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Role of Reflection Model's Temporal Window in f-x Prediction Filter

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Abstract: *F-x prediction filters are made use of in this exercise for random noise attenuation. These filters require definition of spatial filter length, spatial design window and primary (signal) model's temporal window for a cut off frequency. It is inferred using real earth data that attenuation of random noise is crucially dependent on the choice of primary model's temporal window in achieving better S/ N and continuity of the primary events.*

Keywords: *f-x prediction filter, gather, random noise, spectrum, stack*

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I. Introduction

In the land data, random noise masks the primaries with varying strengths and their attenuation is mandatory in the preprocessing phase. Prediction error filtering is made use of in this exercise. We attempt to show that in prediction error filtering, right choice of primary model's temporal window leads to better result.

Spatial prediction filtering in the frequency-offset (*f-x*) domain is an effective method for random noise attenuation. Originally proposed by Cannales (1984), the idea exploits signal predictability in the spatial direction. The method he used to extract the predictable signal is the (*f-x*) prediction filtering where the noise is computed by applying the prediction error filter (PEF) to the data. Soubaras, 1994, showed the inconsistency of this method, and that the correct way to proceed is to obtain the noise by applying the autodeconvolved PEF to the data. This leads to the (*f-x*) projection filtering. We opted for *f-x* projection filtering for random noise attenuation in this work.

II. Method

In the current study, a land 2D seismic data set is used. First of all, data sets' geometry and navigation information is updated in trace headers, field statics is incorporated, a band-pass filter (8-12-70-80 Hz) & time gain function is tested and applied. Next, manual editing is carried out & first break mute is designed and applied.

FX Prediction filter works by first calculating the Fourier Transform of every trace. The complex frequency samples are then multiplexed so that we get a series of mono-frequency values across space (f-x transform). Next we calculate a two-sided complex Wiener Prediction Filter for each Mono- frequency series. This filter is then applied and the inverse f-x transform calculated. The effect is to "smooth" the data across space (x). The method used here is described in Canales L.L. 1984, Random Noise Reduction, 54th Annual SEG meeting, Atlanta. As a general rule, the effects of f–x prediction are harsher on smaller windows i.e. fewer traces and short time intervals. The big disadvantage of f–x prediction is of course the inability to handle conflicting dips such as "curving" structure, so split the data into sections each containing only consistent dips prior to inputting to f–x prediction. Vista processing software is used for seismic data processing. The parameters for FX Prediction filter are shown in the following dialog box.

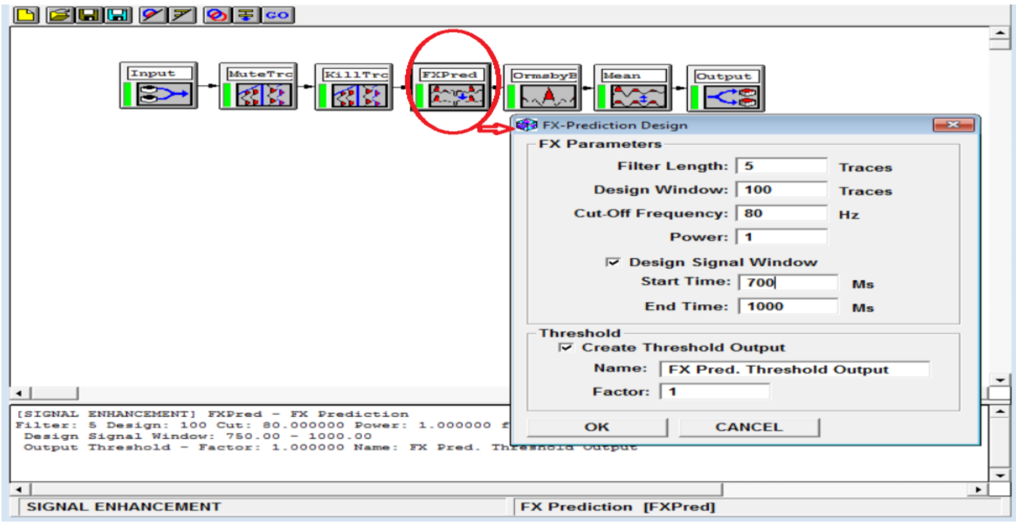

Figure 1: Dialog box showing FX prediction filter's parameter

The input data can be stacked traces or pre-stack data sorted by some key (e.g. Shot, Receiver or CMP sort indexes). In these cases, FXPrediction filter will automatically stop at the end of each "group" (be it Shot, Receiver or CMP gather).

Temporal window is interpreted for the primary reflection model from a raw gather and raw stack as well and is found to be 700 – 1000 ms. (figure 1 & 2)

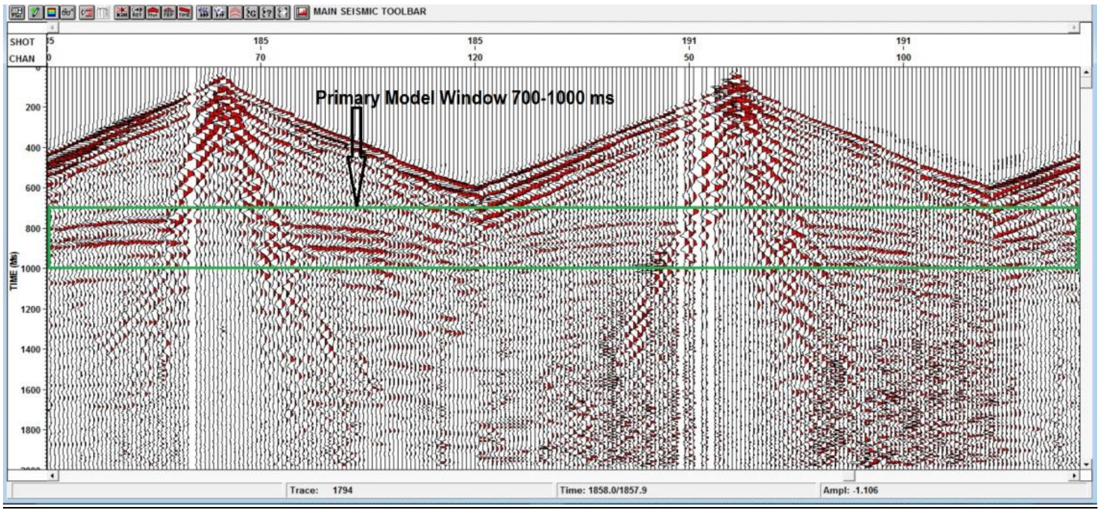

Figure 2: Temporal window for primary i.e. signal window is depicted in Raw gathers

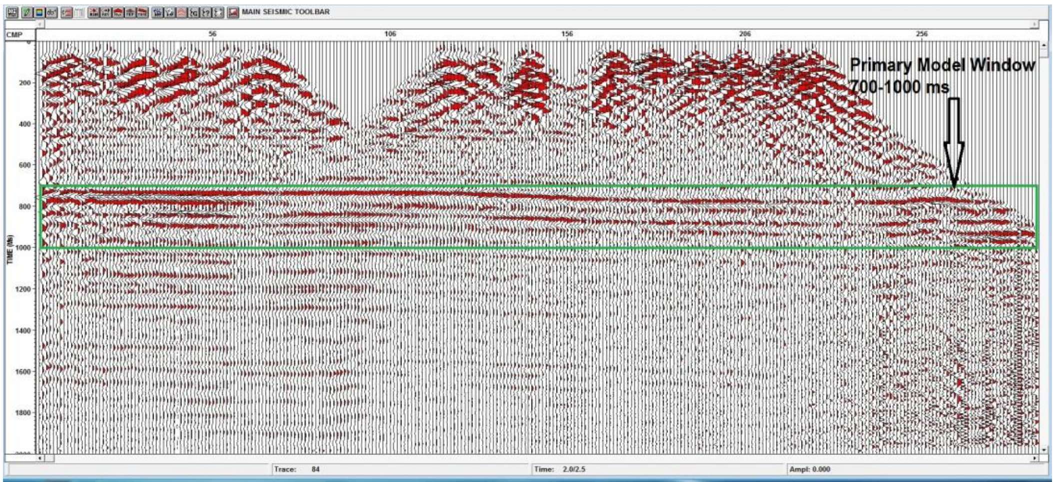

Figure 3: Temporal window for primary i.e. signal window is depicted in Raw stack

III. Results and Discussion

Random noise attenuation using FX prediction filter is carried out in two streams: stream-1 & stream-2. In the stream-1, primary model's temporal window is chosen as full trace length (i.e. 0 – 2000 ms.), while in stream-2 temporal window (700 – 1000 ms.) is interpreted from raw gathers (figure 2) & raw stack (figure 3) as well. Other parameters such as filter length, spatial design window, cut-off frequency are kept same for both the streams.

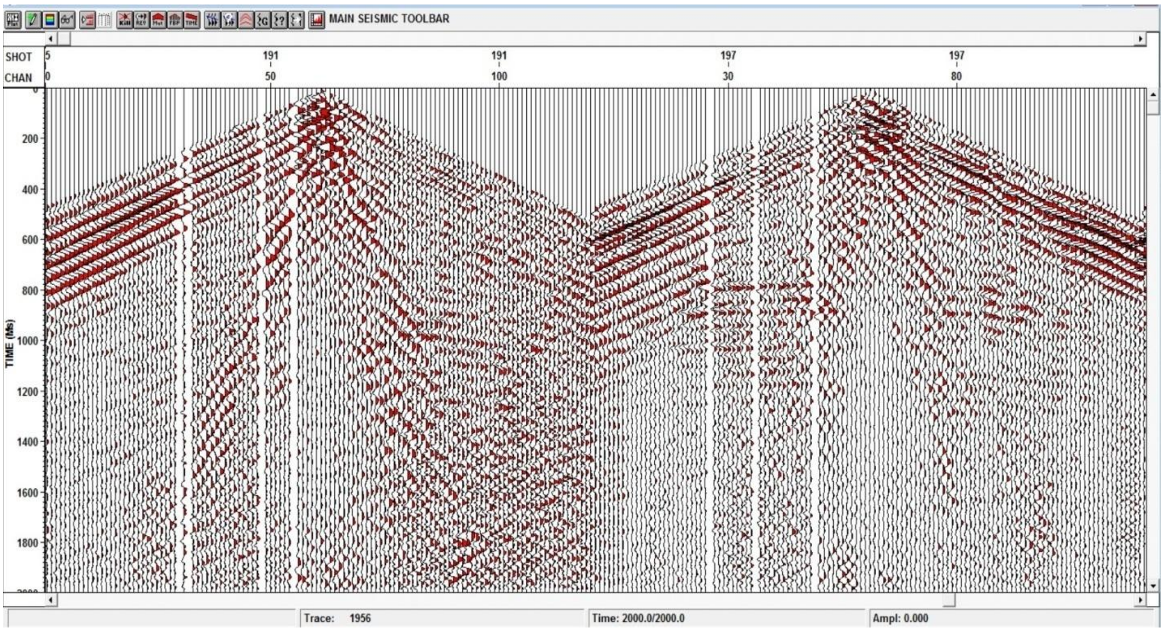

Figure 4: FX prediction filter applied gathers with model temporal window 0 – 2000 ms (stream-1)

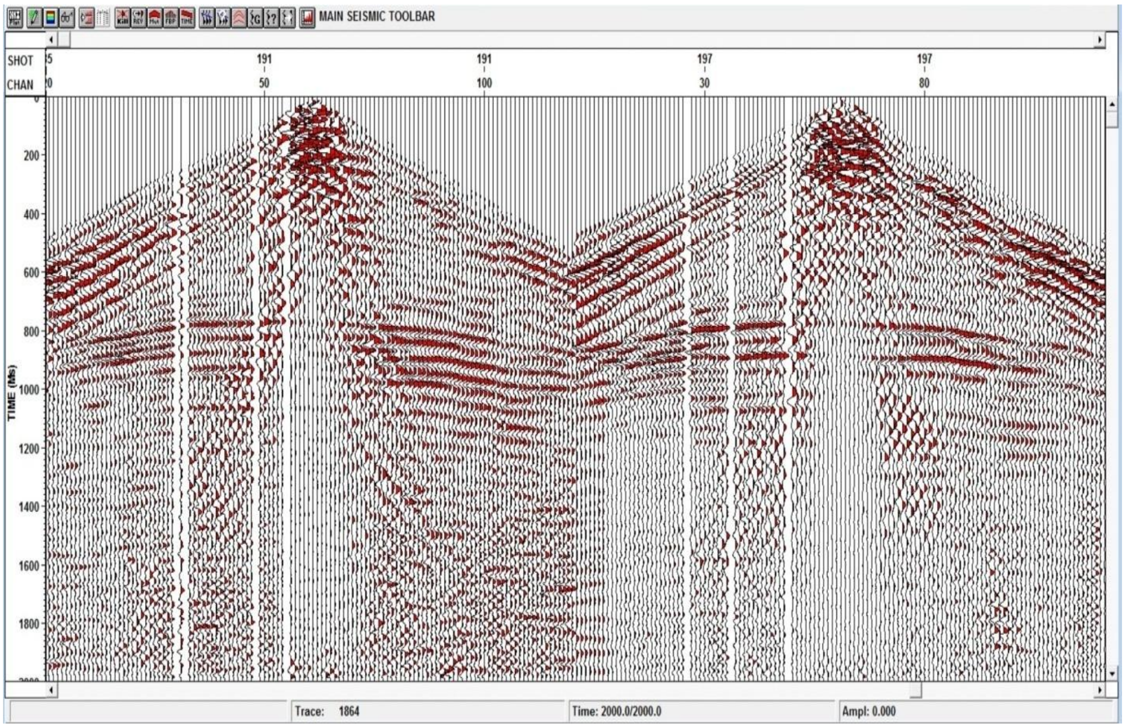

Figure 5: FX prediction filter applied gathers with model temporal window 700–1000 ms (stream-2)

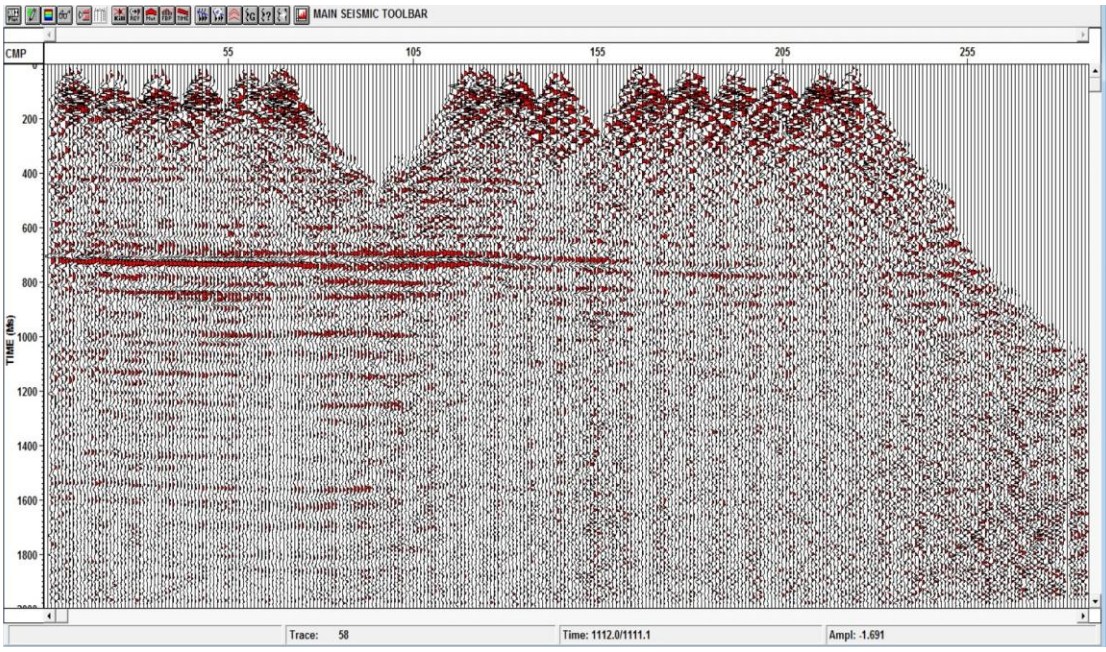

Figure 6: FX prediction filter applied stack with model temporal window 0–2000 ms (stream-1)

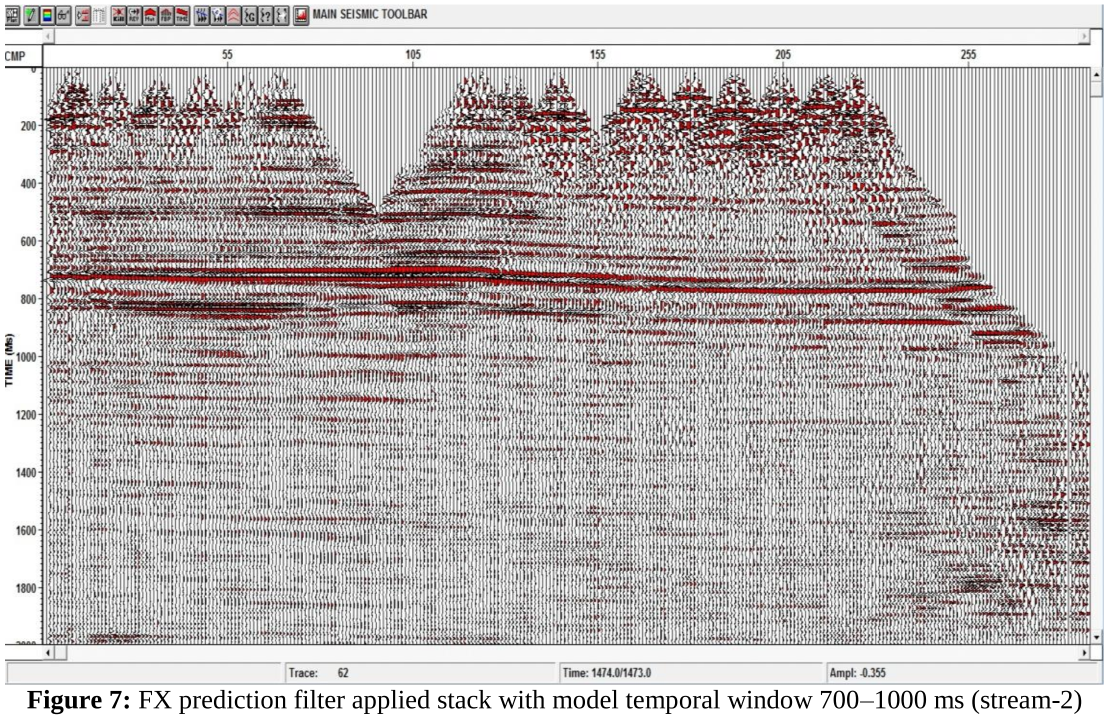

Figure 7: FX prediction filter applied stack with model temporal window 700–1000 ms (stream-2)

Reflection hyperbolae are heavily masked by noise in stream-1 gathers (figure 4), while reflections have clearly stood out in stream-2 gathers (figure 5).

Next, we deconvolved the data in both the streams using same parameters (i.e. operator length = 200ms, prediction distance = 8 ms and white noise = 0.1%) and generated stream-1 & stream-2 stacks. Stream-2 (figure 7) stack shows up with better S/N ratio & event continuity than that of stream-1 (figure 6). Also, shallow events in stream-2 stack have started showing up with better alignment.

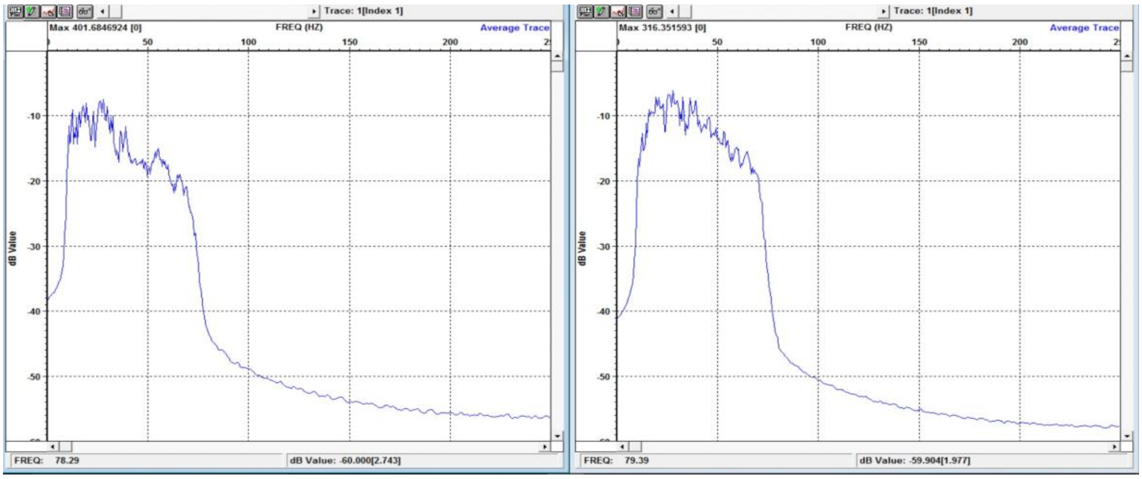

Figure 8: Stream-1 (left) & stream-2 (right) amplitude spectra

Amplitude spectra have been computed for both the streams and it is apparent from figure 8 that stream-2 frequency components are slightly more boosted than that of stream-1 in the seismic bandwidth.

IV. Conclusion

It is inferred in the present work, that choice of reflection (signal) model's temporal window is very crucial when attempting random noise attenuation using f-x prediction filter. We attempted to show this using S/N ratio, event continuity & amplitude spectra of seismic gathers and stacks.

Acknowledgments

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References

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