

3D COIL SHOOTING SURVEY ON TULIP FIELD: DATA PROCESSING OVERVIEW – PLANNING, CHALLENGES AND OPPORTUNITIES

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The Tulip 3D survey is a single-vessel Coil Shooting project east of Kalimantan, offshore Indonesia. The coil geometry is very different to the conventional race-track towed streamer approach. Whilst it results in many acquisition and imaging benefits, the circular geometry introduces several differences, a number of new challenges and opportunities in data processing. A fit for purpose processing workflow was tailored to address the challenges, and at the same time taking advantage of the opportunities provided by the circular geometry.

The Tulip survey area is geophysically very complex due to the presence of several unfavourable geological factors, especially in the near surface. In particular the rough sea bottom and very bright Bottom Simulating Reflectors (BSR) below the seabed generate several orders of multiples and degrade the subsurface illumination. The presence of free gas below the BSR causes a sudden frequency and amplitude decay of primary reflections. Complex subsurface geology further complicates the scenario. All these conditions when combined result in very strong and high orders of surface multiple reflections, diffracted multiples, absorption, scattering and poor transmission of seismic signal energy. The consequences of these complexities is overall poor seismic response, very low acoustic impedance contrast at the reservoir level and therefore extremely 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 for the appraisal campaign, eni successfully acquired a Coil shooting (French, Cole, 1984; Durrani et al, 1987) survey on the Tulip discovery. The acquired data was processed through to depth imaging utilizing multi-azimuth tomography velocity model building.

The circular geometry introduces several differences and new challenges in survey design, modeling, acquisition and processing workflow (Reilly, Hird, 1994; Reilly, 1995). For Tulip survey, a careful pre-survey modeling and processing simulation was critical to evaluate the feasibility of future post-acquisition processing of the survey, with respect to both the geophysical challenges and the geometry induced constraints and opportunities. Prior to the commencement of the acquisition, a subset volume of 3D synthetic data with coil geometry was generated to assess the application of 3D processing algorithms. When processing a Coil shooting survey,

the first difference, compared to the conventional data, is the presence of the turn noise due to acquiring data while the vessel and cables were tracking continuously in circles. The level of noise is inversely proportional to the curvature radius of the circles being acquired and proportionally related to any apparent crossflow of currents. The second aspect and very different to the conventional processing is related to the spatial sampling, with the Coil shooting geometry, the trace offset distances are not regularly spaced in the shot or midpoint domain. This result in the midpoint/offset clustering inside the circles and inducing some apparent geometrical or moveout distortion in the seismic reflections, which makes the application of conventional straight sail line based processing methods unsuitable. The third and perhaps the main challenge related to the Tulip's geometry is the although very high, but irregular fold of coverage, resulting in amplitude footprints, which change position as a function of the incidence angle, and require proper treatment in order to avoid amplitude inconsistencies and migration artifacts.

On the advantages and opportunities aspects, the circular geometry allows the full 3D processing algorithms to work at their best. The true-azimuth 3D demultiple tools work very well for the Tulip survey. The same conclusion is valid for velocity model building and migration algorithms due to the large azimuthal content.

This paper will discuss some of the pre-emptive measures taken during the survey design stage prior to both acquisition and processing as well as the overview of the processing experience of the Tulip project and some relevant results.

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