PAPER F

CROSSWELL REFLECTION DEPTH AND VELOCITY ANALYSIS

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ABSTRACT

A method is described for estimating depths of reflections in crosswell data. The depth determination allows for accurate velocity analysis to find the HNMO and VLMO stacking velocities. These velocities are used in the CLP reflection imaging algorithm described in another paper in this volume (Smalley, 1994). It is use of these velocities that allow us to maximize the coherency in the stacking of reflection data and to take into account 2 - D variation in the velocity of the medium.

INTRODUCTION

Recently a method was introduced to obtain stacking velocities from crosswell reflection data (Smalley, 1993). It was shown that these stacking velocities could improve the coherency of individual reflections. This paper shows how the CLP-VLMO domain (Common Lateral Point gather after the VLMO correction (Smalley, 1993)) is used to estimate the depth of the reflection, which allows for subsequent velocity analysis. By allowing for variation in the lateral location of the reflection point as well as reflection depth when we do velocity analysis we can obtain a 2-D sampling of the medium (Figure 1). This 2-D sampling allows us to account for 2-D variation in velocity when doing cross-well reflection imaging. This is particularly important as we go towards wider well offsets.

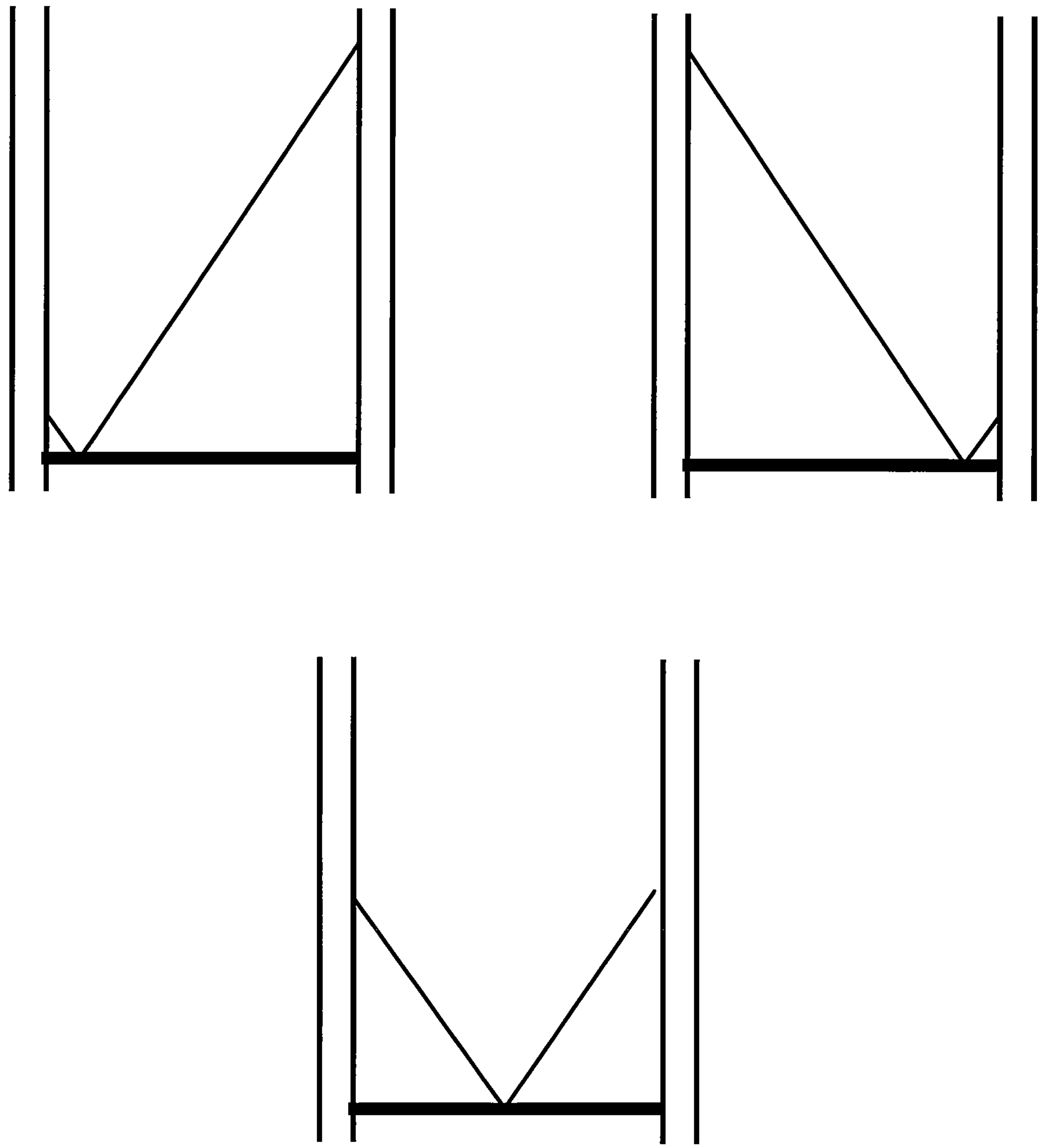

Figure 1. By doing velocity analysis for different reflection points on for a given reflection depth we obtain a 2-D sampling of the medium.

REFLECTION DEPTH AND VELOCITY DETERMINATION

Estimation of Reflection Depth

Before we can determine the HNMO and VLMO stacking velocities for reflections we have to accurately estimate the reflection depth. In a previous paper (Smalley, 1993) we showed that we could use the CLP-HNMO gather to estimate the depth of the reflection upon which we want to do velocity analysis. The disadvantage of this domain is that we were looking for a residual hyperbolic moveout at small radial distances or large angles of incidence. Also, while we were looking for non-linear moveout, the slope of the linear moveout that we needed to see was unknown since it depended on the velocity. By using the CLP - VLMO gather (Smalley, 1993) we can more easily separate the depth - velocity ambiguity. In this domain the desired moveout is zero or a perfectly flat event. Before we estimate the HNMO and VLMO stacking velocity vectors we can apply constant velocity HNMO and VLMO corrections for a set of assumed reflection depths. The velocities and reflection depth pair that yield the least deviation from zero moveout gives us the depth of the reflection. Therefore we choose a lateral location of the reflection point and determine the reflector's depth. This gives us a 2-D location of a control points at which to do reflection velocity analysis.

Velocity Analysis - Determination of HNMO and VLMO stacking velocities

Once we have determined the depth of the reflections we can then align it to zero moveout by use of the HNMO and VLMO corrections. A previous paper described how to align reflections with combinations of HNMO and VLMO stacking velocities in the CLP-VLMO gather (Smalley, 1993). A real data example after depth conversion and velocity analysis is shown in figure 2. The reflector depth was determined to be 2950 ft, and the lateral points are 4, 6, and 8 feet from the source well where the total well offset is 187 ft. A set of the HNMO and VLMO stacking velocities as a function of the radial distance r(Zr) is shown in figure 3 for the lateral point 6 feet from the well. We allowed the HNMO and VLMO stacking velocities to be the same which is a very good approximation except when there is very large changes in velocity (> 50%).

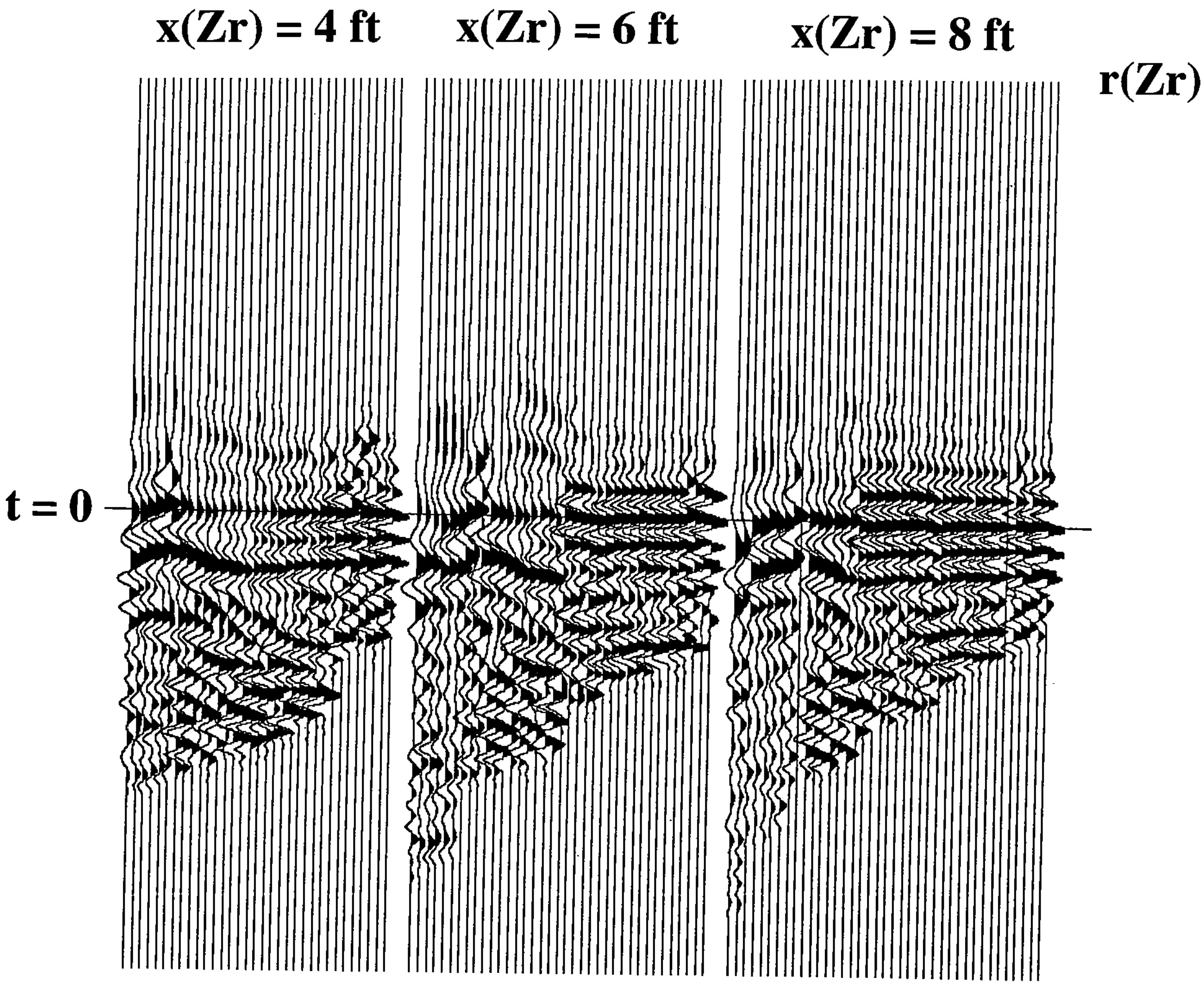

Figure 2. CLP - VLMO after depth estimation and velocity analysis for three reflection lateral points at locations 4, 6, and 8 feet from the source well. The depth of the event at t = 0 was determined to be 2950 ft.

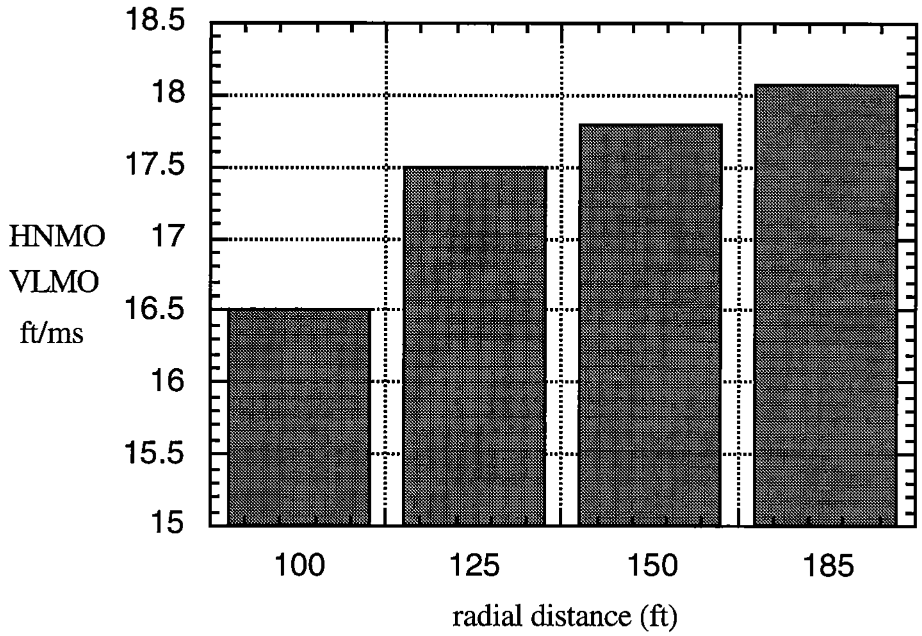

Figure 3. HNMO and VLMO stacking velocites for a lateral point near the source - well

CONCLUSIONS AND FUTURE WORK

We have presented an improved method for depth estimation of reflection data which allows for accurate velocity analysis. Future work involves automating the velocity analysis to the level of surface seismic work so that we can more closely tie it with the reflection imaging procedure.

ACKNOWLEDGMENTS

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