A005 UPDATING OF MACROMODELS BY GLOBAL INVERSION OF FOCUSING OPERATORS

R.F. HEGGE and J.T. FOKKEMA

*Delft University of Technology, Centre for Technical Geoscience, PO Box 5028, 2600 GA Delft,
The Netherlands*

Summary

A method to estimate or update macro velocity models is introduced, which is based on the global inversion of focusing operators.

Introduction

Prestack migration can be performed by several different procedures. The main difference lies in the treatment of the velocity problem. Traditional methods tackle this problem directly by iterating through the sequence of migration (i.e. double focusing), some form of velocity analysis and macromodel updating. In the Common Focus Point approach (Berkhout, 1996) the velocity problem is addressed after more information about the subsurface has been gathered. This approach is based on the principle that all subsurface gridpoints can be addressed individually by an appropriate focusing operator. By using such an operator we can illuminate a specific gridpoint only, in case of errors update the operator and finally detect the response of that single gridpoint. Thus a complete subsurface image can be made by performing two separate focusing steps. The updating of an erroneous operator is straightforward and shows rapid convergence (Morton and Thorbecke, 1996). The advantage of this approach is that the updating is performed in between instead of after two focusing steps. The focusing operators themselves contain valuable information regarding the structure and velocities of the subsurface. Based on this information we can estimate or update macro velocity models with a controlled accuracy. This is done by inverting simultaneously for the velocity model, structure and focus point locations

The inversion method

The CFP operators contain both traveltimes and amplitude information. Here we use only the traveltimes and restrict ourselves to the first arrivals. The inversion takes the form of an optimization process based on the comparison between the true traveltimes and the traveltimes from modeled operators. By using Fermat's principle we can derive a formula which relates the change in traveltimes to model perturbations and/or the perturbation of the focus point location (Hegge and Fokkema, 1996). If the focus point locations were known it would be similar to the formula used in traveltimes tomography. The information of all the rays for all focus points can be combined in a system of equations. To this system we can add constraints which limit the range of possible slowness values and constraints to make sure that the positions of the focus points relative to the others is preserved. Finally the system can be solved by a standard constrained least squares routine.

Examples

Here we use part of the picocol model as a complicated true velocity model. This model is given in Fig. 1. At the top left part a number of thin layers are present, which vanish as we go to the right. Also a large high velocity layer is present in the center of the model. The initial model consists of flat constant velocity layers. The final estimated model is given in Fig. 2 with a pseudo velocity below the deepest interface. To compare the depths we superimposed the interfaces of the actual

and final model in Fig. 3, whereas the velocities are given in Table 1. The errors are mainly due to the limited aperture. However the overall structure of the model is very well resolved.

Conclusions

The use of focusing operators for the simultaneous inversion of the velocity model, structure and focus points proves to be an excellent method to update complicated macro models. In addition the accuracy of the velocity model is part of the inversion result.

References

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Fig. 1: Picrocol subsurface model

Fig. 2: Final estimated velocity model

Fig. 3: Interfaces (superimposed)

nr	actual	final	nr	actual	final
1	1700	1698	7	2800	2805
2	1800	1905	8	3200	3904
3	2000	2113	9	3500	4443
4	2200	2242	10	4200	4860
5	2310	2409	11	4500	5084
6	2450	2472	12	5000	4067

Table 1: Velocities (m/s) per layer