Editorial

Exploring the mysteries of deep oil and gas formation in the South China Sea to guide Palaeocene exploration in the Pearl River Mouth Basin

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Abstract:
Deep oil and gas resources in the South China Sea have drawn increasing attention in recent years, involving several essential challenges such as favorable zone prediction, deep burial, poor data quality, non-homogeneous reservoir properties, low drilling rate, and the low research degree of Palaeozoic strata. These issues vastly affect the exploration and development of deep oil and gas resources in this area. Specifically, the Lufeng and Huizhou Depressions exhibit rich hydrocarbon accumulation and distribution areas in the Pearl River Mouth Basin, thereby possess great resource potential. The seven papers discussed here propose a set of practical techniques that can be applied to the exploration of deep Paleogene in the shallow layers of the Pearl River Mouth Basin. All of these works make important contributions deepening the theory of Paleogene reservoir formation and promoting further exploration of Paleogene in the Pearl River Mouth Basin, to increase the hydrocarbon storage and production prospects.

1. Introduction

The South China Sea is extremely rich in oil and gas resources (Metelitsa and Kupfer, 2014). To date, 48 oil and gas reservoirs have been discovered in the Zhu I Depression, with proven oil and gas reserves of 7.7 billion tons, which are mainly distributed in Neoproterozoic sandstone reservoirs (Liang et al., 2021). As China’s oil and gas needs are on the rise, and oil and gas exploration in the Pearl River Mouth Basin is expanding into the surrounding depressions, as well as into the deeper Palaeogene (Xia et al., 2019). A large proportion (80\%) of the discovered oil and gas reserves in the Zhu I Depression are distributed in the Lufeng Depression and the Huizhou Depression. The number of exploratory wells drilled in the Palaeozoic and deeper strata is high at more than 50. The seismic information includes good quality three-dimensional data covering an area of 11,000 km\textsuperscript{2}, which comprises the most significant favorable window to explore deep oil and gas resources in the South China Sea.

The characteristics of deep burial, poor data quality, non-homogeneous reservoir properties, low drilling rate, and low research degree of Palaeozoic strata in the Zhu I Depression, have led to inconsistent results from evaluations of the oil and gas resource potential of Lufeng and Huizhou depressions, inconclusive characteristics of the spreading sand body reservoir, the lack of definitive criteria for effective reservoir identification, uncertain boundaries of buoyant and non-buoyant reservoir formation, and difficulties in predicting the distribution of conventional and unconventional oil and gas reservoirs. To solve these scientific challenges, the research group of Prof. Pang from the China University of Petroleum (Beijing) and experts from the Research Institute of Shenzhen Branch of China National Offshore Oil Corporation (CNOOC)
have cooperated to carry out the research of “Comprehensive
evaluation of ‘source-migration-accumulation’ of the Paleoe-
cene system in shallow water and the exploration direction
of medium and large oil and gas fields”. The seven papers
published in this issue summarize the results of preliminary
exploration on the above listed scientific problems.

2. Comprehensive evaluation of
source-migration-accumulation

In the paper “Quantitative prediction of structural fractures
in the Paleocene lower Wenchang formation reservoir in the
Lufeng Depression”, Hui Li et al. simulated the distribution
characteristics of stress field and fracture development during
the key Paleocene tectonic change in the Lufeng Depression,
and a planar distribution of reservoir fracture development
intensity was determined, creating conditions for the prediction
of deep oil and gas rich zone and target.

Kuiyou Ma et al. delivered an essay on “Hydrocarbon
dynamic field division and its relevance to oil and gas explo-
roration for Paleogene reservoir in Lufeng depression”. Based
on the large volume of drilling results, oil and gas production
test data and statistical analysis of the reservoir physical
resources, the authors determined the lower limit of buoyant
reservoir formation in the Lufeng Depression, and divided the
hydrocarbon free dynamic field and restricted dynamic field,
providing a theoretical basis for predicting the distribution of
conventional and tight unconventional reservoirs.

In the paper titled “Controlling effect of tectonic-
paleogeomorphology on deposition in the south of Lufeng sag,
Pearl River Mouth Basin”, delivered by Mengya Jiang et al.,
the impression method is used to recover the paleogeomorphic
pattern of the Paleoproterozoic period, which clarifies the role
of tectonic-paleogeomorphology in controlling the type and
scale of the depositional system, and finally obtain a tectonic-
paleogeomorphology controlled model of deposition in the
south of Lufeng sag. The findings provide theoretical guid-
ance for hydrocarbon source rock and reservoir distribution
prediction.

In a paper entitled “Potential resources of conventional,
tight, and shale oil and gas from Paleogene Wenchang For-
mation source rocks in the Huizhou Depression”, Tao Hu et al.
adopted the hydrocarbon generation potential method to
predict the original hydrocarbon volume and planar distribu-
tion characteristics of conventional, tight, and shale oil and
gas from the source rocks of Huizhou Depression in a more
comprehensive way than previous researches.

Bowei Guo et al. conducted a study on the “Quantitative
prediction of palaeo-uplift reservoir control and favorable
reservoir formation zones in Lufeng Depression”. The rela-
tionship between palaeo-uplift and oil and gas reservoir formation
and distribution is clarified and a quantitative relationship
model is established, which is utilized to predict the distri-
bution range and reservoir formation probability of palaeo-
uplift-controlled reservoirs in the Lufeng Depression.

In the essay on “Criteria and favorable distribution area
prediction of Paleogene effective sandstone reservoirs in the
Lufeng sag, Pearl River Mouth Basin”, Sa Yu et al. utilized a
novel method to predict and evaluate deep effective reservoirs
based on the ratio method of pore throat radius of sandstone
and mudstone, providing a scientific basis for determining the
oil and gas-rich reservoir formation and target zone.

In the paper “Hydrocarbon accumulation model based on
threshold combination control and favorable zone prediction
for the lower Enping Formation, Southern Lufeng sag”, Lili
Zhang et al. applied geostatistical methods and numerical
simulation techniques to determine the boundary, extent and
probability of hydrocarbon distribution by the key elements
of hydrocarbon formation. Moreover, they constructed the
functional element combination reservoir model to quantita-
tively predict the boundary, extent and probability of reservoir
formation in the lower Enping Formation, which provides a
theoretical groundwork for the optimal selection of drilling
targets.

3. Conclusions

Taking the Huizhou Depression and the Lufeng Depression
as examples, the seven papers discussed here constitute a
complete set of research methods and application results, from
basic studies on tectonics, sedimentation and hydrocarbon
generation, to analyzing reservoir characteristics, determin-
ing the main control factors, establishing reservoir formation
models, to forming favorable zone prediction and evaluation
techniques, and to finally determining favorable reservoir
formation zones and selecting drilling targets. On the whole,
new theoretical guidance and exploration targets are provided
by these quality studies for deep-seated oil and gas exploration
in the South China Sea.

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Conflict of interest

The authors declare no competing interest.

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