V025 THE SEISMIC CONTRIBUTION TO RESERVOIR CHARACTERIZATION

STEPHEN J. PHAREZ

CGG, CGG House, 4 Dukes Green Avenue, Feltham Middlesex TW14 0LR, UK

Introduction

There are many attributes now available to help characterise hydrocarbon reservoirs. Typically these attributes can be examined in three main groups - first those pertaining to the geometrical relationship of the reservoir; second the reservoir content, for example, lithology, fluid and petrophysics; and finally attributes which change with time over the life of the reservoir (figure 1). This paper will examine these groupings and the contribution that seismic data can offer in quantifying the attributes. The issues faced in integrating this wide variety of attributes will also be explored.

Reservoir geometry

State of the art 3D imaging techniques now enable the seismic method to provide an accurate measurement of structural reservoir geometry. The impact of the advances on characterisation can be seen in examples such as that shown in figure 2, which illustrates the improved accuracy gained from 3D depth migration of a survey containing an overhanging chalk wall. The target event at 2.5kms was previously mis-positioned and incorrectly defined. The final 3D post-stack depth migration, as seen in figure 2b, better images the target, producing improved definition of position and geometry, and enables the correct location of the fault to be established.

Lithology and fluid content

Prediction of reservoir lithology and fluid content is important to all stages in the life of a field, from exploration, through appraisal and development to production. Whilst imaging enables us to directly measure the geometry, the seismic method does not enable direct measurements of the reservoir content. For this we must invert the seismic data and unlock the relevant attributes. Pre-stack AVO and offset cube analyses and true 3D post-stack acoustic impedance inversion will be examined through case examples. The ability of these techniques to provide quantitative rock property information will be discussed and the role of the attributes in defining the geometrical interrelationships of target bodies will be seen. Figure 3 illustrates the delineation of a channel feature within a particular layer extracted from the acoustic impedance inversion and visualised in 3D with the seismic data. Assuming a relationship between impedance and porosity enables not only the lithostratigraphic layer geometry to be defined but also the volume fractions. This

information can then be input directly to the reservoir model builder for incorporation with the geological data and thus directly input to the reservoir simulator.

Life cycle effects

During the development and production phases of a field's life, changes occur in the characterisation of the reservoir. These changes such as fluid flow and pressure can only be detected from seismic data by comparing the difference between attributes derived from repeat measurements (4D seismic). Thus in addition to the techniques described above, we need to analyse the differences.

This increasing number of attributes offers an exhausting range of correlations in order to define the elements that positively contribute to the characterisation. 3D visualisation of these attributes can be used as an analysis tool to aid this process and examples will be shown.

Conclusion

The contribution of seismic data to reservoir characterisation has been illustrated with a number of case examples. The role of key techniques has been demonstrated and the ability of seismic data to directly impact the development of reservoir models explored.

Figure 1 : The seismic contribution to reservoir characterisation

Figure 2a : Initial post-stack 3D depth migration. The overhanging chalk wall causes inaccurate imaging of the deeper reflectors at 2.5km.

Figure 2b : Final post-stack 3D depth migration. Note the improved imaging of the reflection at 2.5km and clarity of the fault definition.

Figure 3 : Visualisation of a delineated channel feature present on a single layer produced by true 3D post-stack acoustic impedance inversion.

Normal 3D seismic mapping resulted in adequate structural configuration which in turn led to a better understanding of the hydrocarbon distribution. Detailed attribute analysis by correlation with well data helped in mapping sand development. The resulting correlation was then used in the calibration of the seismic attributes.

Volume interpretations showed variations in acoustic impedance properties within the field. By setting appropriate threshold cut off for visualising the data, the significant geological bodies have been tracked. With bodychecking, the connectivity of these geological features in 3D space has been assessed. The lack of connectivity between the fields at shallow reservoir levels could explain the different hydrocarbon accumulation conditions at these levels. The isolated sand body in the northern flank of the O70 reservoir has been shown to be the reason for the difference in the original hydrocarbon contacts.

Production from these intervals has been related to the distribution of the sand bodies. The result of the volume interpretation has been useful in understanding the reservoir sweep efficiency. This has been used to optimise further field development.