Seismic processing workflow for supressing coherent noise while retaining low-frequency signal

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ABSTRACT

Two different processing workflows were applied to the same dataset to evaluate the effect of noise attenuation methods while attempting to preserve low-frequency signal with the purpose of obtaining broadband seismic data to benefit inversion studies. The approach was based on a previously conditioned dataset with a conventional processing sequence versus applying a specialized processing sequence focused on attaining coherent noise. The conventional sequence used surface wave noise attenuation and spiking deconvolution processes, while the specialized sequence used radial filter and gabor deconvolution processes. The specialized processing flow resulted in better attenuation of low-frequency noise while succeeded in retaining the low frequency signal. In comparison with the previous processed stacked, current result showed higher low-frequency content around the target zone (~ 5-9 Hz) than the previous processing (~ 9-14 Hz), but showed a structural depression in the middle part of the section possibly related with a shallow channel caused by an old meander of the North Saskatchewan River. However, no velocity or statics anomalies were observed during the processing of this dataset.

2D SEISMIC PROCESSING WORKFLOW

The seismic data for this project consists of two 2D seismic lines. The raw gathers and processed stacks were available for this study. Table 1 summarizes the main parameters of both lines.

Table 1: 2D seismic lines main parameters

PARAMETERS	HIGHVALE	VIOLET GROVE
Source type	Dynamite (1Kg/18m)	Vibroseis
Source interval	80 m	132 m
Receiver interval	20 m	33 m
Sample rate	2 ms	2 ms
Record length	3 sec.	3 sec.
Number of channels	201	96
Lines length	17.38 Km	12.91 Km

The processing was focused on imaging the main reflectors, including the Nisku Formation, without compromising the low frequency character present on the seismic data. Especial attention was paid to noise attenuation processes which appear to be the greatest factor in attaining low frequency signal (Isaac, 2012). The processing flow will be explained using the Highvale line as a reference.

Two approaches were undertaken in this study: a conventional one and an specialized one. the conventional sequence used surface wave noise attenuation and spiking deconvolution processes, while the specialized sequence used radial filter and gabor deconvolution.

Figure 1 shows the shot 104 after geometry definition, first break picking and elevation and refraction statics calculation. The next step was applying an amplitude recovery gain followed by noise attenuation were two approaches were undertaken. Using a conventional approach based on surface wave noise attenuation versus using a specialized approach based on radial filter.

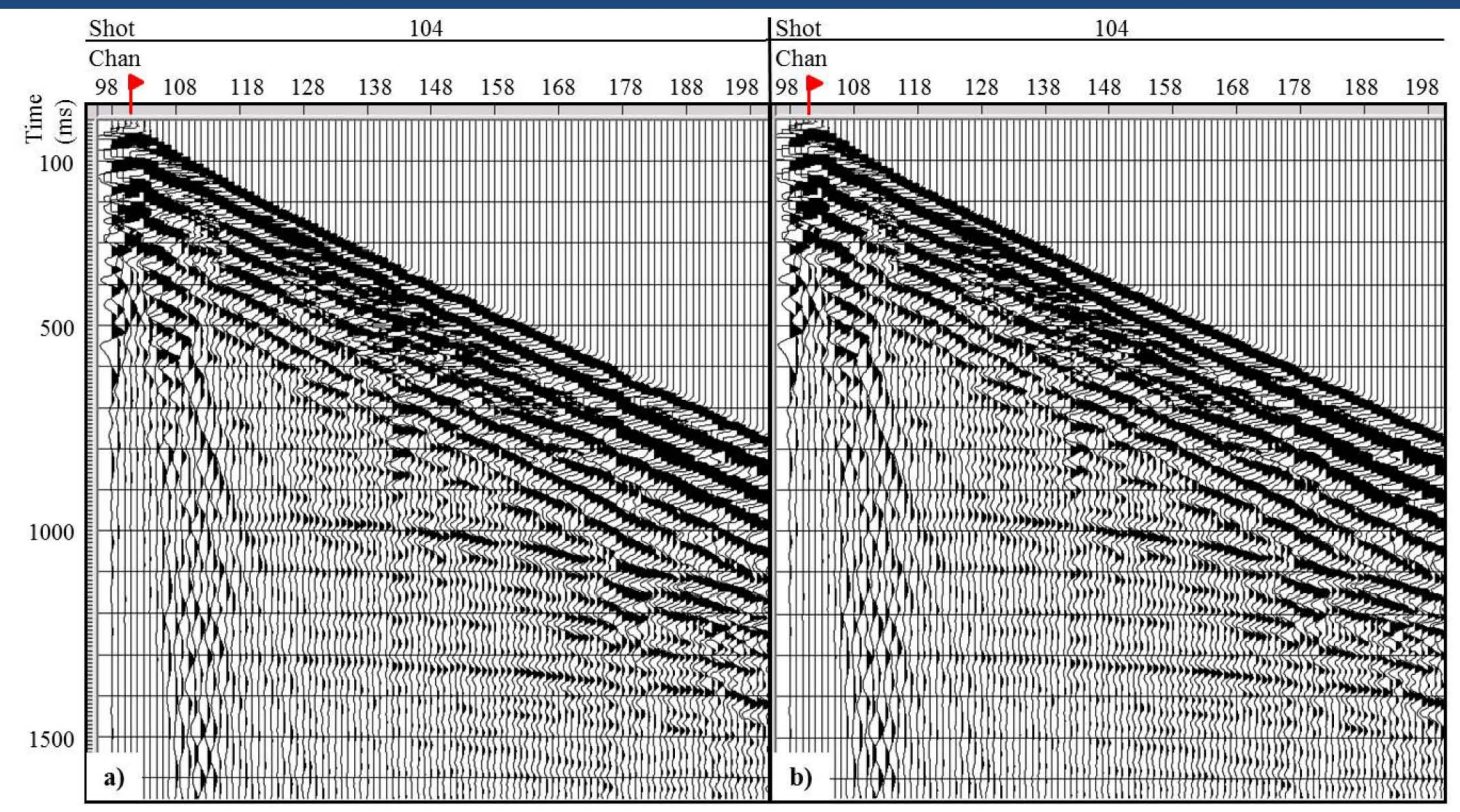

Fig 1. Highvale line shot 104 a) before and b) after statics correction.

Figure 2 shows the comparison between the surface wave noise attenuation and the radial filter outputs.

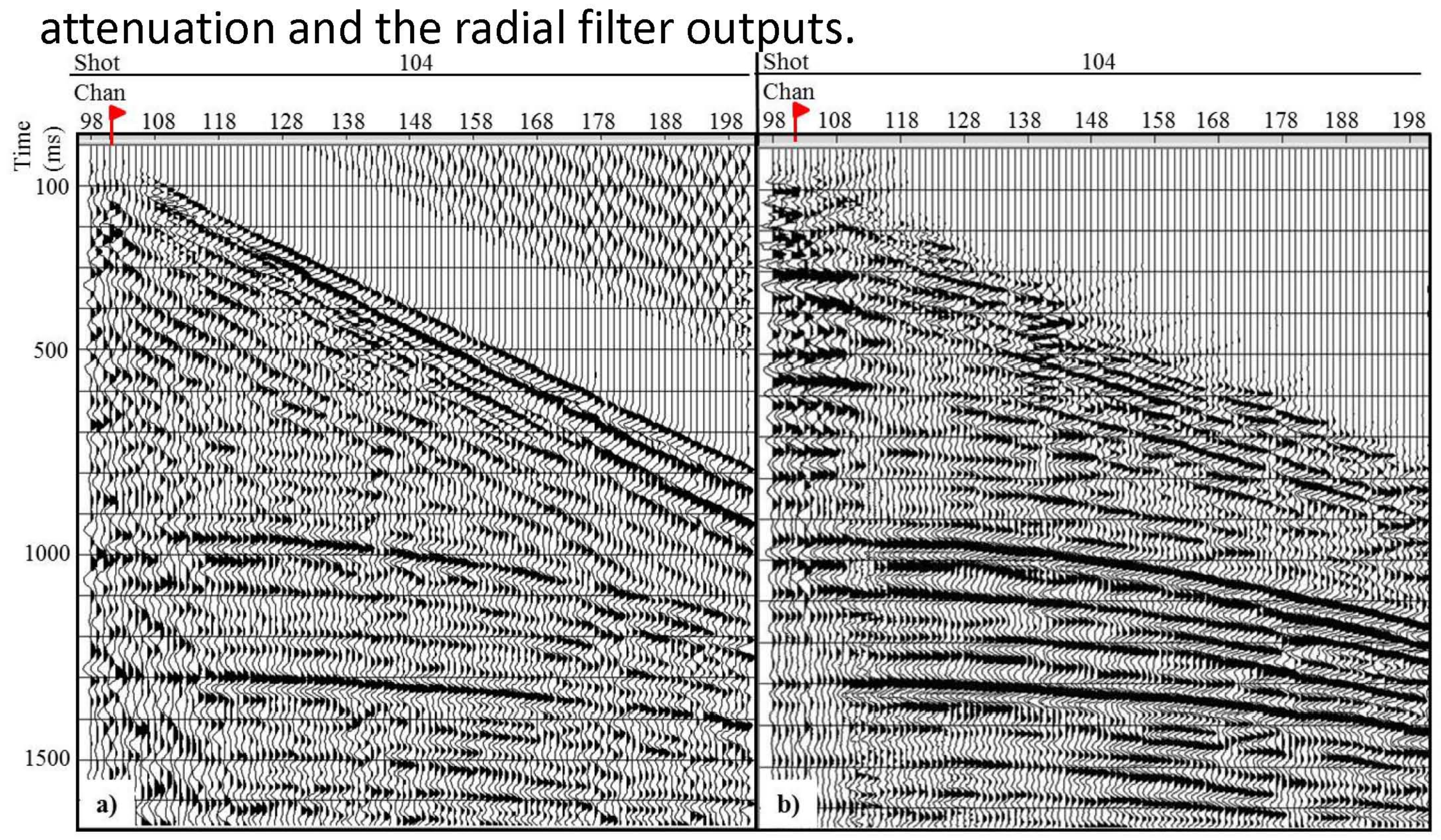

Fig 2. Shot 104 of the Highvale line a) after surface wave attenuation and b) after radial trace filtering.

Figure 3 shows the result of applying Gabor Deconvolution and a bandpass filter of 5-6-55-70 Hz to attenuate boosted high frequency noise on shot 104.

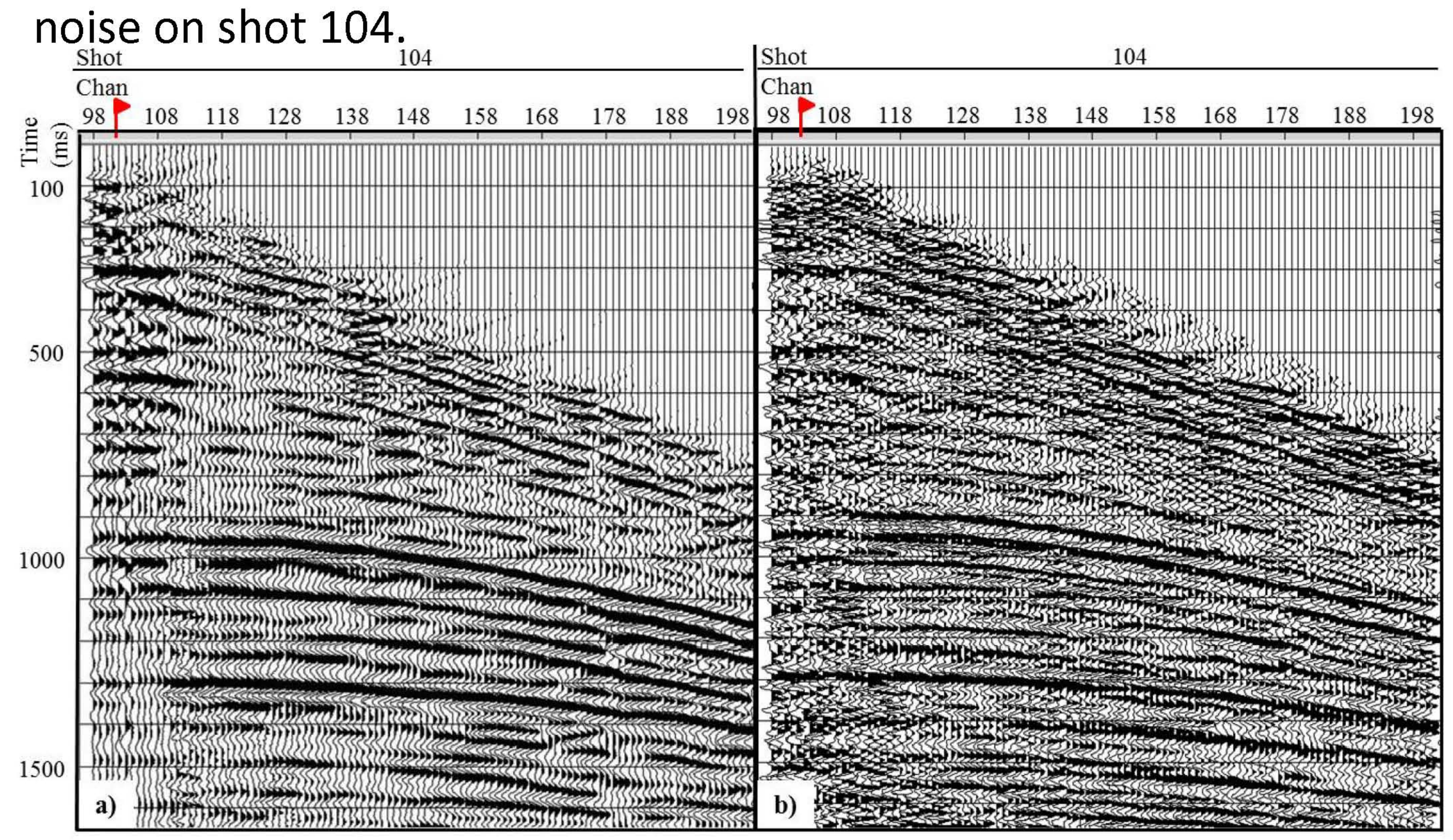

Fig. 3: Shot 104 of the Highvale line a) before and b) after applying Gabor Deconvolution and a bandpass filter of 3-6-55-70 Hz.

The final steps were: NMO correction, CDP stack, residual statics and finite difference time migration. Figure 4 shows the final result comparison between a) previous processing, b) new specialized sequence, and c) new conventional sequence.

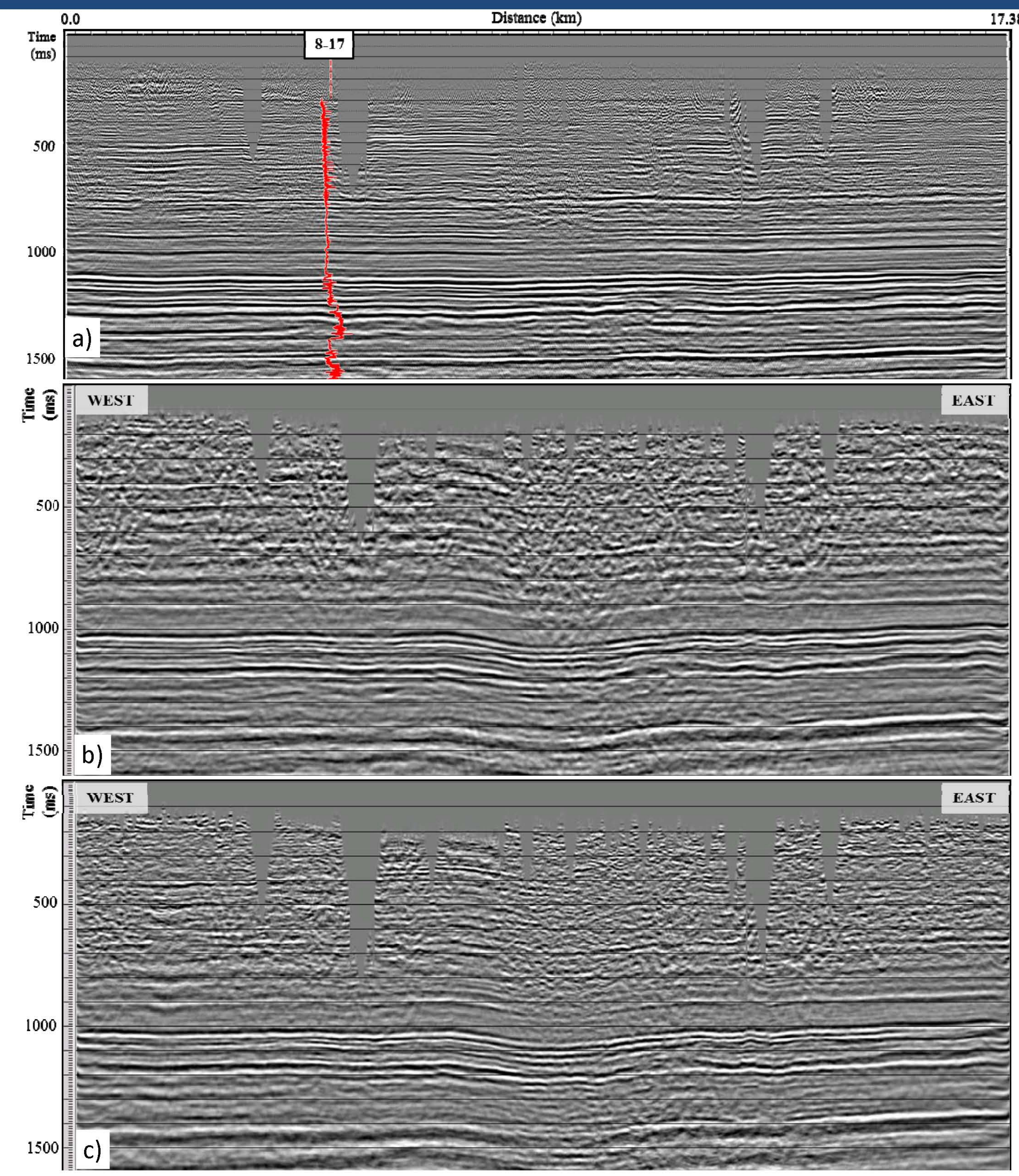

Fig. 4: Comparison of processing results: a) previous processing b) current specialized sequence and c) current conventional sequence.

In Figure 5 the amplitude spectra for each dataset are displayed. As can be observed, the low frequency content includes ~5-9 Hz in cases b) and c), while in case a) the frequency content includes only ~10-14 Hz. Results b) and c) are similar but the radial filter was better in attenuating noise while keeping more low frequency signal but showed a structural depression in the middle possibly related with a shallow channel caused by an old meander of the North SK River. The events are more continuous in sequence b).

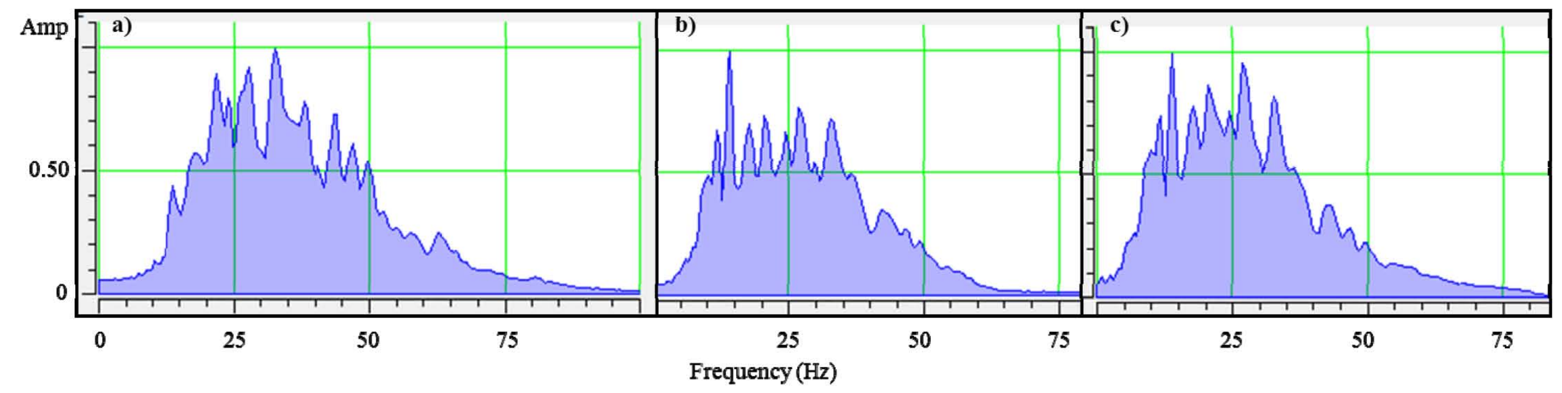

Fig. 5: Frequency spectra of the datasets shown in Figure 4 in a 700 ms window around the target formation. Note the low frequencies include 5-9 Hz in cases b) and c), while in case a) the frequency content includes 10-14 Hz.

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