Introduction

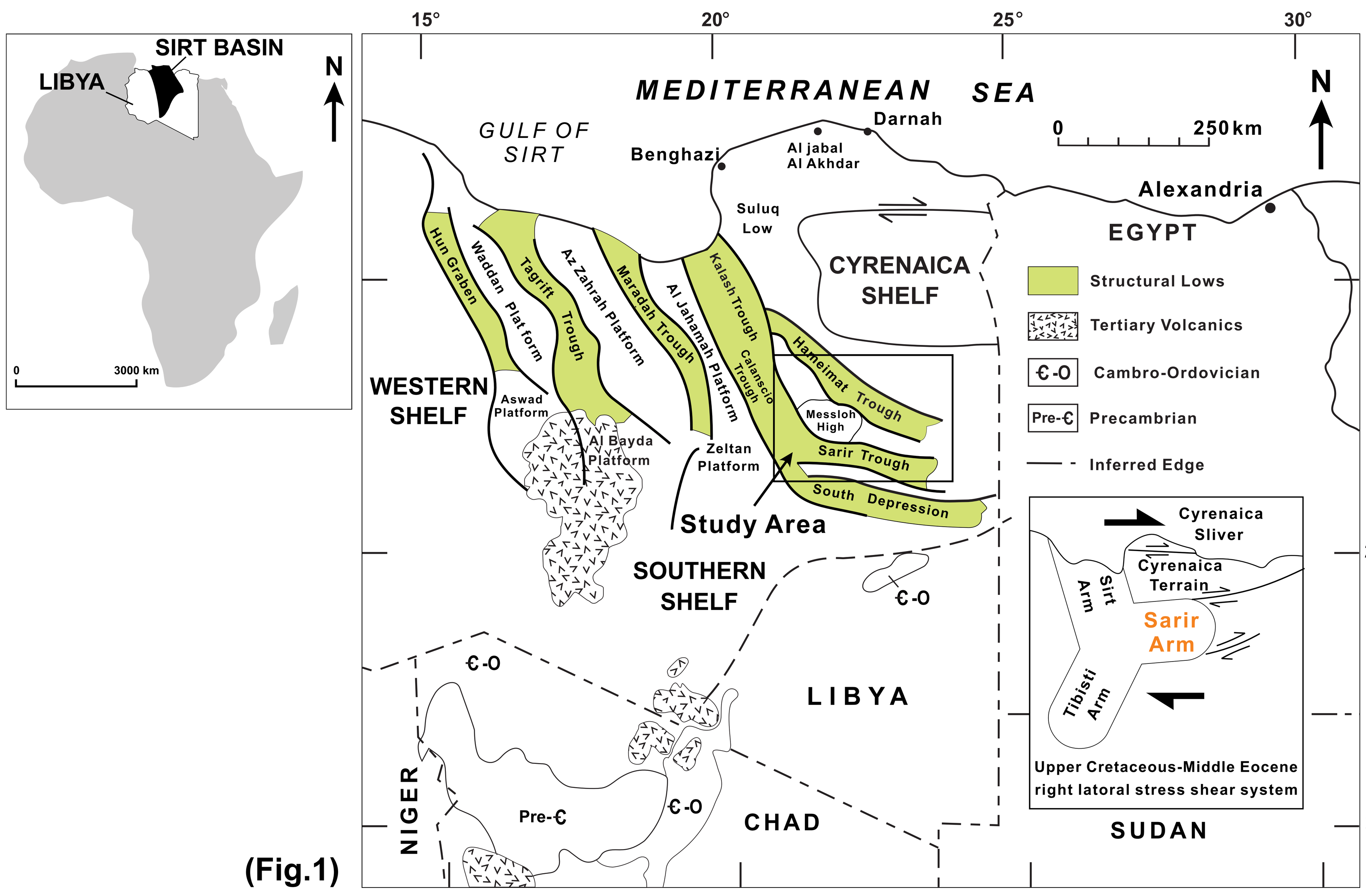
Fossil fuel production and consumption are central to global CO_2 emissions and the geological storage of CO_2 is among the promising solutions to achieve the global Net Zero targets.

As the largest crude oil holder in Africa, Libya is one of the main hydrocarbon suppliers in North Africa region. However, the fossil fuel dependency for economic and energy needs put the country in real challenge in keeping up the global trends toward low-carbon transition [1].

This research aims to explore options for Libya to transition its subsurface resources for net zero applications, with particular focus on CO_2 storage potential. The objectives are to (a) examine geological suitability of the giant oilfields for CO_2 storage and estimate CO_2 storage capacity. (b) conduct fault stability analysis to ensure CO_2 storage security.

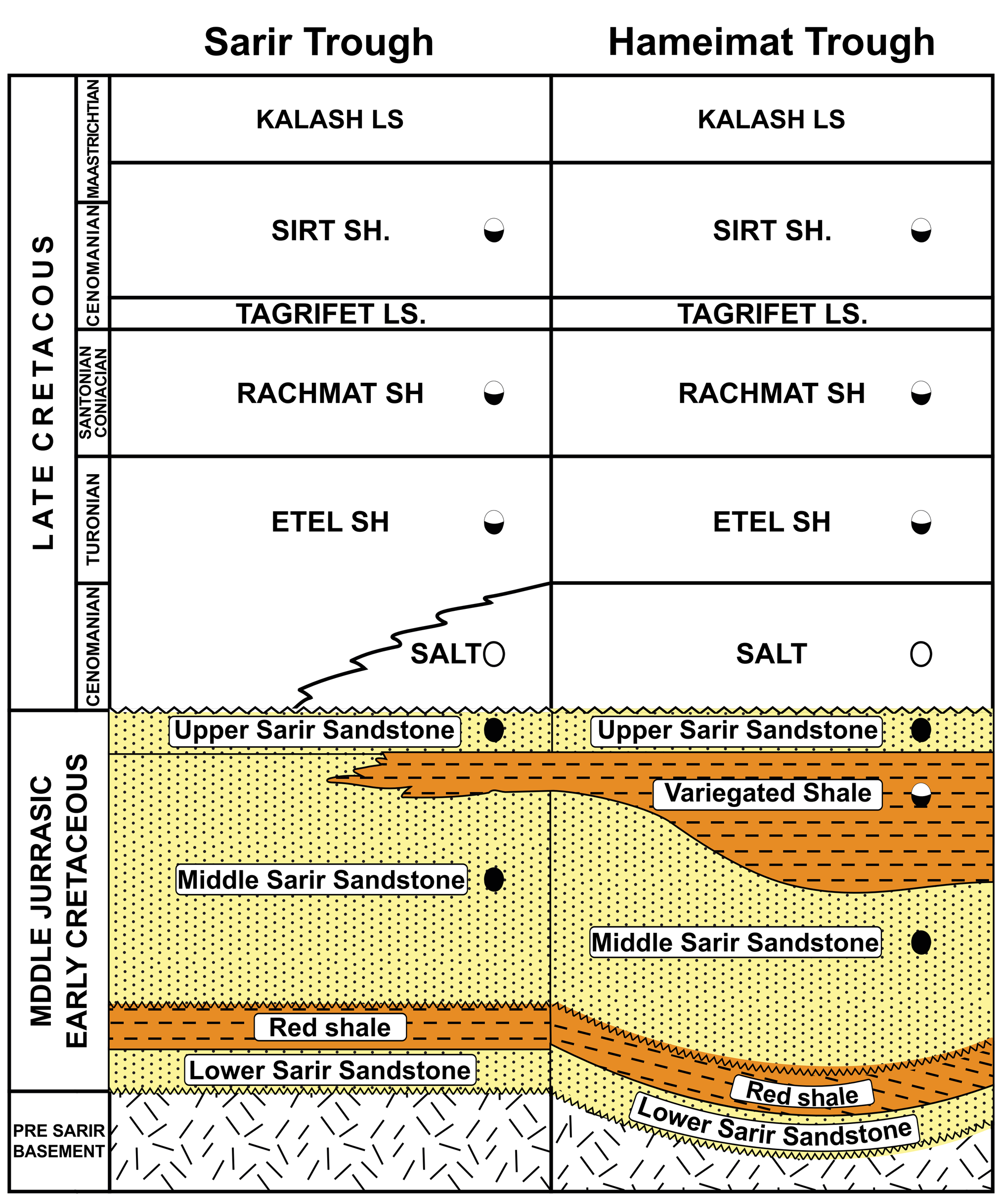
2- Study Area

The study area lies in eastern of the most prolific petroleum province of Libya's Sirt Basin. This basin was formed by crustal rifting during Cretaceous and Tertiary times and resulted in triple junction failed arms: the northern Sirt Arm, the eastern **Sarir Arm** that chosenas a case study and the southwestern Tibesti Arm (see Fig. 1) [2].



(Fig.1)

The pre-Upper Cretaceous Sarir/Nubian Sandstone is the primary hydrocarbon reservoir [2], as shown in the stratigraphic column in (Fig. 2). The suitability of this reservoir and overlying units will be considered for CO_2 storage. Key geological information about the Sarir Arm is summarised in Table 1.



(Fig.2) ● Main Oil Reservoir ◒ Source and Seal ○ Seal

Table 1: Key Facts [2][3]

Geology	• Syn-rift fluvial sandstone. • Mainly deposited in Early Cretaceous • Multiple seals are existed. • Structural traps are common.
Thickness	Typical section is about **1400 m** in Hameimat depocenter.
Depth	Between **2.5** to **4 km** subsea.
Activity	Most of oil production commenced in the **1960s** and **1970s**.
Recourses	Several giant oilfields with greater than 500 million barrels of originally recoverable reserves exist in this area.
Possible Risk	Freshwaters of Post-Nubian Aquifer System is adjacent to the oil and gas fields, makes CO_2 injection and storage challenging.

3- Research Workflow

Step 1: Assessment of the Geological Suitability of the Sirt Basin Giant Oilfields for CO_2 Storage

When considering CO_2 storage in oil reservoirs, several basin criteria need to be considered to ensure the effective use of oil fields for subsurface Net Zero transition [3][4]. Based on that, Table 2 summarises the assessment criteria for basin-wide storage capacity in the study area.

Table 2: Screening CO2 Storage in the Sarir Arm, Sirt Basin

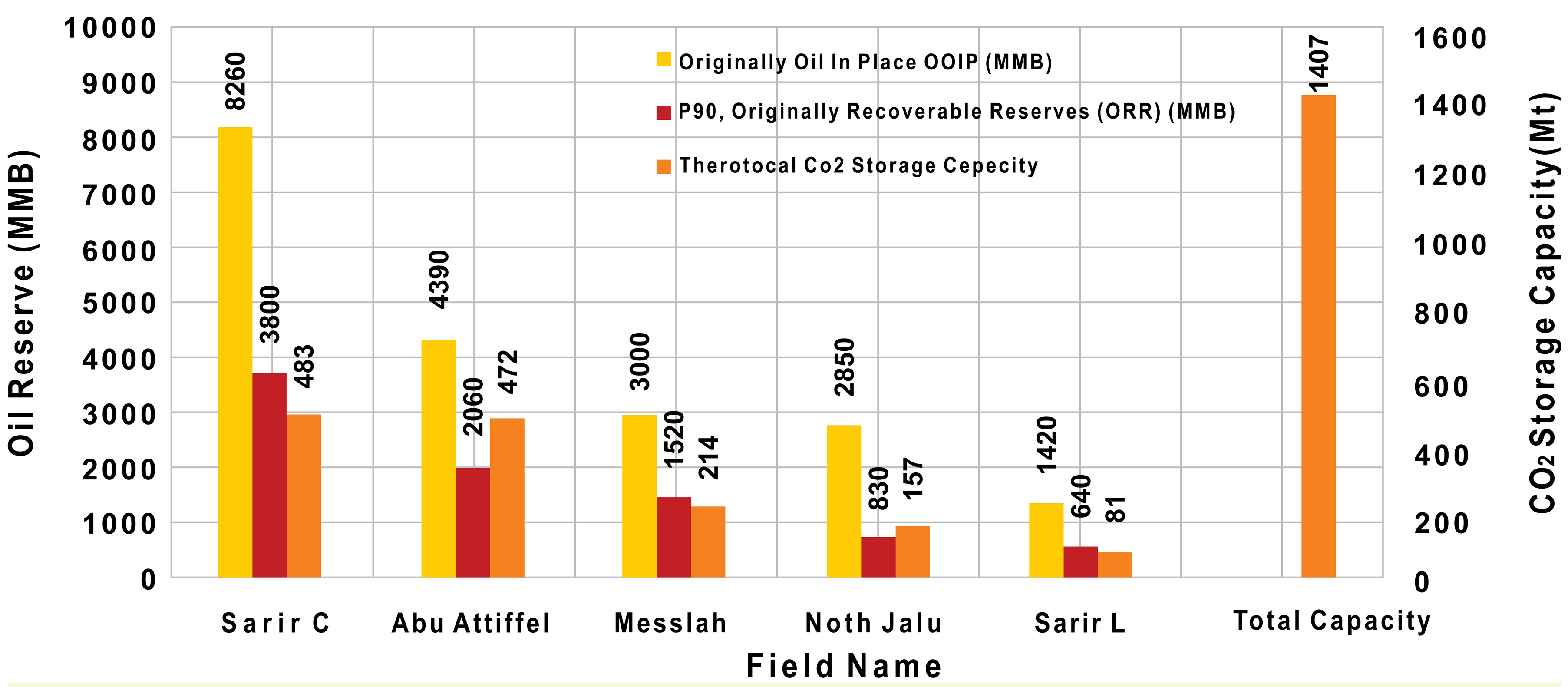
	Criteria	Best Case Scenario based on [3] and [4]	Sarir Arm, E. Sirt Basin [5] (Risky / Accepted / Ideal)
Containment	Tectonic setting	Cratonic Basin	Intra-Cratonic Rift
	Faulting intensity	Limiting Faulting & frac.	**Extensively Faulted & Frac.**
	Evaporites	Beds	Beds
	Depth of basin	Deep (> 3500m)	(2500 – 4000 m)
Capacity	Size of basin	Giant (> 50,000 km2)	Large (25,000-50,000 km2)
	Aquifer	Regional Flow System	Regional Flow System
	Geothermal regime	Cold basin (<30 °C/Km)	Moderate (30-40 °C/Km)
	Hydrocarbon Potential	Giant	Giant
Feasibility	Industry Maturity	Over-mature	Mature
	On/offshore	Onshore	Onshore
	Climate	Temperate	Desert
	Accessibility	Easy	Acceptable
	Infrastructure	Extensive	Extensive
	CO_2 Sources	Major	Moderate

Step 2: CO_2 Storage Estimation **(Preliminary Finding)** [5][6]

$$M_{CO_2} = \rho_{CO_2res} \times RF_{BT} \times OOIP/S_h$$

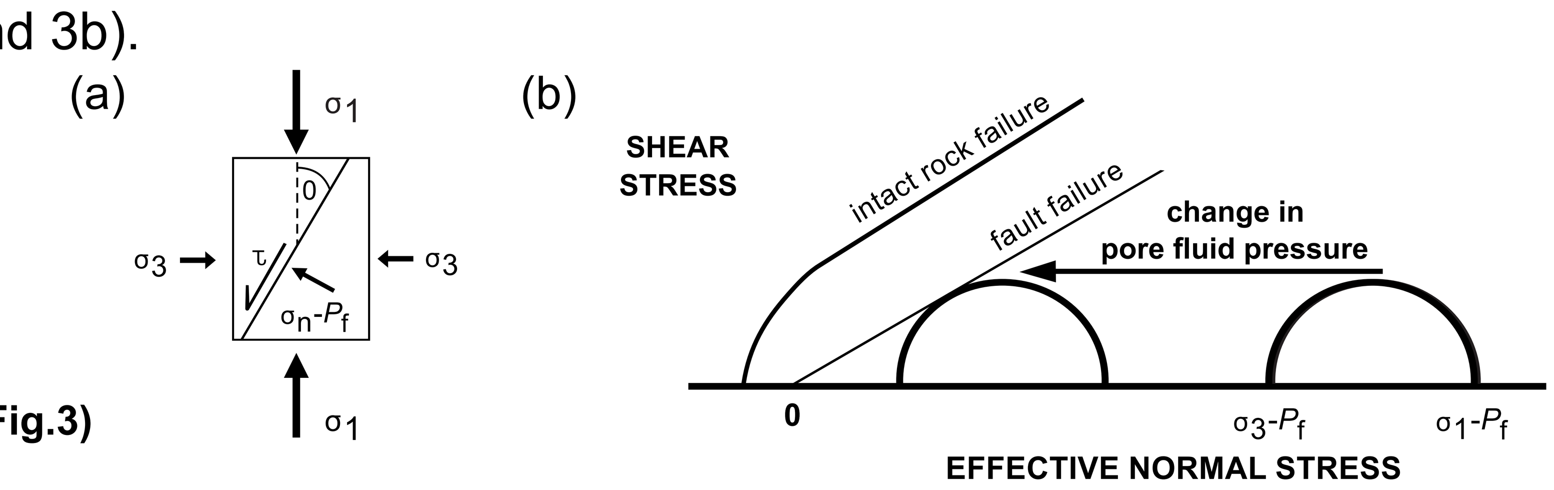
M_{CO_2}: CO_2 storage capacity in Megatonne (Mt).
ρ_{CO_2res}: CO_2 density at reservoir temperature and pressure (assumed 700 Kg/m3).
RF_{BT}: the recovery factor at breakthrough.
OOIP: the volume of the original oil in place in Cubic Meter (m3).
S_h: the oil shrinkage factor.

Gaint Oilfields with>500 Million Barrels (MMB) of Originally Recoverable Reserve(ORR)



Step 3: Fault Stability Analysis **(Ongoing Research)** [7][8]

Geomechanical modelling of pore pressure de-risks CO_2 injection-induced reactivation of pre-existing faults and interaction with vital freshwater aquifers (Fig. 3a and 3b).



(Fig.3)

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