Time correction to eliminate structural ambiguity on velocity anomaly in the upper cibulakan formation of ITEUNG field, northern West Java basin

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Abstract. Converting seismic data or structural maps from time to depth domain is very important in the stage of oil and gas exploration. Interpretation in time domain often produce inaccurate interpretation especially in zones under high velocity such as sub-salt or sub-carbonate. Under this zone, there are pull up velocity anomalies or pseudo-anticline. Otherwise in zones under low velocity such as water bottoms with sharp or fluctuating slopes (canyons), loose material overburden or rapid sedimentation, under detached electric normal faults and shale flaps, there are push down velocity anomaly or pseudo-syncline. The study area is in the Main and Massive Formation of ITEUNG Field, Northern West Java Basin where is proven to have petroleum potential. In the study area there are pull-up velocity anomaly or pseudo-anticline even though in reality they are just flat or even syncline due to the location in the zone under high velocity. This study aims to correct velocity anomaly by doing time correction and convert the time domain structure map into depth domain structure map with the time-depth curve method to eliminate structural ambiguity on velocity anomaly. The result shows that the map is obtained in the form of a depth domain structure map which is more accurate than the time domain structure map. Depth structure map make the interpretation more accurate because the structures in depth structure map is more similar to the original sovereignty after correlating with well data. In this present study shows that pull up velocity anomaly can be avoided so that interpretation can be done more accurately.

1. Introduction
Seismic data conversion is needed in oil and gas exploration. Seismic data conversion is done by changing the map structure from the time domain to the depth domain. Decision making for the drilling process from the results of interpretation in the time domain is very important [1]. This is because interpretation in the time domain will produce interpretations that cause ambiguity, especially in zones under high speeds such as sub-salt or sub carbonate. Under this zone, there is an apparent velocity anomaly or anticline pull up, even though in real conditions it is just flat or even sync. If the zone is under a low speed such as a water bottom with a sharp or fluctuating slope (canyon), loose material overburden or rapid sedimentation, under detached normal faults and the shale is flushed, a push down velocity anomaly or false sync will be obtained, whereas in actual circumstances it is anticline [2].
The purpose of this study is to obtain the structure mapping after correcting the velocity anomaly obtained by converting a time domain structure map into a depth domain structure map. The research location is in the formation of Parigi to Upper Cibulakan is a zone under high speed that can cause the pull up velocity anomaly so that it needs to be done time correction and map conversion into the depth domain. Previous studies have shown that better results are obtained after the time correction is performed in areas with high velocities [3].

2. Research Method
The study was conducted in a field where part of the North West Java basin. The North West Java Basin is a half-graben basin. This basin is formed in the southern part of Sundanese exposure during Tertiary. The study area has a Sunda-Asri sub basin offshore in the southeast of Sumatra. In the Java region there are sub Arjuna basins (offshore), Jatibarang Basin (onshore) and others. The research areas are in the Upper Cibulakan Formation and the Parigi Formation. The upper Cibulakan Formation has sandstone lithology and limestone. The Parigi Formation deposition process above the Cibulakan Formation occurs in harmony and has a reef limestone lithology [4]. A map of the study area is shown in Figure 1.

![Figure 1. Study Region Map](image)

In this study the stages can be seen in Figure 2. The data used are seismic data and data well. Furthermore, binding of seismic data to well data through seismic well tie. Picking continues through picking faults and horizons. From the results of the next pick, the time structure map is made and converted into a time to depth conversion map. Data validation is used through time correction through a time-depth curve graph.

![Figure 2. Flowchart of Research](image)
2.1. Research Data
The data used in this study are seismic data, well log data, and checkshot data. Seismic data used are 2D seismic data and 3D seismic data. 2D seismic cross section is a cross section of a 3D object (geological object from below the surface). In this 3D seismic data has an orthogonal arrangement with regular spacing of data points generated from the geometry of data retrieval [5]. While well logging as a useful geophysical method calculates physical parameters of reservoir rocks that identify information that is below the surface. The information obtained in the form, thickness of the fluid content layer, continuity of rocks from the borehole, lithological characteristics and structure correlation [6]. Checkshot data to obtain a correlation between the time and depth needed in the Well Seismic Tie process, a checkshot is needed [7].

2.2. Well Seismic Tie
Well seismic tie is used in performing seismic horizons in the time scale at the actual depth position. In this research the Seismic Well Tie process is carried out by making synthetic seismograms [8].

2.3. Picking Fault
Picking fault is an interpretation process to mark the visible fault from seismic data [9]. In this process, picking the faults in the section is carried out with increments of 5 feet. The results of the picking fault affect the picking horizon because when the picking horizon must follow existing structures such as faults.

2.4. Picking Horizon
Picking fault is a process of interpretation to mark visible faults from seismic data [9]. In this process picking is done for the fault contained in the section with increments per 5 feet. The results of picking faults affect the picking horizon because when picking the horizon must follow the existing structure such as a fault.

2.5. Time Structure Map
Time Structure Map is a time domain map. Time Structure Map is the result of gridding from the picking horizon. In addition, the time structure map that has been combined with the picking fault [10].

2.6. Time to Depth Conversion
Time to Depth conversion is the process of converting time map domain to depth domain. In this process consists of two steps, namely doing Time Correction and depth map conversion. Conversion map depth with the Time-Depth Curve method [10].

2.6.1. Time Correction
To eliminate structural ambiguity contained in the time domain structure map, time correction is needed [11]. In the time correction process, an isochron map is needed which in this case is a map that illustrates the thickness of the buildup.

2.6.2. Time-Depth Curve
After the time structure map has been corrected, the conversion process is carried out to become a depth map [11]. In this study the single function time depth curve method is used. The curve is derived from the checkshot data where the x-axis is depth and the y-axis is the time data obtained from the data checkshot at BN-32 well. To convert the time structure map into a depth structure map a calculator is used which is the result of the substitution of the equation in Figure 7 with the existing time structure map so that a depth map is generated as shown in Figure 8.
2.7. Depth Map
Depth map is a structure map in the depth domain. Depth Map is a map of the results of the implementation of Time Correction and Time to Depth Conversion. From the Depth Map can be reviewed the structure.

3. Result
Data processing results consist of synthetic seismogram, Time Structure Map, Isochron map, Time Structure Map that has been corrected, Time-Depth Curve, and Depth Map. The results are presented in Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8.

3.1 Result of Well Seismic Tie
From the synthetic seismogram, the results are in the form of a red marker in Figure 3 which is used as a base for picking faults and horizons. Synthetic seismograms are also a reference of how the polarity of the seismic signal is obtained. Synthetic seismograms are created by reviewing seismograms.

3.2 Result of Times Structure Map
The time domain structure map can be seen in Figure 4 showing that there is a build-up structure that has been marked with purple polygons. To eliminate structural ambiguity, time to depth conversion is needed, which in this study uses the time depth curve method.

3.3 Result of Time Correction
After getting an isochron map that can be seen in Figure 5. Isochron map illustrates the buildup of green areas. The isochron map is used to correct structural ambiguities in the time structure map. The results of the time correction can be seen in Figure 6. Figure 6 shows the loss of buildup that is marked by purple polygons found in Figure 4.1 which are considered pseudo anticline.

3.4. Result of Time to Depth Conversion
The curve of the Time-Depth Curve results can be seen in Figure 7. The curve of the Time-Depth Curve produces a single function equation which becomes an equation that is substituted with a time structure map that has been corrected to the equation to produce a depth map. The depth map results are shown in Figure 8. This map is the final result obtained which is a map in the depth domain. To validate the existing depth, a comparison of the depth of the map with the depth of the log data is performed. From the results of the comparison can be determined how much the level of similarity of the log data and the results of the depth map.

**Figure 3.** Result of Synthetic Seismogram

**Figure 4.** Result of Time Structure Map
4. Discussion

The time structure map (figure 4) found that there are several areas that have been marked with purple polygons. The marked area is an area that contains anomaly pull up velocity which causes the formation of pseudo anticline. This pseudo anticline is a structural ambiguity that must be removed because it can cause the wrong interpretation. The Isochron map in Figure 5 is a map used to correct existing structural ambiguities. The isochron map depicts which areas are considered pseudo anticline caused by the pull up velocity anomaly.

The result of Time Correction shows the difference in the time structure map that has not been corrected (figure 4) and the time structure map that has been corrected (figure 6), which is the difference in depth. The time structure map that has been carried out by Time Correction (Figure 6) can be seen in areas where structural ambiguity in the form of pull up velocity anomaly has been corrected. Pseudo anticline that has been corrected makes it easy in the process of interpretation so that the results obtained can approach the original conditions in the field. The depth domain structure map is the result of the conversion of the depth map from the corrected time structure map (figure 6).
From the comparison of Figure 9 and Figure 10 it can be seen in the log data that the depth is 3331 while the depth available on the resulting map is 3307 where there is a difference of 24 feet. The Time Depth Curve method is the most preferred approach for certain conditions. However, the reliability of well depth conditions becomes quite doubtful with the condition of error validation value which is quite large but better than the error of just using a time structure map [10]. The result of Time correction from this research shows that velocity anomaly can be corrected by using this method. In the comparison with past research that also discuss about Time correction for eliminate the velocity anomaly [11] shows that The time to depth conversion method observes the velocity anomaly in the overburden during the time to depth conversion. The method deduces a specific velocity distribution in the overburden which is used indirectly to predict the time change from the target. The corrected time structure map shows the results relating to the anomaly-free cover layer. From these comparisons, it shows that time correction is important for seismic interpretation because if this velocity anomaly is not reduced and binds the raw predicted depth surface to the top of the well it will cause an error in the wing elevation readings on both sides of the slow velocity anomaly and false wing depression on both sides of the fast velocity anomaly.

5. Conclusions
In this study, there are differences in depth in areas considered pseudo anticline. On the time structure map there is pseudo anticline while on the map Time Correction has done structural ambiguity that is pull up velocity anomaly is gone. By doing Time Correction, irregularities or structural ambiguities on the time structure map, as in the case in this study, pull velocity anomalies can be avoided and interpretation made more accurate. In the log data the depth obtained is 3331 while the depth available on the resulting map is 3307 where there is a difference which is equal to 24 feet. The time-depth curve method provides a fast step solution and is the only one that can be accepted under minimal budget conditions and project time constraints. This method is the most preferred approach under certain conditions. However, the reliability of well depth conditions is quite doubtful with the condition of the validation error value which is quite large but better than the error of just using a time structure map.

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