Economic Development of Shallow Oil Sands in Trinidad, West Indies Using Electrical Conductivity Imaging

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ABSTRACT

Middle Pliocene oil sands occur near surface in the Morne Diablo Field in Trinidad, W.I. Historically there has been little interest in developing these sands, as they have been considered too shallow to be economic. The economic potential of the shallow sands was re-evaluated using new technology and a new development strategy. Evaluation included geologic mapping based on electric logs, production history analysis, and surface Electrical Conductivity Imaging. For the first time in Trinidad, the technology of surface Electrical Conductivity Imaging (magnetotelluric, MT) geophysics was carried out to test for resistive geo-electric strata which may correlate with the shallow oil sands. The results of the MT data were integrated into the geologic maps already developed using existing well data. Evaluation of the resultant composite maps revealed potential oil bearing sand trends which were not previously identified using traditional well log data.

In order to test the trends, formation specific planning was developed for the drilling, completion, and production operations to minimize cost and reduce damage to the low pressure, unconsolidated formation and hence maximize production.

Thirteen wells were drilled on the basis of geologic mapping and the MT technology results. All wells were completed having encountered the target sands ranging from 8’ to 380’ from surface. The paper reviews the economically successful results of the shallow wells in proving up additional oil reserves in the Morne Diablo Field.

The paper concludes that the use of new geophysical tools like surface Electrical Conductivity Imaging may allow cost effective data collection to aid in development and recovery of additional shallow reserves in mature fields that would otherwise be bypassed.

INTRODUCTION

The Morne Diablo Oil Field, located in southern Trinidad, W.I. was first developed in 1937. Predominantly oil was produced from Middle Pliocene to Middle Miocene sands ranging in depths from 900 to 6000 feet. Several surface hole well logs showed the presence of shallow sands at depths less than 500 feet. Resistive shallow sands as indicated on well logs were concluded to be either fresh water or possibly oil bearing. Limited testing was carried out on some possible oil sands, however rapid decline of oil production due to water inflow proved the sands uneconomic.

In 1991 well MD 45 was perforated in resistive shallow sands and continues to produce oil to date. Investigation of the shallow sand potential in the area using electrical conductivity imaging, devising a economic development strategy and follow up drilling of 13 wells is discussed in this paper.

ELECTRICAL CONDUCTIVITY IMAGING

The method discussed in this paper incorporates the use of surface measurements of the earth’s magnetic and electrical fields from discrete stations along an arbitrary line. The signals measured are from two sources. First, the natural electromagnetic signals from the earth and second, man-made signals from a transmitter. The signals from the transmitter compliment the natural signals and fill in voids in the earth’s signal spectrum.

Data acquisition involves the placement of two electrical dipoles and two magnetometers, orthogonal to each other, in the ground at each station along an arbitrary line. The receiver measures a band of frequencies from the earth and transmitter sources. Different frequencies are able to resolve features at varying depths. Low frequencies are required at depth and high frequencies near surface. The receiver simultaneously measures the electrical and magnetic fields and transforms them to an apparent resistivity profile.

The field data was acquired using 82 and 165-foot dipole spacing along lines from 330 feet to 1500 feet in length (Figure 1, Basemap). Measurements were made at each adjacent station, providing a continuous profile along the line.

The data shown represents field data and was not processed to remove any spurious responses or noise. Spurious data can be seen as discrete resistivity anomalies at single stations which do not continue to adjoining stations. Resistivity profiles were then generated, interpreted and results incorporated into geologic maps (Figure 2).