Application of new techniques in the seismic data interpretation to enhance their examination effectiveness

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Aplikácia nových technológií interpretácie seizmických dát za účelom prehĺbenia efektívnosti skúšok

The presentation shows an application of new techniques in the structural and litho-facies interpretation of seismic data. The newest: Halliburton Digital and Consulting Solutions- Landmark and Hampson Russell Company softwares were used.

Key words: *seismic interpretation, attributes, facial analyses, reservoir properties*

Introduction

Modern interpretation systems which are based on new solutions used in the seismic data interpretation permit for a quick access to various types of data and their full integration. The utilization of the specialized software packet: Halliburton Digital and Consulting Solutions- Landmark and Hampson Russell Company allows to shorten the work time to rise the data quality and to better and more effective interprete seismic data (Fig. 1). Hydrocarbons prospecting in the areas with a complex tectonics require to use a set of software operated by teams of specialists.

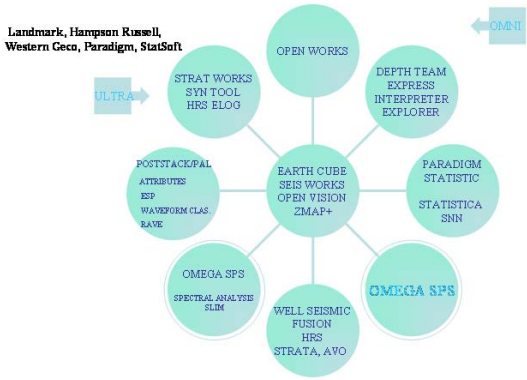

Fig. 1. An integrated system to the seismic data interpretation.

Structural and litho-facies interpretation of seismic data

In the scope of structural interpretation, the possibilities of spatial interpretation and seismic data visualization (EarthCube, OpenVision) were shown. A geological-geophysical interpretation was performed and the obtained spatial, structural result with other more detailed reconstructions was juxtaposed to supervise a regularity of mapping of geology with the help of EarthCube (fig. 2).

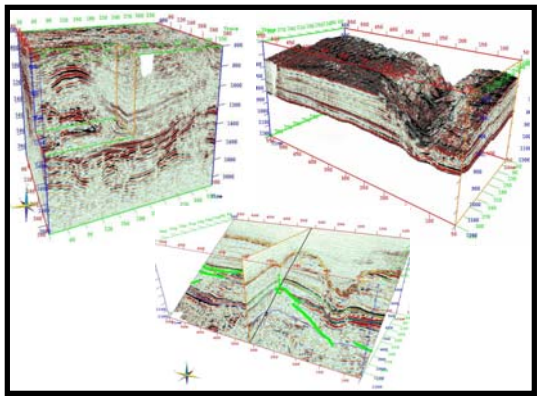

Fig. 2. The spatial interpretation of seismic 3D data.

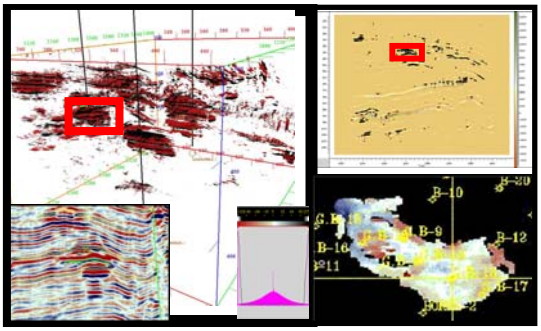

Fig. 3. Seismic facies in Miocene sediments, distinguished from seismic image.

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The utilization of the visualization technique aimed at distinguishing defined, specified anomaly attributes intervals (linked with seismic facies) allows a further detailed facies analysis in the RAVE and PostStack programs (fig. 3). Prospect areas which after drilling turn out a gas accumulation are shown in the spatial configuration, on the time cross- section and on the map.

The analyses performed by the usage of structural attributes from the Reflection Pattern group were demonstrated. Also the way of utilization of the Event Similarity Prediction (Coherency Cube) application in aim order state accurately the discontinuities and the location of dislocation zones which are important in terms of the hydrocarbon exploration was presented (Fig. 4).

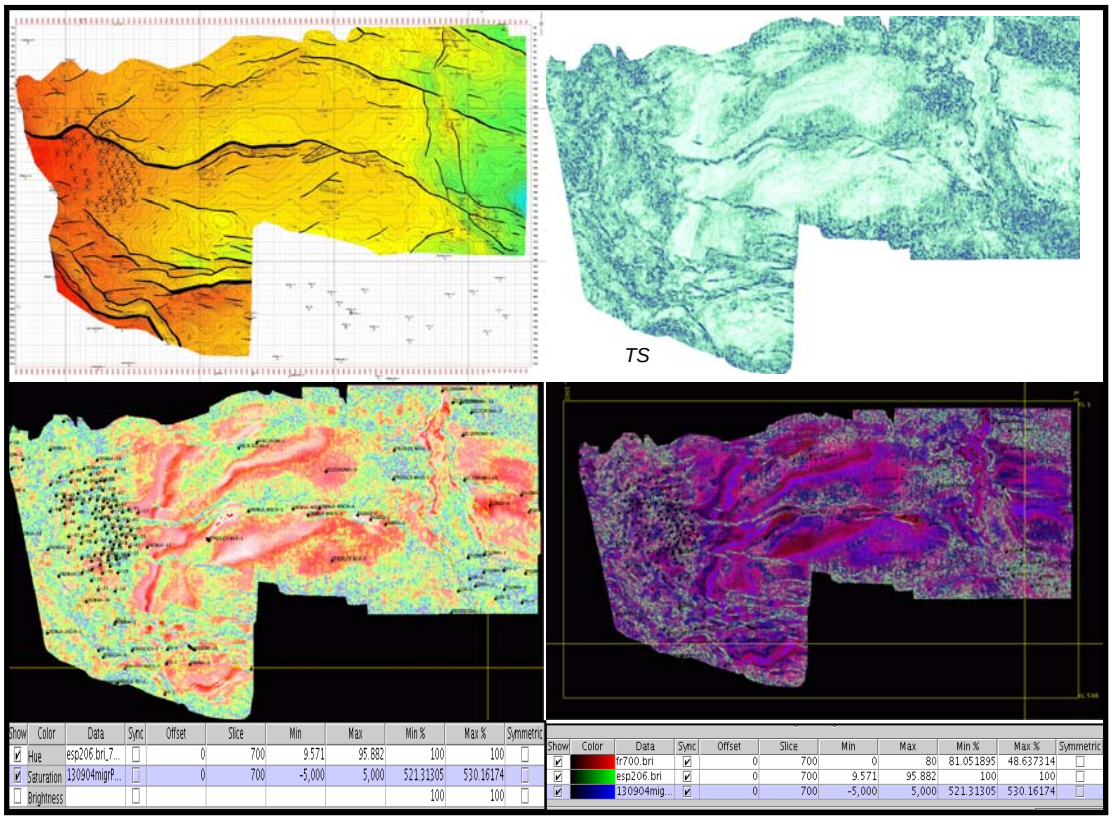

Fig. 4. The combination of results of structural interpretation performed for Jurassic sediments.

Thanks to the ESP application- based on the analysis of similarity between adjoining traces- the seismic image distinguishing subtle changes in tectonics (so essential during hydrocarbon prospecting) a without previous interpretation was received (Fig. 4/B).

A structural map of the top Jurassic (Fig. 4/A) which is a result of the structural interpretation reveals a high conformity with the Time Slice at the time 700ms: the coherency cube (ESP) reconstruction (Fig. 4/B). The facies were exposed and pointed at the potential hydrocarbon traps trough a combination of various attributes: the amplitudes, frequency and the ESP in the Power View program (Fig. 4/C, D).

The interpretation of non-structural (lithological) facies is linked with the analysis of objects in respect to the reservoir properties. Althrough the routine structural analysis of the modern geological-geophysical interpretation is based on a complex data analysis and supplies an information about the litofacies changes, the rock properties, and about the medium.n the scope of the litho-facies interpretation it was shown a wide spectrum of the nonstandard attributes analysis on seismic data before and after the stack (Fig. 5.)

One of the methods used for an integrated analysis of seismic data, geological data, well logging and downhole seismic data is the seismic inversion (Fig .6). This analysis enables to perform porosity maps (Fig. 6/C). A comparison of the edge effects map (Fig. 6/B) with a spatial structural image (Fig. 6/A) as well as the results of the performed seismic inversion and the calculated porosity yield positive exploring results in the presented area.

Important tools used in the litho-facies interpretation of detritus sedimentation basins are the advanced AVO methods. Examining the relationships of amplitude distributes depending on the seismic traces offsets effective helps to detect places characterized by gas accumulations (Fig. 7).

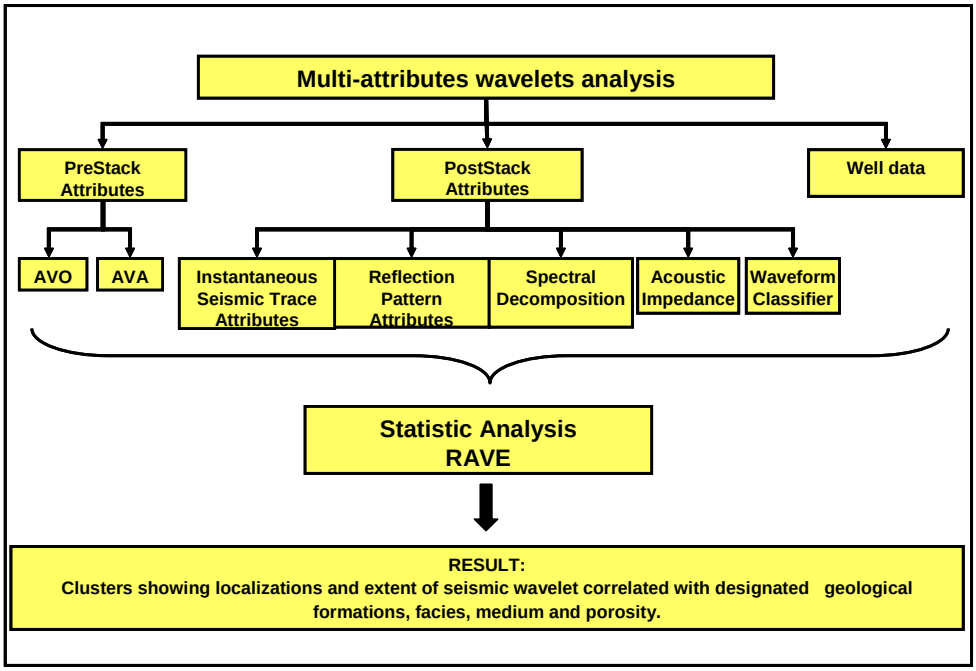

Fig. 5. Chart of lithological-facies interpretation of 3D seismic data.

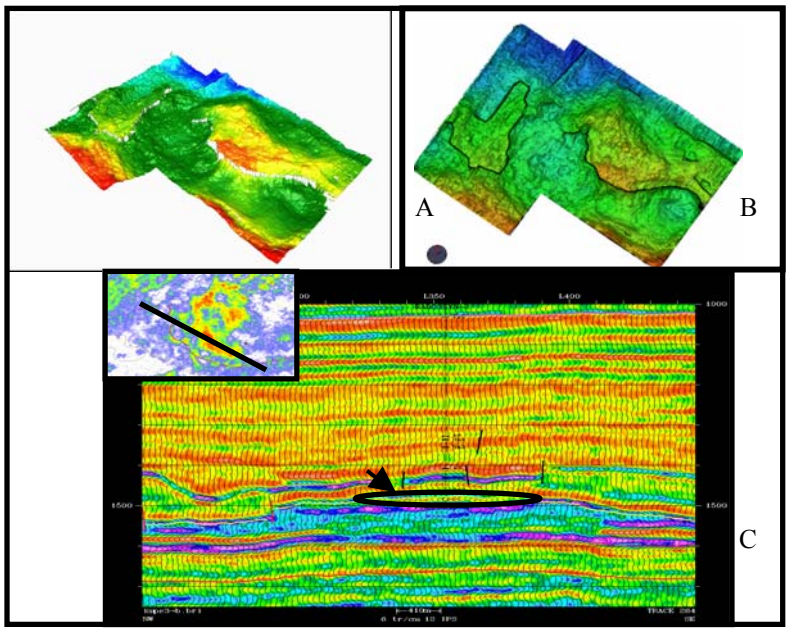

Fig. 6. Time cross-section: acoustic impedance – it goes through the prospect object.

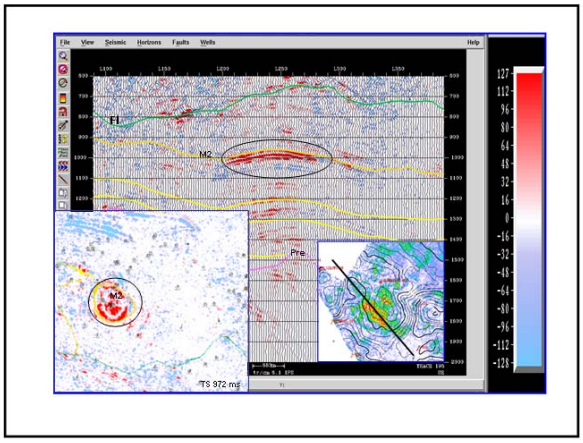

Fig. 7. AVO Product anomaly registered in Miocene sediments.

A comparison of the seismic data with the well loging data by using various types methods and tools is crucial to the litho-facies interpretation. Applications: Waveform Classifier, RAVE (Reservoir Attributes Visualization and Extrapolation) and Well Seismic Fusion based on geostatic functions allow to predict the distribution of the reservoir characteristics trough crosscorelation seismic data with the well data (Fig. 8).

Performed cross diagram between AVO attributes, the most linked with rock reservoir properties, permits to state lithology, and thereinafter features connected with porosity, permeability, and net/gross ratio.

The creation of regional, model trends specifies analyzed, sediment basin, effective approximate information about hydrocarbon traps.

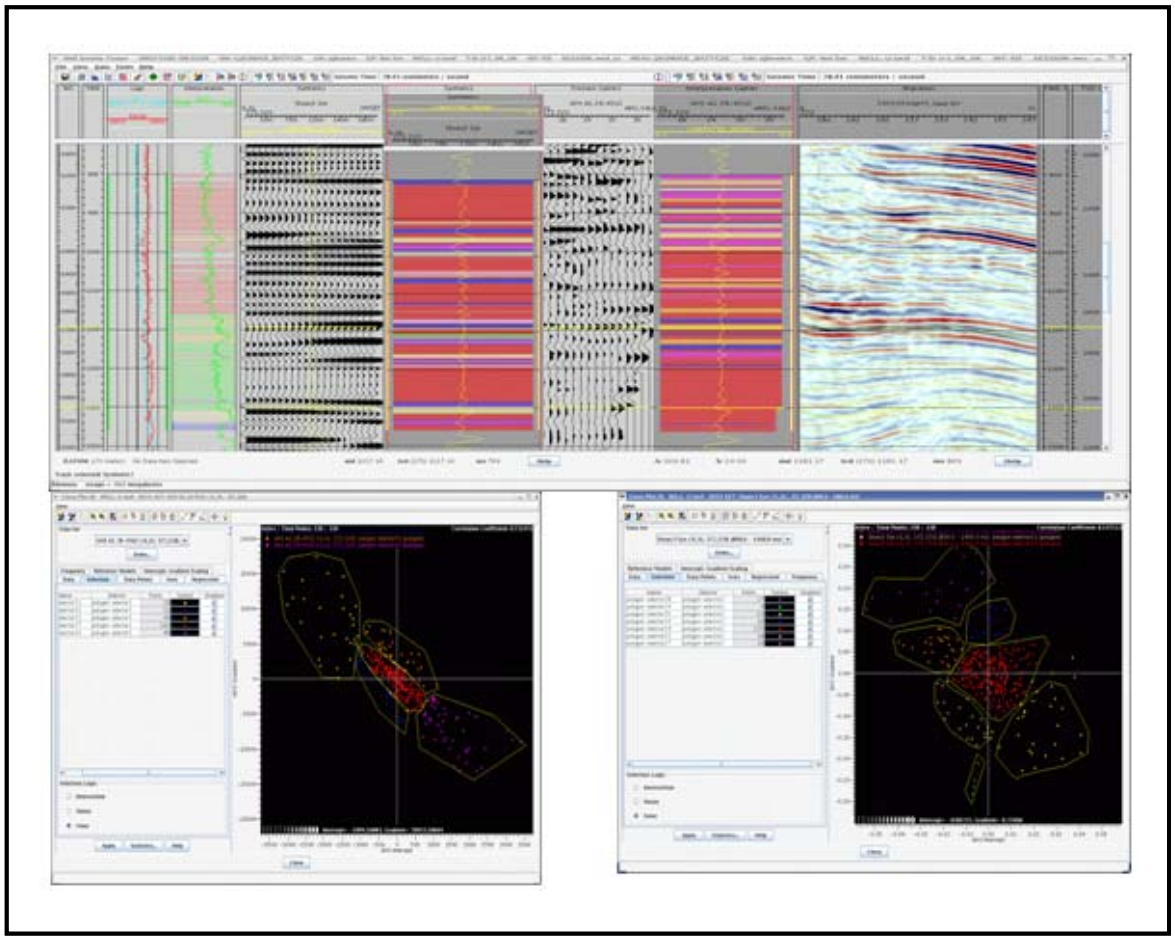

Fig. 8. Analysis performed in Well Seismic Fusion.

Conclusion

- The advanced methods of seismic wavelet analysis enable to arrive at the more effective determination of geology, both in structural and litho-facies aspects.
  - **EarthCube** software allows to perform the spatial interpretation which generates a more reliable seismic facies distinction.
  - The analysis of wavelet similarity in the **ESP** program allows to determine geological discontinuities zones without previous interpretation of seismic horizons
  - Structural attributes of the **Reflection Pattern** types make easier to find features of complex morphology

- The integrated litho-facies analysis based on the newest technical solutions allows to predict the basin lithology and the medium properties derived from seismic data
  - **Seismic inversion** which utilizes seismic data before and after stack is a method which is applied to predict reservoir properties
  - **Spectral Decomposition –** identifies geological, lateral changes

- **Waveform Classifier and RAVE** allow a classification and clasterization by distinguishing the most favorable area in terms of hydrocarbon exploration
- **Decision Space Well Seismic Fusion program –** is a modern tool used for looking for empiric relations between the seismic pattern and the physical characteristic of basin, it generates a number of AVO/AVA attributes which determine physical properties, in many cases it distinguishes anomalies connected with the hydrocarbon occurrence from another seismic anomalies.

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