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Normal moveout stretch mute on shallow-reflection data

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ABSTRACT

This paper demonstrates the potential consequences of overlooking the significance of allowable stretch ratio when performing normal moveout corrections on shallow-reflection data. Two shallow reflection data sets with drastically different near-surface geologic settings conclusively show the significance of subtle changes in allowable stretch mute. An improper stretch mute can reduce the dominant frequency and bandwidth of a stacked reflection by as much as 50 Hz. The sensitivity of shallow reflections to offset may require allowable stretch selection accuracy to be within ±1 percent. It may be necessary to reduce the fold of an individual stacked shallow reflection by as much as 60 percent to avoid excessive degradation of wavelet properties and consequent loss of resolution. A proper normal moveout stretch mute can reduce distortion of reflection wavelet spectra caused by nonvertical incidence recording to less than 10 percent. Stretched reflection wavelets improperly muted can be misinterpreted on CDP stacked sections as stacked refractions or subtle stratigraphic features.

INTRODUCTION

Selection of an improper normal moveout (NMO) stretch mute on shallow reflection data can drastically degrade the spectral and amplitude characteristics of CDP stacked sections. On the average, maximum allowable frequency change or stretch for processing reflection data for petroleum targets generally ranges between 50 and 100 percent (Yilmaz, 1987). By contrast, optimal maximum allowable frequency change or stretch for engineering, ground water, and environmental targets can be as low as 15 percent (Miller et al., 1990). Ignoring allowable stretch ratio when processing shallow-reflection data can significantly reduce the dominant frequency bandwidth and apparent coherency by allowing overstretched reflection wavelets to be included in CDP stacked traces.

Dynamic adjustment of reflection wavelets for nonvertically incident raypaths is necessary prior to CDP stacking. The amount of sample dependent dynamic-adjustment or NMO correction necessary depends on source-to-receiver offset and reflection-wavelet arrival time. The NMO correction adjusts recorded reflection wavelets to simulate vertically incident raypaths. This dynamic adjustment of reflection times is accomplished through increasing or stretching the time separation between individual samples according to arrival time and selected NMO velocity. The stretching process distorts the reflection wavelet (Buchholtz, 1972; Dunkin and Levin, 1973). The effects of excessive stretch on reflection wavelets must be removed prior to the stacking process to avoid degradation of wavelet properties and misleading interpretations.

The detrimental effects of the stretching process are most prominent on shallow reflections at larger offsets (Yilmaz, 1987). Damage to spectral and amplitude properties of a stacked wavelet can be minimized with a proper prestack mute. The selection of allowable stretch ratio, which is directly related to the mute zone, has traditionally been based on qualitative comparisons of signal-to-noise ratio versus wavelet distortion. The stretch mute zone for data sets with several reflection events is generally conservative so as to retain as many of the long offset traces as possible. The inclusion of long offset traces improves both signal-to-noise on shallow events and the effectiveness of multiple reflection suppression routines. Shallow reflection data are chronically plagued with poorly recorded reflection events due to both limited recording channels and narrow optimum offset windows (Steeples and Miller, 1990; Hunter et al., 1984). Subtle changes in allowable stretch ratio can have drastic effects on the overall quality of reflections from shallow interfaces (Miller et al., 1990).

The significance of allowable stretch is evident from the examination of two reflection data sets targeting interfaces shallower than 50 m. One example data set from Henderson,

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