Real time logging and real time decisions

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ABSTRACT

The exploration and development of oil fields are high cost activities, commonly involving millions of dollars. Usually, technicians face situations where proper and quick decisions could imply money saving.

In offshore areas, an exploratory or development well may have a final cost close to 15 US$MM. The main expenditure is the rig rental, normally paid in a daily base. Every effort done to reduce the drilling period would imply in cost reducing.

The real time logging is one technical procedure that allows immediate interpretation on some rock and fluid properties. This interpretation may constitute a solid base on making decisions, such as stop drilling and downhole casing/logging; anticipation studies for an immediate nearby wildcat; and net pay computations and oil volume estimation. All of these are some immediate tasks that can be performed based on real time logging data.

This paper focuses on some examples of real time interpretation of geological and geophysical data and its implication in real time decisions.

INTRODUCTION

An exploratory well is one preferential situation where real time logging could be used. The risks and uncertainties of an exploratory well are higher if compared with a development well. In the case of development wells there is Geological and Engineering Database from previous wells that support the project for a new well. In prolific oil basins the risks and uncertainties of an exploratory well is lower, but the application of real time logging still provides data for real time decisions. Anyway, the use of real time logging in development wells is cost effective and is also frequently used.

TIME TO STOP FOR CASING OR TO STOP FOR WIRELINE LOGGING

A wildcat drilling project is supported by technical information. The amount of risks and uncertainties calibrate the safety procedures and amount of technical resources to be applied. One common procedure is to decide the best moment to stop for casing or wireline logging.

Real time logging may help to decide for the best moment to stop. In an actual example in Campos Basin, we used log information from a LWD (**L**og **W**hile **D**rilling) profile to stop drilling and casing. The original project was to stop after drilling 50 m of shale in a specific time horizon in the seismic line. The goal was to isolate reservoir rocks of Upper Cretaceous from reservoir rocks of Lower Cretaceous age.

In practice, we were based at a central office and continually receiving LWD information from an offshore drill unit. At first, we built a time to depth table by extrapolating and integrating the sonic data. The Figure 1 presents the sonic readings from the LWD (red dots), time to depth curve (green), average velocity (pink), interval velocity (red) and check shot readings of a nearby well (blue squares underneath the green curve). The check shot data were used to calibrate the LWD sonic extrapolation (see Souza, 2001).

Secondly, the target was to construct a synthetic seismogram to correlate the well been drilled with the seismic section. We must be careful about the density log because the density readings are quite sensible to rugose wells. Specifically in this example it was necessary to edit the density readings close to 2500 m depth. Figure 2 is a synthetic seismogram built with the use of the density readings. When the density readings are not good enough it is possible to build the synthetic seismogram by using sonic densities, once the sonic profile in general have better reading quality. These sonic densities may be computed with the methodology presented by Souza, 1999. In figure 2, from left to right it may be seen the sonic readings (red dots), density readings (black dots), reflection coefficient (blue dots), acoustic impedance (black and white bars over orange color), the synthetic seismogram (depth scale) and the synthetic seismogram (time scale, last on the left).

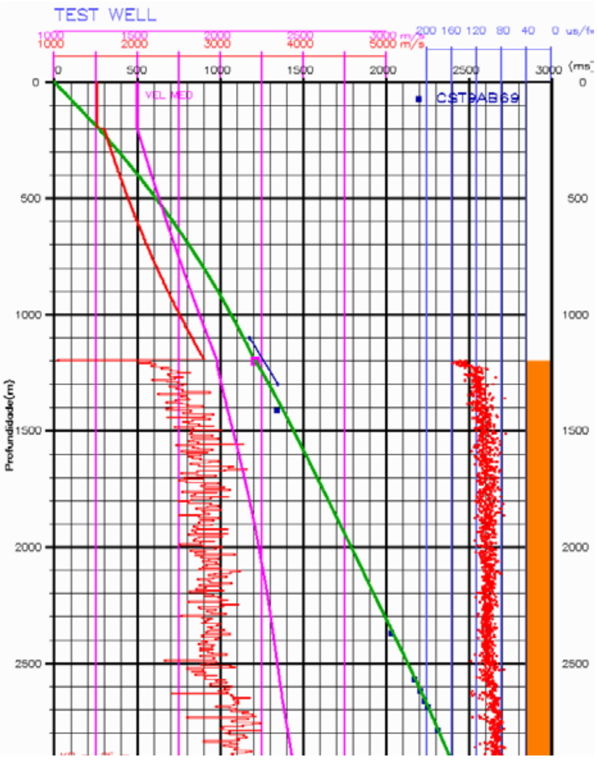


Figure 1 – Time to depth curve

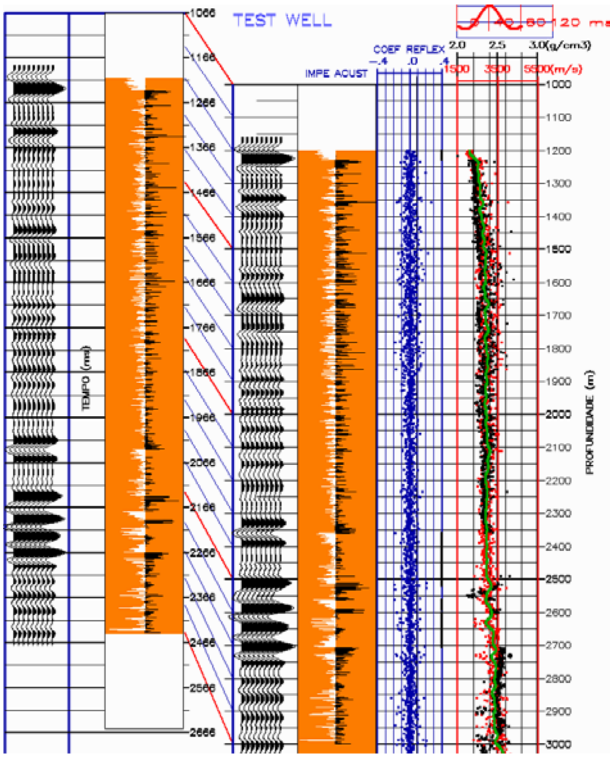


Figure 2 – Synthetic seismogram (readings)

The Figure 3 presents the synthetic seismogram built with the sonic densities. Figure 4 is the synthetic seismogram computed with the LWD density readings. We used both seismograms to correlate with the seismic section nearby the well. There are some important differences between these two seismograms, directly connected to the use of different densities. As a general rule it is preferable to use the synthetic based on LWD data, mainly because sonic densities do not translate very well the fluids in reservoir rocks.

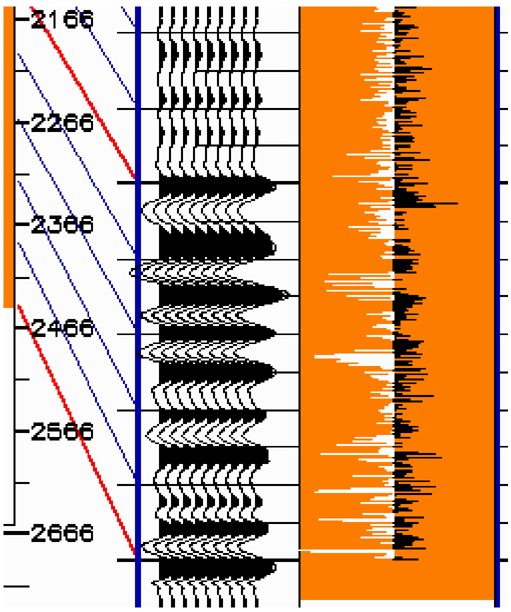


Figure3–Synthetic seismogram (sonic density)

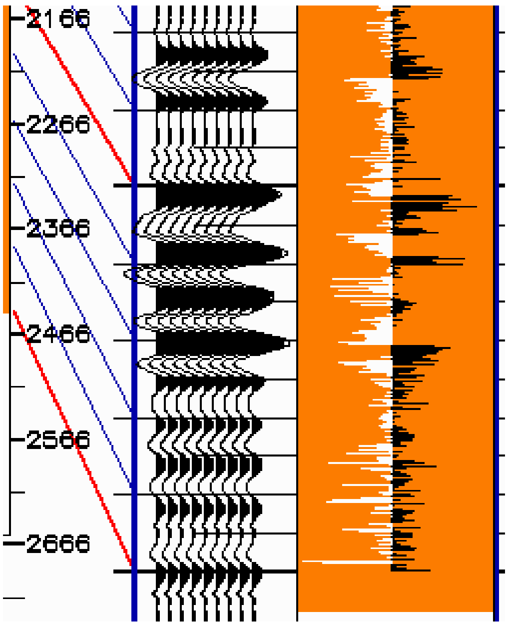


Figure 4 – Synthetic seismogram (readings)

The Figure 5 shows the correlation between seismograms, seismic section, and well position (colored vertical line). This was the last correlation we have done before stopping drilling and starting casing the well. The last reflection pointed out by the red arrow was the check point to stop drilling. Both seismograms (sonic densities on the left, density readings on the right) indicated the proper moment for stopping.

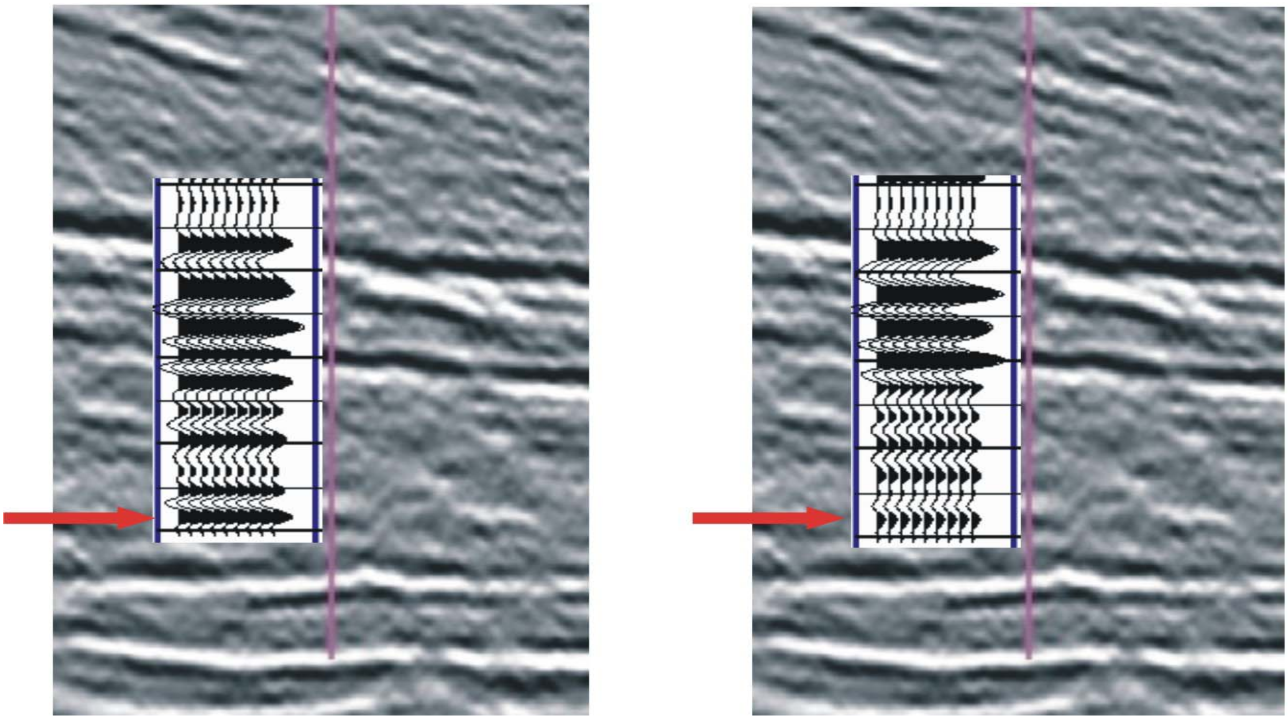
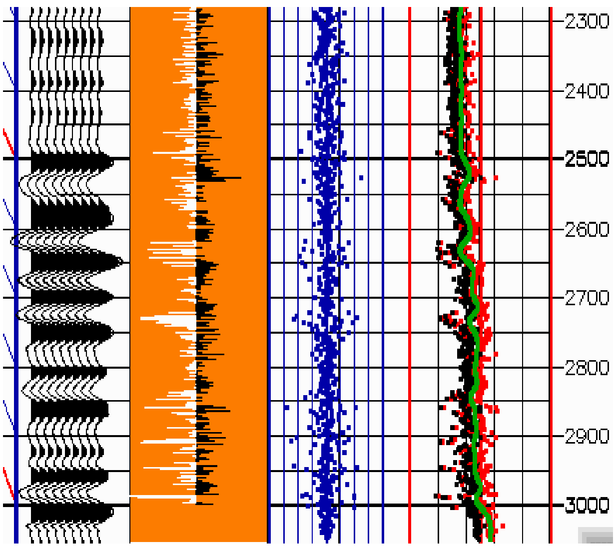


Figure 5 – Correlation of synthetic seismograms with the seismic section at the well position

LWD AND WIRELINE LOGGING

The LWD acquisition is done under non-ideal conditions, submitted to many drilling interferences. Sometimes the data are lost or do not have enough quality to be used. The figures 6 and 7 are synthetic seismograms based on LWD and wireline logging, respectively. Analysing both figures the most important differences are in the acoustic impedance (black and white bars over orange column): LWD data presents more negative impedance values. This is directly connected to the density and sonic readings (may be readings affected by drilling mud). Density readings (black dots) and sonic readings (red dots) in LWD clearly are lower compared with density and sonic readings on wireline logging.



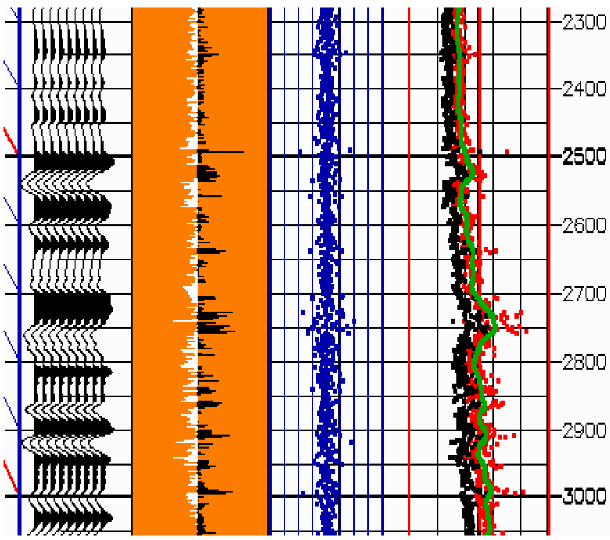


Figure 6 – synthetic based on LWD data **Figure 7 – synthetic based on wireline data**

FORMATION EVALUATION AND NET COMPUTATIONS

Other tasks that can be executed by using LWD data are the formation evaluation and net computations. Technical data obtained in those tasks could change the well project or anticipate decisions. Two possible changes could be in the casing project and logging schedule. One possible anticipated decision might be defining a side track, or drilling a new well immediately after finishing the current one. This is very dynamic and really imply in real time decisions.

The figure 8 presents a reservoir characterization based on LWD data. By using density (red), sonic (blue) and gamma ray (green) logs it is possible to define the reservoir and non-reservoir layers. Black color point out the interpreted reservoir layers. Figure 9 is similar to figure 8, adding the interpretation of resistivity log (light blue). Black color point out the interpreted reservoir layers saturated with oil.

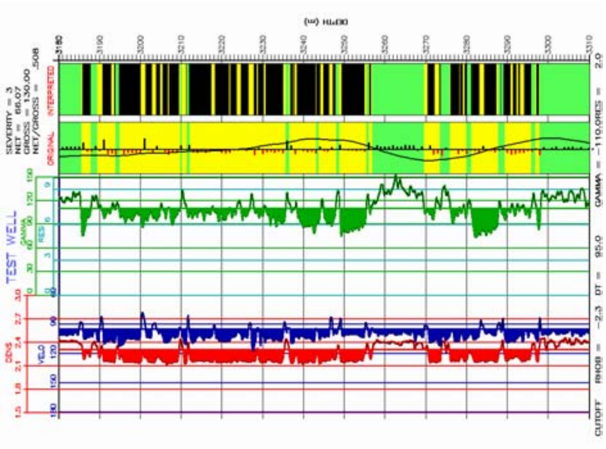


Figure 8 – Reservoir characterization

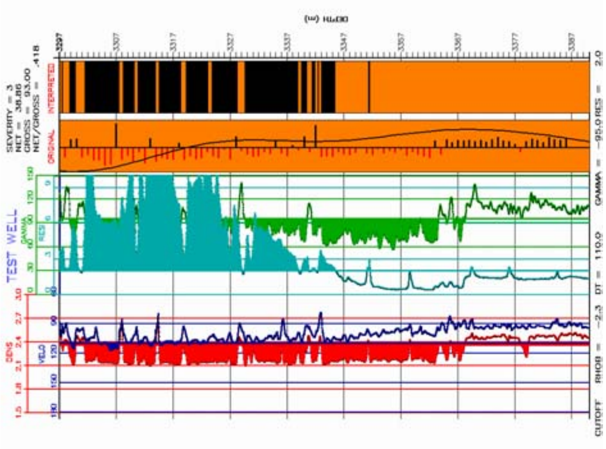


Figure 9 – Net pay definition

CONCLUSIONS

A comparison between real time logging and wireline data has been done showing that real time data could be more affected by drilling mud. Anyway, the data quality is sufficient to do a lot of analysis. The drilling project or the wireline logging schedule can be altered based on real time logging information. Reservoir characterization may anticipate decisions. Other important subject is that LWD data may substitute wireline log data in non-interesting zones, reducing the total length of logging profile. In other words, time and money save.

REFERENCES

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