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### Summary

In this paper we propose to do AVO on target-oriented  $\tau$ - $p$  gathers. The  $\tau$ - $p$  gathers are generated just above a zone of interest, in contrast with traditional AVO techniques that are generally applied on surface related  $\tau$ - $p$  gathers.

After surface related preprocessing, shot records are downward extrapolated to the upper boundary of the target. Next, local  $\tau$ - $p$  gathers are generated, preferably after reordering the redatumed shot records into CMP gathers. By using a locally 1-D model for the target, modeled  $\tau$ - $p$  data are compared with the 'redatumed'  $\tau$ - $p$  data.

Per  $\tau$ - $p$  gather an iterative inversion scheme is applied, since we can use a fast forward modeling. Finally, all individual solutions are integrated to form one 2-D (or 3-D) solution.

The proposed inversion strategy holds for complex overburden structures where traditional AVO methods are not applicable any more.

### Introduction

Prestack AVO analysis is generally performed on surface data, either in the time-offset domain (see e.g. Yu, 1985) or in the  $\tau$ - $p$  domain (Diebold and Stoffa, 1981; Pan et al., 1990). In *surface* data the target response can be heavily distorted due to an irregular overburden. For complex overburden structures, amplitude corrections on surface data prior to AVO analysis becomes very elaborate, if not impossible, and therefore another route must be followed.

After surface related preprocessing, we propose to downward extrapolate surface data (PP, PS, SP and SS) to the upper boundary of the target zone. There we transform the redatumed shots into local  $\tau$ - $p$

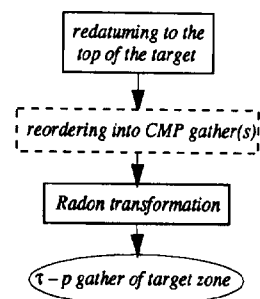


Figure 1 : After redatuming to the upper boundary of the target zone, a target oriented  $\tau$ - $p$  gather is obtained by Radon transformation.

gathers, preferably after reordering the data into CMP gathers (see Figure 1). Next, a comparison can be made with simulated  $\tau$ - $p$  data from a model of the target zone. This forms the essence of the consecutive elastic stratigraphic inversion step (de Haas and Berkhou, 1990).

### The generation of local $\tau$ - $p$ gathers

Considering the 2-D subsurface model of Figure 2, it is clear that traditional AVO methods are not applicable here. However, with our DELPHI processing scheme, shown in Figure 3, such subsurface geometries can be handled very well. After decomposition of the data into separate  $P$ - and  $S$ -wave responses and removing the surface related multiples, we apply downward extrapolation of both source and reflected wave fields to the upper boundary of the target. The downward extrapolation, which needs a macro model, removes the propagation effects of the overburden in a correct way, no matter how complex the overburden is. The redatuming level is chosen such that it is just above and parallel to the local layering of the target. At this datum we then reorder the data into CMP gathers. Next, a Radon transformation is applied, yielding the desired  $\tau$ - $p$  gathers for  $PP$ ,  $PS$ ,  $SP$  and  $SS$ .

### Example

For the generation of target-oriented  $\tau$ - $p$  gathers for the model of Figure 2, we redatumed elastic finite difference modeled shot records to the CMP indicated in Figure 2. For *PP* data the 'redatumed'  $\tau$ - $p$  gather is shown in Figure 4, together with the true *PP*  $\tau$ - $p$  gather at this CMP, modeled using the correct model of the target. Note the high resemblance of the 'redatumed'  $\tau$ - $p$  gather with the modeled  $\tau$ - $p$  gather, for the  $p$ -values that are present in the surface data.

### The consecutive inversion strategy

Because of our choice of the new datum together with the use of CMP data, we can accurately represent the target zone *locally* with a 1-D model. For each target CMP we may use simple and fast forward modeling in our iterative inversion scheme. This process can be repeated at different lateral positions along the target, each time inverting CMP data in the  $\tau$ - $p$  domain for a *locally* 1-D medium (de Haas and Berkhout, 1990). Next, all midpoint solutions need be integrated to one 2-D (or 3-D) solution.

### Conclusions

There are two major advantages of using target oriented  $\tau$ - $p$  gathers instead of surface data:

- 1) Surface data contains the target response modified by the overburden. In complex areas this modification may be serious and redatuming prior to inversion for target parameters is a prerequisite.
- 2) Compared to a global inversion approach, as proposed by e.g. Crase et al. (1990), our inversion process is target-oriented and can be subdivided in a number of small, local, *independent* inversion problems. This reduces the amount of computation time considerably and allows user interaction when all solutions are integrated.

### References

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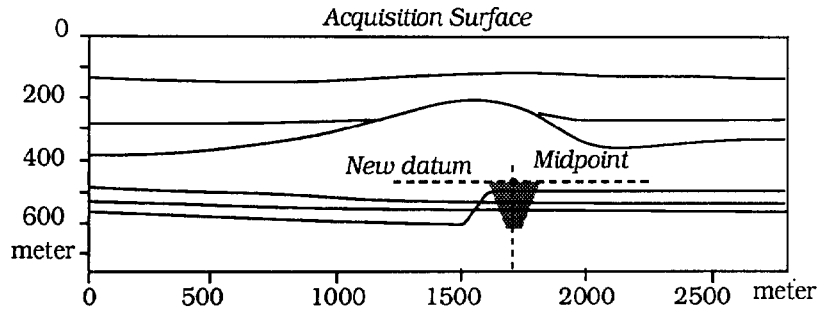


Fig. 2 : Example of a 2-D subsurface model, where the new datum is indicated by the dotted line and one CMP by the black dot.

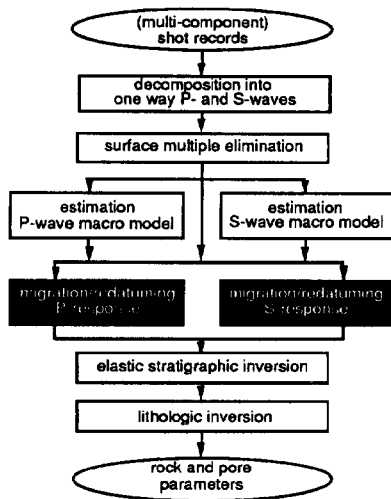


Fig. 3 : The DELPHI scheme for elastic seismic processing with the redatuming module highlighted. For single component data (or marine data) there is no S-response.

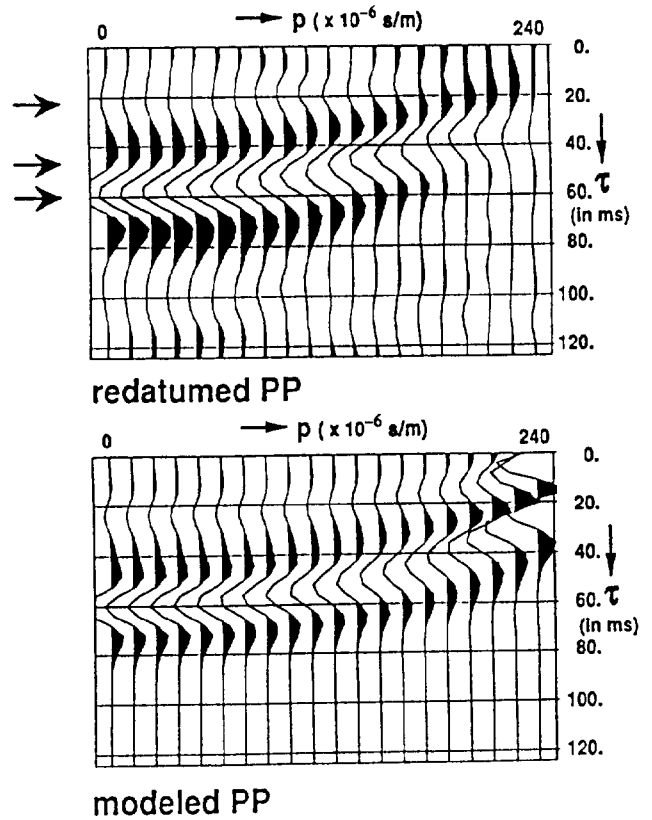


Fig. 4 above: Target-oriented PP  $\tau$ - $p$  gather at the CMP indicated in Figure 2, generated after surface related preprocessing and prestack redatuming; below: the modeled PP  $\tau$ - $p$  gather.