ПРИМЕНЕНИЕ ЛУЧЕВОГО МЕТОДА В ЗАДАЧЕ ДИНАМИЧЕСКОЙ ДЕКОМПОЗИЦИИ ВОЛНОВЫХ ПОЛЕЙ И РЕКОНСТРУКЦИИ МОДЕЛИ ПО ДАННЫМ ВСП.

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Dynamic decomposition of seismic wavefields and media model reconstruction with raytracing method by VSP data.

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Summary

New method of VSP seismic data processing and interpretation is proposed. The method is applicable to inhomogeneous media models with partially-smooth interfaces. The results comparison of ray-tracing and finite-difference methods is made.

Аннотация

В предлагаемом докладе представляется новая методика обработки и интерпретации данных сейсморазведки ВСП для моделей неоднородных сред с кусочно-гладкими границами. Проводится сопоставление годографов и амплитуд прямой волны рассчитанных лучевым методом и снятых с поля, вычисленного методом конечных разностей.

Introduction

As a rule, the processing and interpretation of the seismic data are divided in time and often are carried out by the different software packages. Thus the information about model is used not in complete volume, and some simplified approaches are aviable in this surrounding.

Now most imaging procedures are based on ray-tracing and various migration transformations, but each of such methods separately has a number of serious disadvantages. Only parts of whole wave field, for example imaging P or PS waves are used.

Besides in many cases the strongly simplified models of environment (such as flat boundaries, absence of gradients of velocities etc.) are used, that results in the large errors in interpretation.

The first approach to the new technique of processing and interpretation of the VSP data in complex models consisting of ajaisent system of arbitrary-non-uniform bodies with fragmentally regular borders, is presented lower.

The regular waves of various types and orders have to be consistently located and subtracted from an initial field and projected on the image with use of basic model. For subtraction the time graph and amplitudes calculated on initial model of environment are used within the framework of a ray-tracing method.

The obtained image can be used for correction of initial model, and this way is one of iterative steps to determine model which is adequate to interpreted wave field.

In the further this method we shall call as a method of Dynamic Decomposition and Reconstruction (DDR).

The formulation of problems

To apply DDR method it is necessary to solve the following problems:

1. Construction of model satisfying to conditions of a ray-tracing method.
2. Calculation of times, amplitudes and polarization of wave by ray-tracing method.
3. Estimation of a wave signature.
4. Depicting a wave on a section.
5. Correction of a model.

The model of sections realized in a most general case as adjacent system of bodies with boundaries, described by the fragmentally parametrical splines with smoothing. Criterion of smoothing of borders of bodies is the restriction on the maximal curvature. Each of bodies is supposed arbitrary non-uniform.

For calculation of kinematics and dynamic characteristics of various wave types technological computing methods are developed, based on use of the locally exact decisions of differential equations for a ray-tracing method.

As the real media are a thin-layered, the form of scattered waves always does not coincide with the form of short signature. Therefore the signature of a wave scattered on the appropriate boundary of basic model, should be defined from real records.

For the subsequent specification of model, the form of a wave should be represented in deep scale in a point of scattering. The specification of model can be executed by displacement of boundaries to the position which corresponds to the wave position in seismogram.

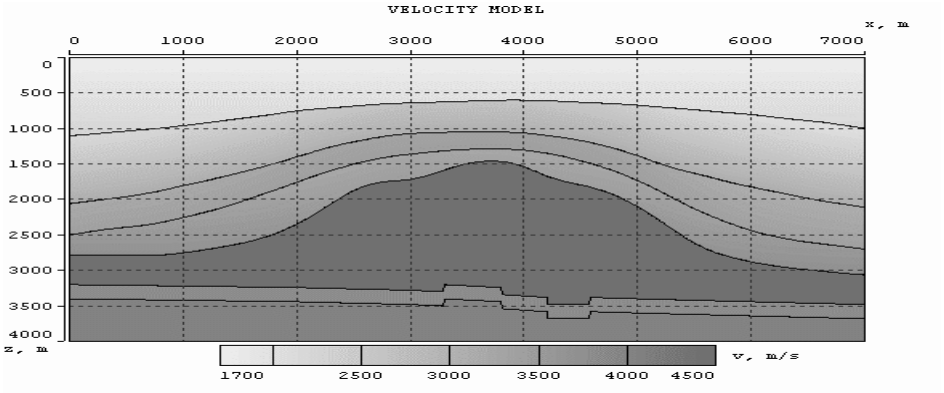


Fig. 1 Model of environment used for the further accounts.

Comparison of parameters of waves designed by the ray-tracing and finite-difference methods

Kinematics parameters of waves calculated by a ray-tracing method and determined from a field calculated by a finite-difference method have close correlation to each other. While the dynamic characteristics well coincide only in separate intervals of depths.

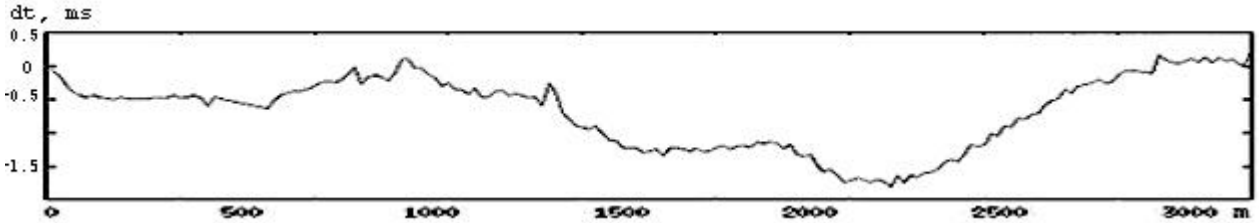


Fig. 2 Diagram of a difference of arrival-times calculated by a ray-tracing method and received from a field calculated by finite-difference method.

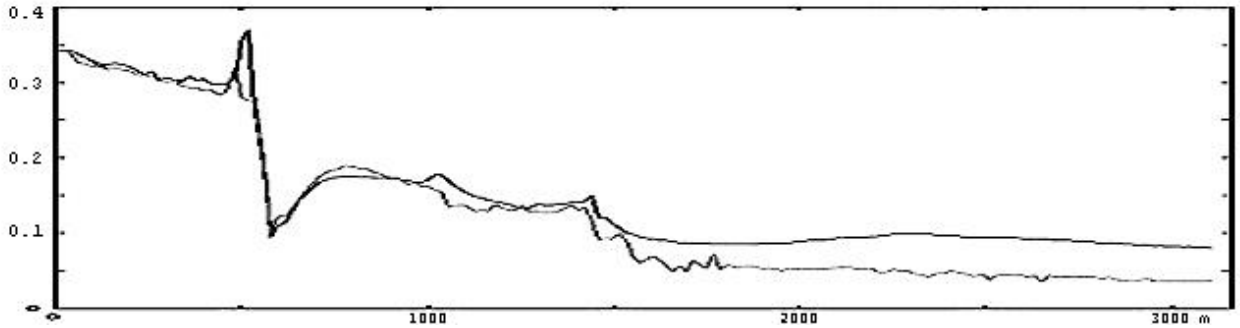


Fig. 2 Diagrams of a amplitudes calculated by a ray-tracing method and received from a field constructed through finite-difference method

DDR technology

The technology of VSP data processing on a DDR technique consists of several procedures:

1. Construction of the first approach to model as a result of kinematic inversion of travel times and polarizations for visually correlated events in original data.

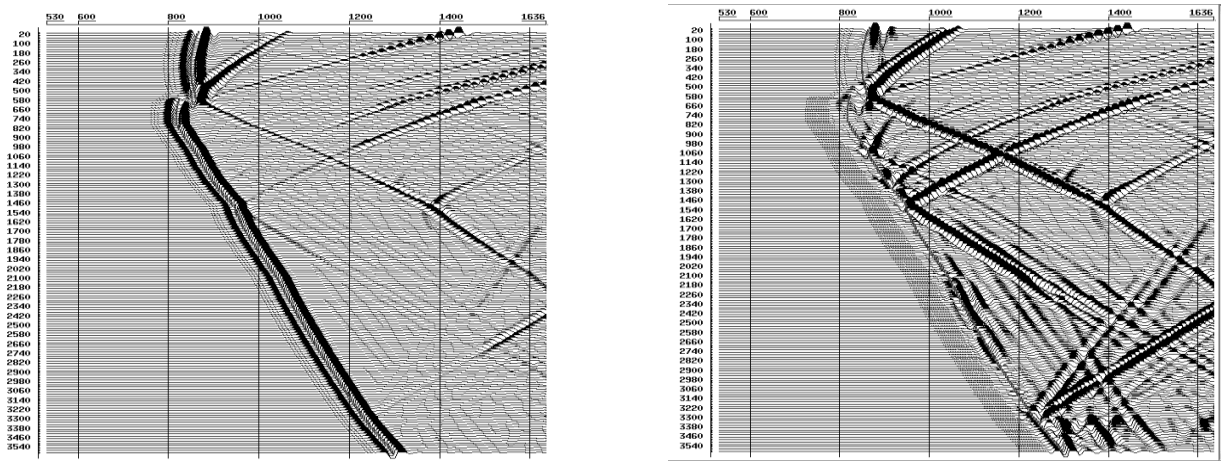
2. The synthetic wave parameters are calculated by ray-tracing method for strongest event.

3. The estimation of the form of a wave along calculated arrival times-graph with use of designed distribution of amplitudes and polarization is carried out

4. The located wave is subtracted from an initial field and is projected in points of scattering on the image with recalculation on factor of reflection of a P-wave on external perpendicular to border. The waves of various types from the same point of boundary are stacked with weights proportional to their original amplitude. The process is repeated for all types of waves and all boundaries until all regular events are subtracted and projected on section. Not only primary, but also multiple waves may used in the process.

After imaging the basic model can be corrected and the process may be repeats until the image will correspond to model with necessary accuracy.

In figure 4 the result of subtraction of direct wave with use of computed times, amplitudes and polarization is depicted.



(а) (б)

Fig 4. Fields designed by a method of finite-difference: а) a complete field, б) a field after subtraction of a direct wave.

Conclusions

- Within the framework of DDR technology the efficient methods of description the two-dimensional models and the methods of ray-tracing in gradient block fragmented media are developed.

- Ray-tracing method is proved by comparison with finite difference of the modeling results.

- The DDR technology provides the way to find iterative solution of a two-dimensional inverse problem for vector wave fields, combining improved of model based method of wave separation and imaging.

Greetings

The authors express to SEPTAR Company for the model which was used for comparison of finite difference and ray-tracing method.

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