The Better Subsurface Imaging Using a Quality Seismic Processing

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Abstract. This study have been conducted to get a better imaging with seismic processing using 2D land reflection data. Some corrections are applied to get pre-stack time migration such as elevation correction, refraction correction, amplitude energy correction, filtering, deconvolution, velocity analysis, residual static correction, and migration process respectively. The final result of the image in time domain shows that many of the changes from the previous reflector that is not on the actual position. However, the result of the seismic picture has been improved in a better understanding to give the subsurface geological structure.

Keywords: 2D land, reflection seismic, migration

INTRODUCTION

In hydrocarbon exploration, Seismic method is commonly used because of its high resolution in picturing the seismic cross section. In principle, the method is utilizing the seismic wave propagation of subsurface and reflected back to the surface and recorded by receivers called geophones. Results of recording time data would be obtained the seismic waves propagation recorded as two-way-time (TWT). In the assumptions of seismic wave propagation used, seismic wavelength much be smaller when compared to the earth’s layer thickness, seismic waves propagation considered as a ray that follows Snell’s Law and Huygens’ principle, the earth’s considered medium layered, and seismic wave propagation of each layers have a different velocity (the greater velocity growing downward).

There are three important stages in the seismic method such as data acquisition, processing, and interpretation. In this study only conducted on data processing which is very influential as its purpose to get a subsurface imaging. In the data processing also improves the S/N (signal to noise ratio) without change the curve of reflection in the sense of how to muffle noise and amplify seismic signals. One of the stages in processing data is migration which is a process to restore the position of reflector on actual conditions in the subsurface. This is due to irregular wave propagation the subsurface as well as complex structures such as faults, build up structure, wedges and others.

METHODOLOGY

In this study, we use the 2D (two dimensional) land reflection seismic data in a SEGY’s (Society of Exploration Geophysicist) format, field geometry data such as receiver point (RPS), Shotpoint (SPS), receiver-shotpoint correlation data (XPS), and observer report data (Table 1).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Record length</td>
<td>6 s</td>
</tr>
<tr>
<td>Sampling interval</td>
<td>2 ms</td>
</tr>
<tr>
<td>Spread length</td>
<td>20 Km</td>
</tr>
<tr>
<td>Distance of shotpoint</td>
<td>60 m</td>
</tr>
<tr>
<td>Distance of geophone</td>
<td>30 m</td>
</tr>
<tr>
<td>Shotpoint depth</td>
<td>30 m</td>
</tr>
<tr>
<td>Total channel</td>
<td>280 (split-spread)</td>
</tr>
</tbody>
</table>
The seismic data processing was performed using software GMG and Geocluster on Linux operating systems in PT. Elnusa Geosains, Jakarta such as the stages shown in Figure 1.

**FIGURE 1.** The flow of 2D Land seismic data processing

**RESULT AND DISCUSSION**

The study result from 2D land reflection seismic data processing to get subsurface imaging, begin from the raw data input until final pres-stack time migration (PSTM) has been carried out through a sequence from Figure 1. Looks at the raw seismic data have done geometry labeling (Figure 2.). The seismic stacking section has not been cleared. Sequence of CDP (Common Depth Point) seen from 1-2884 eliminated by noise and the circled cross section has been seen between layers still discontinuous.

**FIGURE 2.** The raw seismic data before processing

It needs some corrections to get a better subsurface imaging according to pres-stack time migration such as elevation correction, refraction correction, amplitude energy correction, filtering, deconvolution, velocity analysis, residual static correction, and migration. The elevation and refraction correction are in the process of doing a static correction which aims to eliminate the effects of topography, thickness and variations in velocity weathered layer...
near the surface. The process is carried out which put the shot and receiver on the same datum as well as the first-break picking of seismic data using the refraction seismic concept [2].

**FIGURE 3.** The result of static correction

It shows that difference of elevation and refraction correction in which the circled is discontinous (Figure 4). This is due to the reduction in travel time of the material between the datum of each source and receiver. While the right is already better because the results obtained from the firs-break picking by using the delay time calculation and GRM (Generalized Reciprocal Method). Amplitude energy correction or True Amplitude Correction (TAR) aims to recover the seismic wave energy due attenuation caused by the distance factor and absorbed by each layer of rock in traversed. This is done as if the seismic waves arriving of each point with same energy that more representative in the investigation. Visible changes to the shot gather at depth of 2.30 to 2.60 s with trace numbers 1-41 (Figure 5) that circled before the TAR is unclear than after TAR done on the trace of shot gather.

**FIGURE 4.** TAR on shot gather 111 with trace numbers from 1 to 271

The seismic data still contain unwanted noise and seismic signal itself which must be preserved during processing. An attempt to muffle the noise or denoising is done kinds of filtering such as band-pass, low-pass and high-pass [1]. In this study, we only use band-pass filtering for seismic data because low-frequency noise contaminated ground roll as shown in Figure 5 and Figure 6.

**FIGURE 5.** Filtering on shot gather 1006
In Figure 7 shows that trace still amplitude value is too small or large compared the trace smoothing neighbors, so its need to carry out the trace amplitude smoothing to fit the trace neighbors. In Figure 8 shows that shot gather before smoothing on the circled still has amplitude trace is too large on appeal after the smoothing process.

The seismic trace is still regarded as result of convolution between the reflection coefficient with seismic signals. Therefore, it is necessary to deconvolution, i.e., to extract the signal from the seismic trace to obtain the reflection coefficient. It aims to improve the resolution of seismic data and reduce the influence of noise and improve complex wavelet due to the influence of noise. In this study we perform the Gap Deconvolution i.e. using autocorrelation function of seismic traces is assumed as signature wavelet [3]. Shown in Figure 8 and Figure 9 where before deconvolution is carried out that wavelet remains slim. But after deconvolution is carried out it looks slim wavelet, increased the temporal resolution, and reverberation been eliminated. The stack section had passed the deconvolution stage that shown in Figure 10 (before and after deconvolution).
The section still showing discontinuous layer so must be velocity analysis (Figure 11). The correct and absolute of velocity value is very difficult to achieved and often performed repetitions to the truth. Seismic wave velocity in the rock strongly influenced by various factors such as an effect of depth, a porosity effect where the greater porosity reduced velocities, and an effect of pore fluid and rock matrix effects. Figure 11, left side shows the velocity analysis based semblance analysis and Contanst Velocity Panel (CVP). And the right side shows the values of velocity picking results from the left. The section be obtained that each layer have different velocity and the greater velocity growing downward.

After the velocity analysis, there is an inaccuracy of statistical data caused error estimate from velocity determination in weathered and first consolidated layer so must be residual static correction. It aims to correct the trace in certain CDP trace is not statistically appropriate. In Figure 12, visible image results before and after residual static correction is performed on the circled.
The seismic section still exists an angled reflector on depth-coordinated, then the reflector is not in actual position. Because the seismic imaging using assumptions the Snell’s wave propagation formula on a flat plane. So for the incline is necessity correction to taste in a manner sufficient to restore the migration field reflector to the actual position. In this study performed a migration into the time domain migration (Pres-Stack Time Migration). This is done before stacking process for earth’s model with constant velocity could be described approach the wavefront or hyperbolic diffraction method. Shown in figure 13, the seismic prior to the migration process is still showing a discontinuous layer compared to having performed the migration.

**FIGURE 13.** The migration result (before and after)

**CONCLUSION**

This study have investigated how to get a better subsurface imaging with several stages of seismic processing. The quality in shot gather is very influential in processing flow because each stages gives its purpose that correct or eliminate the noise in the data recorded. The final result of the processing stages still not gives the best picture of the image due to the disposition reflector. However, after the migration is performed the seismic cross-section gives the better image.

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**REFERENCES**