GEOL. CROAT.	49/2	227 - 230	4 Figs.			ZAGREB 1996

Scientific note

Seismic Line Calibration - A Main Reference for the Rational Exploration and Development of Very Complex Oil and Gas Fields and Reservoirs (Bizovački Čret Case Study)

PROCEEDINGS

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Key words: Seismic line calibration, Synthetic seismogram, Synthetic attributes, Key - seismic line.

Ključne riječi: kalibriranje seizmičkog profila, sintetski seizmogram, seizmički atributi, ključni seizmički profil - etalon.

Abstract

Comparison of Well-1 log data, and Seismic Line - 1 reprocessing with synthetic seismogram parameters, results in a high level of correlation making possible the precise location of the Well-1 on particular seismic trace of Seismic Line - 1.

Results indicate that such Key seismic line (a reference) may be useful as an entry for three-dimensional (3D) seismic surveys.

The application of such procedures in complex reservoirs as the Bizovac field area (characterised by fracture porosity), will minimise the risk in drilling a horizontal, re-entry well (to determine the production potential of the area around the Well-1), and drilling a second well on the Northeast side of Bizovački Čret Structure.

Sažetak

Postupcima približavanja parametara sintetskog seizmograma bušotine Well-1 seizmičkom profilu i obratno, ponovnom obradom Seizmičkog profila - 1 s parametrima sintetskog seizmograma, uspostavlja se visok stupanj korelativnosti po vertikali čime se omogućava precizno postavljanje bušotine na odgovarajući seizmički trag, te prenošenje informacija u prostor izvan bušotine.

Dalji postupci su rezultirali ključnim seizmičkim profilom (etalon) kao ulazom u 3D seizmičke postupke.

Primjena provedenih postupaka u složenim poljima i ležištima koja karakterizira pukotinska šupljikavost i hidrotermalne promjene će smanjiti rizik bušenja horizontalne, bočnodrenažne bušotine koja bi trebala utvrditi proizvodne mogućnosti otkrića Bizovački Čret. Također se ukazuje na prostor sjeveroistočno od bušotine Well-1 kao prostor s boljim kolektorskim svojstvima.

1. INTRODUCTION

The Bizovački Čret locality was discovered during the development of the Bizovac oil field after classical interpretation of two- dimensional (2D) seismic data.

In the first outpost well, located 2.6 km from the nearest producing well and 1.2 km from a dry well, oil was discovered under the Upper Pannonian unconformity approximately 300 m deeper than the Bizovac oil field (Fig. 1).

Drillstem test (DST) carried out in the top of the reservoir resulted in 6 m^3/day of oil, proving the oil prospects of this area. The top of the reservoir was determined 50 m deeper than predicted. In a vertical sequence some of lithological settings were determined analogous to the known lithology of Bizovac field (basement gneiss breccia, basalt, diabase, tuffite, Upper Cretaceous mudstone, Badennian siltstones, breccia - GAĆEŠA & MESIĆ, 1994). The reservoir rocks beneath the Pannonian unconformity are characterised by fracture porosity and hydrothermal alteration.

The technological procedures applied during the workover test operations have not provided any data either on the reservoir pressure or on the well production potential.

To reduce the risk and to facilitate the choice of development plans for the Bizovac Čret discovery two problems had to be solved:

- the productivity of palaeouplift, and
- the detailed reinterpretation of Well-1 and the seismic data.

The above mentioned characteristics resulted in very complex lithological and reservoir rock properties, and it is necessary for further development to evaluate the possible changes within the reservoir rocks (Fig. 2). To this end all the currently available computer techniques (hardware & software) have been used.

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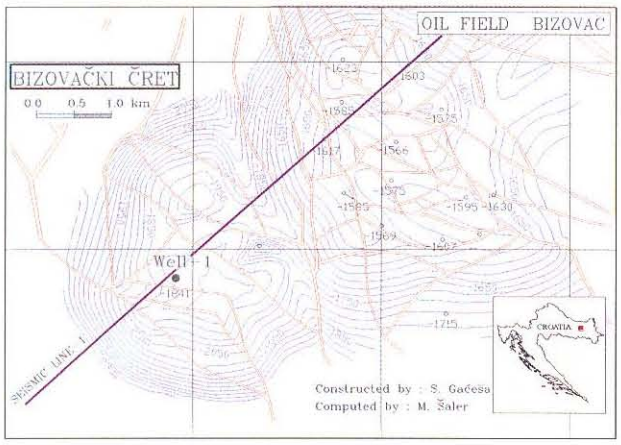

Fig. 1 Upper Pannonian unconformity map.

2. PROCESSING AND INTERPRETATION

The only possibility at our disposal was to make more detailed analyses of the seismic data, applying special seismic processing methods and their combinations.

Applying the velocity data from the Bizovac oil field resulted in a 50 m error when the entry point in the assumed reservoir top (target) was predicted. Therefore, new velocity surveys and Vertical Seismic Profiling (VSP) measurements were performed in Well-1. The results of VSP measurements were used to check the seismic velocity survey and to compare it with a synthetic seismogram.

Sonic logging was carried out from 350 m and density log from 1009 m down to the total depth. For the missing intervals the logs from one well of the Bizovac field well were also used in order to create the synthetic logs.

Transfer of the identified well data to the seismic line was performed as follows:

1. Checking the seismic velocity surveys - Only five shot points out of 12 shot points used in the velocity survey were suitable for the time/depth conversion, while the remaining points would have caused too large distortion on the sonic log curve.
2. Synthetic seismogram - Implementation of density log of another well was proved to be better than the application of the computed "Gardener's" density log. The synthetic seismogram was generated by applying various filters. Filtering with 20 Hz filters (50% matching) provided the best matching along the entire wellbore length with the existing migrated seismic line.
3. Seismic reprocessing - The seismic line reprocessing was done with a minimum phase. Matching of the reprocessed line and the synthetic seismogram was better, but still not satisfactory.
4. Intervention by applying the Ricker wavelet - The 20 Hz Ricker wavelet was used for final intervention on the synthetic seismogram.
5. Sliding the synthetic seismogram - The well is located approximately 50 m from the seismic profile trace. The best matching of the synthetic seismogram and seismic line was achieved by sliding the synthetic seismogram from 132 CIF on seismic line to 142 CIF. The comparison with the VSP trace also indicated that the results were very good (Fig. 3).
6. The analyses of seismic attributes - The following seismic attributes were analysed: phases, amplitudes and frequencies. Along the seismic section only amplitude changes have been observed. The amplitudes are higher (in range from 4500 - 6000) in the central part of the paleouplift, while on both flanks they are lower (1500 - 4500) (Fig. 4).

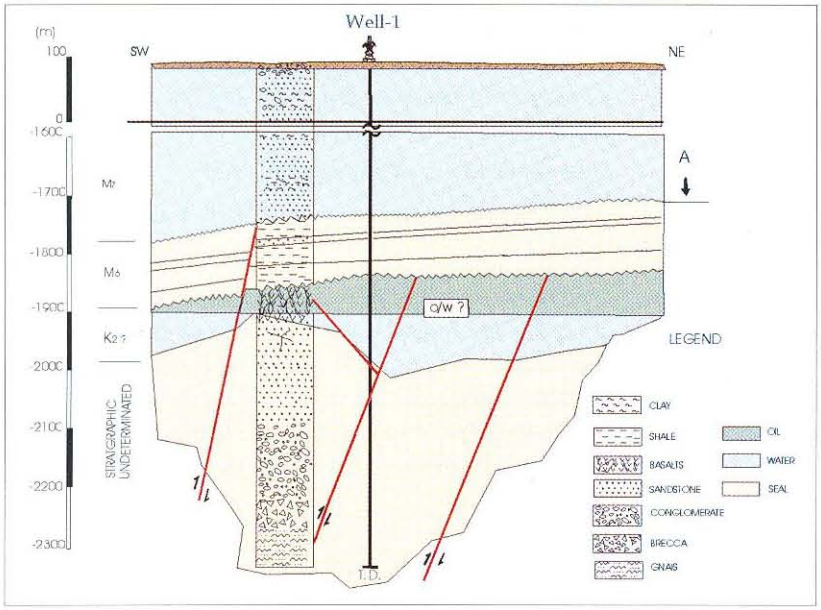

Fig. 2 Geological cross-section of the Bizovac field and Bizovački Čret location.

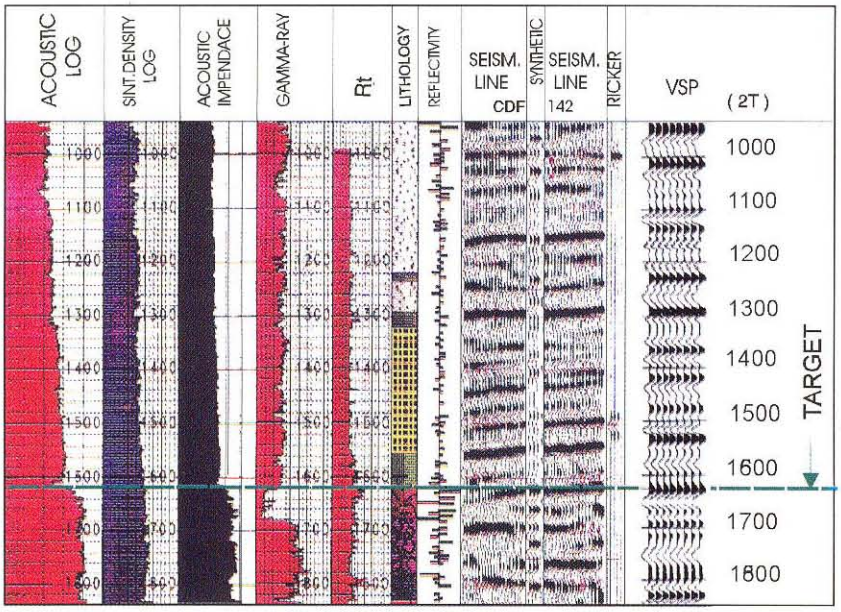

Fig. 3 Synthetic seismogram procedure on the Bizovački Čret location.

The amplitudes of the cap rock (shale) are the same along the palaeouplift.

Higher amplitudes of the reservoir lithology could be an indicator of the less fractured reservoir rocks. The decreasing velocity and density in highly fractured reservoirs results in decreasing amplitude values. Amplitudes analyses alone still can not be used to distinguish good reservoir areas from non-reservoir, or poor reservoir rocks. Further improvement will occur when analysing the amplitude versus offset (AVO) and by analyses of acoustic impedance along Seismic Line - 1.

3. CONCLUSION AND RECOMMENDATION

Analysis of a "key" seismic line previously determined with synthetic seismogram makes possible more precise and reliable determination of the top of the reservoir and allows the transfer of the well "properties" to the seismic line.

In this case it is possible to state that south-west of the Well -1 and on the north-east side of the Bizovački Čret palaeouplift, there are more favourable reservoir rocks than in the central part of the paleouplift.

The results of this procedure can be summarised in the following:

- better understanding the petroleum geological model of Bizovački Čret locality;
- better planning and controlling of the slim hole (re-entry) drilling project;
- better matching of all the available seismic lines in the prospect area with Seismic Line - 1.

This procedure alone is still insufficient to locate a new well with a high degree of certainty. Using such

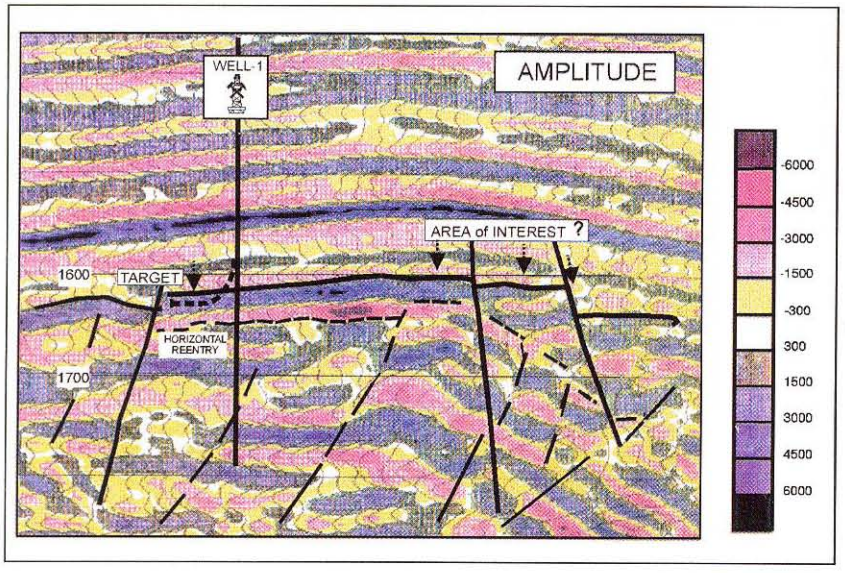

Fig. 4 Interpretation of magnified amplitude section of Seismic Line - 1.

procedures in complex reservoirs (characterised by fracture porosity), will be very useful in planning the three-dimensional (3D) seismic surveys as a basis for locating other wells, and for determining the development plan with optimally spaced wells.

Acknowledgement

The authors would like to thank to INA dd., Naftaplin for permission to publish this paper. Thanks are also offered to colleagues Marija Vidović and Z. Budanović for the special seismic processing, and to M. Šaler, Z. Đurić, B. Nikolić and N. Filipović for their contribution in preparing this article by using various PC-software.

4. REFERENCE

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