Reservoir Capacity and Injectivity Characterization for Carbon Dioxide (CO_2) Geo-Sequestration in the Niger Delta

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Abstract **- One major environmental challenge faced by the human race today is the issue of global warming, leading to drastic climate change. Rigorous research has linked the emergence of this threat to human activities that have led directly to dangerous levels of accumulation of greenhouse gases (including CO_2) in our atmosphere. Of the various options explored to manage the excess CO_2 in the atmosphere, capturing and storing the anthropogenic CO_2 in underground geologic storage units (like deep saline aquifers, unminable coal seams and depleted oil and gas reservoirs) have presented itself as a more promising option. Within this study, analysis of data (well log and seismic) was done to estimate reservoir capacity and injectivity of reservoirs within the study area with the potential to hold sequestered CO_2. Well log correlation led to identification of two predominantly sandstone reservoirs (RESERVOIR I and RESERVOIR II) with a potential to serve as storage site, with average thicknesses of 20.67m and 61.81m, respectively. After estimating reservoir variables (like porosity, water saturation, permeability, potential mass of CO_2 to be sequestered, lateral continuity, thickness and depth) alongside variables of the sealing unit (lateral continuity, thickness and depth), preliminary results showed that reservoir-seal units identified in the study area have sufficient capacity and injectivity for purposes of CO_2 geo-sequestration.**

Key words: **Supercritical CO_2, Sequestration, Capacity, Injectivity, Porosity, Permeability, Water Saturation**

I. INTRODUCTION

One of the most challenging and pressing issue posing a threat to the existence of the human race as we know it today is the issue of climate change, with carbon dioxide (CO_2) and other greenhouse gas emissions identified as major contributing factors. The presence of these gases in the atmosphere have been majorly attributed to the human activity of burning fossil fuels to generate energy [1]. In other words, figuring out how to reduce anthropogenic CO_2 from our atmosphere becomes quite vital in dealing with this threat. Since humans are unlikely to use less energy in the future, this concern has led to fundamental research globally, relative to identifying economically and environmentally friendly means of reducing CO_2 that is present in our atmosphere [2]. One possible solution, proffered by Geoengineers in the past [3], was to introduce large mirrors in space or to saturate the earth's atmosphere with sulphur dioxide; both of which are capable of reflecting solar radiation. This of course was considered redundant as it could potentially plunge the Earth into a dangerous and unknown state that couldn't be predicted [4].

Further research led to identifying one very promising scheme for managing the excess CO_2 in the atmosphere, involving the capture and storage of anthropogenic CO_2 in underground geologic storage units like deep saline aquifers, unminable coal seams and depleted oil and gas reservoirs [5, 6]. A process generally referred to as carbon sequestration.

Basically, the term carbon sequestration is a description of both intentional and natural undertaking aimed at removing CO_2 from the atmosphere or channeling it from its emission sources and storing it in terrestrial environments, oceans and geologic formations [7]. This requires adequate characterization of the site intended to be used for the long-term storage of sequestered CO_2.

It has been sufficiently established that human activities have led to an accumulation, at dangerous levels, of greenhouse gases (including CO_2) in our atmosphere [8]. This is a global issue as every industrialized region in the world have contributed in one way or the other to this accumulation, albeit at different levels. As of 2017, it was estimated that the global emission of CO_2 has risen over 38 billion tonnes, increasing exponentially from an initial value of 5 billion tonnes in 1950 [9].

Relative to other continents though, Africa has contributed a relatively low percentage to the accumulation of these greenhouse gases. Nigeria in particular, as of 2017, had contributed about 0.3% to this global estimate [10]. However, it has been suggested in some quarters that Africa may be worst hit by the inevitable consequences of adverse climate change [8, 11]. Recent advancements in carbon capture and storage in Africa have been relatively slow, though this venture is seen as one major step towards mitigating the effect of climate change.

This study is therefore geared towards providing a window into the carbon capture and storage venture in Nigeria. It will achieve this by seeking to provide a means of geoscientifically estimating the reservoir containment and injectivity of a typical oil and gas reservoir in the Niger Delta area.

II. LITERATURE SURVEY

Irrespective of its promising nature, the sequestration of CO_2 remained a matter of ongoing research, as it is yet to be completely understood [12]. In others words, the matter of carbon capture and storage have divided opinions amongst researchers.

As an instance, Zoback and Gorelick [13] had claimed that carbon capture and storage have the potential of being a risky venture due to increasing reservoir pressure arising from injecting CO_2 into the subsurface, which they argue could be a trigger for earthquakes and leakages. On the contrary though, White and Foxall [14] had claimed that, while seismicity is a major concern during carbon sequestration, evidence as presented by successful carbon capture and storage (CCS) projects suggest that this risk can be greatly minimized by carefully selecting the storage site and paying attention to details while designing the CCS project. Additionally, the behavior of the CO_2 after sequestration have also created a divide amongst researchers.

There are those who have claimed that properties such as diffusivity and reservoir thickness are primarily responsible for the convective dissolution of CO_2 after sequestration [15, 16], while others have suggested that, under certain conditions, these variables are redundant [17, 18]

In all of these, every study that has been pro-CO_2 sequestration have one thing in common; they all agree that geologic storage units with potential to hold sequestered CO_2 must possess adequate injectivity, capacity and confinement capable of at least keeping the sequestered CO_2 from migrating to the surface.

In other words, over the lifetime of the carbon capture and storage exercise, a storage site must have sufficient capacity to store the intended volume of carbon dioxide. Several parameters such as, formation thickness, area of the storage capacity, rock porosity and CO_2 density (which could vary even in a single given reservoir), and storage efficiency are used to generate a capacity estimate, of which pore volume (a bulk term based on effective formation thickness and porosity) is the most important [19]. Estimates of pore volume can be derived from data generated through core analysis, wireline logs, or geophysical surveys (Bachrach and Dutta 2004). Another parameter in capacity estimates is the utilization factor, or the effective pore volume. It is the fraction of the pore volume that would actually retain or store injected carbon dioxide. Utilization factor is a function of the fluid already present in the reservoir, and reservoir heterogeneity at all scales, ranging from pore-throat diameters to kilometre scale connectivity, unit architecture, and residual phase (or capillary) trapping [20]. According to Bachu et al. [21], it is however simplest to estimate the storage capacity of depleted oil and gas reservoirs relative to other potential storage media (coal beds and deep saline aquifers) considered for CO_2 geo-sequestration purposes. This is mainly because all it theoretically requires is to estimate the mass of CO_2 that can be potentially stored in any study area. Additionally, since, relative to other potential storage media, oil and gas reservoirs are rather discrete, the capacity of any storage site at any scale is taken to be the sum of the capacities of all the individual reservoir within any study area. Injection wells as a means for waste disposal started in oil fields during the 1930s, when depleted reservoirs were used for the disposal of brines and other waste fluids from oil and gas production [22].

Additionally, injectivity describes the rate of injection that can take place in a given well and reservoir. This is the ability of the reservoir to accept/take carbon dioxide at the rate that is supplied from the emitter(s) [23]. Injectivity is calculated based on a variety of data, including effective thickness over the injection interval, reservoir permeability, bulk connectivity, and reservoir pressure [24]. Crucially, the injectivity depends on the interval of reservoir exposed to the wellbore; thus, injectivity may be increased through drilling long-reach horizontal wells or increasing well count [23]. It is important to note that the greater the injectivity the fewer wells will be needed, reducing the cost of sequestration [25]. been identified to be associated to the Niger Delta basin and it is known as the (Akata-Agbada) petroleum system [15, 16].

III. METHODOLOGY

A. Dataset

The principal data used for this study is suite of well logs from five oil wells, checkshot data, well information (well coordinates, well deviation) and seismic section within the study area. The suite of well logs includes Gamma Ray, Resistivity, Spontaneous Potential and Neutron log. These, whose locations are shown in Fig. 1, have been given generic names (Well 1, Well 2, Well 3, Well 4 and Well 5). The data from these well logs will be analyzed using specialized reservoir modeling software (Petrel and Interactive Petrophysics). While the field variables will be extracted from the seismic section, as seen in Fig. 1.

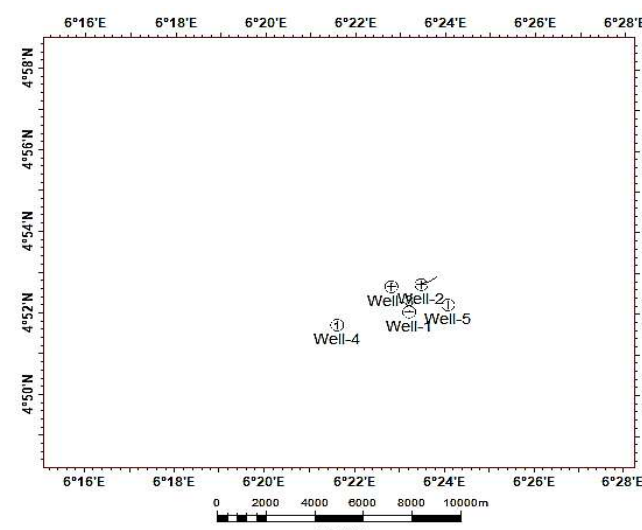

Fig. 1: Location of Well Logs

B. Reservoir Characterization

This research will involve characterizing (geoscience characterization) delineated reservoirs to determine their carbon sequestration potential, relative to their capacity and injectivity. This will involve evaluating storage capacity (to accept the intended volume of carbon dioxide) and injectivity (to take in carbon dioxide at the rate that it is supplied from the CO_2 emitters), as delineated from the available well logs. Preceding these processes;

- Data from well log (Gamma Ray logs, Spontaneous Potential logs, Resistivity log and Neutron log) will be used for lithology discrimination and delineation of the reservoirs.
- Together with other empirical relationships, data from the analysed well logs will also aid in quantitatively defining certain reservoir parameters.

Axis	Min	Max	Delta
X	422700.50	443925.50	21225.00
Y	93828.50	104853.50	11025.00
Time	-6002.00	2.00	6004.00
Lat	4°50'42.364...	4°56'43.353...	0°06'0.9896"
Long	6°15'54.993...	6°27'24.709...	0°11'29.715...
Trace	-6000.00	0.00	6000.00
Seismic (tem...	~-30469.04	~30231.00	~60700.04
Amplitude (d...	~-30469.04	~30231.00	~60700.04

Description	Value
Original CRS:	PowerPlan:NIG...
Origin X:	422713.00
Origin Y:	93841.00
End first inline X:	422713.00
End first inline Y:	104841.00
End first crossline X:	443913.00
End first crossline Y:	93841.00
Number of inlines:	849
Number of crosslines:	441
Inline length:	11000.00
Inline interval:	25.00
Crossline length:	21200.00
Crossline interval:	25.00
Inline rotation from north:	0.00
Inline range:	8091 to 8939 st...
Crossline range:	93841 to 10484...

Fig. 2: Field variables as extracted for Seismic section within the study area

1) Determination of Reservoir Capacity: Theoretically, carbon sequestration capacity is a measure of the mass of carbon dioxide that can be stored in a hydrocarbon reservoir [26]. For this work, the storage capacity of the reservoirs of interest will be estimated according to NETL [27] and Bachu et al. [21], who suggests that;

$$M_{CO_2} = A \times h_n \times \phi_e \times (1 - S_w) \times B_o \times \rho_{CO_2} \times E \qquad 1$$

Where;

$M_{CO_2} =$ Mass estimate of the underground reservoir CO_2 storage capacity (Megatonne, Mt)

$A =$ Area of reservoir accessed for CO_2 storage capacity estimation (Km^2) as defined from Fig. 2

$h_n =$ Average thickness of the reservoir column (Km)

$\phi_e =$ Average porosity over net thickness h_n (Ratio of effective reservoir porosity to h_n)

$S_w =$ Average water saturation within the reservoir

$B_o =$ Volume factor of the reservoir; converting standard oil/gas volume to subsurface volume at reservoir pressure and temperature.

$\rho_{CO_2} =$ Density of CO_2 evaluated at pressure and temperature that represents storage conditions in the reservoir (kgm^{-3})

$E =$ Storage efficiency factor; reflecting a fraction of the total pore volume from the reservoir that can be filled by CO_2

In their work, Davies et al. [28] was able to show conclusively that porosities estimated from density logs provided better estimates for in-situ porosities for reservoirs in the Niger Delta region. Therefore, porosity estimates for this work will be made from density logs as described by Krygowski [29];

$$\Phi_D = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_{fl}} \qquad 2$$

Where,

$\phi_D =$ Density log-derived porosity

$\rho_{ma} =$ Matrix density ($2.69gcm^{-3}$, Density of sandstone)

$\rho_b =$ Formation bulk density from density log (in gcm^{-3})

$\rho_{fl} =$ Fluid density ($0.75gcm^{-3}$, Density of oil contained in the drilling mud)

Also, the estimate for water saturation for this work will be made using Archie's relationship (which relates which relates water saturation to the porosity, Φ, formation water resistivity, R_w, formation resistivity, R_t, saturation exponent, *n*, cementation exponent, m, and tortuosity factor, *a*) mathematically described as;

$$S_w = \left[\frac{a \times R_w}{R_t \times \Phi^{\mathrm{m}}}\right]^{\frac{1}{n}} \qquad 3$$

For the value of m, Davies et al. [30] showed that a typical sand stone reservoir in the Niger Delta has a value of m equal to 1.65. The tortuosity factor (a), will be given a value of 1 according to Aigbedion and Ilukhor [31], assuming that the reservoirs in the Niger Delta are average sand units. The formation resistivity will be taken from resistivity logs while the formation water resistivity will be taken as 9.80 Ohm-m, according to John et al. [32]. Generally, according to Asquith et al. [33], a value of two is used for the saturation exponent, n.

A value of 1.6 will be used for the volume factor, B_o, adapted from Ameloko and Owoseni [34]. Though most literatures [27, 35, 36] have suggested that the storage efficiency factor for CO_2 sequestration be taken between 1-4%, Ehlig-Economides and Economides [37] argued that sequestered CO_2 can occupy no more than 1% of the pore volume. Hence, 1% will be adopted for the value of the storage factor in this work.

Ouyang [38] developed a simple and explicit method to estimate the density of supercritical CO2 at conditions suitable for carbon sequestration. According to him;

$$\rho_{CO_2} = A_0 + A_1P + A_2P^2 + A_3P^3 + A_4P^4 \qquad 4$$

$$A_i = b_{i0} + b_{i1}T + b_{i2}T^2 + b_{i3}T^3 + b_{i4}T^4 \qquad 5$$

For values of $i = 0,1,2,3,4$. Where;

$\rho_{CO_2} =$ Density of Carbon Dioxide (in kgm^{-3})

$A_0 - A_4 =$ Correlation coefficients (as defined by equation **5**)

$P =$ Pressure ($1070.38\ Psi$)

$T =$ Temperature (31.1^oC)

$b_0 - b_4 =$ Correlation coefficients (as defined by Table 1)

Table 1: Value of $\boldsymbol{b_{ij}}$ Coefficients in equation $\mathbf{3.5}$ for Pressure < $\mathbf{3000\ Psi}$ [38]

	$\boldsymbol{b_{i0}}$	$\boldsymbol{b_{i1}}$	$\boldsymbol{b_{i2}}$	$\boldsymbol{b_{i3}}$	$\boldsymbol{b_{i4}}$
$\boldsymbol{i = 0}$	-2.15×10^5	1.17×10^4	-2.30×10^2	1.97	-6.18×10^{-3}
$\boldsymbol{i = 1}$	4.76×10^2	-2.62×10^1	5.22×10^{-1}	-4.49×10^{-3}	1.42×10^{-5}
$\boldsymbol{i = 2}$	-3.71×10^{-1}	2.07×10^{-2}	-4.17×10^{-4}	3.62×10^{-6}	-1.16×10^{-8}
$\boldsymbol{i = 3}$	1.23×10^{-4}	-6.93×10^{-6}	1.41×10^{-7}	-1.23×10^{-9}	3.95×10^{-12}
$\boldsymbol{i = 4}$	-1.47×10^{-8}	8.34×10^{-10}	-1.70×10^{-11}	1.50×10^{-13}	-4.84×10^{-16}

2) Determination of Reservoir Injectivity: The Injectivity of a potential carbon sequestration sight is described by adequate permeability, i.e. the ability to pump fluid or gas into a rock, as sufficient permeability will allow CO_2 to move out more quickly into the reservoir, which is favorable to sequestration. Relative to porosity and irreducible water saturation, the vertical permeability, K_V, for this study will be defined according to the empirical relation described by Owolabi et al. [39];

$$k_V(mD) = 307 + (2655 \times \phi^2) - (34540 \times \phi \times S_{wirr}^2) \qquad 6$$

Where ϕ and S_{wirr} are porosity and irreducible water saturation of the reservoir zone of interest respectively. The porosity will be defined as described in equation *2* above. Since irreducible water saturation is understood to be the fraction of the pore volume occupied by water in a reservoir at maximum hydrocarbon saturation [40], the minimum water saturation at the reservoir zone of interest will be adopted as the irreducible water saturation for this study.

IV. RESULTS AND DISCUSSION

A. Correlated Well Logs

Relying on gamma ray and resistivity responses, 5 well logs were used to identify reservoir and seal pairs of interest. Using Petrel reservoir modelling software, two reservoir-seal pairs were identified relative to their lateral continuity as identified on the logs. The identified reservoir and seal pairs are shown in Fig. 3, with their estimated thicknesses shown in Table 2.

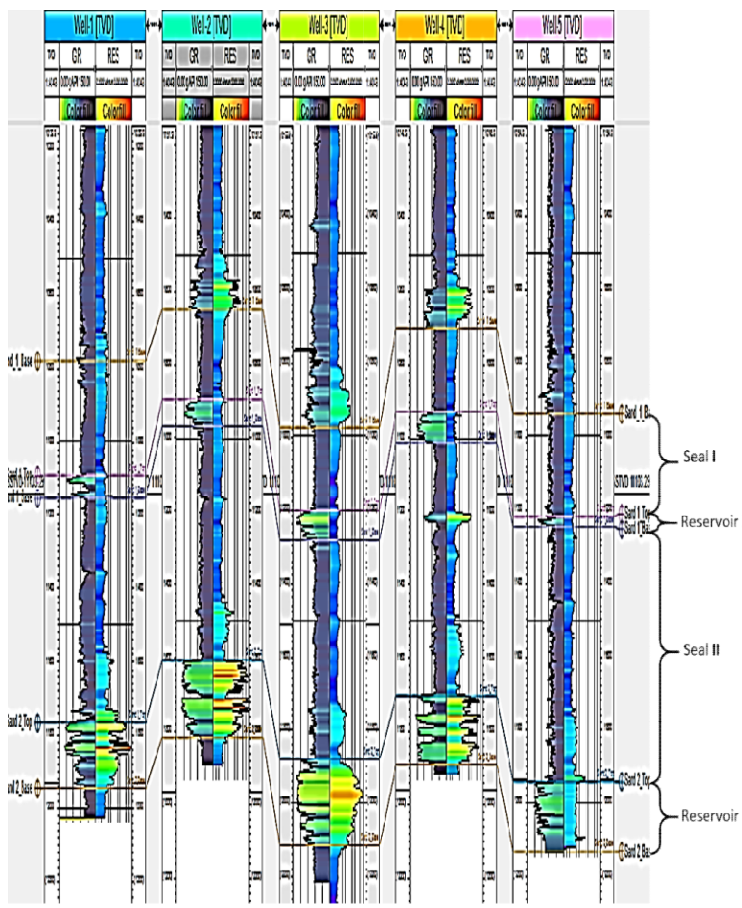

Fig. 3: Correlated Well logs Showing 2 reservoir/seal pairs

Table 2 Reservoir-Seal Pair thicknesses in the 5 analysed wells

Well	Rock Type	Top (ft)	Base (ft)	Thickness (ft)
Well 1	Seal I	10779.00	11103.00	324.00
	Reservoir I	11103.00	11166.00	63.00
	Seal II	11166.00	11778.00	612.00
	Reservoir II	11778.00	11958.00	180.00
Well 2	Seal I	10848.00	11221.00	373.00
	Reservoir I	11221.00	11301.00	80.00
	Seal II	11301.00	11997.00	696.00
	Reservoir II	11997.00	12225.00	228.00
Well 3	Seal I	10974.00	11253.00	279.00
	Reservoir I	11253.00	11336.00	83.00
	Seal II	11336.00	11934.00	598.00
	Reservoir II	11934.00	12172.00	238.00
Well 4	Seal I	10702.00	10944.00	242.00
	Reservoir I	10944.00	11030.00	86.00
	Seal II	11030.00	11720.00	690.00
	Reservoir II	11720.00	11908.00	188.00
Well 5	Seal I	10937.00	11218.00	281.00
	Reservoir I	11218.00	11245.00	27.00
	Seal II	11245.00	11940.00	695.00
	Reservoir II	11940.00	12120.00	180.00

B. Capacity and Injectivity Estimates for the Reservoirs of Interest

The geo-sequestration potential of the reservoir of interest, relative to reservoir capacity and injectivity, have been quantitatively described. To do this, useful petrophysical measures were estimated from data obtained from well logs (using Interactive Petrophysics and Microsoft excel software)

1) Reservoir Capacity: In this study, the mass of CO_2 that can be potentially stored in the reservoirs of interest was estimated. To do this, using the software Interactive petrophysics and Microsoft excel, some petrophysical parameters were extracted from the well logs of interest, analysed and quantitatively defined to describe certain parameters that will aid in estimating the carbon geo-sequestration capacity of the reservoir of interest.

Relevant literatures [21, 26] have suggested that, among other constant variables, the variables that would need to be estimated to give a proper quantitative description of the potential mass of CO_2 that can be stored in any storage site includes the density of the CO_2 to be sequestered and the average porosity and water saturation of the reservoir that is considered as a potential storage site. In this study, since CO_2 is usually sequestered in a super critical state, the density of sequestered CO_2 was estimated at minimum supercritical temperature ($31.1^{□}□$) and pressure ($1070.38□□□$). These values gave rise to an estimated minimum density for supercritical CO_2 of $154.31□□□^{-3}$. This, according to relevant literatures [41, 42, 43], falls within the range of densities ($79.08 - 996.16□□□^{-3}$) for supercritical CO_2 at supercritical temperatures and pressures.

Additionally, digitizing at a feet interval, data from the 5 available well logs were analysed to estimate the average porosity and water saturation for the 2 identified reservoir (named RESERVOIRS I and II) units of interest being considered for potential storage sites. The range of estimated values is shown in Table 3 and Table 4. As seen in Table 6, values estimated were *0.21* and *0.25* for average fractional porosity and *0.23* and *0.07* for average fractional water saturation for RESERVOIRS I and II respectively. These values were typical for a hydrocarbon reservoir located in the Niger Delta [28, 44, 45] and they were typical for a reservoir suitable for carbon sequestration according to the International Energy Agency [46].

These variables, and other relevant variables aided in estimating the mass of CO_2 that can be sequestered in the identified reservoirs within the storage area study area. The mass estimated had values of $□.97□□$ and $8.37□□$ for RESERVOIRS I and II, as seen in Table 6. This suggest that the study area has the potential of storing a total of $10.34□□$ of sequestered CO_2, since Bachu et al. [21] suggest that, for a depleted oil and gas reservoir, the capacity of any study area at any scale is the sum of the capacities of the individual reservoir that makes up the study area. This also implies that the reservoir within the study area has sufficient reservoir capacity for purposes of CO_2 sequestration according to the International Energy Agency Greenhouse Gas Programme [46].

2) Reservoir Injectivity: In this study the next issue that was tackled was that of the ease with which CO_2 can be injected into the reservoirs of interest. In site characterization and selection during CO_2 sequestration, determining the injectivity of the reservoir within the study area is a is a key variable since it would determine the ease with which the sequestered CO_2 is pumped into the storage site, hence determining part of the cost of the whole operation as it would mean that fewer wells will be needed [25]. Though injectivity is often times described in terms of reservoir pressure [47], it is a well-established fact that pressure within the reservoir can be greatly influenced by how easily fluid is pumped into or taken out of the reservoir [48, 49, 50]. Hence, describing the porosity and permeability of a formation will sufficiently describe the injectivity of the formation relative to CO_2 sequestration [47]. Therefore, the focus in this section of this study was centered on estimating the vertical permeability of the reservoir within the study area. To do this, the reservoir was also digitized at a feet's interval for both reservoirs within the study wells. The range of estimated permeabilities is shown in Table 5, with average values of 273.49mD and 486.67mD for RESERVOIRS I and II, as shown in Table 6. According to the International Energy [46], these results suggest that the reservoirs within the study area have sufficient injectivity to aid the sequestration of CO_2

Table 2: Range of Fractional Water Saturation estimates for RESERVOIR I and RESERVOIR II

PETROPHYSICAL PARAMETER	Fractional water Saturation									
RESERVOIRS	RESERVOIR I					RESERVOIR II				
WELLS	Well 1	Well 2	Well 3	Well 4	Well 5	Well 1	Well 2	Well 3	Well 4	Well 5
MINIMUM	0.128	0.161	0.161	0.091	0.186	0.006	0.004	0.007	0.008	0.058
MAXIMUM	0.22	0.311	0.517	0.313	0.41	0.279	0.157	0.545	0.308	0.595

Table 3: Range of Fractional Porosity estimates for RESERVOIR I and RESERVOIR II

PETROPHYSICAL PARAMETER	Fractional porosity									
RESERVOIRS	RESERVOIR I					RESERVOIR II				
WELLS	Well 1	Well 2	Well 3	Well 4	Well 5	Well 1	Well 2	Well 3	Well 4	Well 5
MINIMUM	0.118	0.105	0.106	0.124	0.103	0.109	0.211	0.048	0.076	0.047
MAXIMUM	0.293	0.264	0.264	0.275	0.26	0.289	0.403	0.367	0.281	0.351

Table 4: Range of Permeability estimates for RESERVOIR I and RESERVOIR II

PETROPHYSICAL PARAMETER	Permeability (mD)									
RESERVOIRS	RESERVOIR I					RESERVOIR II				
WELLS	Well 1	Well 2	Well 3	Well 4	Well 5	Well 1	Well 2	Well 3	Well 4	Well 5
MINIMUM	277.52	231.47	231.05	312.42	171.93	338.57	425.45	313.15	322.09	307.55
MAXIMUM	370.23	255.55	254.88	428.78	212.08	528.1	738.14	663.99	516.73	593.15

Table 5: Summary of findings

RESERVOIRS	RESERVOIR PARAMETERS	SELECTION THRESHHOLD, ACCORDING TO THE INTERNATIONAL ENERGY AGENCY [46]	THIS STUDY
I	Reservoir Lithology	Sandstone, Dolomite, limestone & Siltstone for oil and gas reservoirs	Sandstone
	Reservoir Thickness	>10m	20.67m (Average)
	Porosity	>10%	21% (Average)
	Permeability	>200mD	273.37mD (Average)
II	Reservoir Lithology	Sandstone, Dolomite, limestone & Siltstone for oil and gas reservoirs	Sandstone
	Reservoir Thickness	>10m	61.81m (Average)
	Porosity	>10%	25% (Average)
	Permeability	>200mD	483.67mD (Average)
COMBINED	Reservoir-Seal Pairs	Intermediate and excellent; many pairs	Many Pairs
	Storage Capacity	≥4Mt for oil and gas reservoir	10.34Mt

V. CONCLUSION AND FUTURE WORK

A. Conclusion

Haven set out to determine the geosequestration potential of the geologic reservoirs in the Niger Delta, relative to reservoir capacity and injectivity, data (well log suits and 3D seismic data) for from the study area have been analysed in this study. The following conclusions were arrived at after the analysis done within this study;

i. Carrying out a detailed well log correlation, using 5 well logs from the study area, led to the identification of two reservoir-seal pairs within the study area with the potential to hold sequestered $CO_{2.}$
ii. Estimates of reservoir petrophysical parameters (porosity, water saturation) and density of supercritical CO_2, at supercritical temperature and pressure, aided in estimating the storage capacity of the reservoir of interest. Results obtained show that the reservoirs have enough capacity to serve as storage for sequestered $CO_{2.}$
iii. Estimates of other kinds of reservoir petrophysical parameters (permeability) also aided in estimating the injectivity of the reservoirs under investigation. Results obtained led to the conclusion that these reservoirs have sufficient injectivity to aid the sequestration of CO_2
iv. As a matter of fact, it can be surmised that the reservoir-seal units identified in the study have the potential for CO_2 geo-sequestration, relative to its capacity and injectivity.

B. Future Work

For purposes of future research, it is therefore recommended that;

i. To properly account for the effect of heterogeneity, more wells within the study area could be used for further analysis for a more robust result.
ii. Better still, the methodology applied in this study to ascertain the CO_2 geosequestration potential of the Niger Delta should be applied to other geologic reservoir within the Niger Delta region where core data is available, as core data would provide better estimates of petrophysical variables, relative to well log data.
iii. To carry out a complete geoscientific characterisation a potential CO_2 sequestration site, there is a need to estimate the containment potential of the storage sites. Therefore, future work will include a comprehensive description of the containment of the reservoir-seal pairs already identified in this work.

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