

THE INVESTIGATION OF FLUID PROPERTIES AND SEISMIC ATTRIBUTES
FOR RESERVOIR CHARACTERIZATION

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A THESIS

Submitted in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE IN GEOLOGICAL ENGINEERING

MICHIGAN TECHNOLOGICAL UNIVERSITY

1999

This thesis, "THE INVESTIGATION OF FLUID PROPERTIES AND SEISMIC ATTRIBUTES FOR RESERVOIR CHARACTERIZATION", is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN GEOLOGICAL ENGINEERING.

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ABSTRACT

Seismic data are used in petroleum exploration to define geologic features in the subsurface. Recent advancements in seismic exploration have examined the effect of fluid and rock properties on seismic attributes. These advancements may provide improved reservoir characterization using techniques examined here. This is accomplished two parts; first, a study of fluid properties and their effect on seismic response; second, an attempt to relate the seismic attributes computed from a 2-D seismic line to the fluids and the rock framework in a particular reservoir in Michigan.

To study the fluid properties and their seismic significance, a number of published predictors are used to model reservoir data. The models used in this study include the Batzle and Wang (1992) model to predict fluid properties, the Gassmann-Biot model to predict rock velocities as a function of the saturating fluids, and the amplitude variation with offset (AVO) model using Zoeppritz' equations to predict seismic response from the layered rock properties.

The Batzle and Wang (1992) model results are compared to the Batzle and Han (1997) laboratory data to establish the usefulness of the model as a predictor of fluid properties and found to perform reasonably well, although the model slightly underpredicts the velocity of live oils and overpredicts the velocity of dead oils. As a result, this model can be used for specific reservoir cases.

The Batzle and Wang, Gassmann-Biot, and Zoeppritz models are applied to a Gulf of Mexico field; the acoustic impedance and Poisson's ratio are determined and it is shown that an AVO response is present as a result of the fluid and rock properties. The modeling of Lobster Field illustrates the usefulness of predictors described in this thesis for modeling the reservoir through time as it is produced and the pressure decreases.

In an effort to apply these concepts to actual seismic data, 2-D seismic data from Crystal Field, Michigan was evaluated with the intention of identifying a large amount of by-passed oil that has been left between many wells. As a means for identifying by-passed oil, efforts were made to enhance seismic imaging of

faults or karstic features in Crystal Field based on seismic attributes. Karstification and increased porosity or fracturing were not observable on the seismic data due to acquisition parameters that limit the usefulness of the data in the shallow section.

Data acquired for shallow horizons may be very useful for evaluating the seismic attributes in other fields in the Michigan Basin if the fold and offset ranges are appropriate. Good quality seismic data for the horizons of interest is necessary to evaluate seismic attributes.