

Research on the Evaluation Indexes and Methods of Overseas Oil and Gas-Bearing Play

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Abstract

In order to cope with the long-term low international oil price and non-uniform evaluation methods for the potential of domestic and overseas oil and gas-bearing play, this paper puts forward a comprehensive evaluation method of potential plays under the constraints of economic limit reserves. This method has selected out two indexes: geological risks and economic risks. The geological risk contains five sub-indexes: the hydrocarbon supply conditions, reservoir conditions, trap conditions, storage conditions and supporting conditions. The economic risk adopts six sub-indexes, including ground environment, engineering technology, resource quality, payback period, geopolitics and minimum economic reserves. According to different geological conditions, economic conditions and exploration degrees, plays are classified and graded and each index is endowed with different value and weight. This paper uses risk probability method and expert scoring method and gives priority to the minimum economic reserves and the optimization of different risk parameters. Therefore, it can help to realize the evaluation and optimization of potential oil and gas-bearing plays with the same standard, under different financial regulations in different regions.

Keywords

Oil and gas-bearing play, evaluation indexes, minimum economic reserves, evaluation and optimization.

1. Introduction

The international oil price has been at a low position since the second half of 2014. Based on current situations, major oil companies in the world have significantly cut back on funds for overseas exploration and investments in succession. In order to cope with the current low oil price situation, oil companies began to pay more attention on seeking for potential petroleum accumulation zones with fast turnarounds. For example, Petro China's overseas exploration projects have issued a new exploration strategy of "the primary objective is to seek for large-scale high-quality fast-producing reserves". Therefore, the chief problems in front of all oil companies is how to formulate different exploration deployment plans according to different oil prices to realize efficient exploration.

Oil and gas exploration and development projects feature large geological risks, long investment cycles and complex working environment. Oil and gas-bearing basins vary in types, different plays have different geological conditions and exploration degrees, and the oil prices are also different among regions. These all contribute to the complexity of the risk control of oil and gas investment projects.

At present, the evaluation of oil and gas-bearing play in China suffers from various problems, such as non-uniform parameters, short period and significantly different methods. Some apply sorting optimization according to the geological resources and recoverable resources of different plays; some implement sorting optimization based on the net present value (NPV) and internal rate of return (IRR); others pursue the complexity of the evaluation method. Under the new normal of low oil prices, they are hard to serve current objectives of oil companies or precisely express investment risks and the strategic optimization of oil companies.

In view of the above questions, this paper has thoroughly investigated the evaluation techniques and strategies of oil companies from both China and other parts of the world. Then, it puts forward a comprehensive evaluation method of potential plays under the constraints of economic limit reserves. Taking oil and gas-bearing play as the evaluation objective, this method has selected out two indexes: geological risks and economic risks. The geological risk contains five sub-indexes: the hydrocarbon supply conditions, reservoir conditions, trap conditions, storage conditions and supporting conditions. The economic risk adopts six sub-indexes, including ground environment, engineering technology, resource quality, payback period, geopolitics and minimum economic reserves. First, it selects out the oil and gas-bearing play with the most potentials using risk probability method; then it optimize projects with the best economic benefits based on the multiple of minimum economic reserves; finally, it specifies the principle objective when taking in account geopolitical risks for overseas projects and combines with the expert scoring method. Therefore, it helps to realize fast evaluation and decision of potential oil and gas-bearing plays with the same standard, under different financial regulations in different regions.

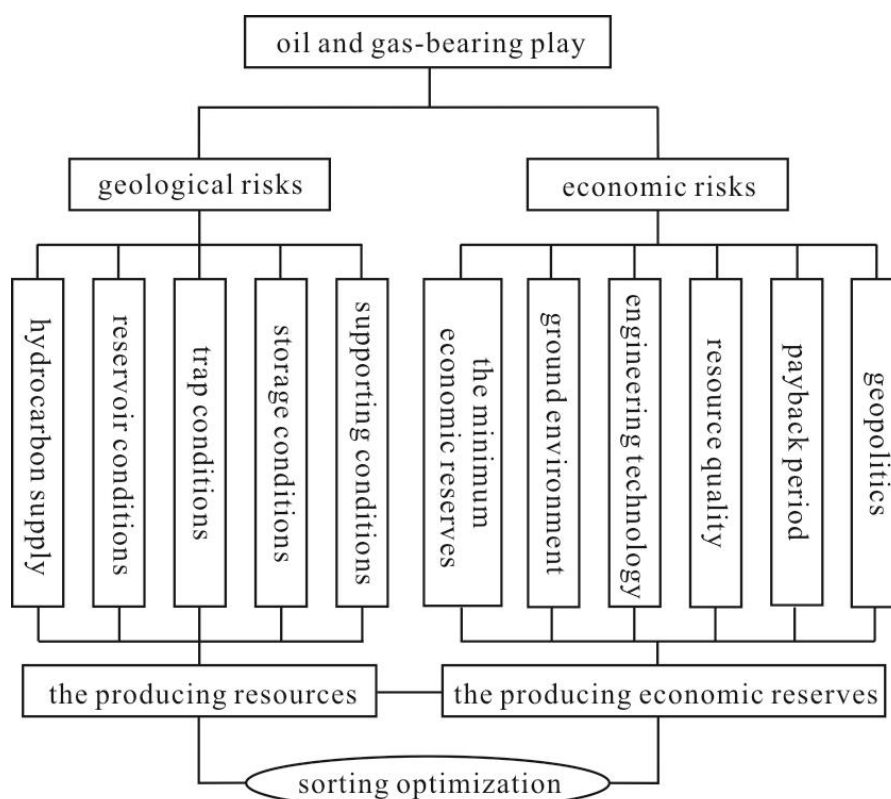


Figure 1 Flow Chart of the Evaluation and Optimization of Plays

2. Evaluation process

Play is the basic unit for the commercial exploration evaluation system. It is also an evaluation gradation that is most valued by international oil companies during the process of global oil-gas exploration activities. Its definition and division were first brought forward by Allen P A (1990) and White D A (1980, 1988) [1-3]. After that, Exxon and other Western oil companies began to establish their own systems one after another. Domestic scholars Wu Shoucheng (1994), Guo Qiulin (2004), Yan Xiangbin et al (2010) and Sheng Xiujie et al (2013, 2017) carried out studies on the causes, definitions, types and division of plays based on the actual geological characteristics of China[4-8].

This paper also takes plays as the evaluation units, which are a series of neighboring traps or reservoir forming assemblage, featuring similar sedimentary and tectonic settings and migration and accumulation rules of oil and gas. Oil and gas reserves are the prerequisite. First, the exploration degrees of the target plays and conditions of the explored oil and gas field should be confirmed. While

taking full advantage of the known geological cognition, the hydrocarbon supply conditions, reservoir conditions, trap conditions, storage conditions and supporting conditions should be confirmed one by one. The geological and reservoir engineer will forecast the producing resources of the target plays based on different reservoir types and corresponding geological models. The key point of the project economic efficiency lies on the minimum economic reserves calculated from the current oil price, total project investment and predicted number of oil fields to be discovered. Then the minimum economic reserves can be used to constrain the producing resources to obtain the producing economic reserves. Finally, risk probability models and evaluation based on scores given by the expert group are combined for the sorting optimization of target plays (Figure 1).

3. Evaluation indexes

Since the geological conditions and exploration degrees of different plays are quite different, they can be hardly evaluated with the same standard. This paper divides all plays into high, medium and low, three exploration degrees based on drilling, 2D seismic density and 3D seismic coverage (Table 1).

Table 1 Plays classification

	High exploration degree	Medium exploration degree	Low exploration degree
Drilling	<500km ² /well	500~2000km ² /well	<2000km ² /well
2D seismic density	>5km/km ²	0.5-5km/km ²	<0.5km/km ²
3D seismic coverage	>60%	30-60%	<30%

Due to different exploration degrees, the geological and economic risks considered in this paper have different values and weight coefficients for each index (Table 2). Plays with high exploration degrees have higher cognition degrees for basic petroleum geological conditions and accumulation rules of oil and gas, and uncertainties during the process of risk assessment are also fewer. During the geological evaluation process, the reservoir and trap conditions should be given priority, and their corresponding weight coefficients should be 0.15 and 0.4. During the economic risk assessment, we should consider more about the multiple of minimum economic reserves and applicability of engineering technology, and their corresponding weight coefficients should be 0.6 and 0.4. Plays with medium and low exploration degrees have insufficient cognition degrees for basic petroleum geological conditions and accumulation rules of oil and gas, and the possibility of oil and gas discovery and scale of the producing economic reserves are the key points during risk assessment.

Table 2 Play Evaluation Index and Weight Coefficient Plate

First grade index (weight)	Second grade index	value				weight		
		100~75	75~50	50~25	25~0	High exploration degree	Medium exploration degree	Low exploration degree
geological risks (0.6)	hydrocarbon supply conditions	excellent	fine	general	inferior	0.1	0.2	0.2
	reservoir conditions	excellent	fine	general	inferior	0.15	0.15	0.15
	trap conditions	excellent	fine	general	inferior	0.4	0.25	0.25
	storage conditions	excellent	fine	general	inferior		0.05	0.05
	supporting conditions	excellent	fine	general	inferior	0.1	0.1	0.1
economic risks (0.4)	ground environment	Flat, meeting transportation and environmental requirements	Mild elevation difference, requiring improving transportation	Relatively small elevation difference, worse transportation conditions	The current conditions don't meet required transportation and environment	0.2	0.2	0.15

			tion and environmental conditions		ntal conditions			
engineering technology	Mature supporting technical facilities, meeting exploration and development requirements	Less mature supporting technical facilities. Some key technologies need to be improved	Supporting technical facilities are under establishment. Some key technical issues need to be solved	Supporting technical facilities need large improvement	0.4	0.35	0.3	
resource quality	Low-sulfur light oil	Common sulfur oil	Heavy sulfur oil	Super heavy sulfur oil	0.15	0.15	0.15	
payback period	< 1 year	1-3 years	3-5 years	> 5 years	0.2	0.15	0.3	
geopolitics	Politically stable, best public security	Less stable political situation, less good public security	Politically unstable, public security is barely satisfactory	Politically chaotic, bad public security	0.3	0.3	0.3	
the multiple of minimum economic reserves.	>5	3-5	1-3	<1	0.6	0.5	0.5	

4. Risk estimation

4.1 Minimum economic reserves

Minimum economic reserves refers to the recoverable resources at the break-even point (NPV = 0) under current technological and economic conditions, which is a key for the economic risk assessment of plays. A project implementation can only bring economic benefits when the producing resources of a play are larger than the minimum economic reserves. Minimum economic reserves can be calculated as follows:

The minimum economic reserve =

$$\frac{\text{Total project investment (including 2D, 3D earthquake + drilling + transportation + administration fee etc.)}}{\text{Estimated minimum number of oil fields discovered} \times (\text{NPV after tax / barrel})}$$

4.2 Comprehensive risks assessment

This paper adopts the mature and easy-to-understand risk probability method, which can quickly evaluate the oil-gas possibility and economic feasibility of a play. Value of each sub-index can be evaluated based on field conditions. They should be endowed within four intervals, (100~75), (75~50), (50~25), (25~0), and the weight value of indexes at all levels can be endowed on the basis of exploration degrees (Table 2). Apply weighting to the secondary indexes under the primary indexes, and then the comprehensive assessment value can be obtained. Its formula is as follows:

$$P_i = \sum_{j=1}^n q_{ij} P_{ij} \tag{1}$$

P_i indicates the comprehensive evaluation quantitative value; P_{ij} indicates the corresponding level index; q_{ij} indicates the weight of a corresponding index.

Sort for the first time based on the comprehensive value of plays evaluated, and then the expert group will screen the key target plays through discussion. The expert group should optimize the reliability and validity of evaluation indexes of key target plays for another sorting. Then the whole technological evaluation system of plays based on constraints of economic limit reserves shall be completed to realize the evaluation and decision of potential oil and gas-bearing plays with the same standard, under different financial regulations in different regions.

5. Conclusion and suggestion

- (1) For plays with various exploration degrees and types, their risk indexes are endowed with different value and weight, which effectively improves the reliability of the assessment results of overseas oil and gas-bearing plays.
- (2) The minimum economic reserves is adopted to constrain the undiscovered resources and establish the producing economic reserves of the target play, which serves as a basis for the evaluation of oil and gas resources.
- (3) This paper adopts the risk probability method and expert scoring method to realize the evaluation and optimization of oil-gas possibility and economic feasibility of different plays under the same standard.

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