P040 TARGET ORIENTED MIGRATION BY MEANS OF CONTROLLED ILLUMINATION

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Introduction

Stacking of common receiver gathers at the surface produces plane wave responses of the subsurface, Taner (1976). Since these plane wave responses are physical experiments, wave equation based extrapolation techniques (pre-stack) can be used to migrate or redatum these responses. However, due to the inhomogeneities of the subsurface, the wave front will be (seriously) distorted when arriving at the level of interest, the target zone (Fig 1).

It is possible to synthesize shot records at the surface in such a way, that the wave front arriving at the top of the target zone has a pre-defined shape (amplitude and phase). This technique is called *controlled illumination* (Rietveld et al., 1991).

We will show that synthesizing shot records in a target oriented way, using the method of controlled illumination, followed by a so-called macro shot record migration, gives a very good image of the targetzone, using just *one* synthesized macro shot record.

Controlled Illumination

If the macro model of the overburden is known, it is possible to construct an operator, which enables us to synthesize the shot records in such a way that a particularly shaped wave front *at the surface* illuminates the reservoir in a pre-defined, controlled way.

With our matrix formulation of the forward model, (Berkhout, 1985), it can be easily shown that this synthesis operator equals the wave field at the surface that is obtained by backward propagation of the *desired* source wave field at the target. Fig. 2 shows the synthesis operator for the horizontal plane wave illumination of the target ($z = 2200$m).

Application of the synthesis operator to the shot records, yields the *response at the surface* due to the synthesized source wave field (Fig. 3). This involves a weighted common receiver stack in the frequency domain, the weights being given by the related frequency components of the synthesis operator. Another way of saying this is that in the time domain each shot record is convolved by one trace of Fig. 2 prior to common receiver stacking.

Target-oriented macro shot record migration

The migration of a macro shot record does not differ from the conventional shot record migration. It involves *forward* extrapolation of the areal source wave field (Fig. 2), followed by *inverse* extrapolation of the synthesized macro shot record (Fig. 3), and concluded with applying the imaging principle.

Fig. 4 shows the depth section obtained from migration of the target-oriented macro shot record (Fig. 3). We see already a very good image for *one* macro shot record.

Conclusions

From our experiments we may conclude that by controlling the source wave field in a target-oriented way (*controlled illumination*), a very good image of the target zone can be obtained, even for just *one* illumination angle. Note that the computational effort for the result of Fig. 4 is comparable with the computational effort of *post stack* migration.

References

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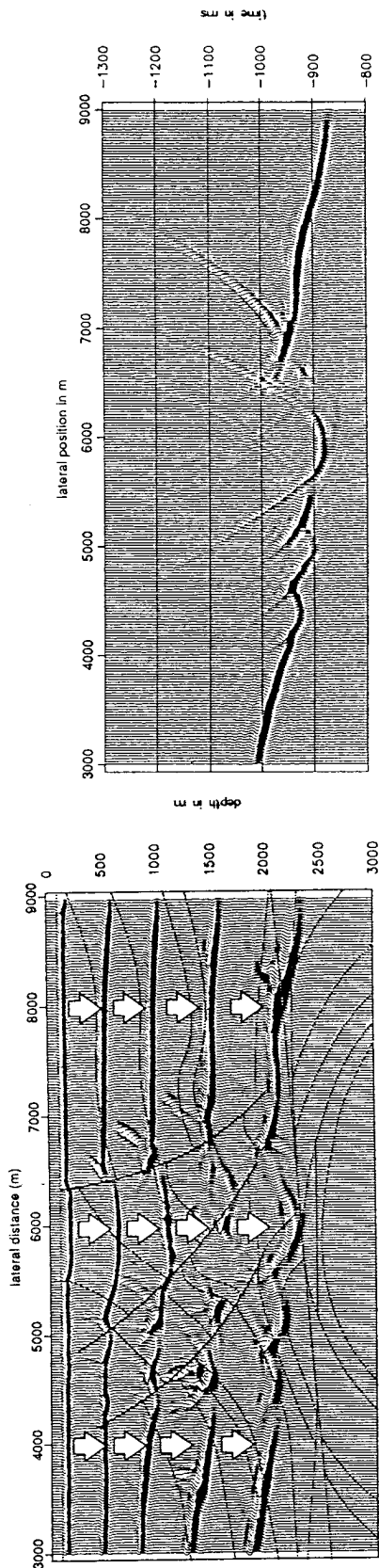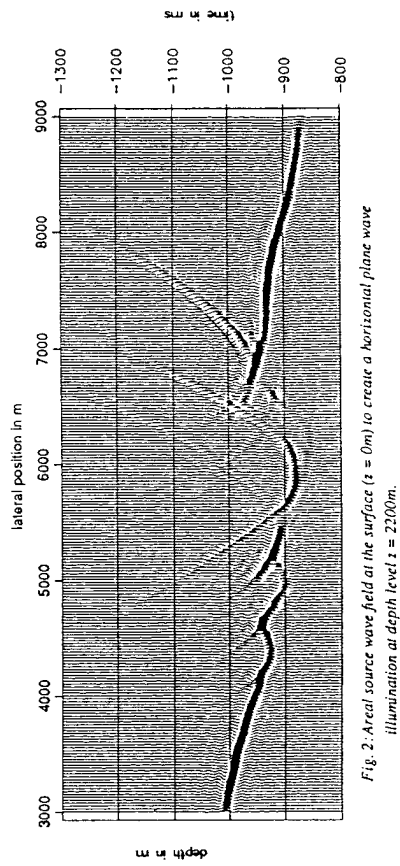
Fig. 2: Areal source wave field at the surface (z = 0m) to create a horizontal plane wave illumination at depth level z = 2200m.

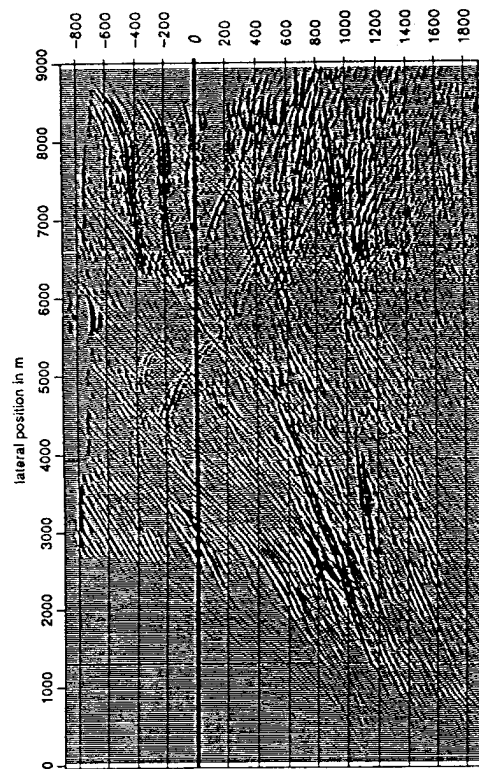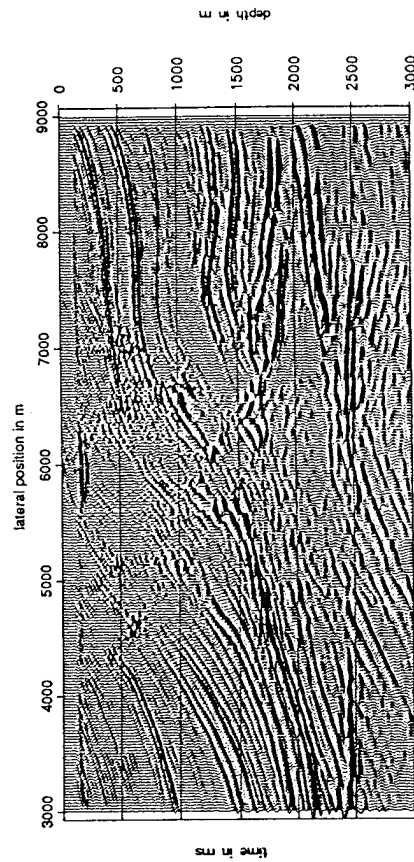Fig. 4: Depth section obtained by migrating the macro shot record of Fig. 3.

Fig. 1: A plane wave at the surface arrives seriously distorted at the target (Marmousi model, Versteeg and Grau, 1991).

Fig. 3: Macro shot record after controlled illumination by a horizontal plane wave at depth level z = 2200m.