Planning 3D Survey -examples-

- Configuration and parameters of the seismic acquisition geometry, location of receiving and shooting lines within the area under study play the crucial role for exploration of hydrocarbon deposits and new territories for oil & gas prospects.
- Full-wave seismic modeling gives the opportunity to get synthetic seismic data practically identical to ones obtained during field seismic survey with the same spread layout. Using a priori information relating to the structure of the upper part of the section, P- and S-velocities, and rock densities, allows obtaining synthetic gathers, which contain all types of useful waves and noise events (reflected, refracted, diffracted, converted, multiple, surface, acoustic, etc.) expected in case of field works. This gives a possibility substantiate not only the acquisition geometry but also plan effective sequence of the data processing procedures revealing the target reflections among noises.
- Full-wave seismic modelling is well-suited for planning of seismic acquisition, in particular for oil & gas exploration in near-salt dome zones, for modelling of mine works' influence on seismic wavefield, for engineering seismics, etc., now has been used increasingly used for tuning of acquisition geometry in complicated seismic & geological conditions.
- The examples of the seismic acquisition systems' parameter tuning and planning are shown for various seismic & geological patterns.

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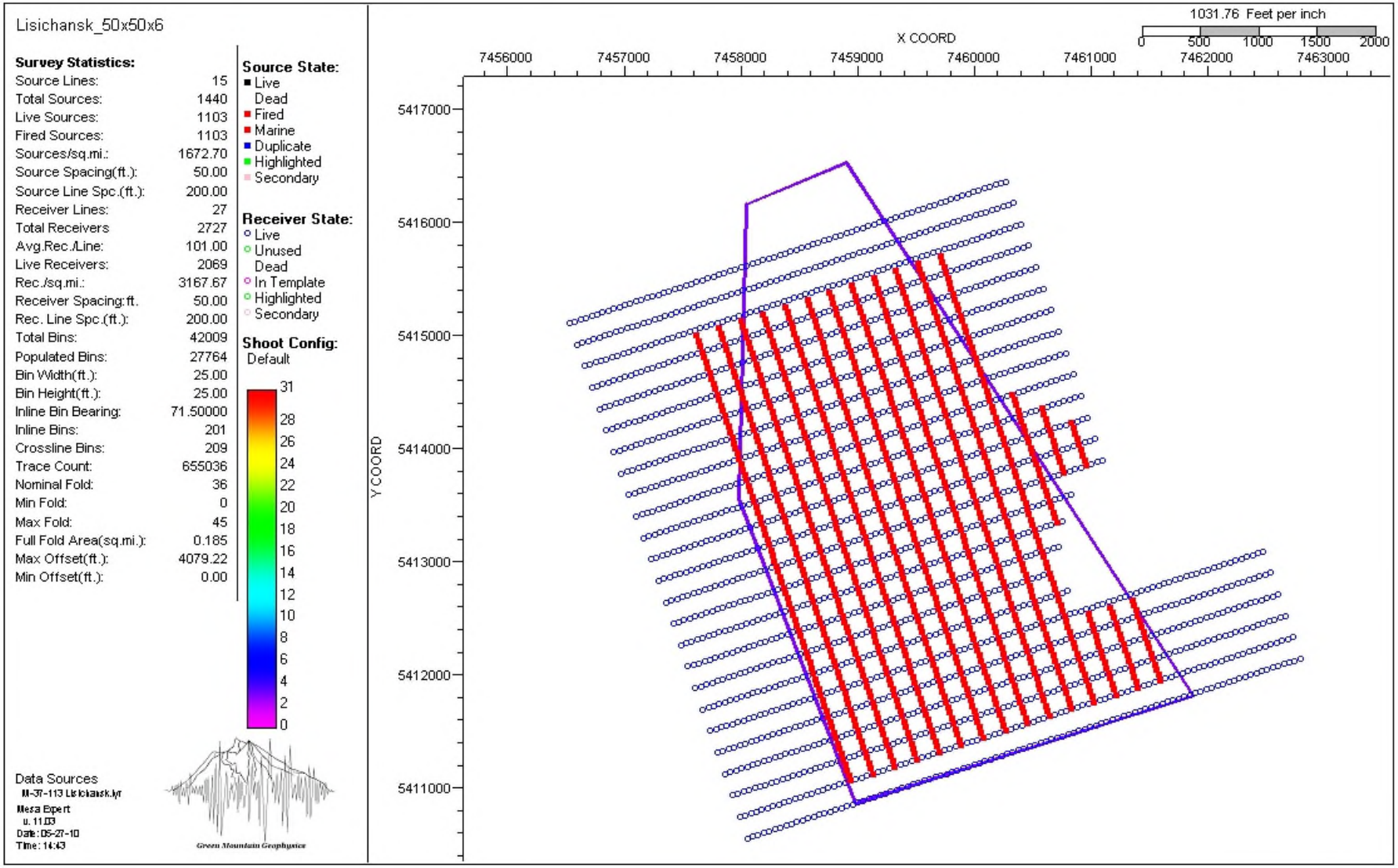
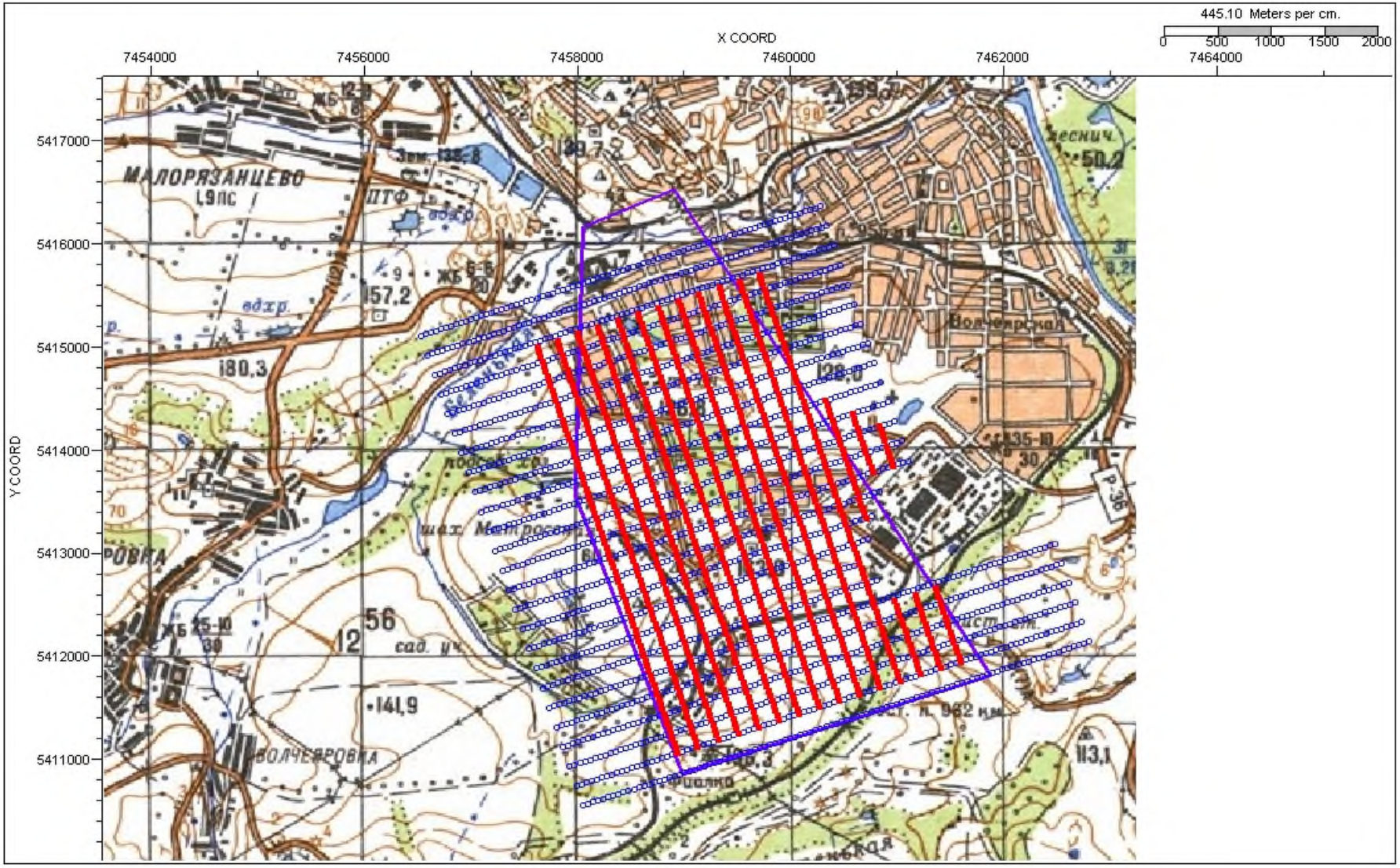
Object 1

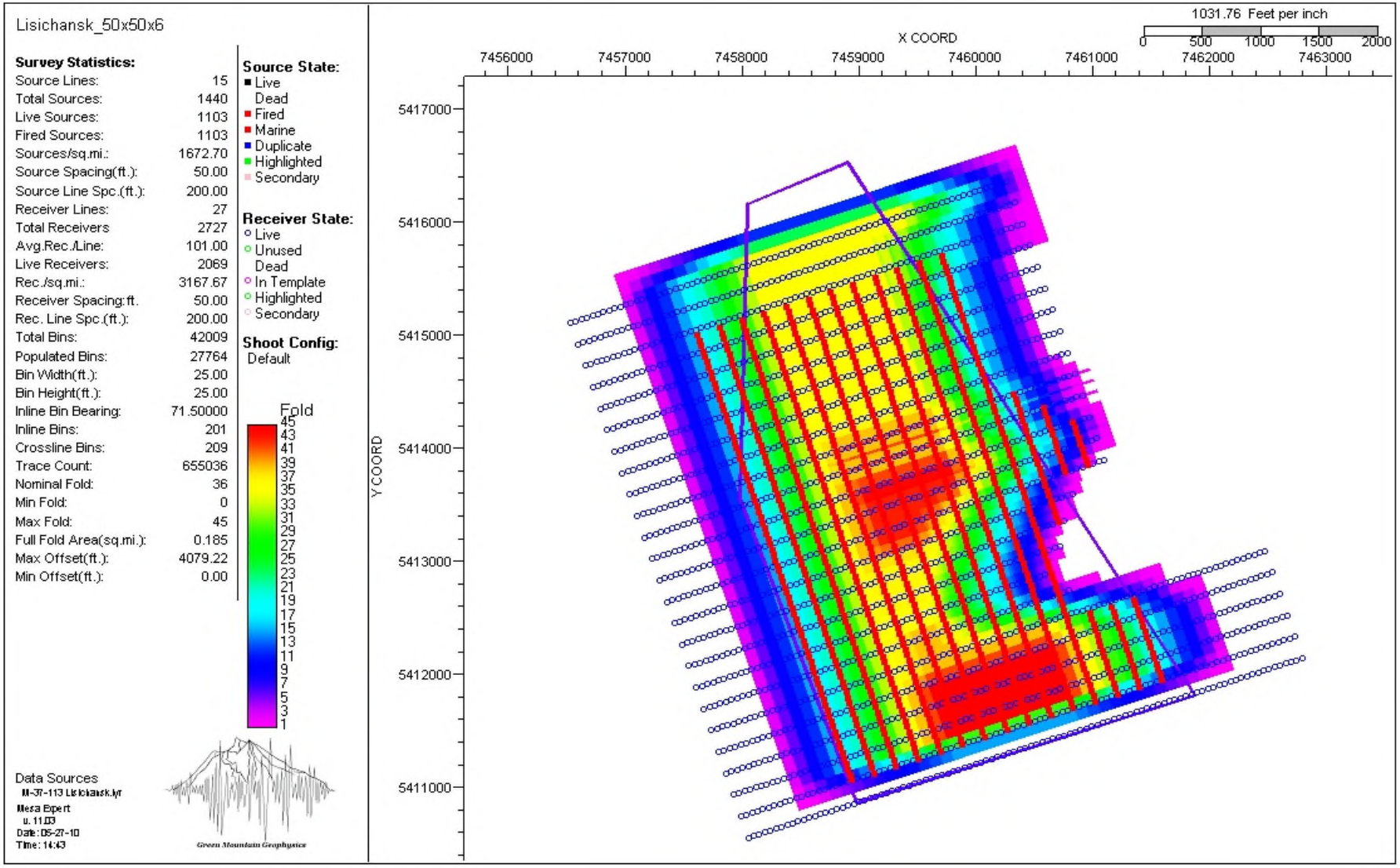
Survey Layout scheme (survey planning package)



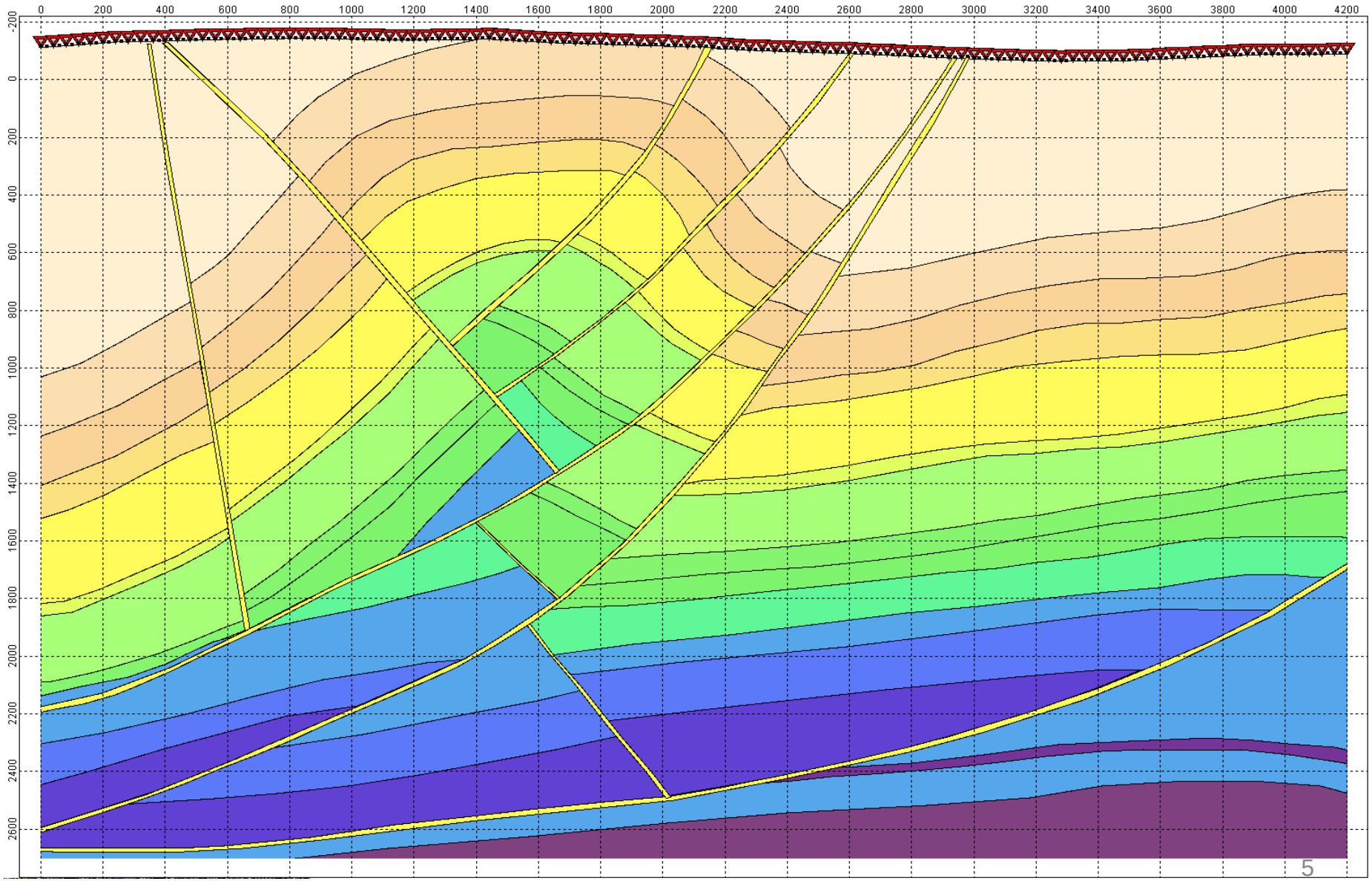
Survey Layout on Land Map (survey planning package)



Scheme of the Survey Overlay Fold (survey planning package)



Seismic-geologic Model of the area (Tesseral, Object #1)



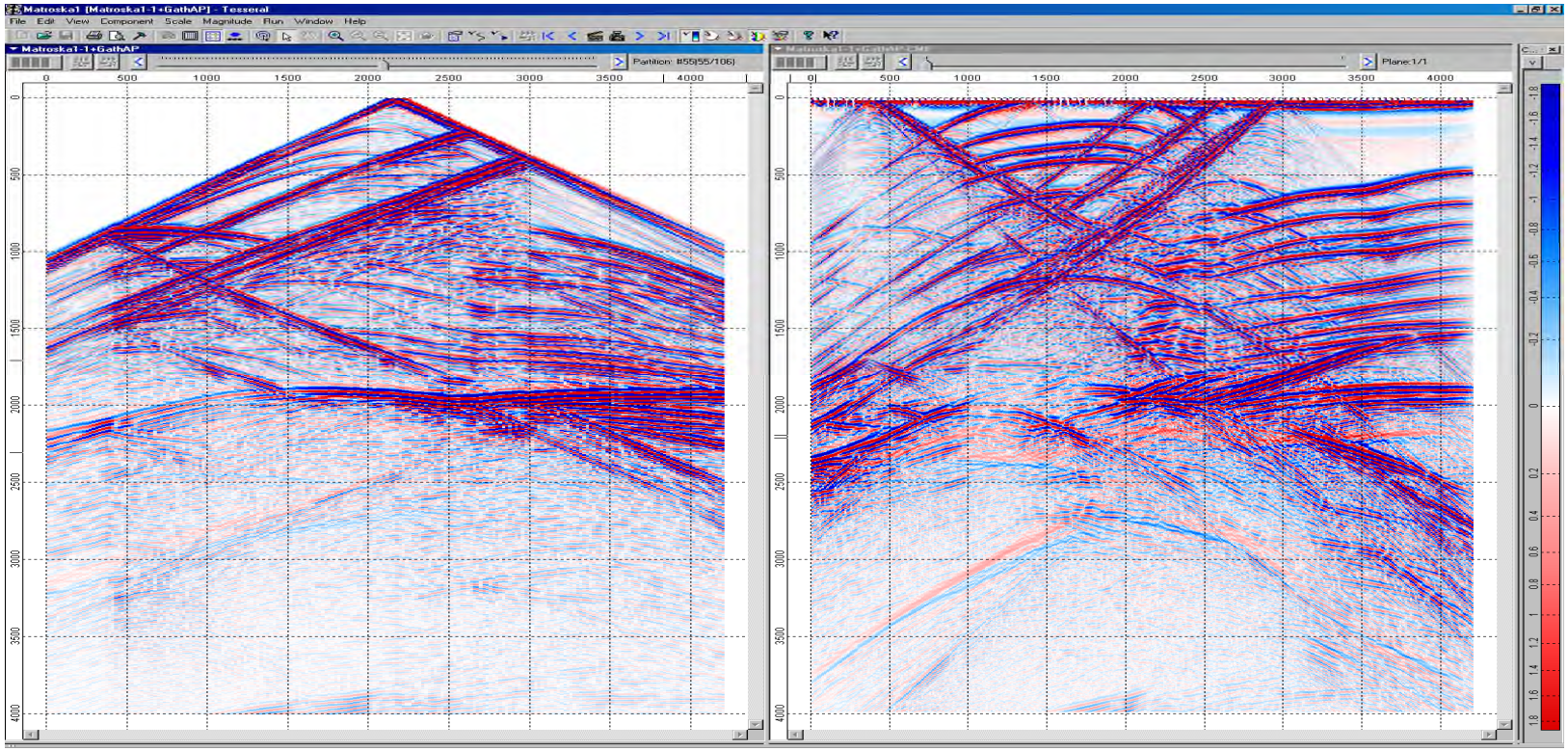
Parameters of the Survey Layout:

- geophone layout	4200 m
- type - static	
- interval between geophone groups	20 m
- interval between shots	40 m
- record sampling rate	2 ms
- record length	4 s
- frequency bandwidth	8-80 Hz

For the initial depth velocity model of the object may be taken:

- The geological section, for instance from the Regional Geological Atlas;
- Seismic & geological section;
- Migrated seismic section in the depth scale;
- Logging data (P-wave and S-wave acoustic logging, density logging);
- VSP data and stratigraphic column.
- The spread parameters are to be selected by practical consideration:
- Intervals for shot points and receiver points;
- Length and type of the spread – end-on, central, fixed, etc. spread;
- Location of the receiver line relatively the target structures;
- Parameters of the signal registration (start time and end time, discretisation step);
- Records grouping. etc.

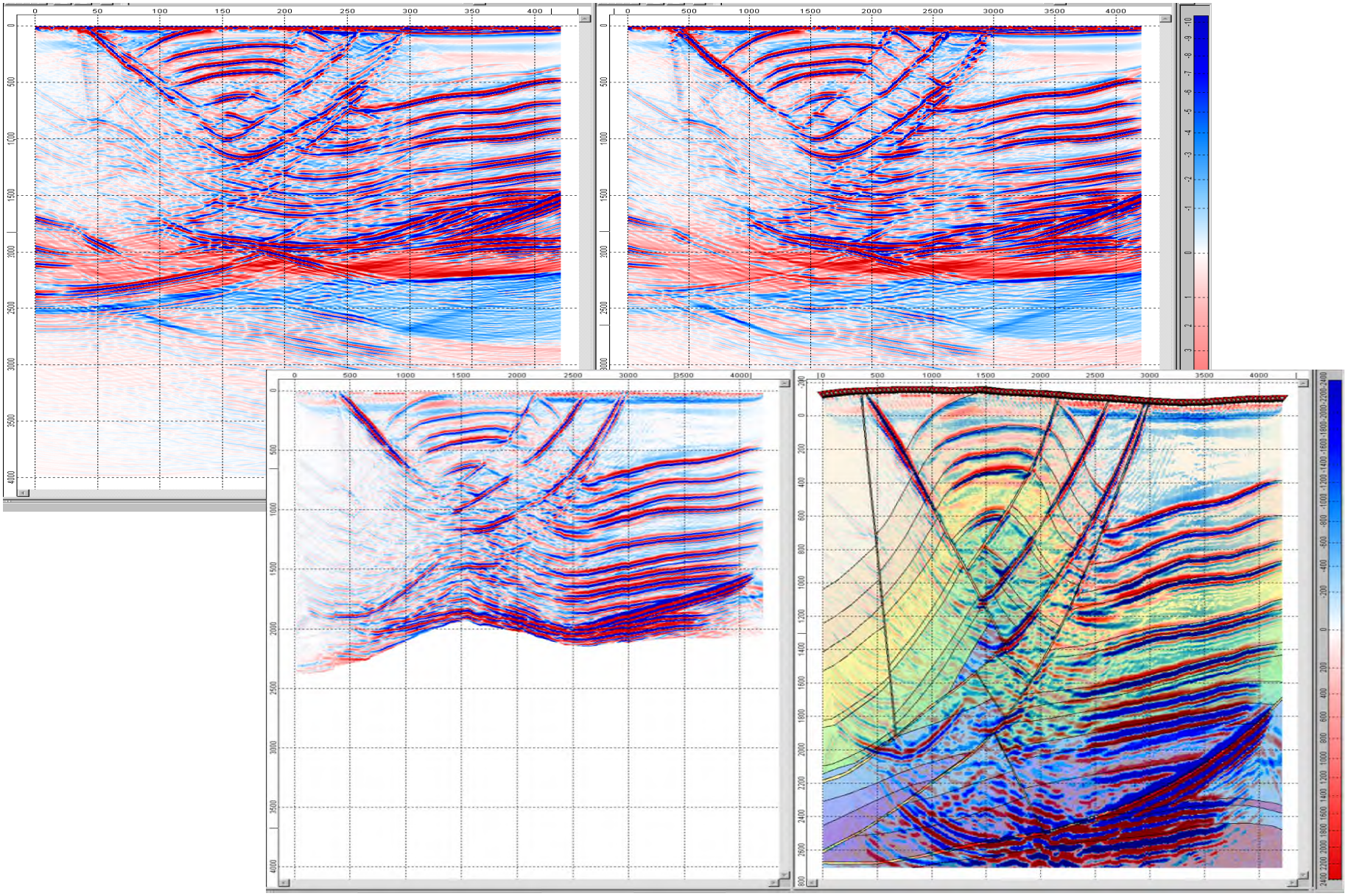
Example of a synthetic gather and CDP time cross-section (Tesseral)



Selection of the modelling parameters:

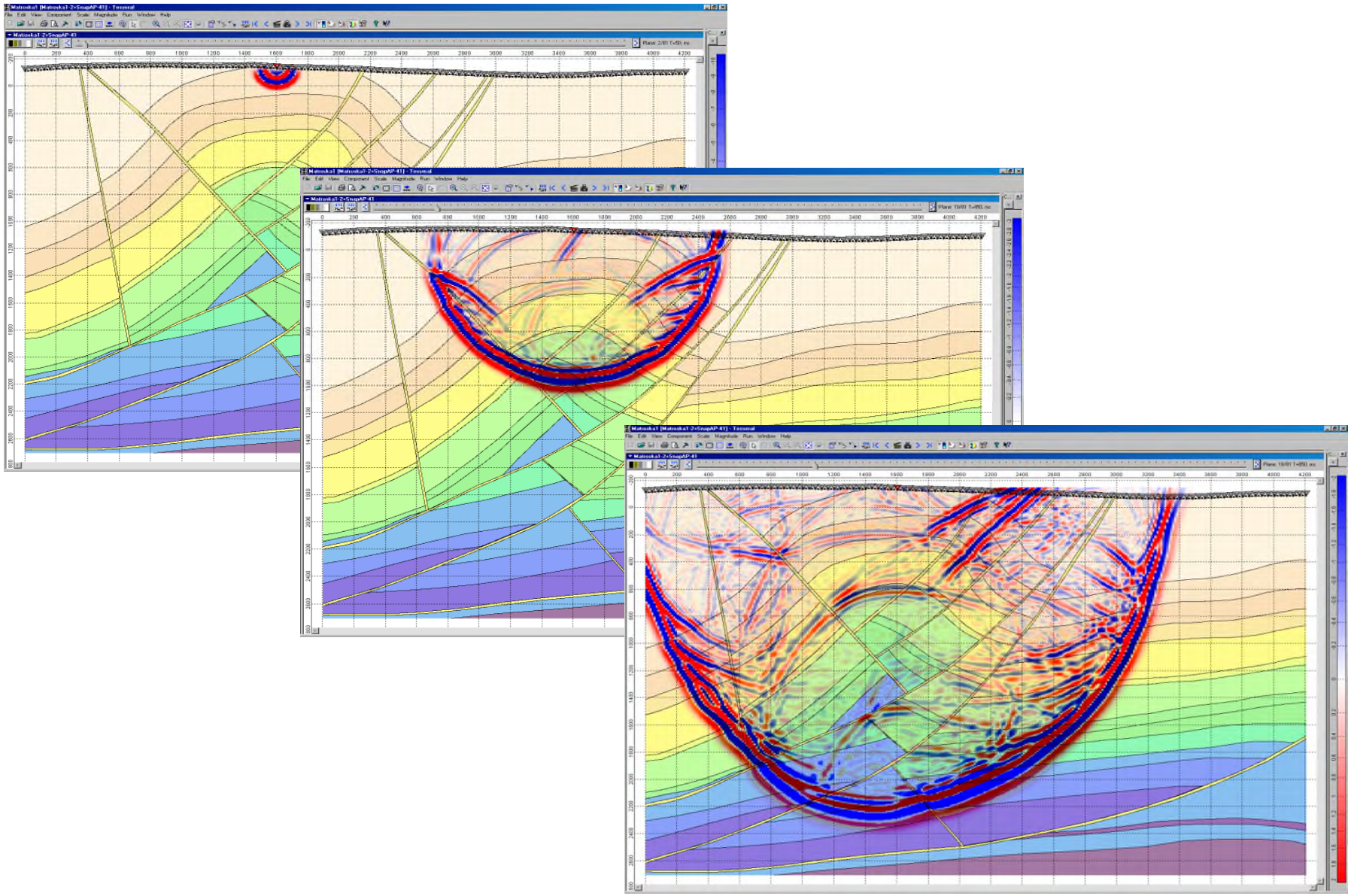
- Wave equation type (scalar, acoustic, elastic, elastic anisotropic, in case some data on anisotropy present; viscose-elastic in case some data on Q-factor for separate layers present);
- Type of the source and type and reak frequency of the signal;
- Mode: with multiples or without multiples; with SV-waves from the source or with attenuation of such waves;
- Anisotropy and fracturing, if present;
- Parameters for the rock matrix and the fluid content, porosity coefficient for the deposit, if present.

Post-stack and pre-stack time migration (Tesseral, in time scale)



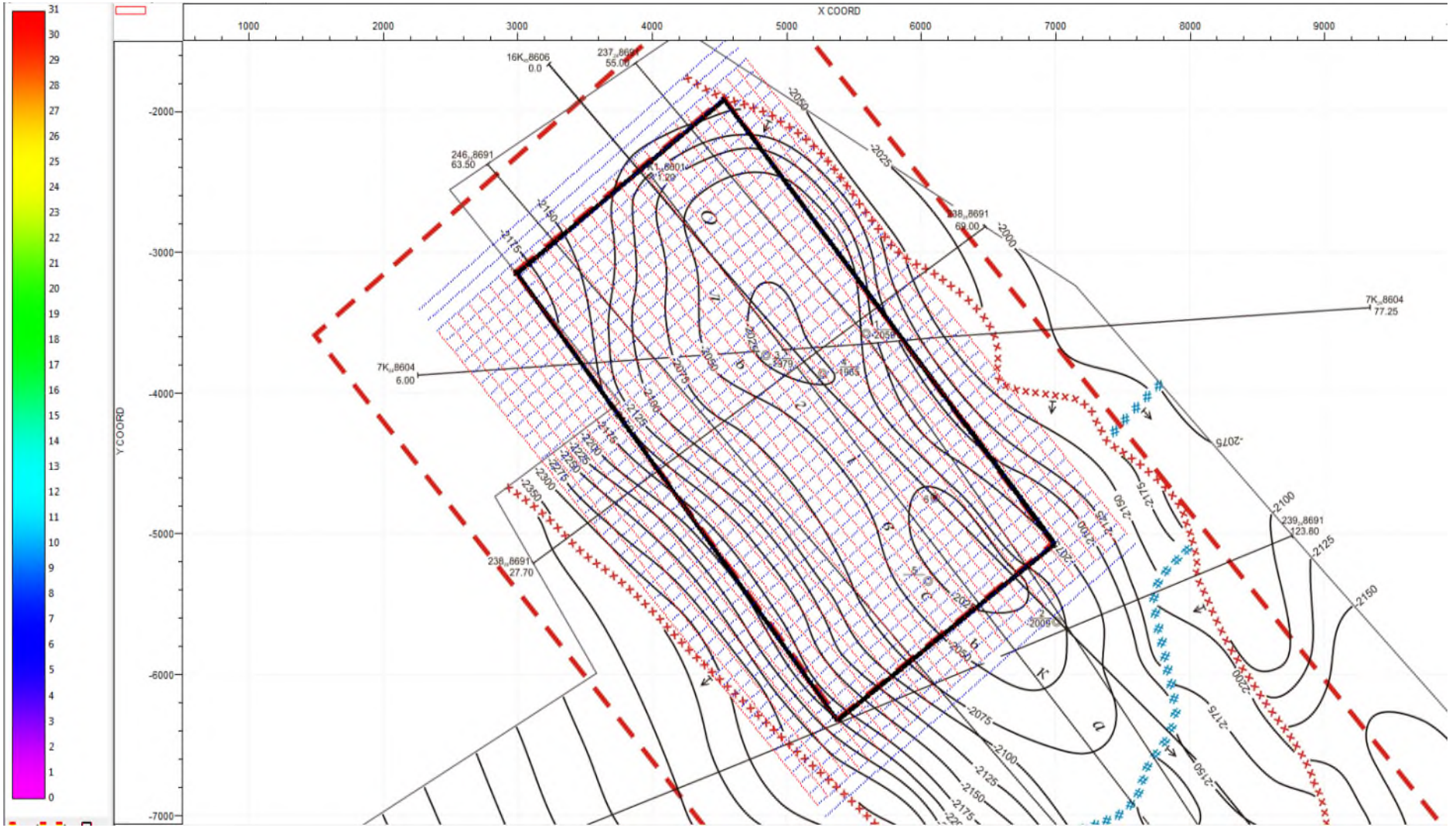
Pre-stack depth migration in (time and depth scale)

Sequence of some wavefield snapshots (Tesseral)

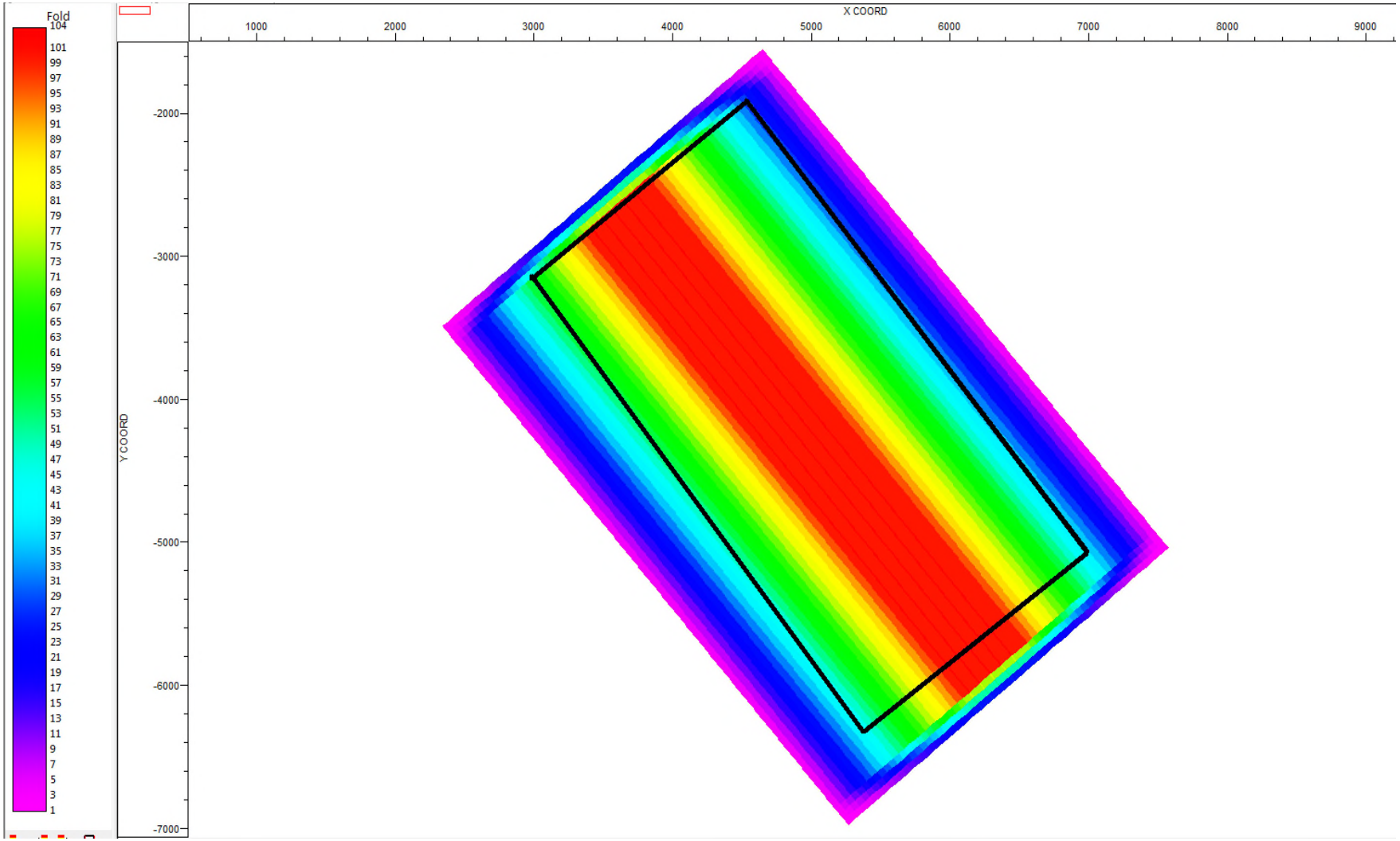


Object 2

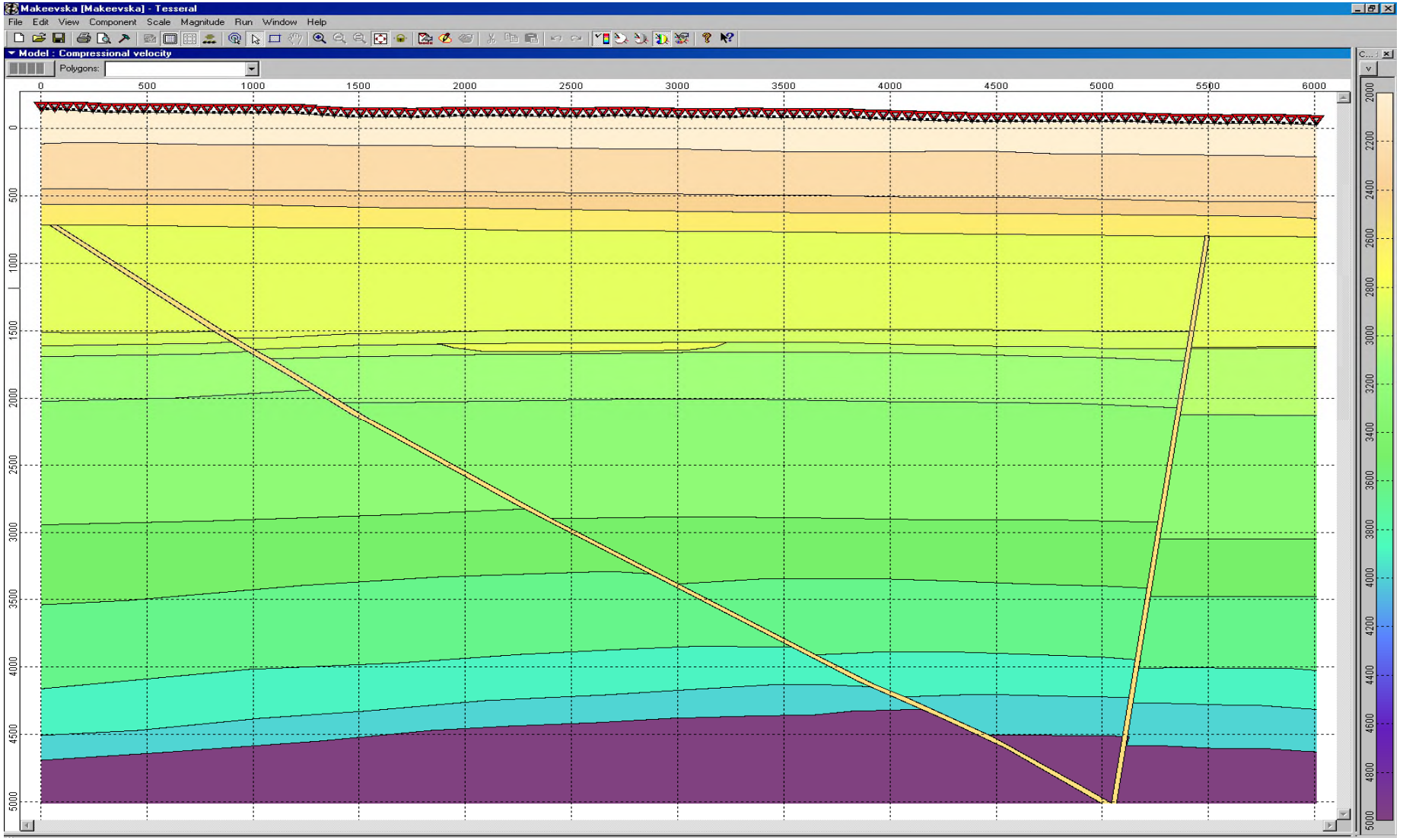
Survey Layout on Structure Map backgroud (survey planning package)



Map of the Survey Overlay Fold Object (survey planning package)



Seismic-geologic Model of the area (Tesseral, Object #2)



Parameters of the Survey Layout:

- geophone layout	6000 m
- type - static	
- interval between geophone groups	30 m
- interval between shots	60 m
- record sampling rate	2 ms
- record length	5 s
- frequency bandwidth	8-80 Hz

The preliminary full-wave modelling of seismic data for a particular object under study provides a possibility to show to the customer that the geological assignment's tasks may be solved successfully by means of the proposed acquisition geometry and workflow of the processing procedures selected by results of the testing based on synthetic data.

In some cases, if the area under study has relatively simple geological pattern, it is enough to use the post-stack time migration for obtainment of the final processing results. If the objects are more complicated, the pre-stack migration may be needed. And finally, for complex structures having steeply dipping reflection boundaries and abrupt lateral velocity changes, it is needed to use the pre-stack depth migration.

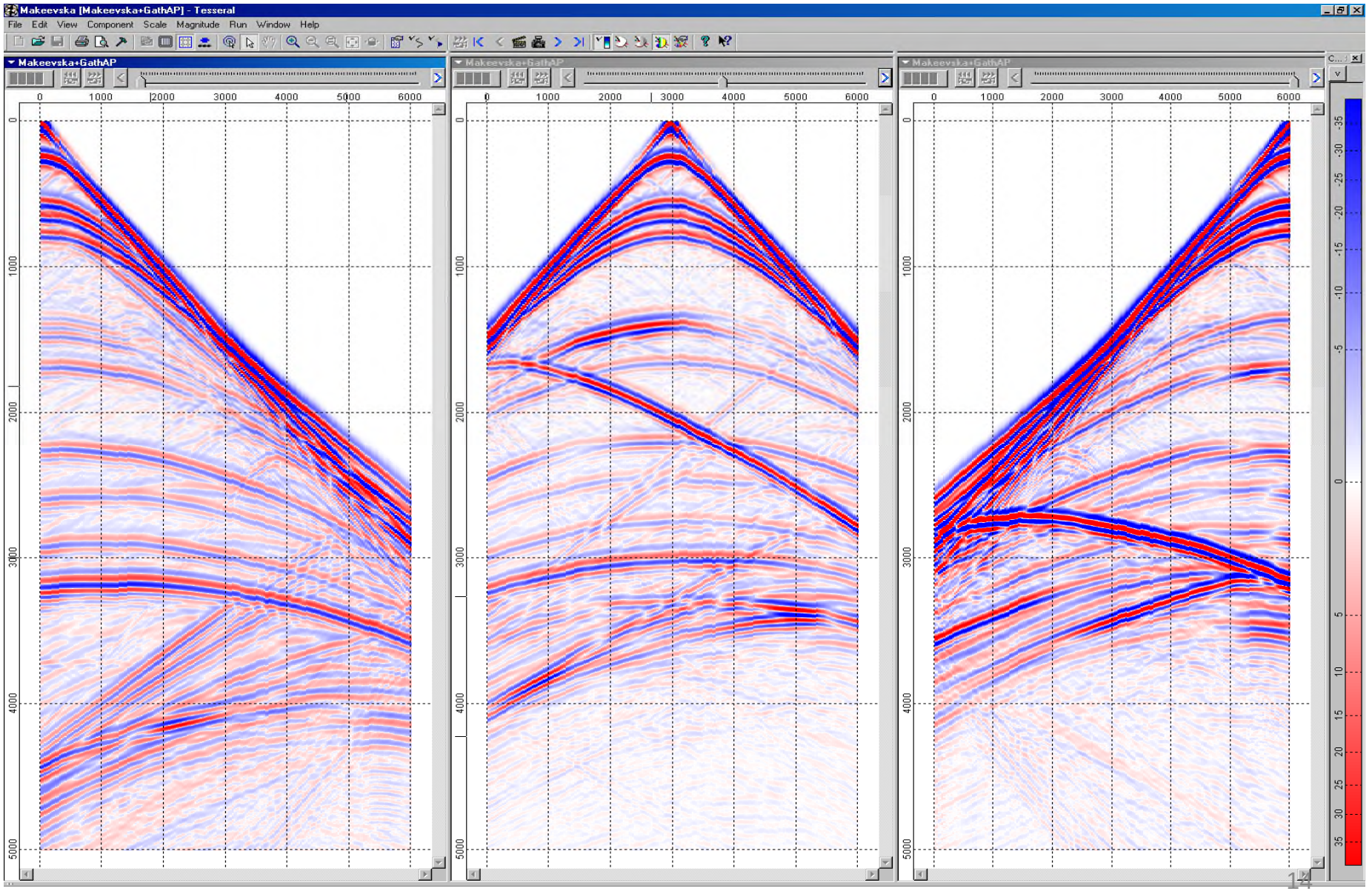
Thus, the full-wave modelling enables not only substantiating the field work technique before beginning of the field observations but also to proposing the proper processing flow, and therefore to supporting a cost sheet taking into account complexity of the object under study.

Synthetic gathers (Tesseral)

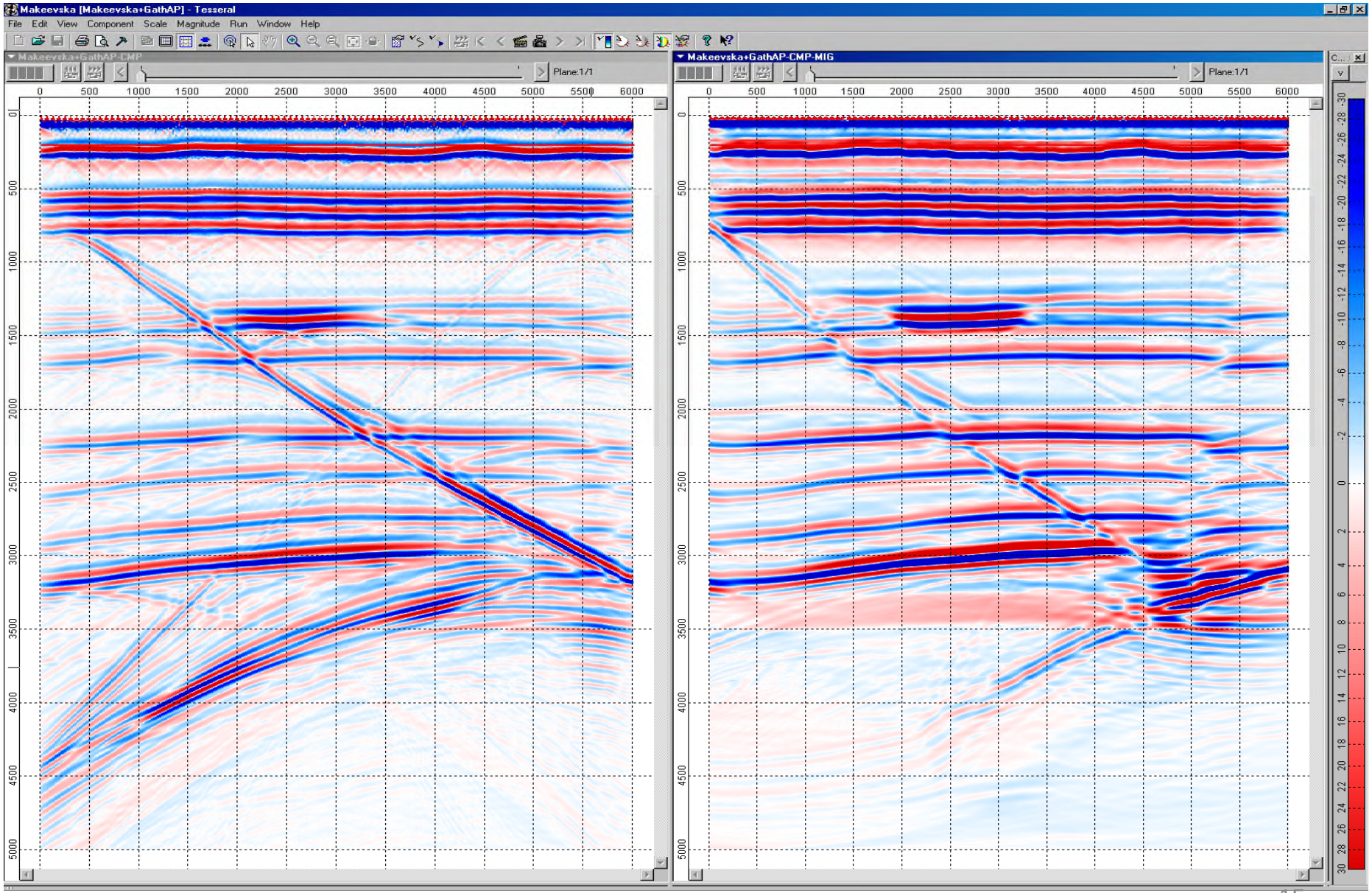
Left Edge of Profile

Middle part of profile

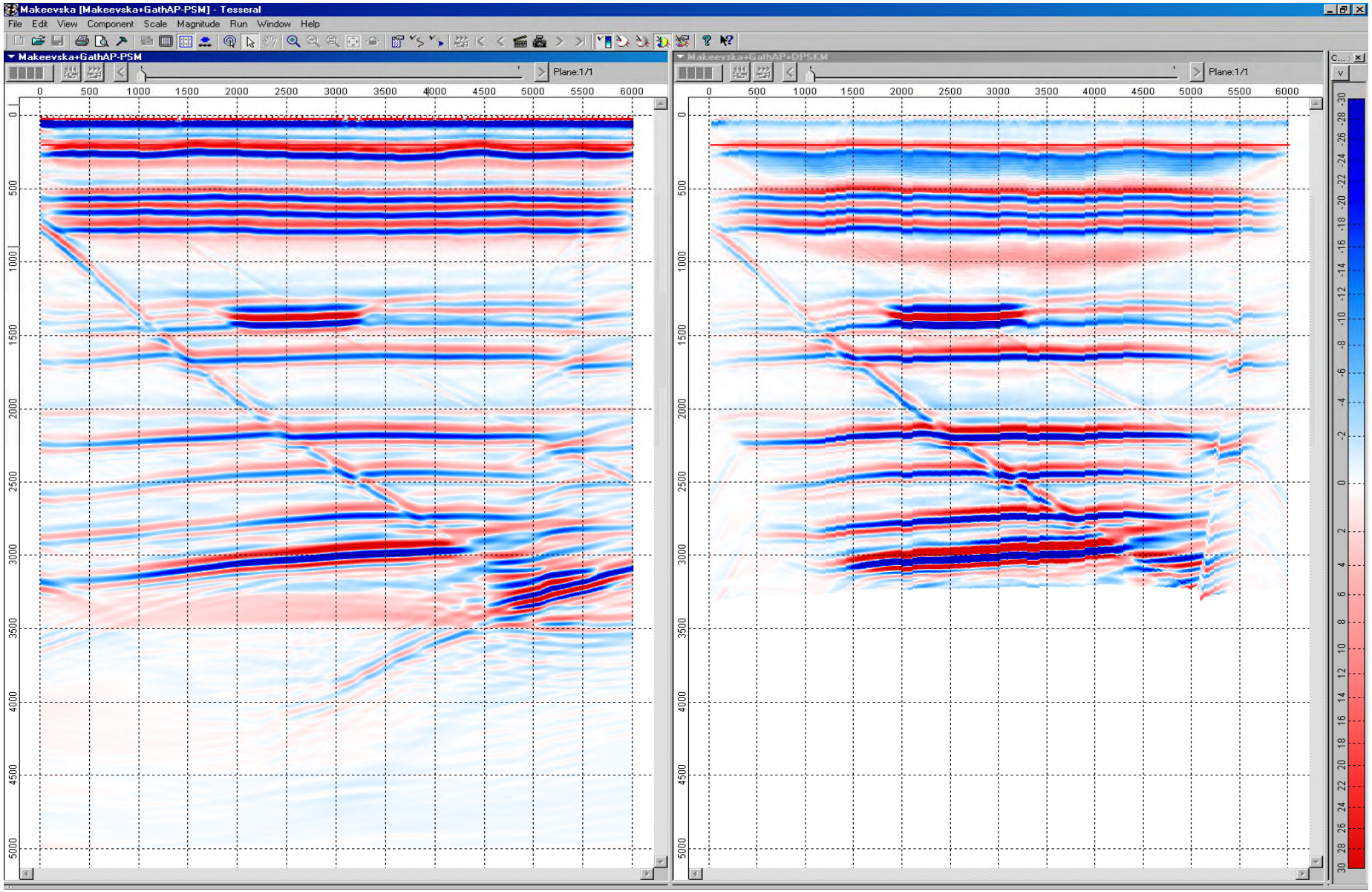
Right Edge of Profile



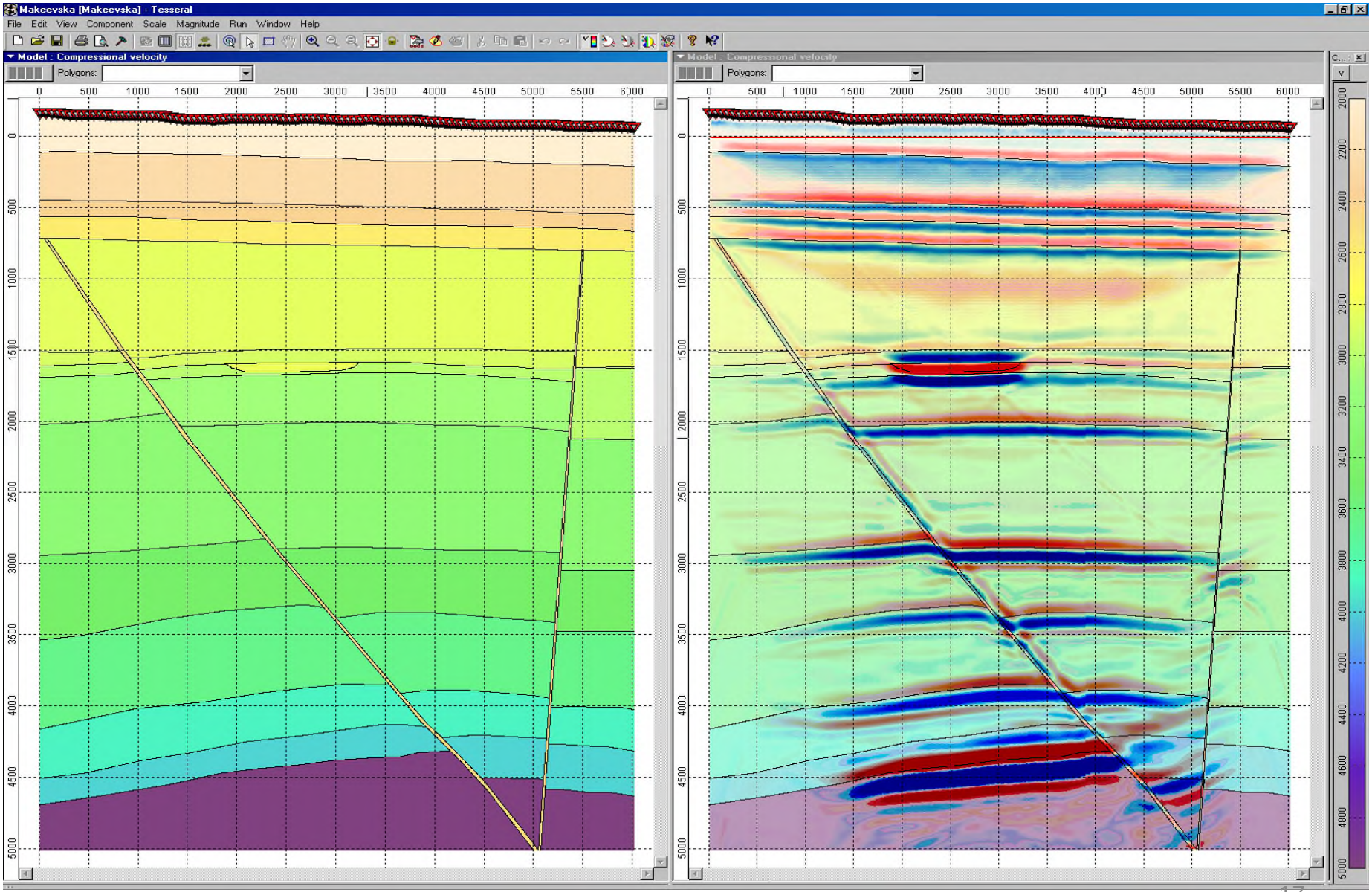
CDP time cross-section and post-stack migrated cross-section (Tesseral)



Pre-stack time and depth migrations (Tesseral, in time scale)

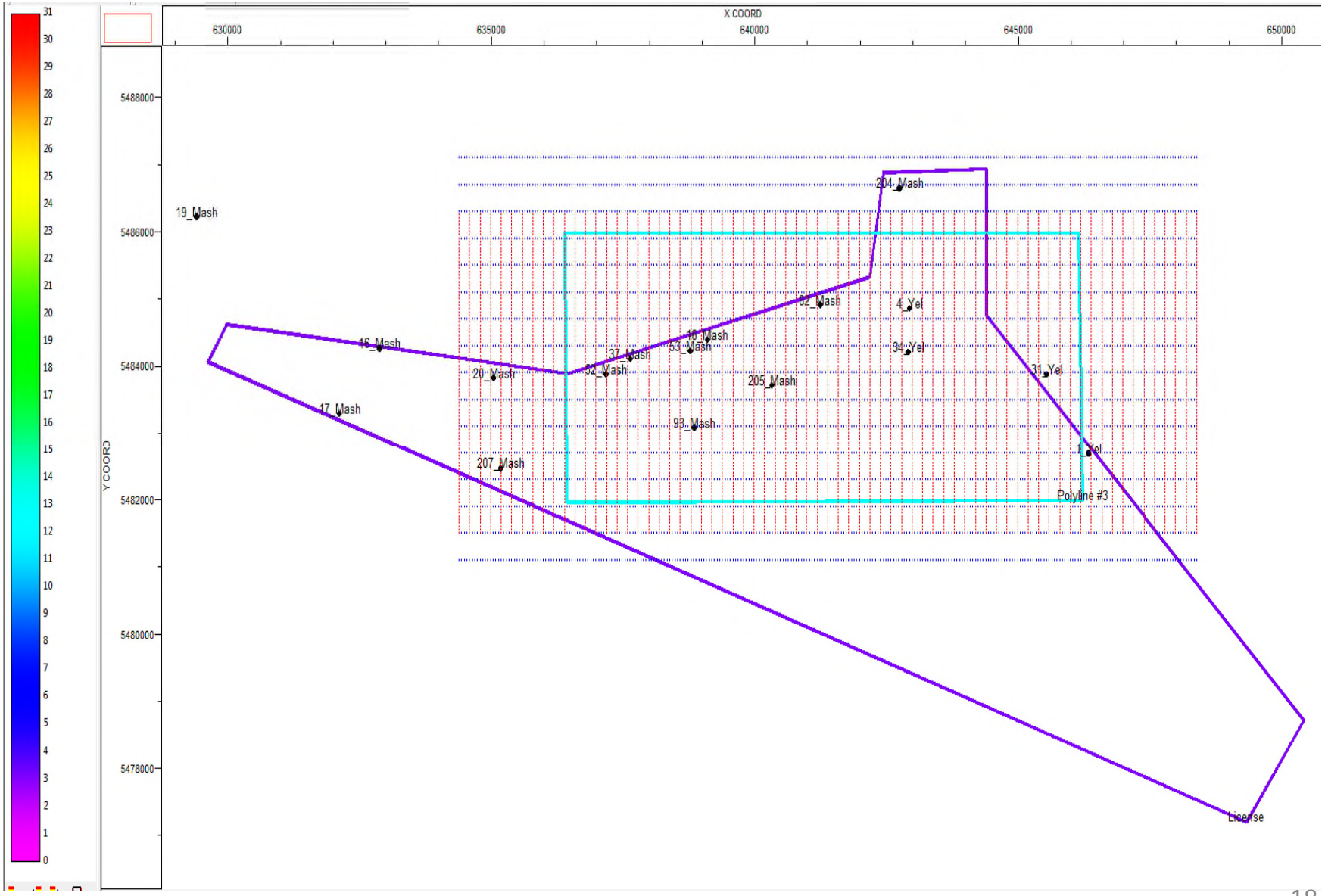


Model and Pre-stack Depth Migration in Depth Scale (Tesseral)

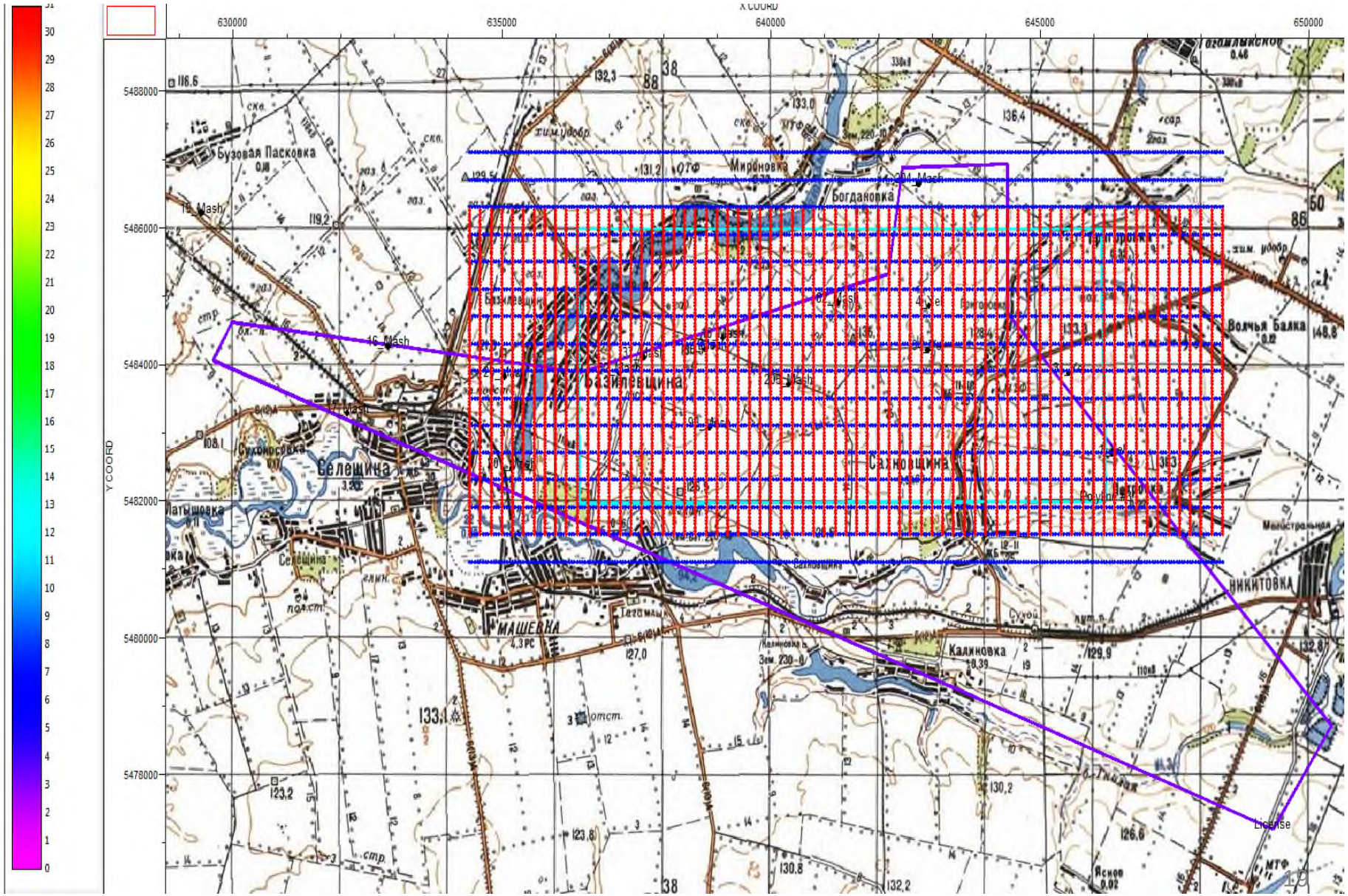


Object 3

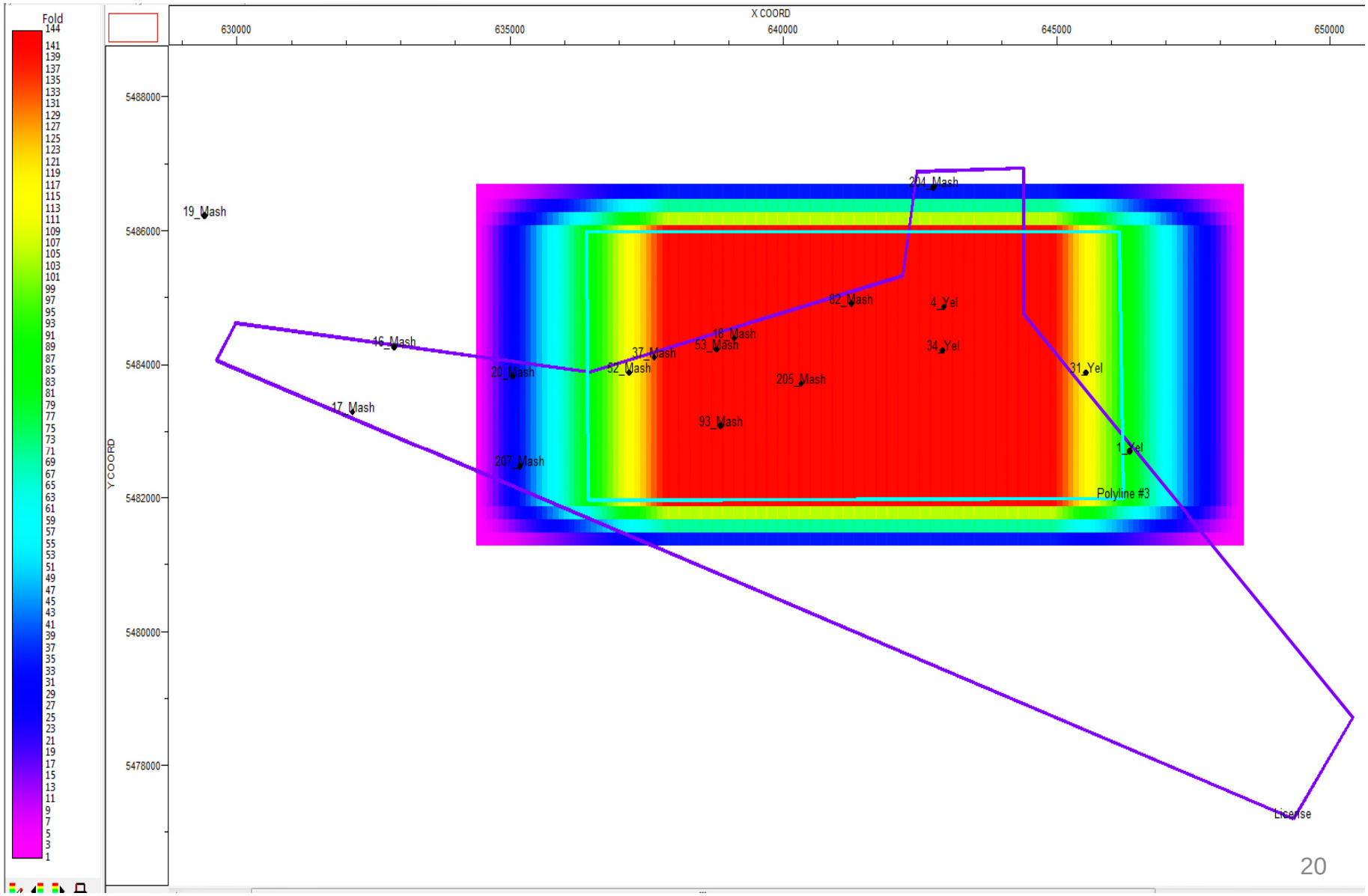
Seismic survey
(survey planning package)



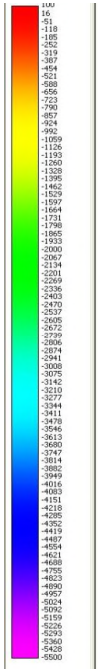
Seismic survey on the topographical map (survey planning package)

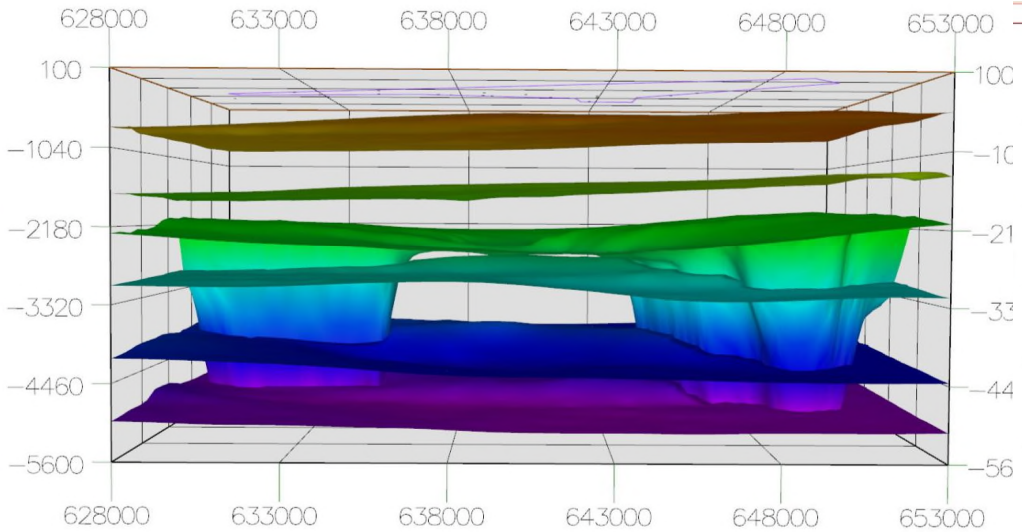


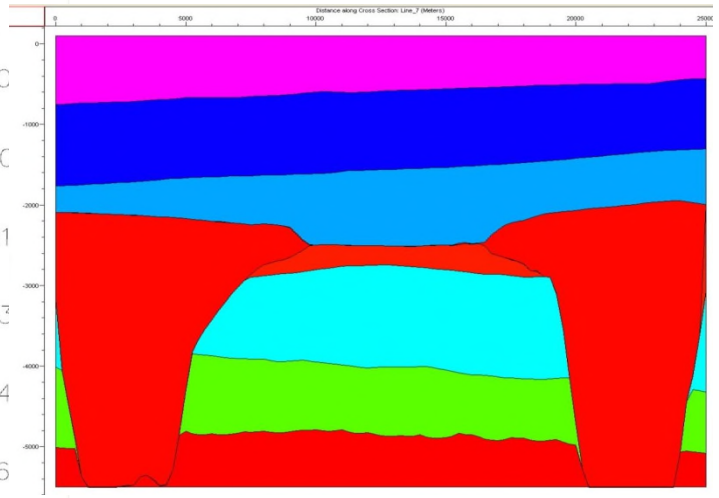
Coverage fold map (survey planning package)

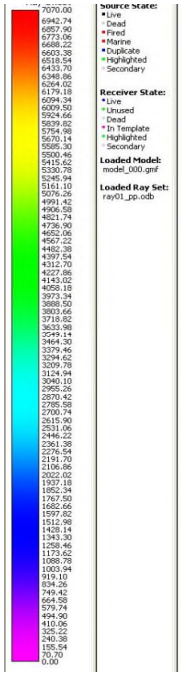


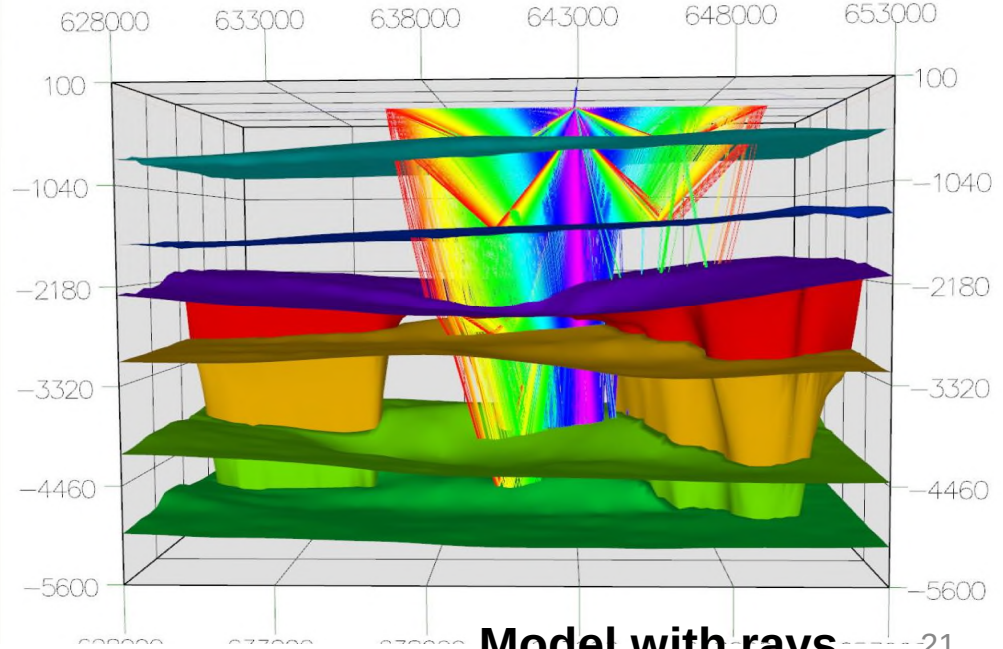
Survey planning package: Model





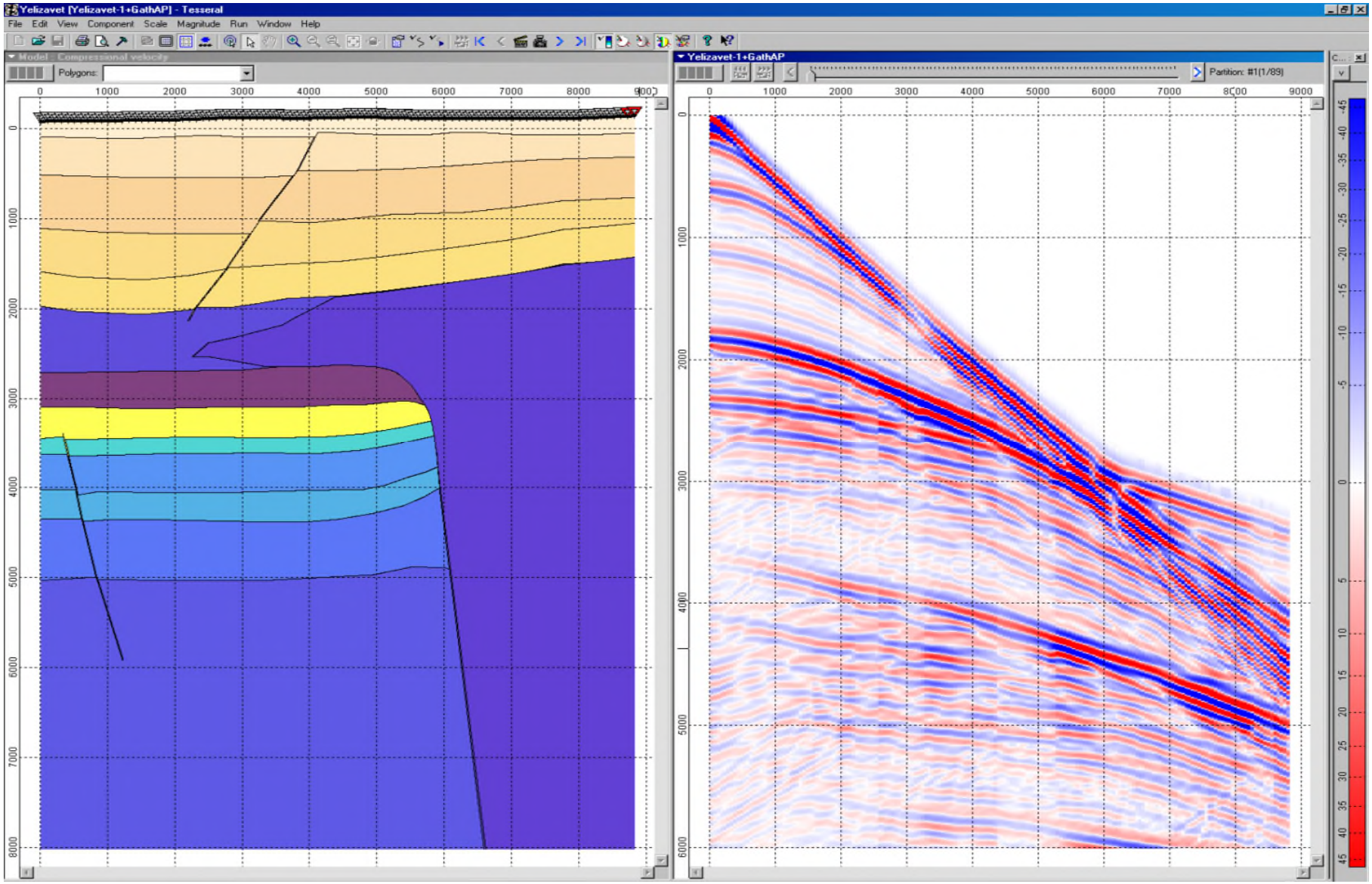


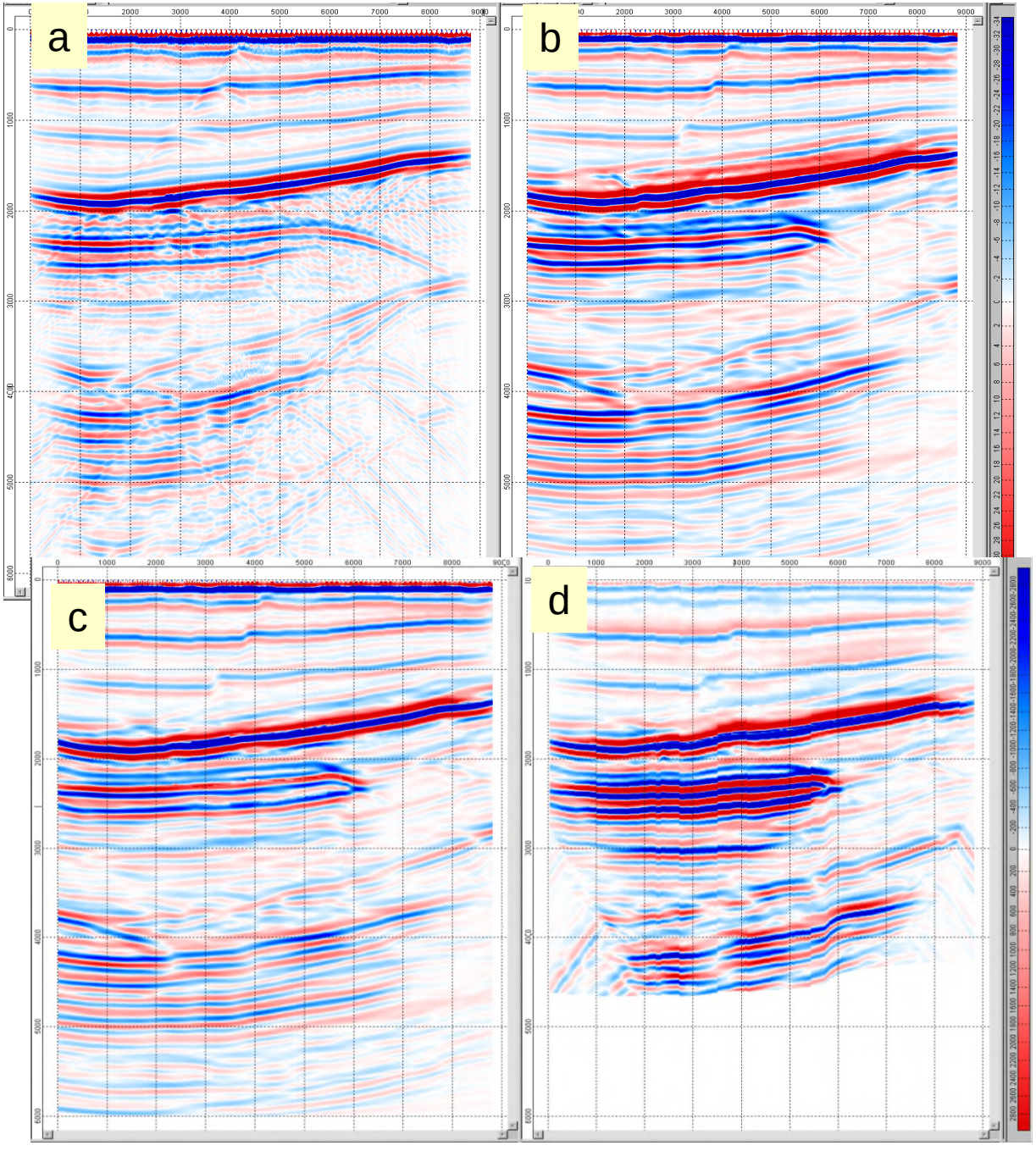




Model with rays

Model and common-shot gathers (Tesseral)





Tesseral:
CMP section (a) and
post-stack migration (b)

PSTM (c) and
PSDM in time scale (d)
then converted to depth scale (e) (on background of initial model)

Conventional modeling sequence at survey planning

1. Building initial depth velocity model basing on available data.
2. Selecting survey layout parameters by practical considerations.
3. Selection of the modelling parameters.
4. Generating synthetic gathers ;
5. Transforming the depth velocity model the grid of velocities' distribution.
6. Transforming the velocity grid to the set of V(t0) curves (RMS velovity column) with a defined step;
7. Building the CDP time section.
8. Carrying out the time post-stack migration to produce the CDP time section.
9. Carrying out the time pre-stack migration.
10. Carrying out the depth pre-stack migration.
11. Transforming results of the depth pre-stack migration into depth scale.

- ✓ At each processing stage, the obtained results are to be analysed. If needed, the spread parameters (item 2) and the modelling parameters (item 3) may be changed.
- ✓ After that, the process of the synthetic gathers generation (item 4) and the data processing (items 5-11) are repeated until a positive result will be obtained.
- ✓ In some cases, if after modelling and processing of synthetic gathers the unsatisfactory results are obtained, it may be needed to change the model, so the modelling process may be repeated again from the beginning (item 1).