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基于两步SVD变换的零偏VSP资料上下行波场分离方法

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Zero-offset VSP wavefield separation using Two-Step SVD approach

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摘要

垂直地震剖面(Vertical Seismic Profiling,VSP)资料处理中波场分离是关键问题之一.随着属性提取技术的发展,新的属性参数(例如*Q*值)提取技术对波场分离的保真性要求越来越高.本文改进了传统奇异值分解(Singular Value Decomposition,SVD)法,给出了一种对波场的动力学特征具有更好的保真性,可以作为*Q*值提取的预处理步骤的零偏VSP资料上下行波场分离方法.该方法通过两步奇异值分解变换实现:第一步,排齐下行波同相轴,利用SVD变换压制部分下行波能量;第二步,在剩余波场中排齐上行波同相轴,使用SVD变换提取上行波场.在该方法的实现过程中,压制部分下行波能量后的剩余波场中仍然存在较强的下行波干扰,使得上行波同相轴的排齐比较困难.本文给出了一种通过极大化多道数据线性相关程度(Maximize Coherence,MC)排齐同相轴的算法,在一定程度上解决了低信噪比下排齐同相轴的问题.将本文提出的方法用于合成数据和实际资料的处理,并与传统SVD法的处理结果进行对比,结果表明本文提出的波场分离方法具有良好的保真性,得到波场的质量明显优于传统SVD法.通过对本文方法和传统SVD法处理合成数据得到的下行波场提取*Q*值,然后进行对比可知,本文方法可以有效提高所提取*Q*值的准确性,适合作为*Q*值提取的预处理步骤.

关键词 SVD, 零偏VSP, 波场分离, 同相轴排齐

Abstract:

With the development of seismic attribute analysis technique, the fidelity of waveform and amplitude becomes important to wavefield separation method. In this paper, we present a zero-offset vertical seismic profiling (VSP) wavefield separation method with good fidelity. The method is based on singular value decomposition (SVD) filtering and has four stages: first, aligning events of downgoing wave by static time shifting each trace of VSP; second, suppressing downgoing wave by high-pass SVD filtering; third, aligning events of upgoing wave by static time shifting each trace of downgoing wave suppressed wavefield; fourth, extracting upgoing wave by low-pass SVD filtering. It is difficult to calculate the time shift of each trace for aligning events of upgoing wave, as the residual downgoing wave in downgoing wave suppressed wavefield is not very weak. In this paper, we calculate the time shift via the largest singular value maximization algorithm. Using the synthetic and real data examples, we demonstrate that the results of our method have good fidelity, and are better than the results of traditional SVD method. The result of synthetic data also show that our method can be used as preprocess of *Q* estimation.

Keywords SVD, Zero-offset VSP, Wavefield separation, Aligning events

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