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Refraction Static Correction without Picking First Arrival Times

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ABSTRACT

A concept of differential delay time is proposed for refraction static correction without picking first arrival times in the CDP reflection data processing. This new method is a modification of the ABCD method; it uses cross-correlation to measure the first arrival time difference between signals received at stations B and C, instead of directly computing them from their picked times. By taking advantage of multiple-fold CDP data, we apply the 'line-up trace' measurement of cross-correlations, which may alleviate the effect of data imperfections. The problem of refractor velocity variation has also been solved to a certain extent, which allows for a reliable delay time to be adequately estimated for each station and consequently the static correction value. A synthetic model and a real case with a severe weathered layer problem have been tested to evaluate the method. Stable and manageable computation processes have been explored to attain the maximum performance. The results are quite satisfactory. It should be possible to apply this method in rough areas with complicated refraction static problem, even in 3D cases.

Key words: Reflection seismics, Refraction seismics, Static correction, High-resolution

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1. INTRODUCTION

Static correction is an important topic in reflection seismic investigations, especially for areas with rough surface conditions (Musgrave 1967; Cox 1999). This correction can be divided into two types: long-wavelength and short-wavelength statics. The long-wavelength static correction is accomplished with refraction statics and the short-wavelength by residual static corrections. This paper extends the ABCD refraction static method (ABCD means two sources at A and D and two receivers at B and C; Bahorich et al. 1982) to the treatment of the first arrival signals acquired in a CDP reflection survey. A differential delay time concept is proposed, which relies on a cross-correlation to measure the difference of the first arrival time (i.e., first-break) at two neighboring stations. Thus, the tedious process of first arrival time (FAT) picking is avoided.

Refraction static correction has been developed over the past 50 years (Yilmaz 2001). This correction technique takes parts of the first arrival signals of regular CDP reflection records, treating them as refracted waves traveling across the near-surface weathered layer. After picking the first arrival time, either the traditional refraction theory (Palmer 1981), least-squares inversion (Farrell and Euwema 1984; Hampson and Russell 1984; Taner et al. 1998), or tomography mapping (Chon and Dillon 1986; Docherty 1992) technique is applied to reveal the shape of the weathered layer, from which the static correction values are determined. Marsden (1993) gave a review of many methods prevailing in the refraction static field. Basically, the refraction static correction is used for removing first arrival time variations from the CDP records, making signals similar to travel through a homogenous surface layer. Hatherly et al. (1994) have suggested correcting them to a straight line, which represents a flat refractor after the correction. However, if the first arrivals of shot records were thought of as the refraction signals, it could seem more convincing to strictly stick to the refraction theory, the basis of refraction statics, to solve the problem (Yilmaz 2001).

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