ABSTRACT

The Tulip 3D seismic survey was the first Coil Shooting - circular geometry- project acquired with a single towing vessel in Indonesia. Coil geometry acquisition records a dataset with a wide range of source to detector azimuths. Amongst the numerous advantages of extended azimuth sampling methods is the advantage of illumination diversity. This has a desirable impact with tomographic velocity model building for depth imaging. The additional azimuth information allows an additional constraint on the tomography (if the software supports it) by providing a network of intersecting rays not available with narrow azimuth geometries.

This case study will describe the multi-azimuth tomography model building and subsequent depth imaging used in the Tulip coil 3D project. It is believed this is the first commercial application of multi-azimuth tomography model building and depth imaging in Indonesia.

INTRODUCTION

The Tulip survey is located in the Bukat PSC block east of Kalimantan Island, offshore Indonesia. The field is located in a water depth of 350-1500m on the continental slope. Shallow over-burden gas, very heavy faulting, sub-surface channels and gas hydrate pockets present throughout the survey area. The target reflectors have very low acoustic impedance contrast and are heavily contaminated by surface and inter-bed multiple energies. The consequences of these complexities is poor overall seismic response, very low amplitude or near invisible target reflections, very low signal-to-noise ratio (S/N), poor imaging and poor illumination of the reservoirs. In order to achieve a better imaging of the zone of interest and reservoir characterization for the reservoir appraisal campaign, ENI successfully acquired a Coil shooting (French, Cole, 1984; Durrani et al, 1987) survey on the Tulip discovery in August-September 2008. The acquired data was processed through to depth imaging utilizing multi-azimuthal tomographic velocity model building and the depth imaging of the survey was completed in January 2010.

It is well known that the benefits of an extended azimuth (multi, wide, rich etc) dataset include not only the illumination improvement, increase in signal-to-noise and event continuity, reducing multiples and enhancing amplitude fidelity, but also help in improving the azimuthal tomography velocity model updating and imaging. However, velocity model building with full multi-azimuth data requires the use of a tomographic method that can fully comprehend the ray-path between the source and receiver, and correctly account for the source to receiver azimuth contribution of each source to receiver residual moveout (RMO) analysis.

Multi-Azimuthal Anisotropic Velocity Model Building and Depth Imaging Workflow

In the Tulip survey, Coil shooting configuration was used to record full azimuth data with a very high density offset-azimuth fold. This additional azimuth information allows us to better constrain our full multi-azimuth tomography to produce a detailed velocity model with high degree of accuracy. Although the Coil recording produces a high density of irregular fold, and offset and azimuth distribution, after careful spatial regularization in the earlier processing, we were able to split the full azimuth datasets into 29 offset groups, and three 60 degree wide azimuth sectors for migration velocity...