THE AVO APPLICATION IN HYDROCARBON EXPLORATION, NILE DELTA, EGYPT.

(A REAL CASE STUDY)

M.Sc. Thesis

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN GEOPHYSICS

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Abstract

Seismic data are used in petroleum exploration to define geologic features in the subsurface. The effects of rock and fluid properties on seismic attributes have been examined recently in seismic exploration to analyze the prospectivity of the study area.

This thesis studied the fluid properties and their effect on seismic response and attempted to relate the seismic attributes computed from 3D seismic data covering the SUN field Pliocene discoveries and some other nearby Pliocene DHI prospects located in the offshore Nile Delta, Egypt. Amplitude versus offset (AVO) attributes are studied for lithology differentiation and hydrocarbon indication.

A number of published predictors are used to model reservoir data and to study the fluid properties and their seismic significance. The models include the Batzle and Wang model to predict fluid properties, the Gassmann-Biot model to predict rock velocities as a function of saturating fluids, and the amplitude variation with offset model (AVO) using Zoeppritz equations to predict seismic response from the layered rock properties.

The modeling of SUN field illustrates the benefits of using AVO analysis methods, as the SUN field is covered by two different seismic surveys; and each survey covers one Pliocene direct hydrocarbon indicator (DHI) discovery and some nearby Pliocene DHI prospects. In this study, each seismic survey was studied

separately, because different kinds of data are available for the two surveys.

First case study: (SUN-1 discovery, STAR and JUPITER prospects), where the common depth point (CDP) data (pre-stack domain) of the older seismic survey are not amplitude-preserved. So, the AVO analysis will be based only on the partial stack data and the enhanced pseudo-gradient analysis.

The second case study: (SUN-2 discovery and MOON prospect) lies in a more recent seismic survey. So, it will be supported by CDP gather, angle gather analysis, attribute analysis and intercept versus gradient cross plotting.

The sand reservoirs of the discoveries and the prospects either within the faulted anticline closures (like the SUN field discoveries and the JUPITER prospect), or the sand channel features (like the STAR and the MOON prospects) are surrounded by the water bearing Pliocene shale. So, the seismic data show significant reservoirs thickness due to the change of the density and the velocity between the gas bearing sand layers and the water bearing layers.

The flat spot due to the gas water contact (GWC) can be detected in the seismic data which can be proved later by the well logs. The positive AVO analysis results of the SUN field which are similar to the results of the nearby prospects by using different AVO analysis techniques give good indications of the presence of dry gas in the sand reservoirs of these prospects.

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