APPLIED GEOPHYSICS, Vol.13, No.1 (March 2016), P. 116-126, 8 Figures.
DOI:10.1007/s11770-016-0546-0

Ground-roll separation of seismic data based on morphological component analysis in two-dimensional domain*

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Abstract: Ground roll is an interference wave that severely degrades the signal-to-noise ratio of seismic data and affects its subsequent processing and interpretation. In this study, according to differences in morphological characteristics between ground roll and reflected waves, we use morphological component analysis based on two-dimensional dictionaries to separate ground roll and reflected waves. Because ground roll is characterized by low-frequency, low-velocity, and dispersion, we select two-dimensional undecimated discrete wavelet transform as a sparse representation dictionary of ground roll. Because of a strong local correlation of the reflected wave, we select two-dimensional local discrete cosine transform as the sparse representation dictionary of reflected waves. A sparse representation model of seismic data is constructed based on a two-dimensional joint dictionary then a block coordinate relaxation algorithm is used to solve the model and decompose seismic record into reflected wave part and ground roll part.The good effects for the synthetic seismic data and application of real seismic data indicate that when using the model, strong-energy ground roll is considerably suppressed and the waveform of the reflected wave is effectively protected.
Keywords: Ground-roll suppression, morphological component analysis, sparse representation, two-dimensional undecimated discrete wavelet transform, two-dimensional local discrete cosine transform

Introduction

Ground roll is a common interference wave observed in seismic exploration. It is mainly distributed near the shot and has the shape of sector. However, some parts of ground roll overlap with reflected waves, thus blurring the phase axis of these waves. The common methods are transforming the seismic data from time-space domain to transform domain to suppress ground roll by using the differences of energy, frequency and apparent velocity between ground roll and reflected wave. For example, the one-dimensional Fourier transform filtering method is used to design a suitable high-pass filter for each

Manuscript received by the Editor on September 1, 2015; revised manuscript received March 3, 2016.
*This research was supported by the National Scientific Equipment Development Project, "Deep Resource Exploration Core Equipment Research and Development" (Grant No. ZDYZ2012-1); 06 Subproject, "Metal Mine Earthquake Detection System"; and 05 Subject, "System Integration Field Test and Processing Software Development".
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