CASE STUDY

UDOMORE-DEPTH: ENGIE IS UPDATING REGIONAL V0,K VELOCITY MODEL BY USING SEISMIC PSDM VELOCITIES IN THE SOUTHERN NORTH SEA

SEISQUARE

UDOMORE-DEPTH
AN EXCLUSIVE PLUG-IN FOR PETREL
DEVELOPED BY SEISQUARE
www.seisquare.com

STAGE THE PROJECT

Exploration (Prospect evaluation)

Reference: Publication EAGE 2017
"Improving regional V0-k TD conversion of the Chalk using local PreSDM velocities – A Dutch Southern North Sea case study " (Ref:2)

CHALLENGES

- PSDM velocities covering the Target area show lateral variations inside Chalk layer & deviations from the trend established using more regional V0-k models. In some cases, the PSDM velocities even show changes of the trend (North or South-West directions)
- No clear visible structural closure for the prospect

SOLUTION

The UDOMORE structural workflow including **UDOMORE-DEPTH** (an Ocean plug-in for Petrel*E&P software platform) for the validation of the multilayer time-to-depth conversion with consistent uncertainty characterisation

RESULTS

- Assessment of the uncertainties of the PreSDM velocities for the TDC of 5 layers
- Updating the regional V0-k Chalk maps with quantified confidence
- Successfully updated, confirmed and validated structural closure of the prospect

UDOMORE-DEPTH ADDED VALUE

1) Multilayer Time-to-Depth Conversion
2) Quantification of all uncertainties
3) Multiple scenarios
4) Real-time
5) Easy-to-use

OVERVIEW OF THE PROJECT

When evaluating a prospect located in the Southern North Sea on recent 3D PSDM data, ENGIE could not confirm its structural closure. The main reason was the extent of the prospect with a spill point outside the PSDM dataset. Combining the PSDM data with older seismic datasets lead to large uncertainties and inconsistencies in the velocity field for TD conversion. The challenge posed by ENGIE was to create a reliable regional depth map regrouping 3 surveys and controlled by over 40 wells.

The regional area is displayed in Figure 1. It consists of the interpretation of three adjacents (partially overlapping)seismic surveys. The first central survey 1 is a recent PreSDM seismic dataset with a detailed velocity field resulting from tomographic updates during processing. Survey 2 to the North is an older merged time migrated dataset, for which no velocity model is available. Survey 3 to the East is a PreSTM seismic dataset, again with no velocity data available. The total area covered by these 3 surveys is about 2.000 km^2 and is penetrated by more than 40 wells down to the Carboniferous but by only 3 wells inside the survey 1 area.

The project consisted in using geostatistical methods, firstly, for validating PSDM velocities for depth conversion, then for updating the regional V0,k velocity model parameters to best match the well depth marker data and, finally, for reconciling PreSDM and updated regional V0,k velocity model. The result is a set of consistent single depth maps of key horizons with associated confidence.

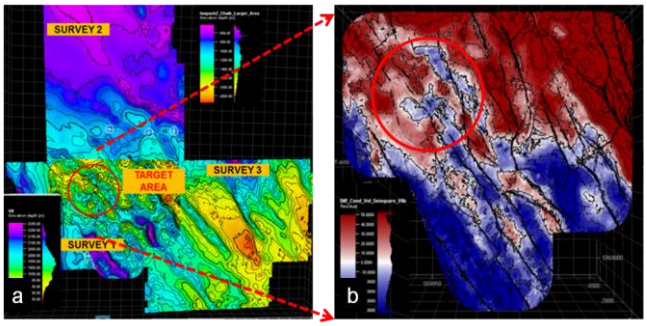

Figure 1:(a) Location map of the 3 interpreted surveys. The chalk isopach map is displayed for survey 2 and 3, and a V0 map derived from PreSDM velocities is superimposed for survey 3. (b)Survey 1: Depth difference map at top Rotliegend (target level) between time_depth conversion using constant V0,k and depth_depth conversion using PreSDM velocities indicating over 75m meters difference in the target area.

THE UDOMORE APPROACH & ITS BENEFITS

ENGIE acknowledged that UDOMORE structural workflow including UDOMORE-DEPTH Ocean plug-in for Petrel* E&P software platform was essential for characterising uncertainties on PSDM velocities that are considered for time-to-depth conversion and to derive reliable depth at the relevant horizon for validating the structural closure of the prospect with confidence.
The UDOMORE structural workflow breaks down as follows (Figure 2):

- Data preparation
- Spatial Data Assessment and Spatial Data Conditioning (SDC) of PSDM velocity fields on five 2D time interpretation maps for 5 layers;
- Updating the regional velocity field model using conditioned PSDM velocities;
- Benchmarking and ranking alternative depth conversion scenarios by using UDOMORE-DEPTH plug-in.

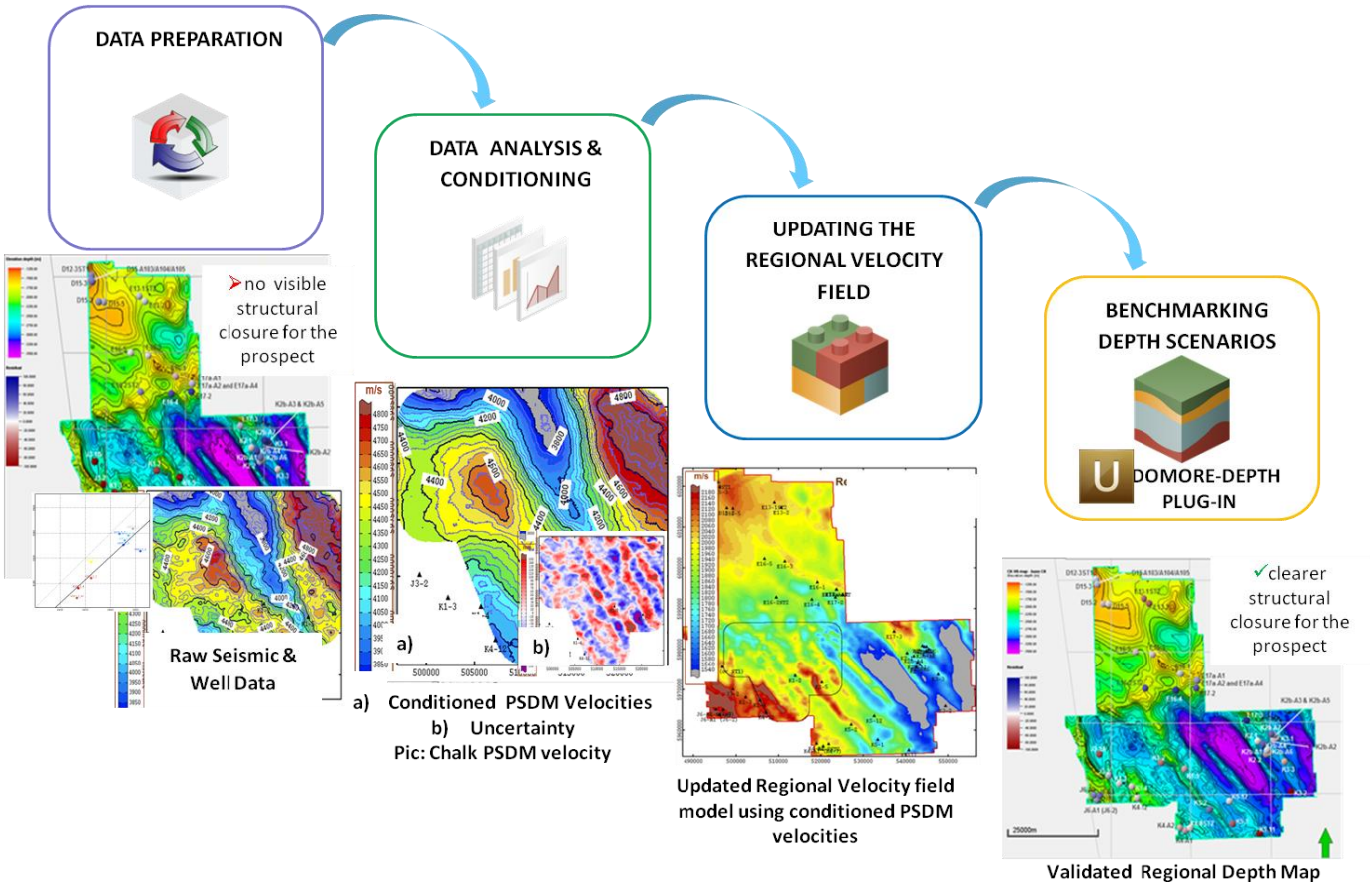

Figure: 2 The UDOMORE Structural workflow applied in the ENGIE Case Study.

Following data preparation, the Seisquare team performed Spatial Analysis and Conditioning of the PSDM velocity fields (Ref 3 L.Sandjivy and al.). It enabled on the one hand to "best estimate" the spatial components from the velocity data sets that contribute to depth conversion, and on the other hand, to "filter out" noisy components that are irrelevant for depth conversion (Ref 4 L. Sandjivy and al.). The main focus of this step has been on the velocity variations in the Chalk, which are most likely related to the burial history. Further, a geostatistical relation between the thickness of the Chalk and the conditioned PSDM V0 map of the Survey 1 has led to an improvement of the updated regional V0_k model using conditioned PSDM velocities. Analysis and Conditioning of PSDM velocities ensued the best calibration of the seismic & well data and quantification of uncertainty on it.

In the next step, the updated regional velocity model with conditioned PSDM velocities showed considerably lower residuals at the wells over the entire area and more reliable depth maps of the base Chalk and deeper key valid horizons comparing to a classical V0-k model with constant V0.

Further, UDOMORE-DEPTH plug-in was used for benchmarking and ranking alternative depth conversion scenarios. UDOMORE-DEPTH simultaneously minimised the depth residuals for the five horizons at all the wells (Ref 1 P. Abrahamsen) before launching any computation. This allowed saving months of the project. The resulted stochastic time-to-depth conversion after Spatial Analysis and Conditioning of PSDM velocities are better matching the well depth markers, and it is significantly different (over 75m) at some locations from the original time-to-depth conversion. UDOMORE-DEPTH allowed to integrate seismic & well data and quantify confidence in the depth & velocity models. Likewise, UDOMORE Structural Workflow was beneficial for the operational support for decision-making.

STRUCTURAL CLOSURE VALIDATION

Using UDOMORE structural workflow and, mainly, UDOMORE-DEPTH plug-in enabled to combine high-quality PreSDM velocities in a restricted area with a detailed V0-k analysis over a wider area to improve the overall time-depth conversion and validate structural closure. The resulting depth maps of deeper horizons obtained through UDOMORE-DEPTH have supported the exploration allowing a much more accurate spill point analysis.

UDOMORE structural workflow provided ENGIE with proven and compelling value for supporting drilling decisions. ENGIE can now use these results for further structural reservoir characterisation (closure probability above contact or spill point) and volumetric analysis following by new drilling campaign.

Acknowledgements

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