H049 3D DATA ACQUISITION ARTIFACTS REMOVAL – SPOT EDITING IN THE SPATIAL-TEMPORAL FREQUENCY DOMAIN

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SUMMARY 3-D surveys acquired with very low fold and in the most economical shooting patterns often require more sophisticated processing to avoid amplitude artifacts in the stacked data!. If such periodic artifacts appear in the stack in spite of our best efforts, they can be suppressed effectively by using k_x-k_y filters at each frequency slice of the 3-D FFT of the poststack data volume.

INTRODUCTION Low-fold data collection which is preferred to reduce cost produces leakage of highly dipping (aliased) noise into stack sections unless field arrays are well tuned with respect to the "CMP array" . The "stack array" concept which deals with the combined array effect of field arrays and CDP stacking is well known. The inadequate spatial sampling produces high amplitudes in certain spatial frequencies (Morse and Hildebrandt, 1988). Zig-zag patterns in the form of CDP to CDP time-shifts occurring after some surface consistent statics applications is of the same origin. Such statics may produce perfect alignment of traces within each CDP yet zig-zag patterns, "hatching", may exist on stacks, usually with a periodicity of 2, 3 or 4 CDPs depending on the recording geometry. Hatching may be also observed in 3-D data, most likely in the crossline direction. In 3-D, adherence to spatial frequency requirements is more difficult and more costly. Instead one seeks uniform fold and azimuth distribution. Kirchhoff DMO artifacts due to operator aliasing and spatial data sampling (Schleicher and Black, 1989) are well known. Multiples also cause hatching after DMO. Although it is possible to compensate for such artifacts in the DMO algorithm itself (Beasley and Klotz, 1992), DMO has a tendency to enhance such artifacts if such care is not taken. The 3-D zigzag shooting which became popular recently is also known to exhibit such hatching. Such artifacts can also be suppressed on the time slices with a deterministic inverse filter (Meunier and Baixas, 1993). Simple dip filtering is not effective because the noise is aliased. Here we propose a method to suppress periodic hatching appearing on stacks, regardless of the reasons behind it, through spot editing certain portions of the f-k spectrum.

METHOD We design an k_x-k_y filter to attack the hatching problem in the spatial-temporal frequency, f-k_x-k_y domain. The algorithm also allows application of f-k_x-k_y filters with conical response as an option.

For 3-D data, and at each temporal frequency slice, the k_x-k_y spectra of the geometry-related artifacts form local amplitude maxima. For example, in the simple case of flat data with N_x trace periodicity in the x-direction (in number of traces) and N_y trace periodicity in the y-direction, the location of local maxima in the k_x-k_y space appear periodic; the period in k_x and k_y directions are $1/N_x$ and $1/N_y$ respectively. Since the region around $k_x=k_y=0$ contains real data, it cannot simply be edited out. For complex patterns, we may wish to detect such locations automatically by local maxima detection on the summed k_x,k_y spectra (sum is along temporal frequency axis), or, simply provide manual control. At a given temporal frequency slice and for each (k_x,k_y) location where there are high amplitudes, we can suppress them by simply zeroing the magnitude of the spectra with an ellipse centered on the maximum and taper the response up to unity within a larger ellipse. When the center of the ellipse is near the edge of the k_x-k_y plane where wrapping occurs, it is likely that the ellipses will extend outside this plane. When this happens we wrap back the ellipses. Aside from that, the k_x-k_y filter process we are applying can be considered as stamping the data in the k_x-k_y plane with the elliptical patterns. Since the size of the ellipses are kept small (a few k samples long) there is no significant spectral distortion introduced to the data.

DATA EXAMPLE A time slice from a 3-D data volume recorded with a zig-zag shooting pattern is shown in Figure 1. Although the data went through the prestack common-shot f-k filtering along receiver lines, we observe the hatching in the time slice as repeated diagonal lines. Surface noise leaked through the f-k process due to aliasing as well as CMP stack and is present on most time

slices. Figure 2 is the same time slice after spot editing in the kx-ky domain at each temporal frequency. We observe that hatching is significantly suppressed to allow better interpretation of data.

CONCLUSION 3-D data which is inadequately sampled in the field produces artifacts known as hatching that may exist on stack volumes even after rigorous true-amplitude processing sequences. k_X-k_Y filters that are applied during data processing are successful in reducing such field recording artifacts. Therefore, k_X-k_Y filtering method provides us with a tool to obtain a better interpretable data from 3-D post stack volumes shot with economical field designs.

REFERENCES

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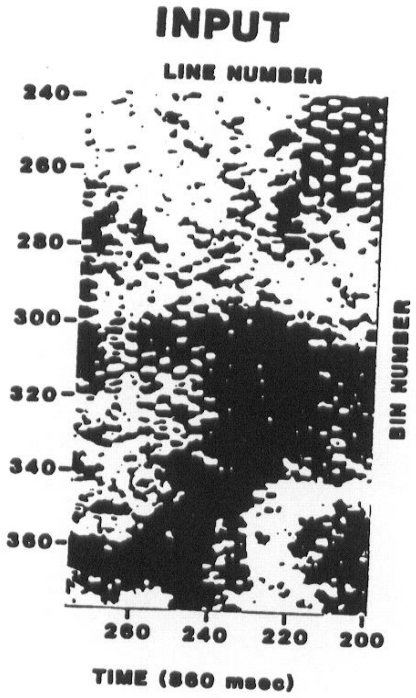

FIGURE 1

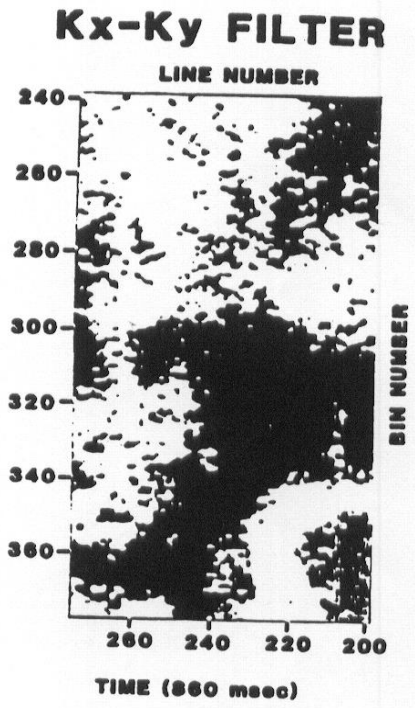

FIGURE 2