Stanford Exploration Project, Report 110, September 18, 2001, pages 1–75

Short Note

On asymmetric Stolt residual migration for imaging under salt edges

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INTRODUCTION

Imaging under salt remains a problem for the oil industry (Muerdter et al., 1996; Prucha et al., 1998) due to illumination problems and poor velocity resolution under the salt body. Residual Stolt migration is a proved technique for updating the image and the velocity field (Sava, 1999), because of that we believe that an asymmetric residual migration operator can help in updating the image just below the salt body.

Rosales et al. (2001) introduced Stolt residual migration for converted waves. The new operator has the property of correcting the source-reflector and reflector-receiver leg independently. This property can be extended for imaging complex single mode (PP) data (e.g. under salt imaging).

We start with a review of the theory already discussed by Rosales et al. (2001) in order to handle separately the source and receiver legs in single mode data. We present a potential frame for imaging update under salt edges, as well as future plans on this area.

THEORY REVIEW

Rosales et al. (2001) presented residual pre-stack Stolt migration for converted waves, this new operator is asymmetric and this asymmetry property can be used for imaging under salt edges, by keeping unchanged one travel-time leg and modifying the other.

The asymmetric pre-stack Stolt residual operator can be written as:

$$k_{z_m} = \frac{1}{2}\sqrt{\rho_s \overline{\overline{{\kappa_0}^2}} - k_s^2} + \frac{1}{2}\sqrt{\rho_g {\gamma_0}^2 \overline{\overline{{\kappa_0}^2}} - k_g^2} \tag{1}$$

where

$$\overline{\overline{{\kappa_0}^2}} = \frac{4({\gamma_0}^2+1){k_{z_0}}^2 + ({\gamma_0}^2-1)({k_g}^2-{k_s}^2) - 4k_{z_0}\sqrt{(1-{\gamma_0}^2)({\gamma_0}^2{k_s}^2-{k_g}^2)+4{\gamma_0}^2{k_{z_0}}^2}}{({\gamma_0}^2-1)^2},$$

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$\rho_s = \frac{v_{s0}}{v_{sm}}$, $\rho_g = \frac{v_{g0}}{v_{gm}}$, and $\gamma_0 = \frac{v_{s0}}{v_{g0}}$; the subscripts s and g denote for source and geophone, respectively.

The definition of the sources and receivers position is important since it explains the meaning of the three parameters used for the residual migration. If we define the source position along the fastest path, the value of γ_0 will be bigger than one. The contrary would happen if we define the geophone position along the fastest path.

METHODOLOGY

Figure 1 illustrates the main idea of this work. We are using a synthetic velocity model with a simple reflector geometry but a complicated salt structure that challenges the image under the salt body (Prucha et al., 2001). We define two groups of rays for the same reflector point, group A travels through the sediments and group B travels through the salt body. Since imaging under salt body is relative complicated (Prucha et al., 2001), we are going to modify and update our image of the reflections points that have, at least, one group of rays traveling through the salt body.

The imaging update is possible by just modifying the rays that goes through the salt body, process that is possible by fixing one of the parameters (ρ_s) in equation (1) to 1, and by varying the other two (ρ_p and γ_0).

It is possible to observe in Figure 2, the different effect that this procedure will have for different reflectors points. Figure 2a presents a reflector point away from the salt, for this reflector we should have no correction at all, since there are no rays going through the salt. Figure 2b presents a reflector point with few rays going through the salt, the correction should be small for this reflectors. Figure 2c presents a reflector point with a significant number of rays going through the salt body, these kind of reflectors are generally difficult to image and for those we expect to improve the quality of the image with the asymmetric pre-stack Stolt residual migration operator.

It is also possible to separate the image in sections where we need to apply correction (Figure 2c), and sections where we do not need to apply the correction (Figure 2a). Therefore, we need to be able to interpolate our final image from those two separate sections.

SUMMARY AND FUTURE WORK

This idea is a work in progress. In this paper we presented how we can use a tool developed for updating converted waves images for imaging complicated geological regions with single mode data.

We are planning to apply this methodology to the velocity model presented in this paper. We would also like to apply to a real data set, that presents interest challenging problems under salt edges.

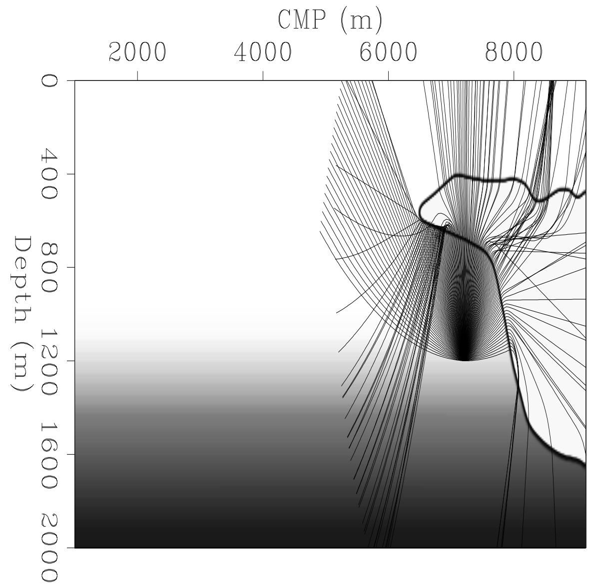

Figure 1: Main problem: Two different groups of rays, group *A* doesn't go through the salt body; group *B* goes through the salt body. daniel2-hwt2c [ER]

REFERENCES

Muerdter, D. R., Lindsay, R. O., and Ratcliff, D. W., 1996, Imaging under the edges of salt sheets: a raytracing study: 66th Annual Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 578–580.

Prucha, M. L., Clapp, R. G., and Biondi, B. L., 1998, Imaging under the edges of salt bodies: Analysis of an Elf North Sea dataset: SEP–**97**, 35–44.

Prucha, M. L., Clapp, R. G., and Biondi, B. L., 2001, Imaging under salt edges: A regularized least-squares inversion scheme: SEP–**108**, 91–104.

Rosales, D., Sava, P., and Biondi, B., 2001, Stolt residual migration for converted waves: SEP–**110**, 49–62.

Sava, P., 1999, Short note–on Stolt prestack residual migration: SEP–**100**, 151–158.

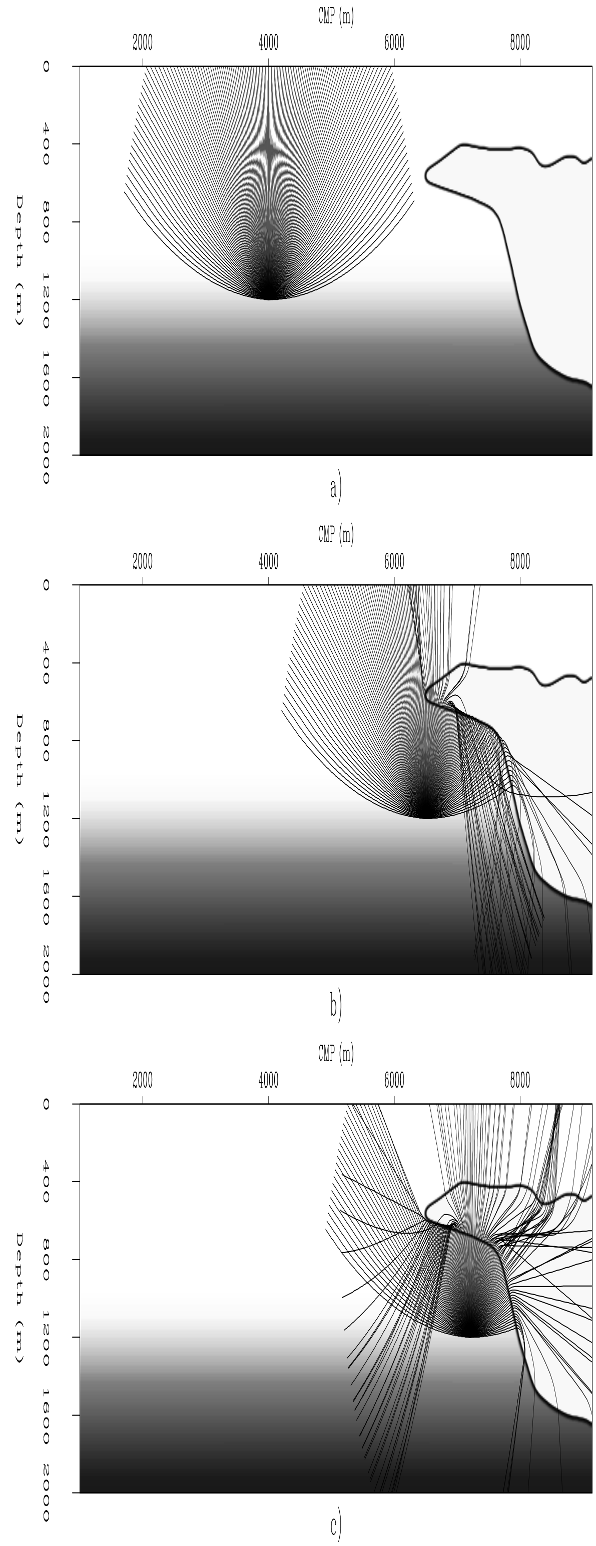

Figure 2: Different ray tracing for different reflector position. a) A reflector position not affected by the salt body; b) A reflector position partially affected by the salt body; c) A reflector position totally affected by the salt body. daniel2-hwt2d2 [ER,M]