One-trace dip move-out

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ABSTRACT

I will describe a process that does normal and dip move-out of one-trace input for a known velocity model. The process is in the (k, t) domain, and is based on multiple normal move-out and recursive bandpassing. The usage of the process is for three dimensional data.

INTRODUCTION

The dip move-out (DMO) operation translates offset coverage to spatial coverage in the direction of the offset vector. Three-dimensional (3-D) surveys should, therefore, be designed to include many offset-directions, e.g., to use two boats in parallel, or on land, to surround every shot by geophones at many directions and distances. In recording geometries like those, the constant-offset section, which is the input to the move-out, will typically have only one trace. The move-out (NMO+DMO) smears that 1-D trace into a symmetrical moved-out, 2-D section that covers a distance of up to half the offset in the positive and negative offset directions. The moved out sections from all the traces combine to produce the 3-D stack.

ONE-TRACE DMO

Description

The input to this process is one trace $p(t)$, the output is a section $q(x,t)$ of $2h/\Delta x$ traces, where h is the half-offset and Δx is the spatial spacing. The process is based on a superposition of NMO with $v(t)/\cos\theta$ and dip-filtering with $\omega/k = v/2\sin\theta$, for many angles θ. The fact that the spatial Fourier-transform of a single trace is just that trace repeating itself is implicitly used.

$Q(k,t) = 0.0$ for all k,t

loop over θ

{

buff(t) = **nmo** with $v(t)/cos\ \theta$ { $p(t)$ }

loop over k

{

$Q(k,t) = Q(k,t) +$ **bandpass** with $\omega = vk/2\sin\theta$ {buff(t)}

}

}

$q(x,t) =$ **inverse fourier–transform** {$Q(k,t)$}

Impulse response

If $p(t)$ is an impulse $\delta(t-t_0)$, than $q(x,t)$ should show the DMO ellipse $(x/h)^2 + (t/t_n)^2 = 1$, where t_n is the normal move-out (NMO) time of t_0. (Figure 1). It takes $2h/\Delta x$ traces to cover this ellipse if t_0 is up shallow.

Remarks

(1) For a time-variable DMO, the velocity v of the Bandpass should be a function of time (but different from the NMO velocity!). This approximate variable-velocity DMO will be costly in time and AP memory, and will have only a minor effect. The program I have, has a time-variable NMO but averages the velocity for the DMO; thus the (2 poles, 2 zeroes) recursive bandpass-filter coefficients (5 coefficients for each $vk/2\sin\theta$) which are pre-calculated in the host, fit in our 64kw memory AP and leave space for $Q(k,t)$.

(2) The DMO is anticausal in time; therefore one could think that the bandpass filters should be anticausal. In fact they should be zero phase, or else the phase error will prevent correct superposition

(3) The Fourier Transform is actually a cosine transform because $q(x,t)$ is a real even function of x.

(4) A bulk phase shift is observed.

Amplitude control

The amplitude can be controlled by the following:

(1) Directly apply h, θ, t, ω/k, or k, dependent terms at obvious stages.

(2) Indirectly by the choice of θ spacing.

I used a θ spacing that gives an approximately uniform spacing of tangency points of the dip-filters to the DMO ellipse at a target time. Improper θ spacing (too sparse, especially near θ=0) was the main reason why my early results (Figure 2) were poor.

CONCLUSIONS

A method for NMO and DMO by semi-ellipses superposition was introduced. This method is designed for 3-D data with cross line offsets for efficient spatial coverage.

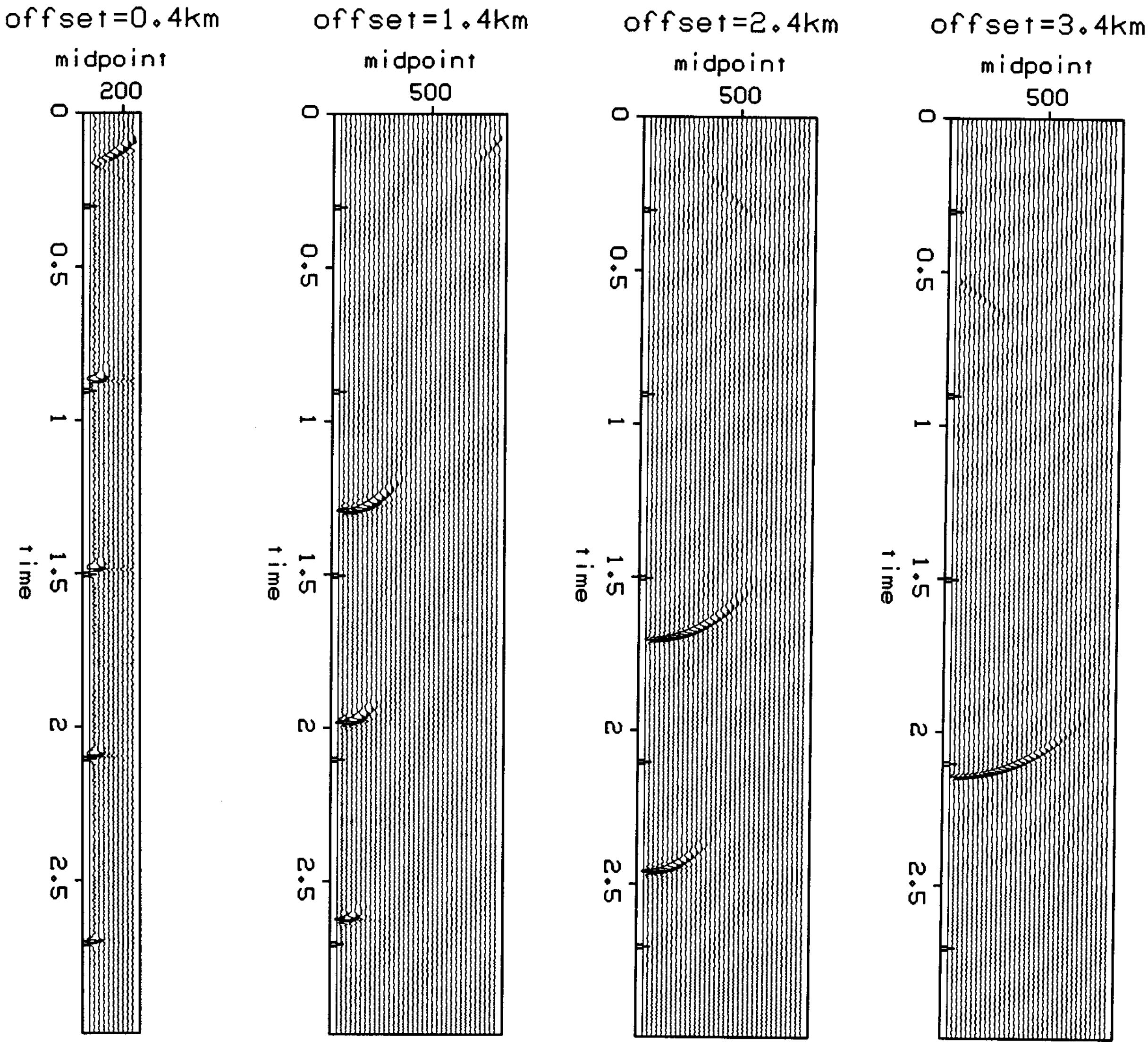

FIG. 1. Impulse responses of the move-out (NMO and DMO) program, for various shot-receiver offsets. The input for each is the trace on the left.

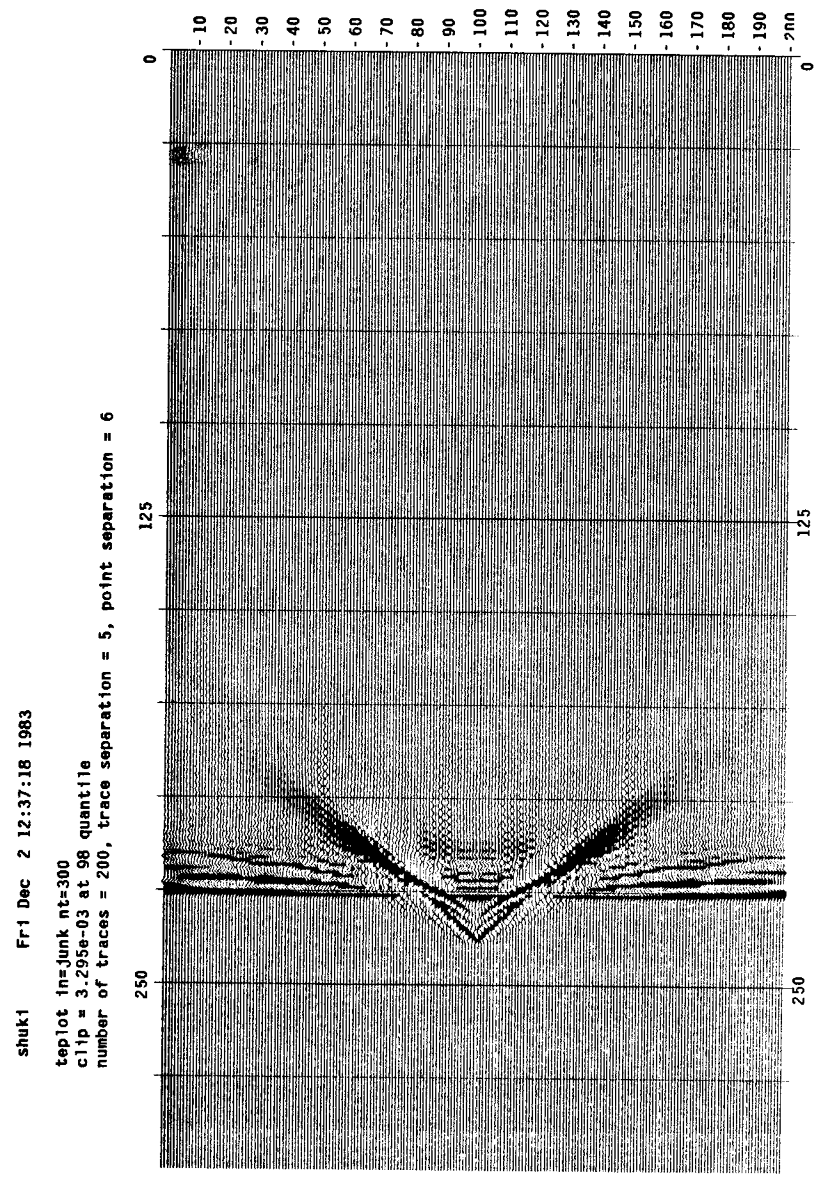

FIG. 2. Impulse response made with a recursive dip-filter and a small number of angles.