

Application of AVO Attributes on Seismic Reflection Data from Hormoz Area of Iran

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Abstract

To determine hydrocarbon reservoir in a carbonaceous formation, AVO attributes were applied on a seismic line placed at Hormoz area in the Persian Gulf. Most of the rock strata in this region are carbonaceous and potentially oil producers. The study of this region has began recently and the experts have many reasons, based on log data and some productive wells, to be hopeful in finding a hydrocarbon reservoir specially in a carbonaceous formation so-called Asmary.

The line under study is about 50 km long with a horizontal resolution of 12.5m and sampling rate of 4ms while processing. The processing procedure consists of surface consistent amplitude correction and F-K, S/N dynamic and Radon filtering, followed by application of surface consistent de-convolution.

After processing a gradient anomaly was determined at the Asmary Formation level on the seismic section that may be a clue to a gas reservoir. The result was important because it showed a relatively large negative AVO gradient. All other geologic evidence like structural settings of the region confirm the obtained result.

Introduction

AVO study has been applied in the oil industry since last few years. Usually, after seismic reflection data acquisition we start data processing and then interpretation takes place. While, normal interpretation procedures are based on promotion of observed less energy reflector, suppression of noises and multiples, in the AVO processing step, recovery of reflection's amplitude level to its true value is the main purpose. In this case a correct analysis of amplitude variations versus incidence angle must be achieved. Existence of gas content into porosity of the rock's reservoir will reduce the P-wave velocity value and therefore the behaviour of the reflection will be changed. This change has a direct relation with the elastic parameters such as Poisson's ratio. When the rock is saturated with gas content, the P-wave velocity decreases and the S-wave velocity increases. Koefode(1955), presented a clear relation between Poisson's ratio and amplitude variation of a reflection. Shuey(1985) derived a simple equation from the Zoeppritz's laws. In this equation a linear relation between incidence angle and reflection coefficient defines the reflection amplitude. The following equation is one of the important one among those related equations pre-

sented by other scientists.

$$R(\varphi)=R_0+B\sin^2\varphi \quad (1)$$

Where $R(\varphi)$ is the reflection's amplitude with an incidence angle (φ) and R_0 is the amplitude of a vertical incidence reflection. Each parameter can show us the physical properties of the upper and lower media of the reflector. Now if we set a gather versus the incidence angle instead of offset, we are able to study amplitude variations with incidence angle(AVA). Since the aim of this paper is not to explain the theory, therefore we continue with an application of AVO attributes on a marine seismic line at the Hormoz area in the Persian Gulf.

In recent years gas exploration boomed in this area. The Iranian Oil Ministry desired to carry out AVO attribute, analysis on some of marine reflection data. The present work is an outcome of this analysis to a prospect in a Gas field reservoir in this area.

Geology

The study area is located at the southern part of the Ghesm Island in the Persian Gulf. From the geological point of view, the seismic

line is located on the Pars and Bangestan Group Formations. In this area, the Asmary Formation with change of its facies has proximity with vaporised formation. Existence of discontinuity and salt dome in this area has caused the area to be a hydrocarbon rich field. Most of the rock strata in this region are carbonaceous and potentially oil producers

Processing Sequence

Seismic reflection data has been acquired with a sampling rate of 2ms with 240-channel equipment. The shot intervals were 25m. To economise the CPU time and memory allocation, the data were re-sampled to 4ms.

In this work the dominant noise were multiples, therefore true amplitudes of reflections were mainly influenced by this noise. The restoration of reflection's amplitude to its origin was the main step of data processing. In this context compensation of spherical divergence and inelastic absorption of wave propagation were made. Amplitude correction and trace balancing were made within a certain window. To suppress multiples Radon filter was applied. Super CDP gather files were provided to suppress the random noise in the data.

Figures 1 (a, b, c) contains three seismic sections. Figure 1a shows the intercept amplitude section i.e. seismic stacked section with an incidence angle equal zero. Figures 1b shows the amplitude gradient section that indicates reflectors with a negative gradient within 1600 to 2000 ms. Note that, the clear existence of such reflector cannot be seen on the left section (Figure 1a). Figure 1c shows the gradient multiplied to sign of intercept. This subsection indicates clear reflectors within 1600 to 2000 ms same as Figure 1 b.

Results

Application of different operator resulted in significant amplitude recovery, while before the usage of such operators, the reflectors were poor (Figure 1 a). In this Figure the reflectors are of such a kind that there is no evidence for presence of any strong reflection in a vast time and depth span (1600 to 2000 ms). This improvement

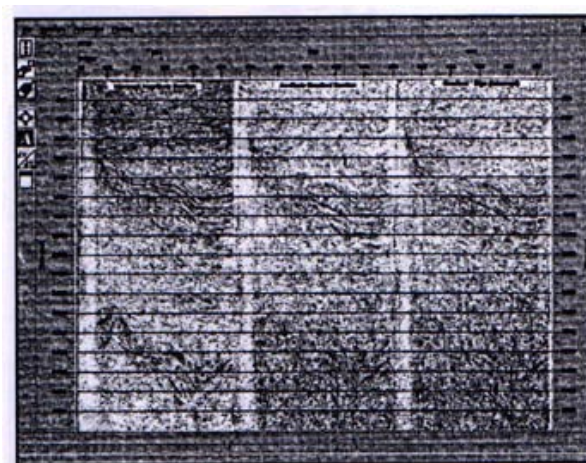


Fig 1(a,b,c) showing a) intercept amplitude section
b) amplitude gradient section c) gradient multiplied by sign of intercept

played an important role when the amplitude gradient section was provided (Figure 1b). AVO attributes showed that strong reflectors can be reconstructed while the section seems to be transparent (Figure 1 a). Instead, a great care has to be taken during processing to avoid some inconsistency to the top and bottom of the stacked section (see Figure 1 b). Observation of a negative gradient along a reflector (i.e. the gradient of a reflected wave at a certain time instead of increment in offset or incidence angle) may indicate an existence of gas content. The reservoir here is carbonaceous and it is an example of stratigraphic trap.

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