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ID 504: VELOCITY CONDITIONING FOR AN IMPROVED DEPTH CONVERSION

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Summary

The time to depth conversion through the use of analytical functions has been a common procedure in seismic work for many decades. This paper describes a methodology for time to depth conversion based on the construction of a debiased velocity grid calibrated with a number of velocity functions.

Introduction

Seismic two-way reflection time (TWT) portrays images of the subsurface. The conversion of these "time images" to depth structures is very crucial to reduce risk in well drilling. Since the only information between the wells is the seismic velocity, accurate velocity estimation is important for producing actual subsurface structure image and giving true reservoir location.

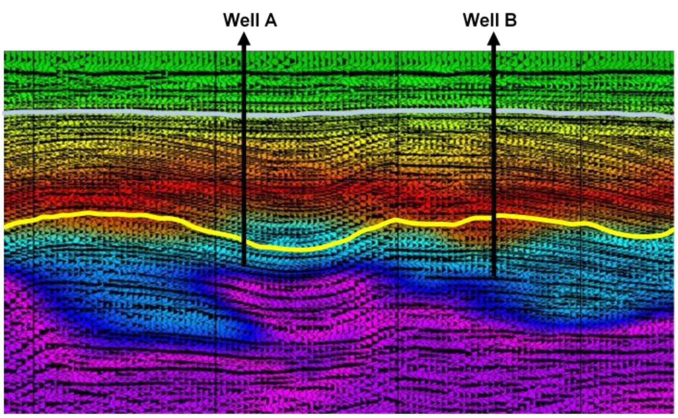

Figure 1*: The only information we have between the wells is the seismic velocity.*

This method described in this paper addresses the advantage of 3D seismic velocity which incorporates geologically feasible lateral and vertical velocity variations. As such makes it particularly suitable for time to depth conversion in complex structural environment. A series of quality control processing leads to increase in accuracy of the velocity model as well as reduction of cycle time.

Methodology

The methodology uses a calibrated 3D velocity data which starts with the construction of a 3D velocity grid and subsurface models, shown in Figure 2. Based on this surface model, a structural framework is developed (see Figure 3). The 3D velocity grid then undergoes a series of correction as to remove all the bias between the layers. Next, the structural framework is populated with a 3D debiased velocity model after calibration with well and seismic velocity information (Figure 4).

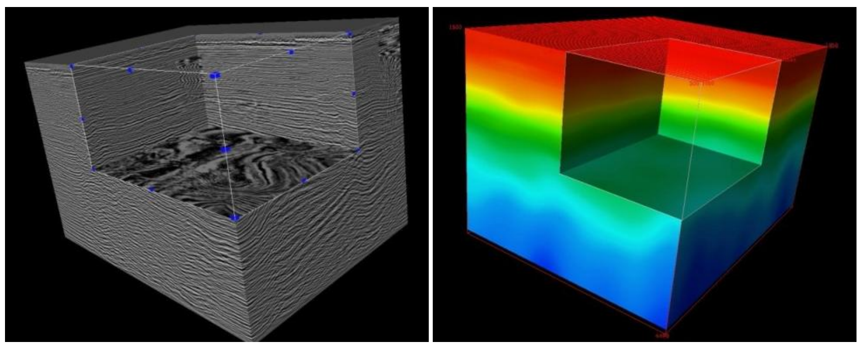

Figure 2: *The seismic volume and the seismic velocity models of the study area were obtained after Pre-Stack Depth Migration processes.*

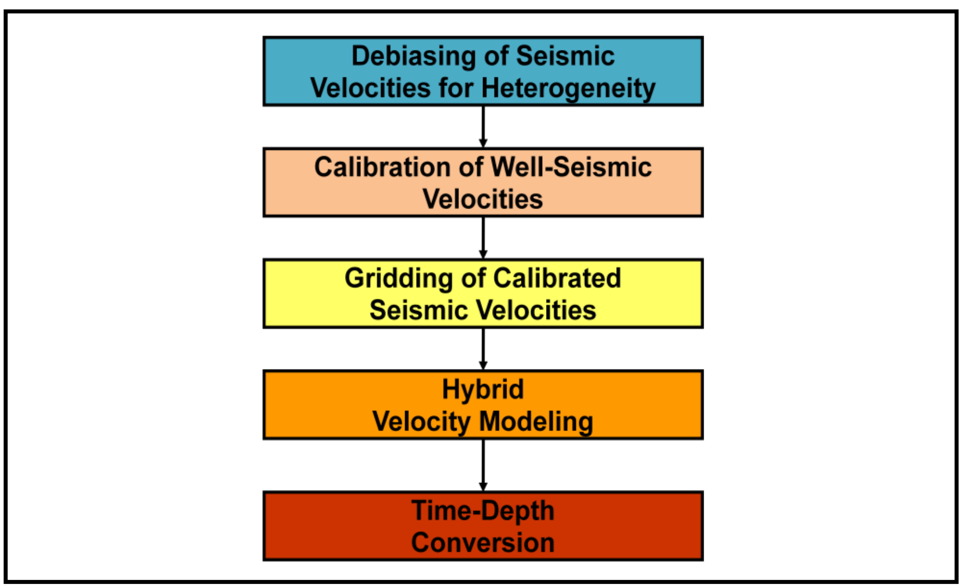

Figure 3: *The proposed workflow of hybrid velocity modeling which incorporate interval and instantaneous velocities based on layering (structural framework)*

The workflow was tested on the selected field in Malay Basin. This work used about 400 square kilometers of study area involving well data, 3D Seismic Data and interpreted horizons (Figure 6). The field exhibits a large anticlinal feature with several domal culminations. The domal was gas-filled and the effect is prominent in the velocity model where it shows lateral velocity variation and velocity sagging beneath the gas zone (Figure 5). The application of this methodology has allowed for reduction of the time for the depth conversion to a 10% from the originally planned time with a remarkable increase in accuracy by about ±3%. Figure 7 shows an example of a depth converted horizon.

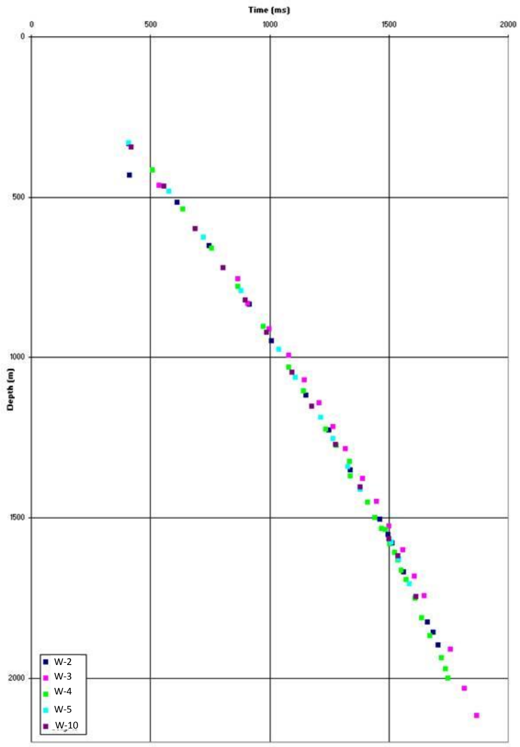

Figure 4*: Composite checkshot of all wells in the area. Seismic Velocities were calibrated to the nearest well checkshots before the velocity modeling*

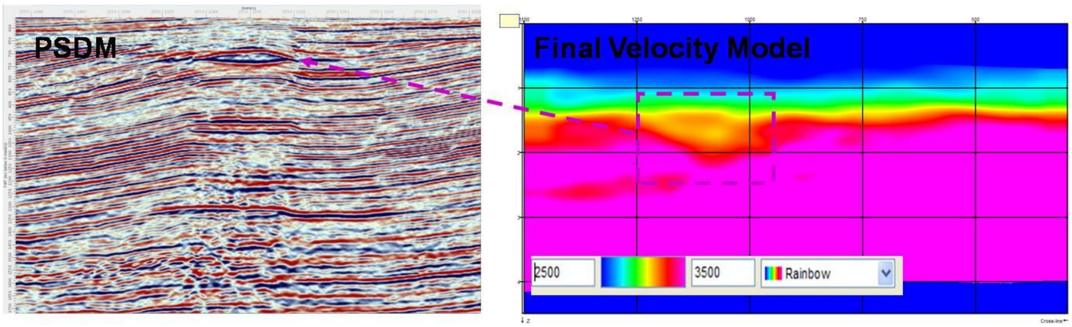

Figure 5*: The effect of gas presence was captured in the velocity model as velocity sagging can be observed from the modeling.*

Result

The application of this methodology helped to solve the problem of lateral velocity variation. A 3D velocity grid is modelled by considering the main structural and stratigraphic features. 3D velocities model from seismic and checkshots are corrected for biased, then calibrated and populated. The result is a new Hybrid Velocity 3D grid that has considered the complex spatial geometry of the structure and the effect of low velocity shallow gas sands. The 3D hybrid velocity model Interval Velocity grid is vertically integrated and mathematically operated to be transformed into the 3D grid used in the depth conversion process. Finally the error in the depth prognosis process was considerably reduced to about 1% (for average 3000m depth).

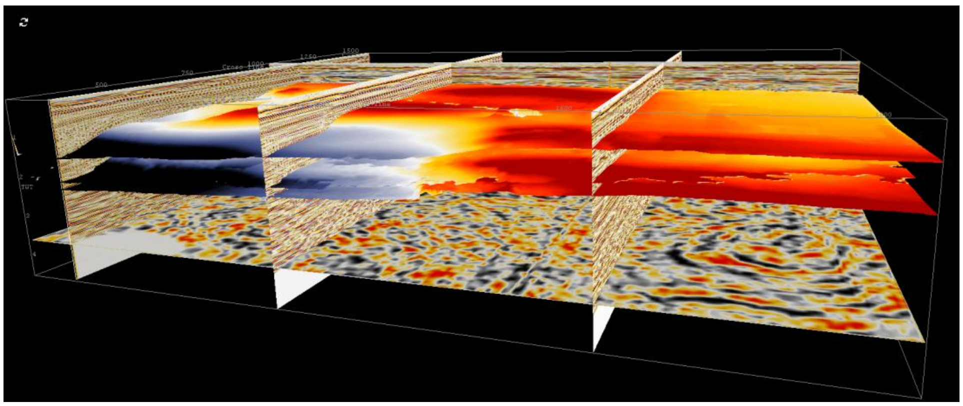

***Figure 6**: Seismic section shows horizons used for hybrid velocity modelling*

7(a) **7(b)**

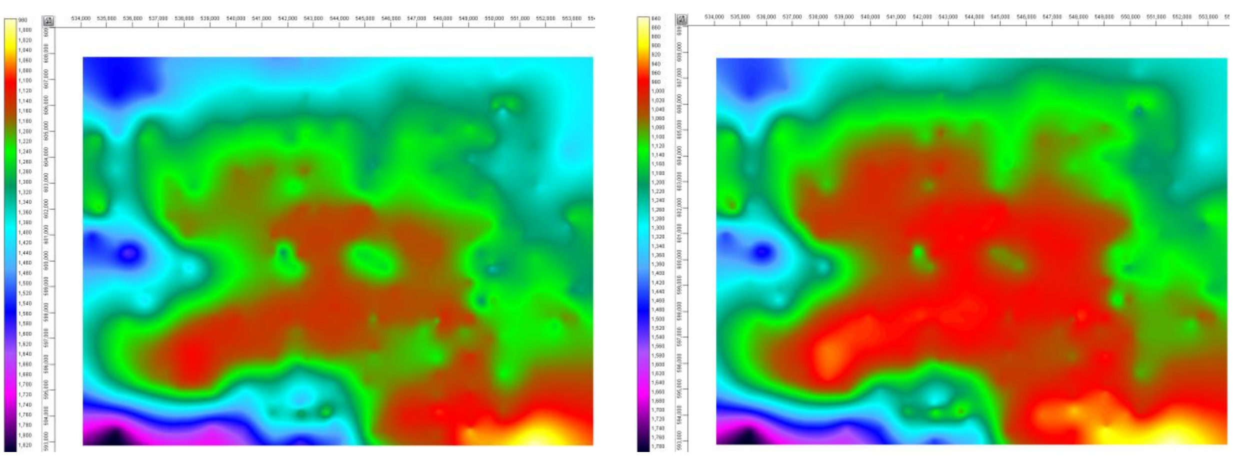

***Figure 7:** a) Picked horizon, before time to depth conversion. b) The red horizon after converted to depth using 3D Hybrid Velocity 3D Grid.*