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Prestack Inverse-Ray Imaging of A 2D Homogeneous Layer: A Tutorial Study

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ABSTRACT

Traveling directions of an inverse ray for the common shot, the common midpoint and the common offset gathers are explicitly determined from the geometry of reflected rays and an envelope of two reflected ellipses in a 2D homogeneous irregular layer. I find that a common shot gather and a common offset gather can be applied to image the structural velocity and interface. However, due to the symmetry of the travel-time hyperbola, a common midpoint gather is not suitable for structural imaging. Furthermore, from a common offset gather, the poststack inverse ray is proved as a special case of the prestack inverse ray.

Error analysis of the prestack inverse ray indicates that the method of elliptic envelope provides more accurate imaging at far offsets than the method of ray geometry if the travel-time picks are limited along a reflected hyperbola. Alternatively, when the travel-time picks are sufficient, the method of ray geometry is superior to the method of elliptic envelope. The prestack inverse ray is also applied to image a sedimentary basin. The results suggest that the best way for applying the prestack inverse ray is to determine the layer velocity from ray geometry and to image the structural interfaces by considering both methods.

(Key words: Common offset, Common shot, Complex structure, Image source, Prestack depth migration, Reflected ellipse, Travel time)

1. INTRODUCTION

Prestack depth migration has been widely applied for the multi-channel seismic (MCS) data processing of the steep dips and faulted structures (Gray et al. 2001). Although the computing speed of the prestack depth migration has been enhanced by the ray-based migration (Operto et al. 2000; Hill 2001), its applications on the migration velocity analysis and the real-time monitoring are still limited (Donihoo et al. 2001). On the other hand, by using the poststack

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