GEOL. CROAT.	49/2	247 - 249				ZAGREB 1996

Professional paper

Critical Geological Parameters in Feasibility Studies of Exploration Projects

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Key words: Geological parameters, Hydrocarbon reservoir, Economics, Exploration.

Ključne riječi: geološki parametri, ležište ugljikovodika, ekonomika, istraživanje.

Abstract

Quantitative feasibility analysis of exploration projects is the basis for rational exploration and it should be diligently undertaken.

The feasibility study should take into account the most critical geological parameters which have an impact on the economics of the exploration project. Each hydrocarbon accumulation has its specific characteristics which are disclosed in various geological data gathered during exploration work. These data have to be interpreted and sorted out in a way to reflect the most prominent reservoir characteristics. The data represent the basis for the selection of the most appropriate development and production technology. Such an integrated and multidisciplinary approach is essential for obtaining the best exploration results at the lowest possible cost.

Sažetak

Kvantitativna procjena opravdanosti istraživačkog projekta osnova je racionalnog istraživanja, ali i nju je samu nužno obavljati na racionalan način.

Procjena opravdanosti istraživačkih projekata treba uzeti u obzir najkritičnije geološke parametre s najvećim utjecajem na ekonomičnost projekta. Svako ležište ugljikovodika ima osobite značajke vezane uz različite geološke parametre definirane tijekom istraživanja. Ove podatke treba interpretirati i razvrstati na način koji će odražavati najvažnije značajke ležišta. Kritični parametri ujedno pružaju osnovu za odabir odgovarajuće tehnologije razrade i proizvodnje. Takav integrirani i multidisciplinarni pristup bitan je za postizanje najboljih istraživačkih rezultata uz najniže moguće troškove.

1. INTRODUCTION

Feasibility studies, with critical regard for geological parameters, have been carried out in INA-Naftaplin exploration department for several decades.

In the late 1960's work started on the systematic gathering and interpretation of geological data and economic indicators. PLETIKAPIĆ (1984) made a significant contribution with the introduction of economic analyses as an important part of complex exploration studies. In the 1970's Hajnšek led some exploration projects as the head of a team of multidisciplinary experts (HAJNŠEK et al., 1978). The present author together with other colleagues, has tried to mantain the continuity of this work and to develop it further (KOLBAH & RUKAVINA, 1985).

Information technology has greatly aided the development and advancement of preparation of the studies. Initially, data processing was undertaken using Mainframe computers. Of course, technology has became more sophisticated and Naftaplin invested quite a lot in the procurement of new equipment and software and training of its personnel in order to be able to follow recent trends in feasibility studies.

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The new organization of Naftaplin's Exploration Department, mainly based on team work, should enhance performance results. Teams of experts including geophysicists, geochemists, geologists and economists work directly on project tasks but indirectly they are also involved in making strategic decisions.

2. ECONOMIC ANALYSES

Economic analyses of exploration projects are extremely important in the oil business which involves great risks (HAJNŠEK et al., 1978) but also great potential. It is important to identify and evaluate all the important factors which can have an impact on exploration costs (KOLBAH & RUKAVINA, 1985) but also the overall success of an oil project. This is one reason why oil industry experts have devised a complex methodology (ŠEGO et al., 1987) for carrying out such analysis. This methodology (MILLER, 1987) assumes some typical input data relating to the reservoir characteristics on one side and economic parameters on the other, which are then modelled and interpreted.

The reliability of the input data is extremely important, e.g. the water depth in off-shore drilling can have a large impact on the economics of exploration and production, or, changes in taxation policy related to oil production can also have positive or negative effects on the

financial results of a project. For this reason all the data have to be checked and updated. Economic appraisal will also take into account concession terms, risk spreading, political risks and possible technological improvements. In the decision making process the management has to consider all of the above factors. Due to the high degree of uncertainty which is inevitably involved in the oil business, some sophisticated methods have been promoted, like Monte Carlo simulations and sensitivity analyses.

An exploration project usually starts with the accumulation of various reservoir data. Gelogical-geophysical surveys have to be carried out. The data are processed and interpreted. On the basis of such data various information can be obtained, including the probability of source and migration, reservoir rocks, trapping integrity, reservoir thickness, porosity and permeability.

3. IMPORTANCE OF CRITICAL GEOLOGICAL PARAMETERS

Critical geological parameters are derived from the above surveys. After prospect identification and definition, exploration drilling follows. This is the costliest part of exploration. Here savings are already possible if the critical geological parameters are better defined.

After exploration drilling is completed, appraisal of the prospect will be easier as more data are collected about the reservoir and the fluid. Total reserves can be estimated together with recovery potentials. These data are included in the model by which we can determine the most appropriate technological solutions for development wells and field facilities. However, even at this early stage by modelling critical geological parameters and exploratory drilling data we can predict the production technology and related costs.

There are two different approaches to obtain the required parameters: by gradually defining them through geological properties (from the environmental models to the sand body porosity for example), or deducing them in retrospect from the actual production characteristics. However, to some extent it is always extrapolation of data. The best assumptions can be obtained by a combination of both methods.

Such modelling will enable appraisal experts to avoid possible mistakes and focus on the most critical parameters. It will also provide information necessary for defining "plays", the broadest exploration units within an area. A play is primarily defined by reservoirs. In the Pannonian Basin, for example, basic plays are in the basement and Pretertiary, older Tertiary and Lower Pannonian, Upper Pannonian, Pontian and younger deposits.

In the depressions, including Mura, Drava, Sava and Slavonija-Srijem, they are furthermore distinguished in the semiregional reservoirs with common lithostratigraphic characteristics. It is very important to keep these identifications in the data base for easier information management as "Evidence of reserves". There are other important data related to these reservoirs like stratigraphy, lithology, petrophysical parameters and so on.

Fluid characteristics can further define "plays" in more details. For example, in the Croatian part of the Pannonian Basin source rocks are determined in the Sarmatian and lower Pannonian beds. Depending on the local burial history and other later processes we can interpret the appearance of oil and gas fields in one area, and gas and gas-condensate fields in the other. Reserves-in-place depend on reservoirs and fluid characteristics but, further, they are related to tectonic and structural events and pressure/temperature conditions.

Recovery efficiency is in a great part related to the technical and technological approach in production, but it also depends on the above mentioned elements: petrophysics of the reservoir, fluid characteristics and the resulting fluid regime of production.

So, critical geological parameters have an impact on overall upstream activities. Economic analyses are concentrated on cash flow and profit definition including parameters such as payout period, rates of return and profitability index under certain discount rates. These forecasts are made on the basis of time/cash diagrams. The outputs of such analyses enable us to follow and compare the viability of the major costs related to a project including acquisition of land, exploration drilling, production stage including off-shore or on-shore production facilities and equipment, transportation system and so on.

However, economic analyses will also take into consideration some elements in the downstream part of the oil business such as marketing and distribution, refining, storage and distribution. Of course, at such an early stage of a project these are only high level analyses and forecasts. Yet, they are important because early information can help us to avoid risks and losses.

For example, in the case of a gas prospect in the Kanayis concession in Egypt, a change in the price of the product of 1 $/MCF resulted in breaking through the economical threshold, to getting nearly 15 $MM after tax cash flow discounted at a rate of 15%. In another example in Libya, the economics of the reservoir changed dramatically depending on the thickness of the pay zone. A change of several metres affected the break-even threshold value by approximately 100 $MM of after tax cash flow discounted at 15% rate.

In an off-shore project similar analysis showed that the critical parameter was well productivity. In calculations taking into account before tax values the threshold was at about 2 Mbbl/day. By increasing well-productivity the other values were also increased. However,

when we took into account production sharing terms, the economics of the project proved to be less attractive even at high productivity values.

4. CONCLUSION

This paper was prepared for the first International Symposium of Petroleum Geology - Economic Aspects of Petroleum Exploration - An Approach to Rational Exploration which was held in Zagreb in April 1996. It reveals part of the efforts of INA Naftaplin Exploration Department to promote economic analyses in exploration surveys. The Economic aspect of exploration work has not always been properly valued. The present author has tried to emphasise the potentials of economic analyses and how they can predict the success of a petroleum project and make it more rational.

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