P 147

Incorporating different data types in velocity modelling

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Summary

Since PSDM is a relatively expensive and time consuming procedure, although more accurate than PSTM, majority of the oil industry relies on the latter. The simple technique of velocity modelling coupled with any depth conversion scheme, the simplest being the vertical stretch technique, can serve as an alternate to PSDM. Hence it can be stated as poor man's PSDM.

Keywords: *Velocity Modelling, Pseudo Interval Velocities, Dix interval velocities, vertical stretch*

Introduction

Velocity modelling is an essential and challenging aspect of seismic interpretation. Better and more accurate depth imaging entirely relies on the accuracy of the velocity model.

Based on their accuracy, data types can be categorised into different categories. Most accurate data or hard data are the well logs available. Semi-hard data include the VSP/Checkshot data and soft data is the processed (migrated) seismic data available. Incorporating the data by deriving the velocity information from them and calibrating them logically can yield better velocity models.

Methodolgy

A velocity cube is created in space (lateral) and time (vertical) by specifying the lateral and vertical resolution, as per our requirement (sampling theory) and the system's capacity. At most half of the smallest feature we wish to resolve should be the lateral spacing.
Starting from the initial velocity model (Figure 1), default values of velocity (2000 m/s) are defined at each and every node in the cube. The data are incorporated in the cube and calibrated in order of their accuracy. Interval velocity plots from VSP/Checkshot data are directly used to derive the interval velocity plots which will be used. These plots are then vertically and laterally interpolated (Figure 2). Interpreted time surfaces from the seismic can also be used for additional structural control. Identified picks from the well logs and their corresponding interpreted horizons from the seismic data are then used to compute pseudo interval velocity field which is then included in the model (Figure 4). The one-to-one correspondence between the depth picks from well logs and time markers from seismic sections can be established by implementing seismic to well tie.

Incorporation of seismic data is necessary since it provides lateral resolution. The RMS velocities derived from time migrated seismic sections are Dix inverted to give interval velocities which are used in the model.

At each and every step, a new velocity field is generated which is then subtracted from the existing one to give an error cube which is adjusted in the existing velocity field. Keeping in mind the accuracy of the data, the velocities obtained from the seismic will be calibrated with respect to those from VSP/Checkshot which will be further calibrated with pseudo interval velocities from the well logs. Different options for model interpolation are available like Delaunay triangulation, Inverse distance and Normalized inverse distance, of which the latter has been used.

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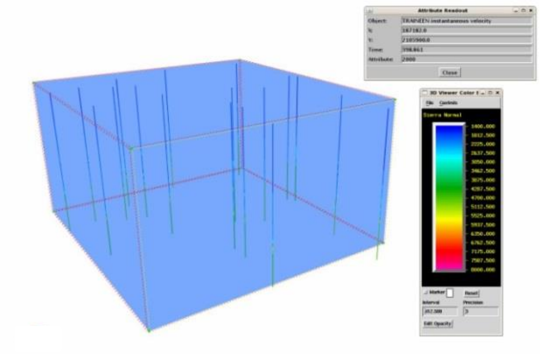

Figure 1: Initial Velocity model with default velocity = 2000m/s
Time (vertical) spacing = 12ms; Lateral spacing = 200m

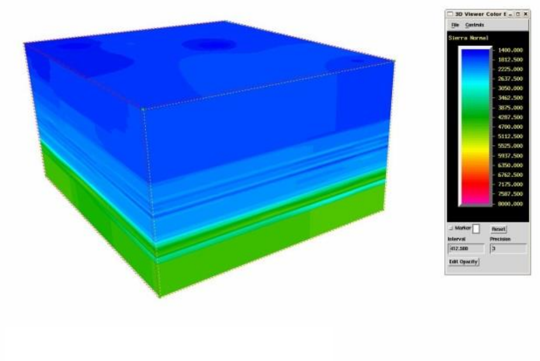

Figure 2: After inputting T/D functions

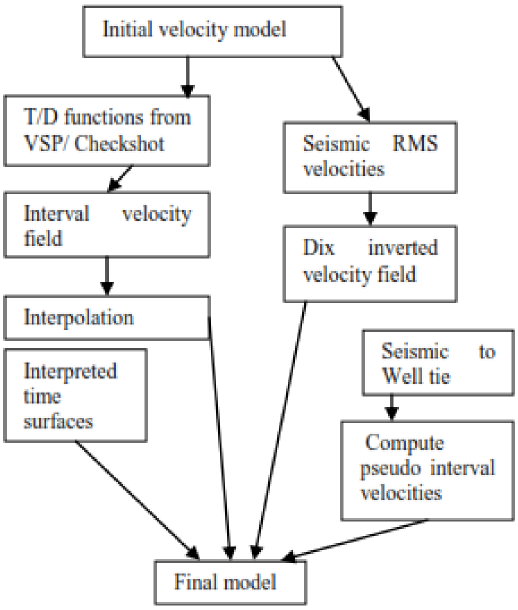

Figure 3: Velocity Modelling flowchart

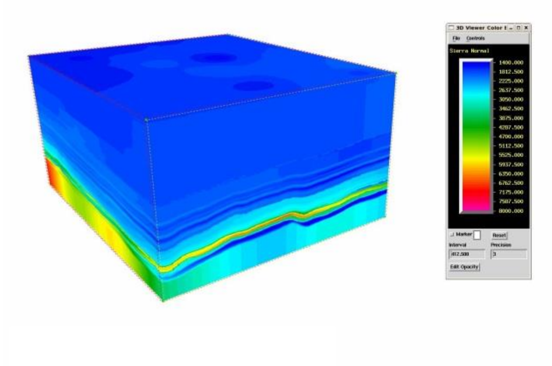

Figure 4: After inputting pseudo interval velocities

Figure 5 represents the final velocity model after incorporating the seismic Dix interval velocities.

A gridded approach to velocity modeling has been followed here. Although 3D time horizons have been also used, they simply bring out the variation of velocity laterally as a function of density (compaction).

Depth conversion of the model is performed by simple first order depth conversion technique, i.e. vertical stretch technique, keeping in mind the structural and velocity simplicity involved for the working area. It simply consists of multiplying the velocity model with one-way time from seismic for the desired line.

The input time section to the model and the corresponding depth section along a particular line are shown in figures 6 and 7 respectively. The depth section has depth converted horizons and well picks overlain to check accuracy of the velocity model.

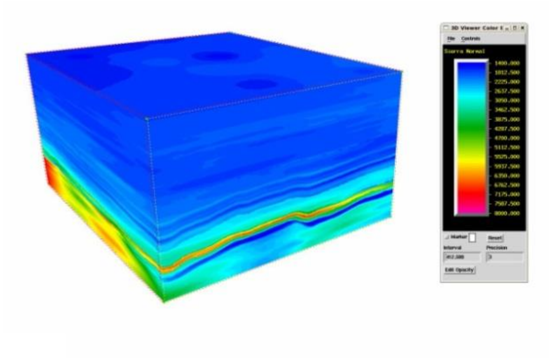

Figure 5: Final velocity model

Conclusions

By incorporating different data types and calibrating them logically, more accurate velocity models can be derived and better depth imaging is possible with diminutive lateral and vertical mispositioning, which are the two most common time to depth conversion errors. Refer to figures on next page.

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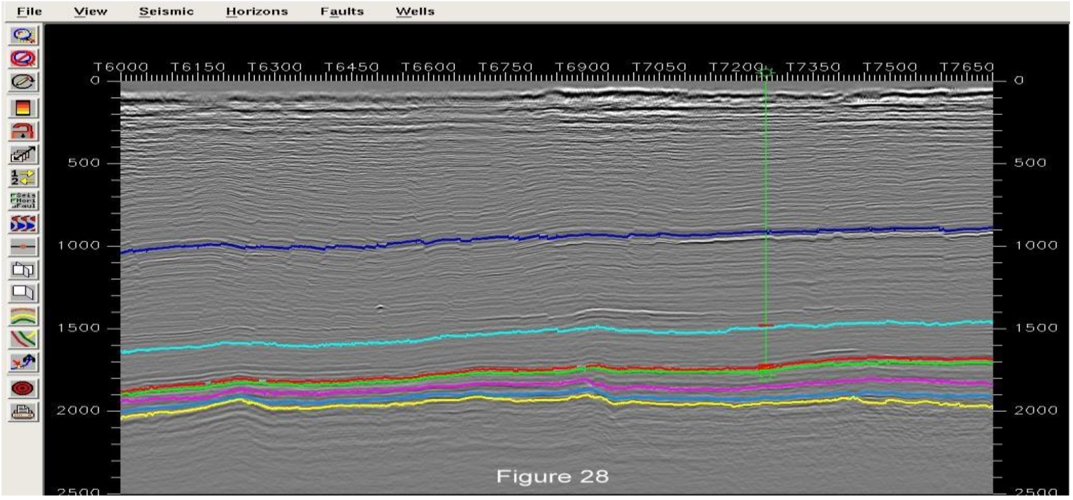

Figure 6: Input time section

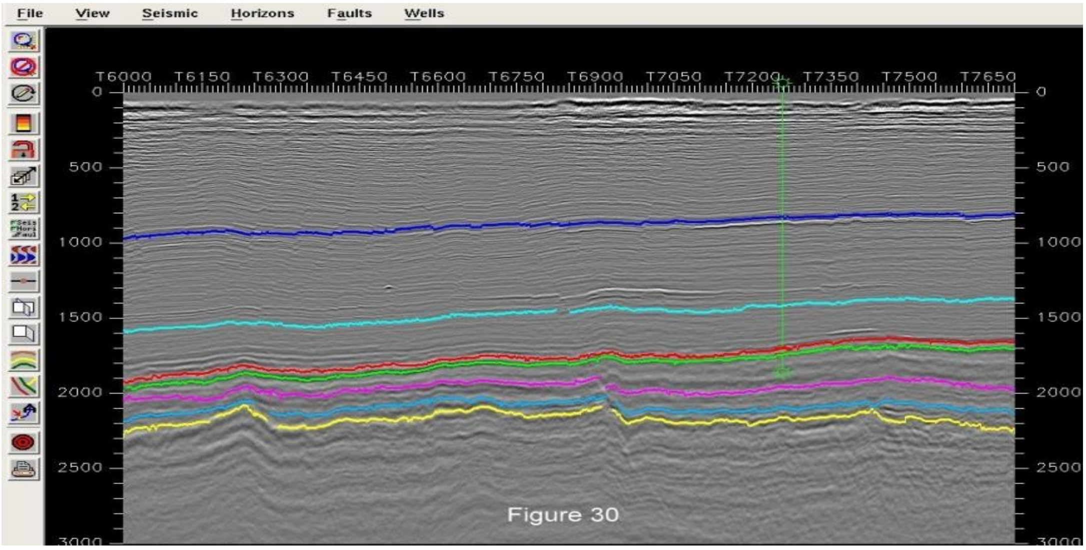

Figure 7: Output depth section