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Lankahuasa Prospect: Open Door to Deeper-Water Exploration in Offshore Veracruz Area.

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Abstract

The Tertiary section in Gulf of Mexico is a new area of development for gas exploration in Mexico. We present the work, step-by-step, followed to propose the first offshore exploratory well in Lankahuasa area through the use of interpretative techniques, which include amplitude attributes and coherence cube. The importance of this prospect is paramount considering that it is the door for future deeper-water exploration and development. I also show, from an amplitude point of view, the difference between post-stack and pre-stack seismic migrations and how the concordance of the last one contour map favored the final interpretation.

Introduction

We present the Lankahuasa Project, which is a frontier area, where the first well to be drilled is Lankahuasa Prospect (Figure 1). With this well, we try to have a better knowledge of the petroleum system, which has been modeled as we show in the Figure 2. We expect to have hydrocarbon contribution from the Jurassic, and the migration of it through the fault system. The sedimentary model can be seen in Figure 3 where we propose the Lankahuasa prospect (Lankahuasa-1) as sand bars in different levels.

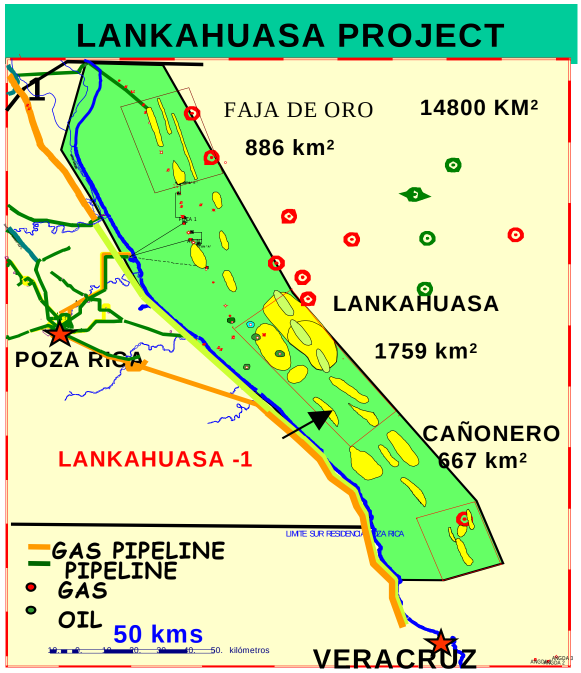

Figure 1.- Localization Map of the Project Lankahuasa, where the prospect is shown.

The 3D seismic information used, was acquired at the end of 1999, and processed in 2000. It has Relative Amplitude Preservation, and we first worked with a post-stack time migration cube till we have the pre-stack time migration cube. As illustrated in Figure 1 there are other leads to be tested, but the proposed one, near to the shoreline and near to the pipeline, is at shallow water depth (60 m). All these factors were important in choosing that prospect.

LANKAHUASA -1

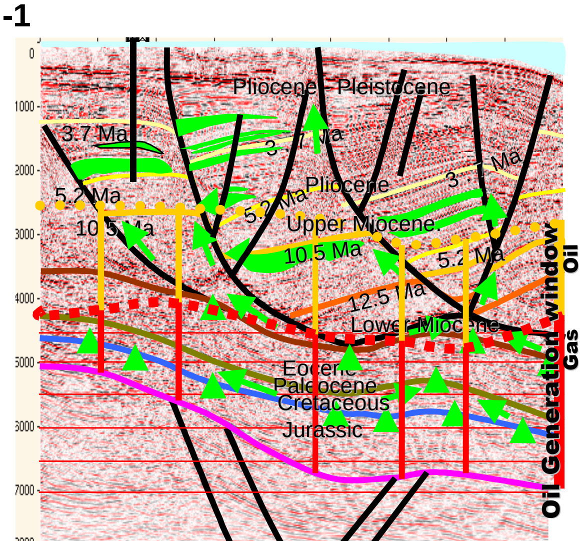

Figure 2.- Geochemistry model in the area assumes that hydrocarbon generation was in the Jurassic.

Interpretation Steps

The inline and the horizon amplitude anomalies that were picked are shown in Figure 4, these horizons are depicted in the Figure 5. At the processing phase, we reviewed the gathers and noticed that we had possible AVO anomalies in the gathers that were studied.

Because of time constraint, it was decided to run the pre-stack time migration on the seismic cube while we continued with the interpretation. The pre-stack time migration improved the date by redefining the fault planes and relocating anomalies in a better structural position, shown in Figure 6, where a timeslice of the bottom horizon is shown at the bottom of the figure. In Figure 7, we present the comparison between the post-stack amplitude and pre-stack amplitude from the bottom horizon, where the last one was much more concordant with the structure. On the other hand, at processing stage we made a velocity picking to try to observe possible velocity change in the zone where we expected gas. In the bottom horizon, we could observe a decrease in the interval velocity after that horizon, and a lateral change in velocity that increased after the left fault (Figure 8).

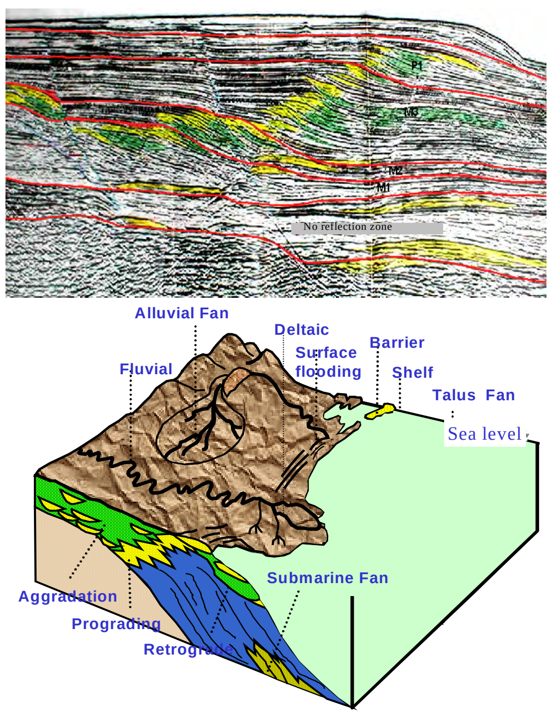

Figure 3.-This line is in the south part of the Lankahuasa cube and represents the sedimentary model we expect in the area.

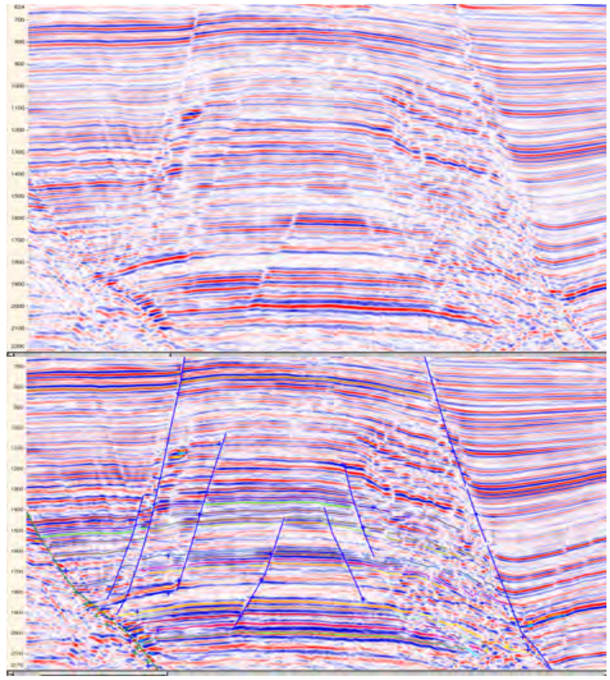

Figure 4.-An inline at the prospect location. The picked horizons are shown.

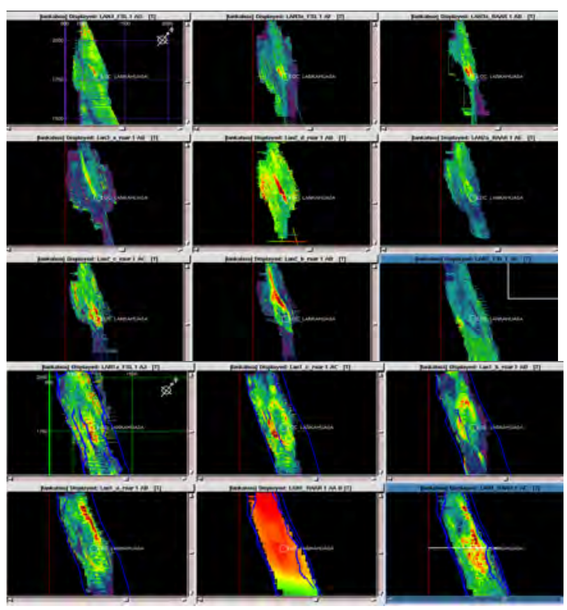

Figure 5.- Picked horizons at the Lankahuasa prospect, more of them were associated with the faults and some of them have a structural component.

POST-STACK MIG. **PRE-STACK MIG.**

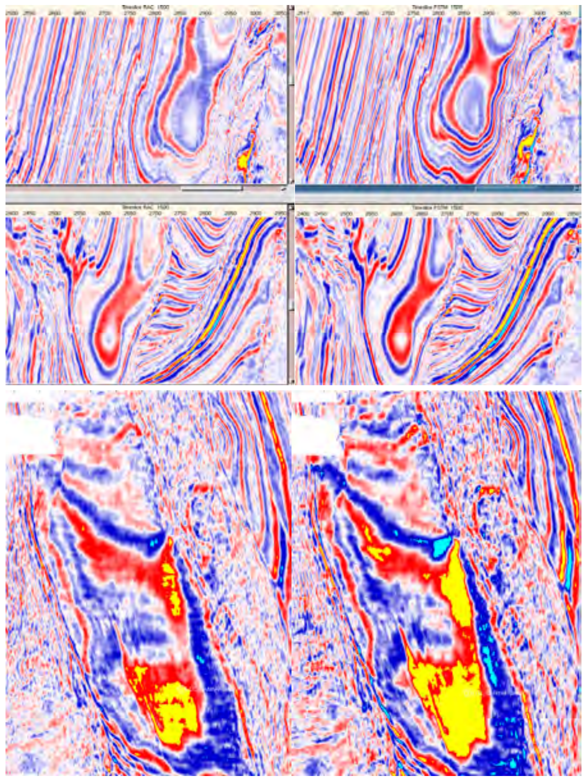

Figure 6.-Timeslices showing the difference between post-stack and pre-stack migration. Notice the better fault definition and better anomalies fit in pre-stack time migration.

TIME **POST-STACK** **PRE-STACK**

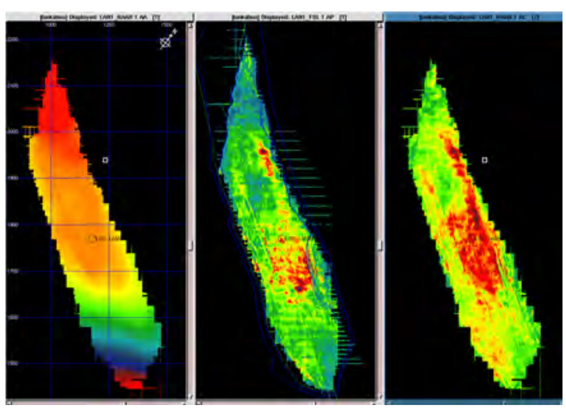

Figure 7.-Horizon time configuration, and the integrate amplitude attribute in the post-stack migration version, and the Integrate amplitude attribute in the pre-stack migration version. The same parameters are used in both cases.

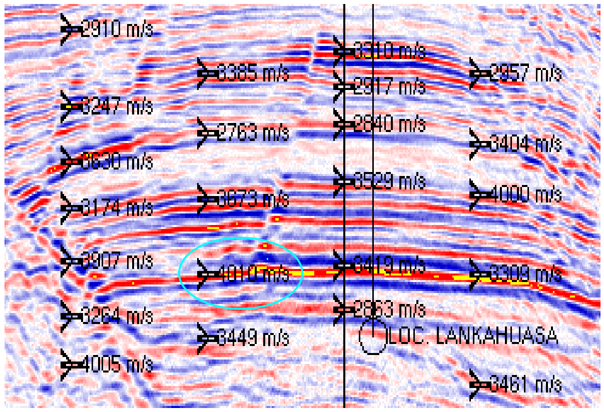

Figure 8.- Velocity analysis that shows some changes in the bottom horizon that could be caused by gas presence. Note the change after the small left fault.

To understand the anomalies, we picked horizons where we expected them and find out that there were some anomalies that had structural component and others that didn't (see Figure 5). In Figure 9, we present some of the anomalies that have structural concordance.

Besides the concordance, we found an inflection point that could be followed in some lines and that was present exactly at the same position where the high amplitude ended and could represent a fluid contact (Figure 10). We obtain attributes that agreed with the expectation of hydrocarbon presence. Some of the attributes are depicted in Figure 11. However we needed to be aware wavelet phase issues. For some shallow bright spots reflectors, in the north part of the cube, we suspected a near 90 degrees phase, but as we didn't have the sea floor we were not able to calibrate.

The frequency attribute shows a decrease value from 35 to 3 Hz, indicating something is happening there. Then, we studied the coherence cube, and it was really amazed that there was a very good agreement between the coherence (more than 98% coherent, that I suspect could be related with the hydrocarbon presence) and other attributes: RMS anomaly extracted from a 32 ms window, and with the Integrated Amplitude Anomaly extracted over the picking horizon (Figure 12).

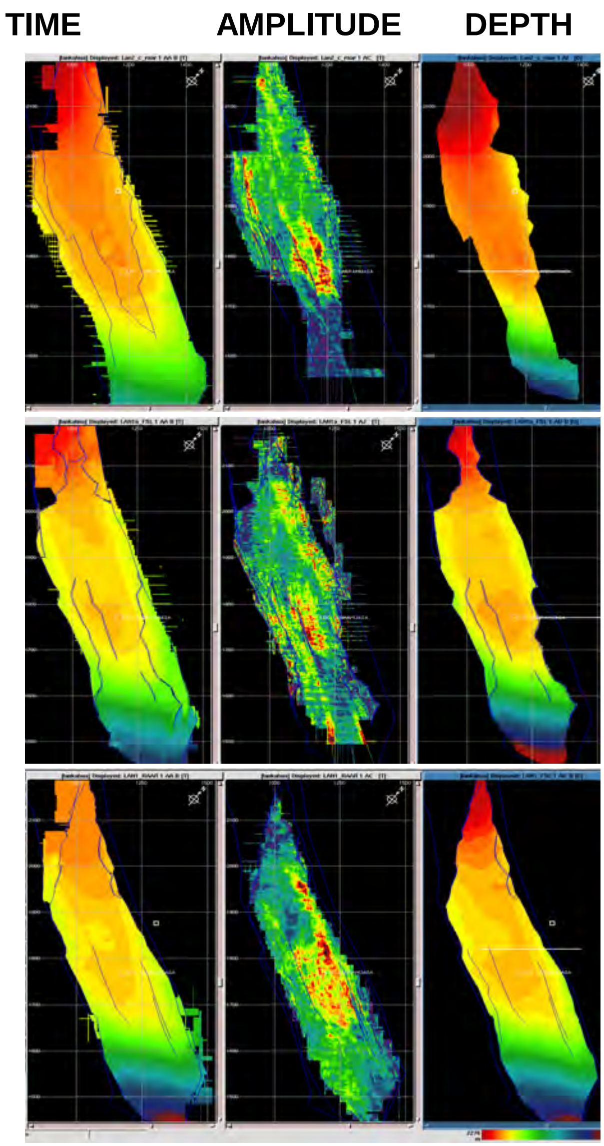

Figure 9.- Horizons illustrating the anomalies with structural component.

Another interesting thing was to see the coherence cube, which helped us confirm the presence of a fault system where the hydrocarbon zone was supposed to be (Figure 13). Some AVO feasibility studies have been done. However, we don't have calibration in the area. A calibration study will be done when more data will be available and the well drilled (Figure14 and Figure15). The tuning effect was calculated using the picked interval velocity (Figure 8) and the amplitude spectrum from the seismic data. In Table 1, we present the possible bed thickness based on different velocities and frequencies.

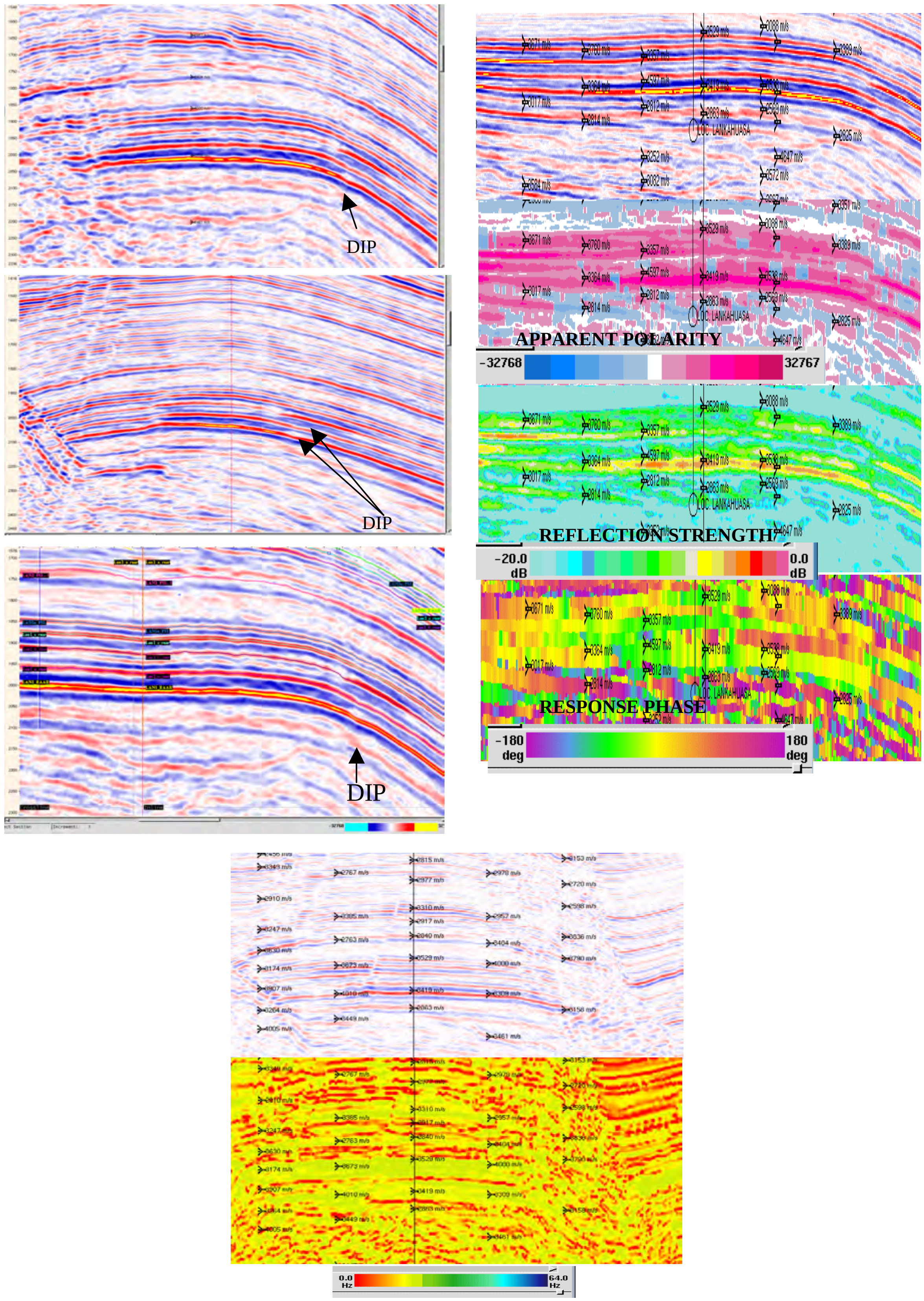

Figure 10.-An inflection point can be seen in some lines that can be associated with a fluid contact.

LANKAHUASA PROJECT					
Tuning Thickness Calculation				$\lambda/4=V_{int}/4*f$	
Interval Velocities	Interval Velocities		Frequency	(Hz)	depth
(ft/s)	(m/s)	40	45	50	(m)
9843	3000	19	17	15	
11483.5	3500	22	19	18	1600
12303.75	3750	23	21	19	

TABLE 1

Calculated tuning thickness using the amplitude spectrum from the seismic and the detailed velocity seismic analysis.

INSTANTANEOUS FREQUENCY

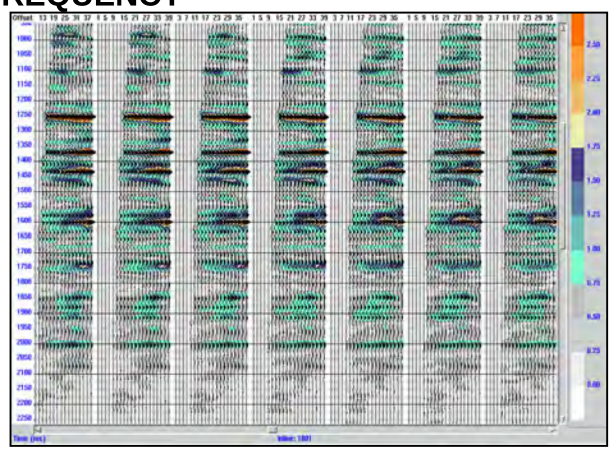

Figure 11.-Attribute extractions from the bottom horizon for a random line that crosses the structure and for an inline at the prospect location.

COHERENCE RMS INTEGRATE AMP.

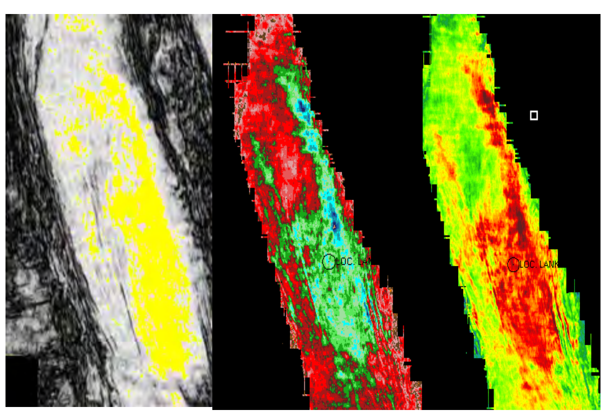

Figure 12.-Note the agreement between the coherence cube, the amplitude rms and integrate amplitude. It can be inferred that maybe the coherence (>98%) we observe could be the result of the hydrocarbon presence.

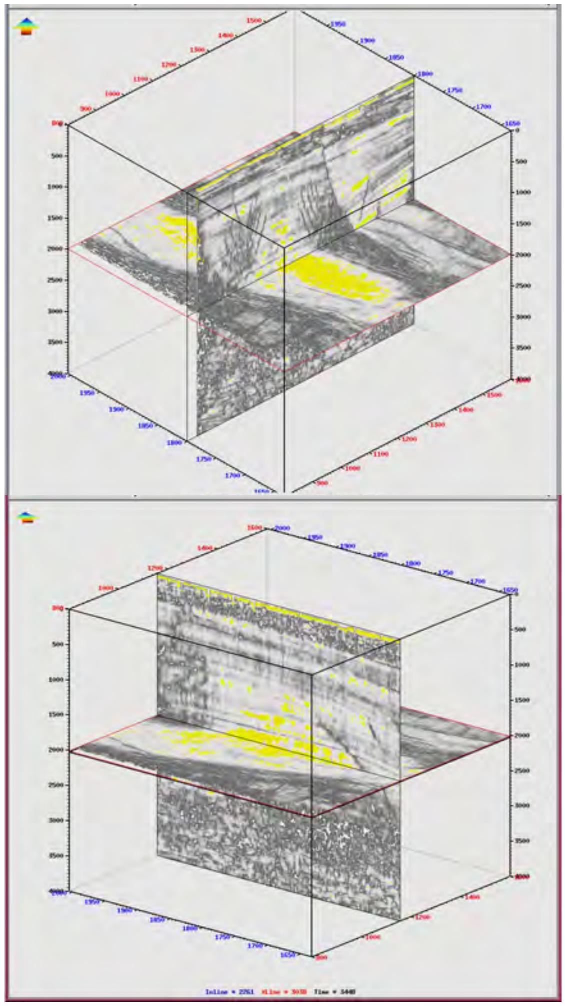

Figure 13.-Coherence cube confirm fault system in the area, we suppose the prospect is restricted by it, and maybe for a change in sedimentation.

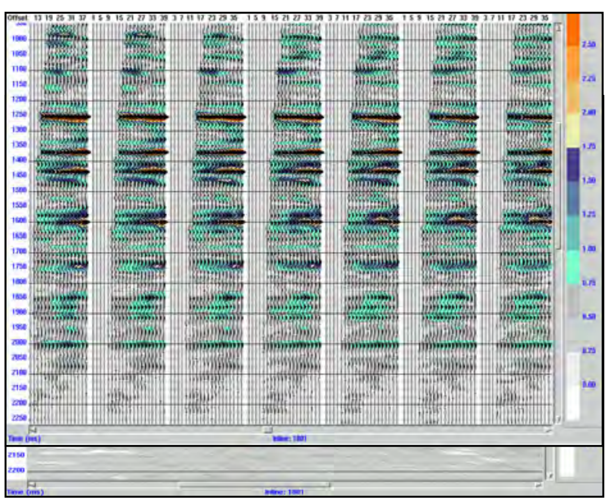

Figure 14.-CDP´s that show the amplitude envelopment with the angle (AVA).

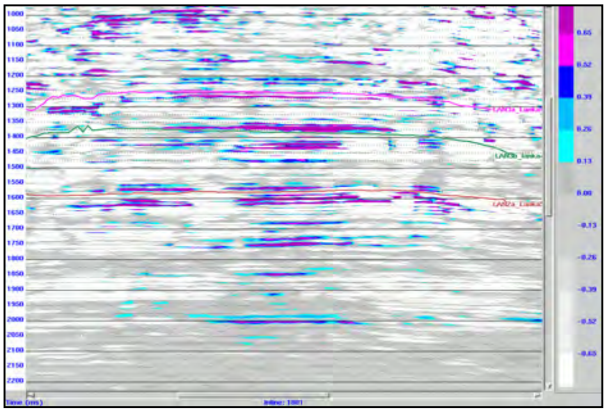

Figure 15.- Stack section for (P*G) attribute.

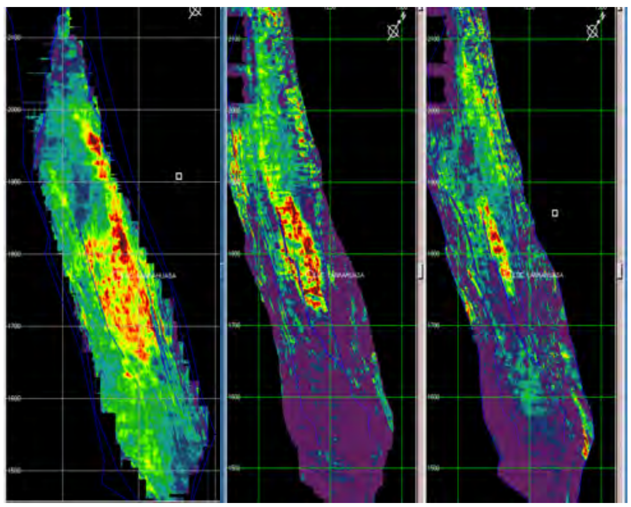

Figure 16.-Horizons used to evaluate the prospect.

Finally, a three-dimensional image of the horizons used to evaluate the prospect is illustrated (Figure 16 and Figure 17).

CONCLUSION

Based on seismic attributes, the change in velocities, the frequency decrease in the zones of interest, the coherence agreement with anomaly, the possible AVO response, the structural concordance and the dip inflection point; we expect to have a geological success, at the same time we will be able to learn more about the area.

Acknowledgments

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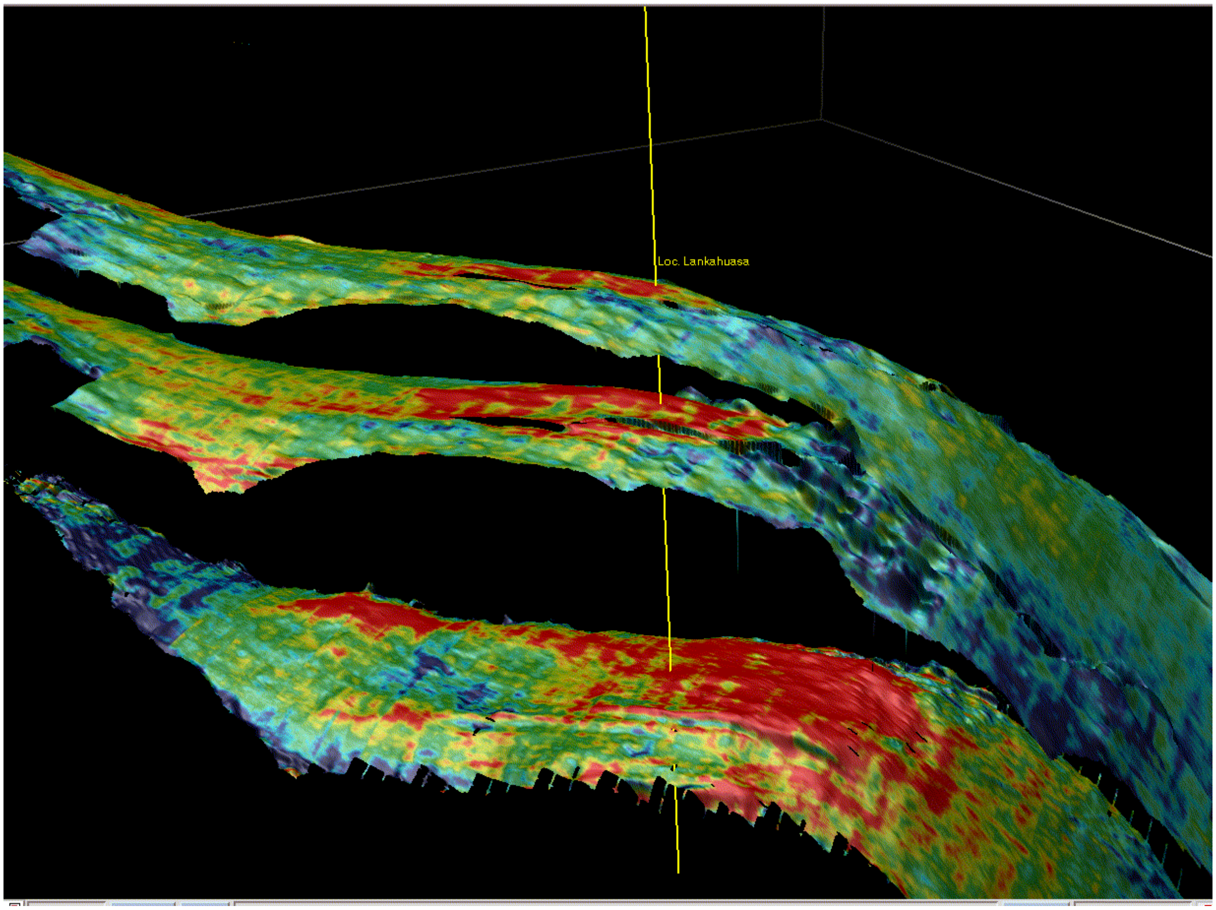

Figure 17.-Three-dimensional view of the anomalies and the horizons in time.