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INTERFEROMETRY APPLICATION TO INTERPOLATE MISSING 2D SEISMIC DATA IN SHOT GATHERS

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ABSTRACT

The recovery process of missing seismic data has been conducted by using the seismic interferometry principle. This research is designed to examine the ability of seismic interferometry to interpolate two kinds of 2D seismic data and composed to have various qualities, which is termed as higher quality and lower quality data. In addition, it is categorized into synthetic data higher quality, synthetic data lower quality and field data lower quality. Cross correlation of traces, which is followed by summation over all shot gathers in seismic interferometry, produce virtual traces that will be used to fill gaps in data. First justification employed to score the qualitative parameter is to see the continuity and the consistency of optimum primary reflector reconstructed by interferometry. Second is to obtain optimum value of correlation of interpolation result, which is considered as quantitative judgment. According to the result, the primary reflector from first synthetic data, which has better quality, produces optimum reconstruction of up to 50%. The result from synthetics data corresponds to correlation value of 0.9508, which is suggested as very strong correlation. Contrary to the previous, the field data, which has worse quality results in optimum interpolation of only 30% maximum. The latter corresponds to correlation value of only 0.4193 and 0.4477. Results from field data indicated that interpolation by interferometry could support attenuation of multiple.

Keywords: Seismic interferometry, interpolation, gap, multiple attenuation.

INTRODUCTION

Seismic interferometry is an exciting new field in geophysics that utilizes multiple scattering events to provide unprecedented views of the Earth's subsurface structures (Schuster, 2009). According to Wapenaar, 2004, the term seismic interferometry refers to the principle of generating new seismic response of virtual sources by means of cross correlating seismic observations at different receiver locations. Interferometry is also helpful to diagnose and to analyze the subsurface condition through pattern of interference that is built from seismic waves, which is accomplished by creating cross correlation from seismic responds with one to another and summation of the resulting correlogram. Thus, the new product, which has been simulated, yields new traces and is termed as virtual traces. It is also commonly named as the redatumed trace, where it acts as though the real source or receiver had been repositioned as the new datum. Redatuming virtually is very familiar, because prior to 1970, myriad exploration geophysicists had undertaken this process, and it is used variously in seismic interferometry to gain multi purposes, some examples being VSP–SWP for stationery phase analysis, SSP-SSP for interpolation missing traces and prediction of surface waves, and VSP-VSP for interpolation and extrapolation of OBS data.

In the past, some authors have developed some methods for doing interpolation, for example, the Fourier method (Liu and Sacchi, 2004), Radon transform (Trad, 2004) and filter-based methods (Spitz, 1991; Curry, 2006). However, they mostly did not take the full benefits of the information from the data. Curry's paper used the multiple for interpolation, by creating and combining both the primary-only data and the multiple-only data (which are separated from the original data). The different data were employed to yield virtual primaries in the frequency domain. The process is continued by a nonstationary prediction error filter to interpolate the near–offset missing traces in a 2D synthetic marine data. Nonetheless, the application is restricted, because it is very difficult to acquire seismic multiple data only.

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In 2007, Wang and Schuster also experimented with the action of interferometry to interpolate the data both in synthetic and the field data for near-offset, and shows that the result in the original can be kinematically predicted, yet, the amplitude was not accurately corrected. Unlike the previous work, this study attempts to create virtual traces without doing separation of multiple and primary data, or simply it can afford to naturally fill the missing data. The reason due to the process is done just based on the original dataset. According to the interpolated trace, interferometry shows that the multiple also has been attenuated and the amplitude correction is well corrected with Root Mean Square (RMS). In addition, this research learnt about redatuming Surface Seismic Profile (SSP – SSP), where it was conducted to transform multiples into primary, and it eventually generates new virtual trace with purpose to interpolate or to recover missing data.

METHOD

To conduct this study, both synthetic and field data was procured, as shown below:

Sigsbee 2B Synthetic Data.

This synthetic data model is based on the geology of the Sigsbee escarpment in the deep water Gulf of Mexico, which is separated into two distinct categories, A and B. In this experiment we only use Sigsbee 2B as the model features due to it has a more realistic hard boundary, which give much more multiple.

2-Layers Model

The model is derived using a forward modeling method and made in purpose to two varying layers with certain velocity.

Block X Field Data

Contributed by PT. Samudra Energy, this data provides a non-optimum signal since processing has not yet been carried out.

In practice, the study's objectives were achieved in several ways and initially, doing separation of Common Shot Gather (CSG) is very important in order to easily loop the data. Continuing to the next process, we produced removal of traces in near-offset with a different percentages to test the ability of the data to do reconstruction. Matlab codes are very useful to help us to show the guidance to interpolate the data.

In the following sections below, several steps were performed and describe fully how the work was completed:

Crosscorrelation.

With Matlab, this step is resolved by crosscorrelating ordinarily trace to trace and done until N-Channel for every selected shot gather, and obviously must be specified on the number of traces. Through crosscorrelation, all events are entirely mixed together to acquire new virtual shot gathers.

Summation

Once the virtual shot gathers are generated, it occupied plenty of shots, hence, it is necessary to sum. The objective is to integrate the different shots into new virtual shot gathers.

Time-shifting

The original data certainly has a large difference of time, if compared to the virtual shot gather which is generated from the previous work. It indicates the time-shifting process is very important to move the time of new shot gather into the time its supposed to be, where it must be similar to the original.

Interpolation

The purpose is to refill or to reconstruct the missing near-offset and can be conducted by means of inserting new virtual shot gathers into them. Note that the new virtual shot are not fully inserted, but only several trace which posse as the same position as the missing trace.

Root Mean Square (RMS) Amplitude Correction

Distinctly, the amplitude of new interpolated shot gathers is diverse to original. Thus, it attempts to correct and to balance it to have the proper value as close as possible to the original shot.

RESULTS

The experiment tested the ability of interferometry to interpolate data, by removing near-offset traces in the numerous percentages, start from 10% up to 50% with 10% interval in every gap, and depended on the number of traces of shot gathers. Figure 1 shows Model 2 Layers interpolated with a very good for over the layers and it exactly corresponds to the correlation value obtained of 0.9508 that tends much higher. Here, both in display and in number correlation, demonstrates optimum interpolation because it is designed with a top quality.

In 2B Sigsbee case, missing-traces in Common Shot Gather (CSG) interpolated (Figure 2) interferometrically to refill gaps by inserting virtual trace data, where it is acquired from corrsum (correlation and summation), time-shifting, and RMS correction to improve the amplitude. Totally, interpolated CSG 2D Sigsbee 2B depicts a good result, however, it is can only be achieved until 30% to gain the optimum qualification with 0.4477 as the appropriate score. In summary, 2B Sigsbee appears not to produce a maximum result for gaps in 40% and 50%, since discontinuity and signal weakening occurred (red circle). On the other side, it will be highly beneficial where it also implies that multiple presences were distinctly suppressed in the interpolated CSG by using interferometry as marked with yellow circle.

Block X field data interferometry yields in maximum 30% interpolation. Correlation value decreased to 0.4193. Not only because of the low quality data, but also owed to real data has seismic artifacts associated with complex layers. The two factors mentioned previously strongly control the ability of the interferometry techniques to interpolate the data.

CONCLUSION

From this study, we deduce that:

1. Qualitatively, higher quality data with an optimum signal provides much better interpolation if compared to lower quality data. This is due to higher quality data was created ideally with less or no noises.

2. Correlation score of lower quality data is prone to decline in which it implied the multiple attenuated within interpolation interferometry method.

3. Two layers model with better quality provide a good interpolation up to 50%, whereas 2B Sigsbee and Block X data only produce optimum interpolation of 30%, due to discontinuity and signal weakening.

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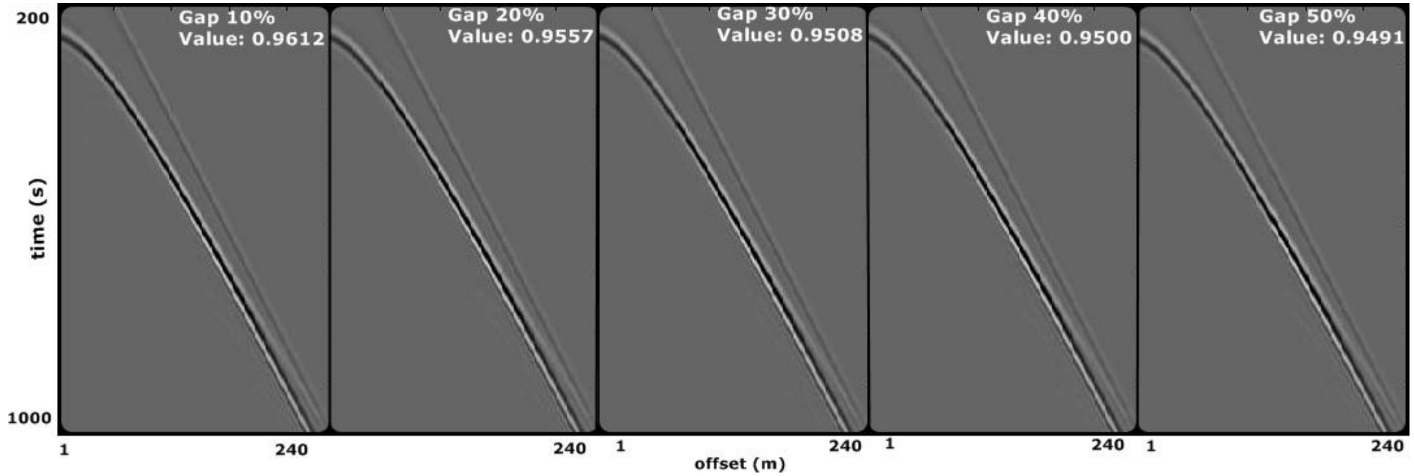

Figure 1 - Two Layers Model with top quality provide good interpolated shot gathers

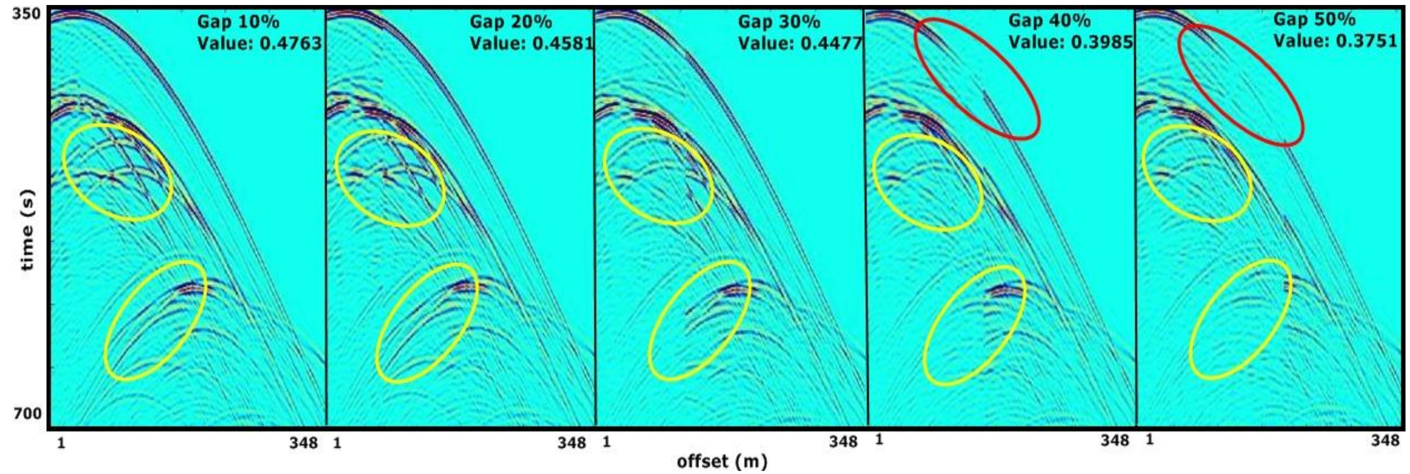

Figure 2 - However 2B Sigsbee only optimum to produce interpolated trace of 30%, but it helps in multiple attenuation (yellow circle)

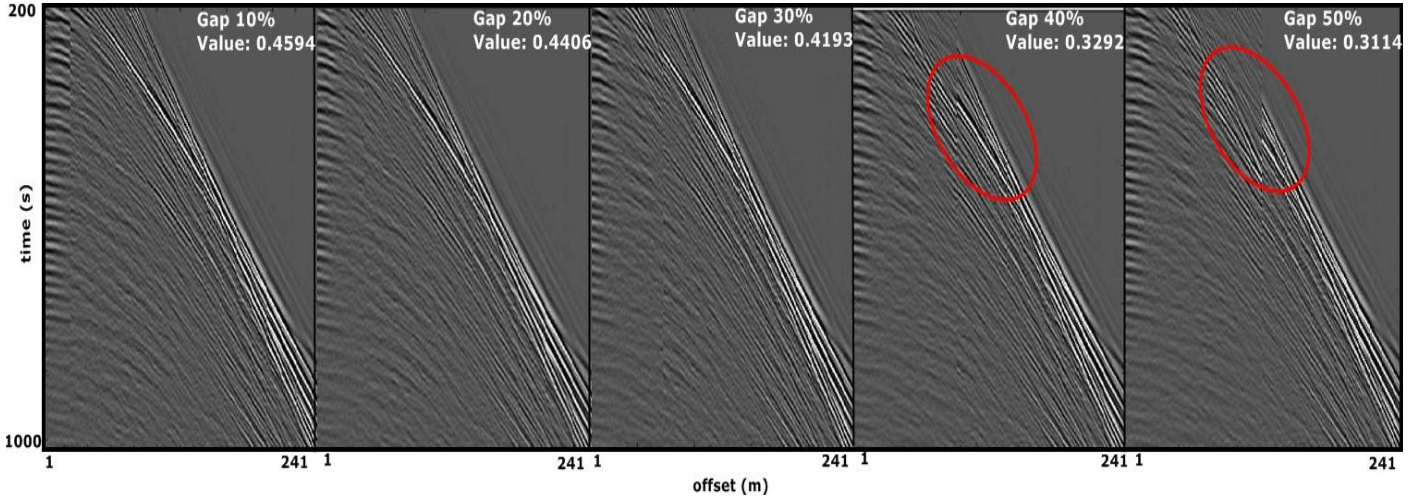

Figure 3 – As Block X interpolated beyond 30%, it implied the discontinuity as marked by red circle