Energy Proceedings
Vol 34, 2023
ISSN 2004-2965

Site Selection Evaluation of CO_2 Storage in Saline Aquifers of Zhuyi Depression, the Pearl River Mouth Basin

Zhang Xuefeng*, Xuan Tao , Gao Bo

CNOOC EnerTech-Drilling & Production Co., Ltd., Tianjin 300452, China

(*Corresponding Author: zhangxf12@cnooc.com.cn)

ABSTRACT

CO_2 geological storage is the primary means of achieving large-scale, low-cost emission reductions. Compared with onshore basins, storage in offshore basins has the advantages of larger storage volume and less impact on people and the environment. At the same time, there are also challenges such as high cost and technical difficulty for storage. At present, there are many researches on the selection and suitability evaluation of CCS in China, and there are also very successful demonstration applications, while the research on CO_2 geological storage in sea areas is relatively few. Taking Zhuyi Depression of Pearl River mouth Basin in the South China Sea as an example in this paper, with the goal of meeting the storage capacity of one million tons per year. Making statistics on the factors affecting the suitability of CO_2 storage of oil and gas-bearing structures in the depression from three aspects: geological characteristics, storage economy and storage safety, and constructs a screening index system of CO_2 geological storage field, which includes 3 levels and 18 evaluation factors. The index weight of each evaluation factor is calculated by AHP. The suitability of CO_2 sealing of selected oil and gas-bearing structures is quantitatively evaluated by multi-source information overlap analysis. The results show that the Xijiang 23 and other oil-bearing structures in the west of Huizhou Sag have priority as the storage field. The results of this study can provide reference for the implementation and management decision of CO_2 saline aquifers storage in this area.

Keywords: CO_2 geological storage, saline aquifers, index weight, Zhuyi Depression

1. INTRODUCTION

CO_2 geological storage is widely recognized as the most effective emission reduction technology, and it is also the key component of CCUS (Carbon Capture, Utilization and Storage) technology system. At present, it is wildly believed that the deep saline aquifers, depleted oil & gas reservoirs and unexploitable coal seam are the main places suitable for CO_2 geological storage[1], while the deep saline aquifers are usually thicker and wider than oil & gas reservoirs or coal seams, so they have greater storage potential. It is estimated that the saline aquifers accounts for more than 98% of the total theoretical geological storage, which is an important technical method to carry out large-scale CO_2 geological storage [2].

The most important problem faced by CO_2 geological storage is storage site selection[3], or to evaluate the suitability of CO_2 geological storage in a certain area. The site selection and suitability evaluation of CO_2 geological storage have been studied earlier in foreign countries. Compared with foreign countries, the study of CO_2 geological storage in China started relatively late, but it has developed rapidly in the past decade, and has been implemented in Shenhua and Jilin oilfields. Many scholars have also done a lot of researches on storage mechanism, site selection, potential evaluation and so on[4-6].

Previous studies have shown that there is lack of favorable conditions for CO_2 geological storage in Guangdong Province, while the large sedimentary basins in the northern part of the South China Sea have great potential for CO_2 storage, so offshore storage is the only feasible way to achieve CO_2 storage in Guangdong Province[7]. Taking Zhuyi Depression in the Pearl River Mouth Basin as the research area, referring to 52 drilling wells data, combined with a large number of logging, geophysical and experimental analysis data, from the

This is a paper for International CCUS Conference 2023 (ICCUSC2023), April 14-15, 2023, Beijing, China.

perspective of safety and economy of CO_2 geological storage, this paper proposes a method based on multi factor statistical analysis, through parameter normalization, and using analytic hierarchy process to calculate the weight. 22 oil and gas bearing structures within 200 km of the coastline in the Zhuyi Depression were selected as alternative sites for implementing CO_2 geological storage, and their suitability for storage was quantitatively evaluated. By estimating the actual storage capacity, the feasibility of million-ton storage in the optimized storage site is analyzed. This method has reference value for site selection and suitability evaluation of CO_2 geological storage in sea areas, and it is also suitable for onshore site selection.

2. REGIONAL GEOLOGICAL CONDITIONS OF ZHUYI DEPRESSION

2.1 Subdivision - numbered sections

Zhuyi Depression is located in the eastern part of the northern depression of the Pearl River Mouth Basin, It is a Cenozoic depression developed on the basement of Mesozoic and Paleozoic igneous rock and sedimentary rock[8]. The depression covers an area of $3.6 \times 10^4 Km^2$, it has a N-E trending, that roughly parallel to the coastline. Five sags, Enping, Xijiang, Huizhou, Lufeng and Hanjiang, are developed from west to east in the depression, these sags are divided by several positive tectonic units, showing a overall tectonic pattern of "five depressions and four rises" [9](Fig. 1).

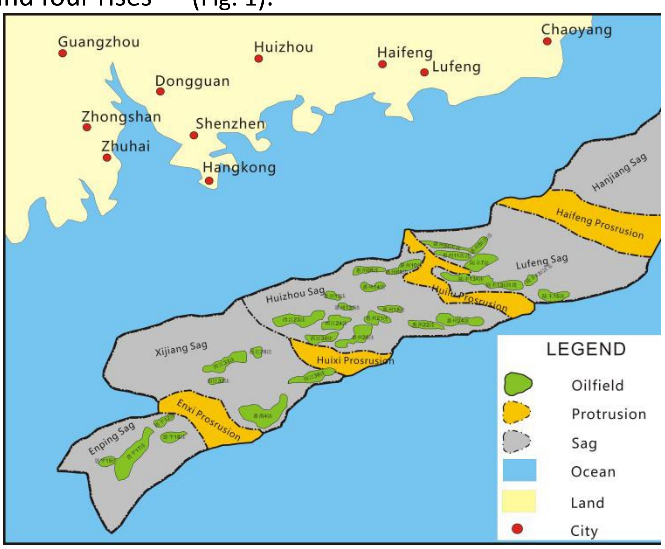

Fig. 1. Small diagram

From the bottom to the top, two sets of continental sedimentary strata Wenchang Formation and Enping Formation are developed in the rift period, three sets of marine continental transitional facies , coastal delta and shallow sea shelf facies sedimentary strata Zhuhai Formation, Zhujiang Formation and Hanjiang Formation, and two sets of continental shelf slope sedimentary strata in the Neogene Yuehai Formation and Wanshan Formation, covering the Quaternary System[11]. The Paleogene Shenhu Formation is basically missing in this area.

3. EVALUATION INDEX SYSTEM

The site selection of CO_2 geological storage is affected by many factors, such as physical geography, geology, climate, social economy and engineering technology. Therefore, a hierarchical index system can be established for site selection based on geological characteristics, safety and economy[2]. With full reference to the relevant guidance documents[2][12] and academic reports on the CO_2 geological storage site selection, and according to the specific characteristics of sea area storage, an offshore CO_2 storage site selection evaluation index system is constructed. It has 3 hierarchical structures and 18 evaluation factors, and statistics are made on all levels of 22 oil and gas-bearing structures in Zhuyi Depression (Table 1). So as to have a basic understanding of the geological conditions, safety and economy under the conditions of the exploration degree and data.

3.1 Geological Condition Indicator Layer

This indicator layer includes two sub layers: reservoir characteristics and geothermal conditions. The reservoir characteristics include five factors: thickness, porosity, permeability, connectivity, and burial depth, while the geothermal conditions include two factors: geothermal gradient and geothermal flow value. These factors relate to the scale and efficiency of aquifers storage.

3.2 Safety Indicator Layer

This indicator layer includes two sub layers: cap rock characteristics and crustal stability. The characteristics of the cap rock include four factors: the thickness of the main cap rock, the burial depth of the main cap rock, the connectivity of the cap rock, and the number of secondary cap rock layers (secondary interception capacity), which describe the breakthrough pressure of the cap rock; There are three factors in the stability of the Earth's crust: the development of active faults, seismic risk, and types of nearby geological hazards. These factors reflect the degree to which the storage site is affected by adverse geological factors [13].

Table.1. Characteristics of evaluation indicators for CO_2 saline aquifers storage in Zhuyi Depression

Structural Name	Aquifer thickness	Porosity	Permeability	Connectivity	Buried Depth	Geothermal Flow Value	Geothermal Gradient	Burial Depth Of Caprock	Thickness of Caprock	Connectivity of Caprock	Number of Caprock	Active Fracture Situation	Earthquake Hazard	Types of Geological Hazards	Carbon Source Distance	Carbon Source Scale	Injection Difficulty	Depth of Seawater
Lufeng13-1	179	20	1084	excellent	2670	69	37	1860	488	regional	5	a few	0.41	none	145	70	ordinary	190
Lufeng13-8	254	20	214	excellent	2866	68	36	1033	116	regional	3	a few	0.41	sand slope	140	70	ordinary	147
Lufeng13-9	125	20	355	good	2850	68	37	1950	645	regional	5	a few	0.41	none	144	70	ordinary	177
Lufeng7-9	188	20	555	good	2900	68	37	1900	14	regional	4	a few	0.41	none	136	70	ordinary	136
Lufeng13-7	155	17	600	good	2700	68	37	1700	835	regional	3	a few	0.41	sand slope	143	70	ordinary	170
Lufeng7-10	421	18	539	good	2600	68	35	2000	750	regional	4	a few	0.41	none	136	70	ordinary	130
Lufeng14-5	161	18	253	good	2900	69	37	1700	850	regional	4	a few	0.41	sand slope	143	70	ordinary	170
Lufeng14-4	172	21	2233	bad	2830	69	38	1566	838	regional	5	a few	0.42	none	145	70	ordinary	203
Lufeng14-3	278	20	380	bad	2500	69	38	1500	820	regional	5	a few	0.42	none	145	70	ordinary	210
Huizhou25-1	145	19	1358	medium	2700	61	34	2600	130	Semi regional	7	much more	0.41	none	195	100	easier	118
Huizhou25-3	137	19	514	medium	2700	61	34	2300	255	Semi regional	6	much more	0.41	none	195	112	easier	117
Huizhou32-2	130	21	685	medium	2550	62	34	1850	200	Semi regional	6	much more	0.41	none	193	112	easier	119
Huizhou25-8	205	23	1172	medium	2300	61	34	1950	315	Semi regional	7	much more	0.41	ancient channel and delta	189	112	easier	113
Huizhou26-1	69	22	1558	medium	2375	62	34	2050	166	Semi regional	8	much more	0.41	none	190	112	easier	121
Huizhou21-1	47	19	485	medium	2360	68	32	2030	195	Semi regional	3	meduim	0.41	ancient channel and delta	185	112	easier	123
Huizhou32-3	90	21	936	medium	2650	62	34	1900	146	Semi regional	5	much more	0.41	none	190	112	easier	120
Huizhou32-5	130	21	689	medium	2500	62	34	2000	166	Semi regional	6	much more	0.41	none	190	112	easier	122
Xijiang23-1	575	27	890	excellent	1500	59	30	1600	96	regional	3	a few	0.39	ancient channel and delta	166	96	easier	90
Xijiang24-1	326	26	1249	excellent	2100	60	32	1701	100	regional	3	a few	0.40	ancient channel and delta	166	96	easier	110
Xijiang24-3	324	28	1868	excellent	1900	60	32	1900	96	regional	3	a few	0.39	ancient channel and delta	166	96	easier	100
Panyu4-2	202	23	2662	medium	2430	62	34	1740	135	regional	4	meduim	0.42	ancient channel and delta	218	84	easier	120
Panyu5-1	221	26	5740	medium	2026	61	34	1600	114	regional	5	meduim	0.41	ancientchannel and delta	214	84	easier	123

3.3 Economic Indicator Layer

At present, CO_2 geological storage has the problems of high technical difficulty and high cost, which is an important factor restricting its popularization and application. Therefore, it is necessary to evaluate the economy of storage when selecting the site for storage. This index layer includes two sublayers: carbon source situation and storage cost. The carbon source situation includes the distance between the storage site and the carbon source. Storage cost includes the difficulty of injection and the depth of seawater. Transportation mode also has a important role in storage cost. In this practice, CO_2 will be transported by submarine pipeline, so transportation mode is not included in the index layer.

4. STORAGE SUITABILITY EVALUATION AND STORAGE SITE OPTIMIZATION

4.1 Quantitative grading of evaluation indicators

In the evaluation index system of CO_2 geological storage suitability, some indexes, such as geological hazard types and injection difficulty are qualitative descriptions, while the remaining indexes are quantitative data with different dimensions. Therefore, these indexes need to be graded according to logical information method or feature analysis[14]. In this paper, five-state logical classification is adopted to quantitatively grade the indexes, which are expressed as excellent, good, medium, poor and very poor according to their storage suitability. Through statistical analysis of the CO_2 geological storage impact factor data, the extreme values of the best and the worst of storage suitability could be determined. Quantification grading is achieved by taking values according to a certain range between the two limit, with a decreasing or increasing threshold[15] (Table 2).

4.2 Calculate index weight

The level of index weight plays a decisive role in the evaluation results and the decision of the storage site. Determining index weight is the key content and difficulty of the suitability evaluation of CO_2 geological storage. These indicators influence each other, even the same indicator may have different importance in different regions. For example, if storage is carried out in Bohai Sea area, the adverse impact of seismicity possibly caused by the Tanlu fault zone on the storage safety must be considered, and the seismic risk should be given a higher weight. The historical data show that the Pearl River Mouth Basin where the study area located is a non-seismically active zone, so the weight of earthquakes should not be too high. In addition, the weight of indicators are often calculated according to experts' experience, and use a judgment matrix to judge the importance of indicators at each level. While experts may have different understanding of the importance of indicators due to they have different professional background or professional experience. In order to weaken the influence of experts' subjectivity, the principle of "underground determines the ground, while underground takes into account the ground" is adopted [16]. At the first level, importance discrimination is carried out according to the logic of "geological factor > safety factor > economic factor", and the weight of three indexes is calculated. Through consistency test, the consistency coefficients of three indexes are all less than 0.1, that's means the judgment matrix has satisfactory consistency. The final index weights are shown in Table 3.

4.3 Evaluation suitability for storage

The suitability evaluation of site storage adopts the index superposition analysis method, and the value of each influencing factors are calculated according to formula (1) :

$$P = \sum_{i=1}^{n} PiAi(i = 1,2,3 \ldots n) \tag{1}$$

Where, P is the score of CO_2 geological storage suitability; n is the total number of single factor evaluation indexes; Pi is the quantitative value of the ith evaluation index; Ai is the weight of the ith evaluation index relative to the target layer. Based on the quantitative grading value and weight of each evaluation factor in the index system of storage suitability, the evaluation results of storage suitability of various oil-gas bearing structures in ZhuYi Depression were calculated (Table 4).

The evaluation results show that the three structures located in the west of Huizhou sag have the highest scores and can be used as the optimal target area for CO_2 marine geological storage in Guangdong Province. In this area, Hanjiang Formation and Zhujiang Formation with good physical properties are widely developed, these formations have great storage potential and good injection conditions. The target area is far away from the active faults, the types of geological disasters are mainly ancient river channels and ancient deltas. The geological structure is stable and the safety of storage is good. The target area is close to the coast. Urban group and Daya Bay petrochemical area provides

Table.2. Evaluation index system for suitability of CO_2 geological storage in Zhuyi Depression

Primary indicators	Secondary indicators	Third level indicators	Unit	Excellent (9 points)	good (7 points)	Medium (5 points)	Not good (3 points)	Bad (1 point)
Geological Conditions	aquifer characteristics	Thickness	m	＞300	200-300	100-200	50-100	＜50
		Porosity	%	＞30%	20-30%	15-20%	10-15%	＜10%
		Permeability	$10^{-3}um^2$	＞200	100-200	50-100	10-50	＜10
		Connectivity	qualitative	regional	Almost regional	Semi regional	Local regional	Not regional
		Buried depth	m	800-1500	1500-2000	2000-2500	2500-3000	＜800 & ＞3000
	Geothermal conditions	geothermal gradient	$℃·Km^{-1}$	＜25	25-30	30-35	35-40	＞40
		Geothermal flow value	HFU	＜54.5	54.5-60	60-65	65-70	＞70
Storage security	caprock characteristics	Thickness	m	＞50	30-50	20-30	10-20	＜10
		Buried depth	m	800-1200	1200-1800	1800-2300	2300-2700	＜2700
		Connectivity	qualitative	regional	Almost regional	Semi regional	Local regional	Not regional
		number	-	＞4	3-4	2-3	1-2	＜1
	Crustal stability	active fault	$number/100Km^2$	＜1	1-2	2-3	3-5	＞5
		Earthquake hazard	-	＜0.3	0.3-0.4	0.4-0.5	0.5-0.6	＞0.6
		Types of geological hazards	qualitative	none	ancient channel and delta	Sand slope & sand ridge	shallow gas	landslide
Storage economy	Carbon source situation	Carbon source scale	104t/a	＞100	80-100	65-80	50-65	＜50
		Carbon source distance	Km	＜150	150-200	200-300	300-500	＞500
	Storage cost	Injection difficulty	qualitative	excellent permeability	Good permeability	Medium permeability	Lower permeability	Low permeability
		Depth of seawater	m	＜150	150-3000	300-500	500-1500	＞1500

a lot of carbon sources, so the economy of storage is quite good.

Talbe. 3. Weights of suitability evaluation indicators for CO_2 geological storage in Zhuyi Depression

Primary indicators	weight	Secondary indicators	weight	Third level indicators	weight
Geological Conditions	0.6154	aquifer characteristics	0.547	Thickness	0.18
				Porosity	0.11
				Permeability	0.11
				Connectivity	0.04
				Buried depth	0.03
		Geothermal conditions	0.0684	geothermal gradient	0.03
				Geothermal flow value	0.03
Storage security	0.3077	caprock characteristics	0.2051	Thickness	0.03
				Buried depth	0.12
				Connectivity	0.02
				number	0.05
		Crustal stability	0.1026	active fault	0.07
				Earthquake hazard	0.06
				Types of geological hazards	0.03
Storage economy	0.0769	Carbon source situation	0.0192	Carbon source scale	0.01
				Carbon source distance	0.02
		Storage cost	0.0577	Injection difficulty	0.04
				Depth of seawater	0.02

Lufeng 7 and Lufeng 13 located in the wast of Lufeng Sag have scores of about 0.5, which can be used as alternative target areas. These two structures have regional aquifers in Zhujiang Formation and Zhuhai Formation at the depth of 2800m, overlying by a large thick cap layer, the storage potential in these area is great. While the burial depth of the aquifers are relatively deep, therefore, the cost of storage in this area is higher and the difficulty of injection is greater. Also because the aquifers are located in the deep stratum, the physical property is worse than that of Xijiang sag.

The structures in Huizhou and Panyu get the lowest scores in this assessment and were not suitable for storage. Most of these structures are located in the southern Zhuyi Depression and around the Huixi low uplift, adjacent to regional large faults and poor crustal stability. Due to the complex geological conditions, the aquifers are deep and the continuity is bad. Far away from the coast, the sea water is deep, storage economy of these palces are really bad.

Talbe. 4. Evaluation results of suitability of CO_2 geological storage in Zhuyi Depression

ID	Name	Score	conclusion	ID	Name	Score	conclusion
1	Xijiang23-1	0.742	Recommend	12	Lufeng14-3	0.458	Unsuitable
2	Xijiang24-3	0.699	Recommend	13	Huizhou32-2	0.434	Unsuitable
3	Xijiang24-1	0.659	Recommend	14	Lufeng14-4	0.430	Unsuitable
4	Lufeng7-10	0.571	Alternative	15	Huizhou26-1	0.421	Unsuitable
5	Panyu5-1	0.533	Alternative	16	Lufeng13-7	0.419	Unsuitable
6	Lufeng13-8	0.524	Alternative	17	Huizhou32-5	0.410	Unsuitable
7	Lufeng13-1	0.509	Alternative	18	Lufeng7-9	0.402	Unsuitable
8	Panyu4-2	0.482	Unsuitable	19	Lufeng14-5	0.399	Unsuitable
9	Lufeng13-9	0.472	Unsuitable	20	Huizhou25-3	0.395	Unsuitable
10	Huizhou25-8	0.470	Unsuitable	21	Huizhou32-3	0.384	Unsuitable
11	Huizhou21-1	0.467	Unsuitable	22	Huizhou25-1	0.360	Unsuitable

5. STORAGE POTENTIAL EVALUATION

5.1 Target storage mode

Both Xijiang 23-1 and Xijiang 24-3 structures in the target area are complete draped anticlines formed on bedrock uplift, while Xijiang 24-1 is a reverse traction anticline that is controlled by the main fault[17]. The proposed injection aquifers the bottom of the Hanjiang Formation and the top of the Zhujiang Formation are the transitional facies and the coastal delta sedimentary environment. There are 3-4 sets of aquifers with the thickness is about 30m to 80m. According to the seismic profile tracking, combined with the logging interpretation results of multiple drilling wells, the aquifers in the west are higher than the east, showing a slight amplitude as a whole. These aquifers distributed continuously in several structures and their length exceeds 40Km.The main caprock is mudstone of upper Hanjiang Formation and Yuehai Formation. CO_2 chould be injected from Xijiang 24-1 structure which is in the east part of the target area, where the aquifers are relatively lower than the west. The CO_2 flows migrate to the top of the structure along the aquifers slowly, eventually these CO_2 stayed in the structure in the forms of construction sealing. The injection should be stopped when the overflow point is near. The low amplitude formation structure and multiple sets of mudstone partitions reduce migration rates and increase migration paths, resulting in large amounts of dissolved and bound storage (FIG. 2).

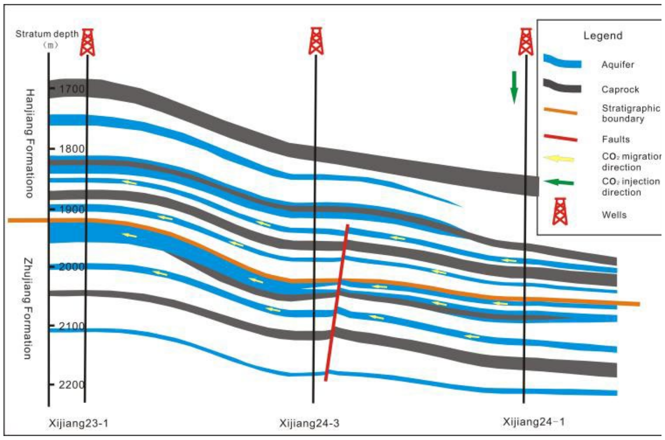

Fig. 2. CO_2 storage mode diagram in the target area

5.2 Evaluation of target storage potential

The project is designed to inject one million tons CO_2 per year for at least 30 years, that is, the lower limit of actual storage stock is 30×10^6t, and its effective storage stock should be around 70×10^6t[18]. The United States Department of Energy (DOE) method is used to calculate the volume of the aquifers:

$$M_e = A \bullet H \bullet \phi \bullet \rho_{CO_2} \bullet E \qquad (2)$$

Where, Me is the effective storage capacity of CO_2 in deep saline aquifers, 10^6t; A is the area of the sealed site (Km^2); H is aquifer's effective thickness, m; ρ_{CO_2} is the density of super-criticality CO_2, kg/m^3; E is the effective storage constant. Refer to the parameter value of previous calculation of CO_2 saline aquifer storage capacity in the Pearl River Mouth Basin[19], 108×10^6t of CO_2 could be stored in the target area.

6. CONCLUSION

Based on the characteristics of geological storage in the sea area, a suitability evaluation index system for saline aquifers storage was constructed, which includes three levels and 18 factors: geological conditions, storage safety, and storage economy. The index weights were determined using the Analytic Hierarchy Process (AHP) to quantitatively evaluate the storage suitability of 22 oil and gas bearing structures in the Zhuyi Depression.

According to the evaluation results, the three adjacent structures located in the western part of Huizhou Sag have the highest scores and can be used as targets for CO_2 ocean storage in Guangdong Province. Compared with other structures, the target area has certain advantages in terms of storage potential, storage security, and economy..

Using the calculation formula of saline aquifer storage potential of the U.S. Energy Administration (DOE), the effective CO_2 storage capacity of the regional aquifers at the bottom of the Hanjiang Formation and the top of the the Zhujiang Formation in the target area reaches 108×10^6t, meeting the basic requirement of injecting a million tons for 30 years.

REFERENCE

[1] Wang Chuang, Zhu Qianlin, Huang Chunxia. Evaluation and analysis of CO_2 geologic storage capacity in Wuqi oilfield. Environmental Engineering 2019:273–278.

[2] The administrative center for China's agenda 21, Hydro geological environmental geological survey center of China geological survey. Research on site selection guidelines for carbon dioxide geological storage in China. 1st ed. Beijing: The geological publishing house, 2012.

[3] LU Ping, BAI Yong, LIU Weigang. Optimization of favorable areas for carbon dioxide geological storage in Majiagou Formation in Ordos Basin. Geological Review, 2021, 67(3): 816-827.

[4] DIAO Yujie, LIU Ting, WEI Ning. Classification and assessment methodology of CO_2 geological storage in deep saline aquifers[J]. Geology in China ,2022, 1-12.

[5] Guo Jianqiang, Wen Dongguang, Zhang Senqi. Potential Evaluation and Demonstration Project of CO_2 Geological Storage in China. Geological Survey of China, 2015,2(04):36-46.

[6] Jia Xiaofeng, Zhang Yang, Zhang Hui. Method of Target Area Selection of CO_2 Geological Storage in China. Journal of Jilin University(Earth Science Edition), 2014, 44(4): 1314-1326.

[7] Li Xiaolong, Zhou Di, Li Pengchun. CO_2 Offshore Storage in China: Research Review and Plan for Demonstration Project. UK-China (Guangdong) CCUS Centre, 2015.

[8] Liu Zhifeng, Wu Keqiang, Ke Ling. Main factors controlling hydrocarbon accumulation in northern subsag belt of the Zhu-1 Depression, Pearl River Mouth Basin, OIL ＆ GAS GEOLOGY, 2017, 38(3): 561-569.

[9] XIE Shiwen, WANG Yuchen, SHU Yu,. Environmental reconstruction for the paleo-lake of Zhu Ⅰ depression and the depositional model for high-quality source rocks. Marine Geology & Quaternary Geology, 2022, 42(1): 159-169.

[10] ZHU Junzhang, ZHU Ming, SHI Yuling. Division of hydrocarbon accumulation assemblage and prediction of favorable accumulation assemblage in Zhu Ⅰ Depression. Marine Geology Frontiers, 2022, 38(5): 67-75.

[11] XIE Lihua. Forced Regression and Normal Regression Deposition of Basin with Continental Shelf Slope break: A case study on Zhujiang and Hanjiang Formations of Pearl

River Mouth Basin. Acta Sedimentologica Sinica, 2009, 27(6): 1093-1100.
[12] GUO Jianqiang, WEN Dongguang, ZHANG Senqi, Suitability evaluation and demonstration project for geological storage of carbon dioxide in China. Beijing: The geological publishing house, 2017.
[13] National Energy Technology Laboratory. Best Practices for: Site Screening, Selection, and Initial Characterization for Storage of CO_2 in Deep Geologic Formations. Morgantown: National Energy Technology Laboratory, 2010.
[14] LOU Debo, XIAO Keyan , DING Jianhua, Application of MRAS in national mineral resource potential assessment, Geological Bulletin of China, 2010, 29(11):1677-1684.
[15] Yan Mancun, Li Huamei, Wang Guangqian, Quantitative Assessment of Geological Environmental Quality of the Land Along Guangdong Coast. Journal of Engineering Geology, 2000, 8(4): 416-425.
[16] Diao Yujie, Zhang Senqi, Li Fucheng, Gao Shiwang, Wang Xiaolong, Jia Xiaofeng. Site Selection for Offshore CO_2 Geological Storage and Its Suitability Evaluation: A Case Study of Yuhuan Power Plant. Journal of Jilin University(Earth Science Edition), 2016, 46(3): 844-854.
[17] LI Xu, HU Guangyi, FANG Ting'en, The application conditions and prospects of time-lapse seismic technology in offshore oilfield. China Offshore Oil and Ges, 2015, 27(6): 48-52.
[18] Zhao Xiaoliang, Liao Xinwei, Wang Wanfu. Evaluative model of CO_2 geological storage and determination of key parameters. Special Oil & Gas Reservoirs, 2013, 20 (6):72-74.
[19] Zhou Di, Zhao Zhongxian, Liao Jie. A preliminary assessment on CO_2 storage capacity in the Pearl River Mouth Basin offshore Guangdong, China. International Journal of Greenhouse Gas Control. 2011,5,(2):308-317.