GC Interpreting Seismic Amplitude Volume Technique Attributes*

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General Statement

The main challenge for a seismic interpreter is to extract the maximum amount of information from seismic data and integrate that with other relevant data so an accurate reservoir model of the subsurface prospect can be conceived. This implies evaluating and comprehending seismic events, their spatial behavior and interrelation and understanding the subsurface geo-architecture in the area of interest. To achieve such objectives, the seismic interpreter makes use of high-end interpretation workstations, where the seismic data are analyzed, integrated with well and other geological data and visualized in a practical and realistic way that other members of the team can understand.

But this represents only one part of the modern seismic interpreter's job. The other challenge for the seismic interpreter is to devise creative and convincing workflows for analyzing the seismic data and its integration as mentioned above. Significant progress has been made in the search for and advancement of such new approaches.

A New Approach for Using Seismic Amplitudes

A seismic interpreter's routine task must include comprehending and analyzing novel and non-traditional ideas, which tap into the individual interpreter's creativity. This is our motivation in pursuing such advancements. A couple of years ago, the first two authors described an amplitude volume technique (AVT) workflow that calculates the root-mean-square (rms) of the amplitudes by choosing a definite analysis window, and then rotates the phase of the data by negative 90 degrees using the mathematical operation of Hilbert transform. This calculation of the input seismic data yields somewhat higher amplitudes of frequencies in the bandwidth of the input data. A variation of this approach called high-frequency AVT was also described, wherein the workflow is applied to input seismic data after its bandwidth is broadened, i.e. includes frequencies at the lower and higher end of the spectrum also. Interpretation carried out on the resulting data (AVT or AVTHF) or attributes generated on these data exhibit more detail and are suggestive of other points of view that have a positive impact on the comprehension of the structural and stratigraphic elements in the subsurface architecture.

In Figure 1a we show the visual impact of the AVTHF sections from Golfo San Jorge Basin in Argentina, where the Deep Neocomian deposits stand out clearly as indicated with the yellow arrow. In Figure 1b we show a chair display with a time slice from a coherence volume generated using commercial software and the vertical section has been co-visualized with the coherence attribute using transparency. The display facilitates the correlation of the fault lineaments as seen on the time slice with those through different sediment sequence patterns. Notice the clear correlation of the discontinuities with the AVT data and the ease with which they can be interpreted.

Next we demonstrate through examples how different attributes can be visualized together and result in a value-addition exercise. In Figure 2a we show a vertical section from the AVTHF volume that has been co-visualized with the ant-tracking volume using transparency. Notice how the many visible discontinuities line up with the ant-tracking volume lineaments in red. Ant-tracking is an image processing procedure that can be run on discontinuity attributes for gaining higher resolution in terms of lineaments, and is available in a commercial interpretation package. We further illustrate that the lineaments in the data can not only be effectively defined by using coherence and curvature attribute data on full stacked data, but by running these attributes on far angle data also.

Figure 2b and Figure 2c show time slice (700 milliseconds) comparison of Coh (AVTHF) and Curv (AVTHF) attributes. The sharpness of the lineaments is crisper on the curvature attribute display as expected. It is possible to run directional filters on the input data so as to rule out the discontinuities in a certain direction so that the orientation of discontinuities in other directions can be visualized better. We show the results of this exercise in Figure 2d.

In the last two examples, we have shown the co-visualization of the discontinuity attributes such as coherence and curvature with seismic amplitudes. For achieving certain objectives, the discontinuity attributes may be co-visualized with lithology or fluid attributes derived from impedance inversion, or even the attributes that come out of their probabilistic analysis. This may be seen as an extension of the co-visualization described earlier, which can lead to a multidimensional interpretation of data. Figure 3 demonstrates the co-visualization of a vertical AVTHF section with an equivalent section through probability reservoir pay derived from geostatistical inversion. Such displays are particularly useful as discontinuity features are easily interpreted and the anomalous zones exhibiting high values of reservoir pay are seen popping up and correlated with the appropriate well log curves.

Conclusions

The visualization workflows described in this article are useful for comprehending the overall architecture of the subsurface events. Of course individual projects and their challenges will decide the level of creativity, innovation and length that the seismic interpreters are expected to go to using the available tools in their arsenal.

Acknowledgements

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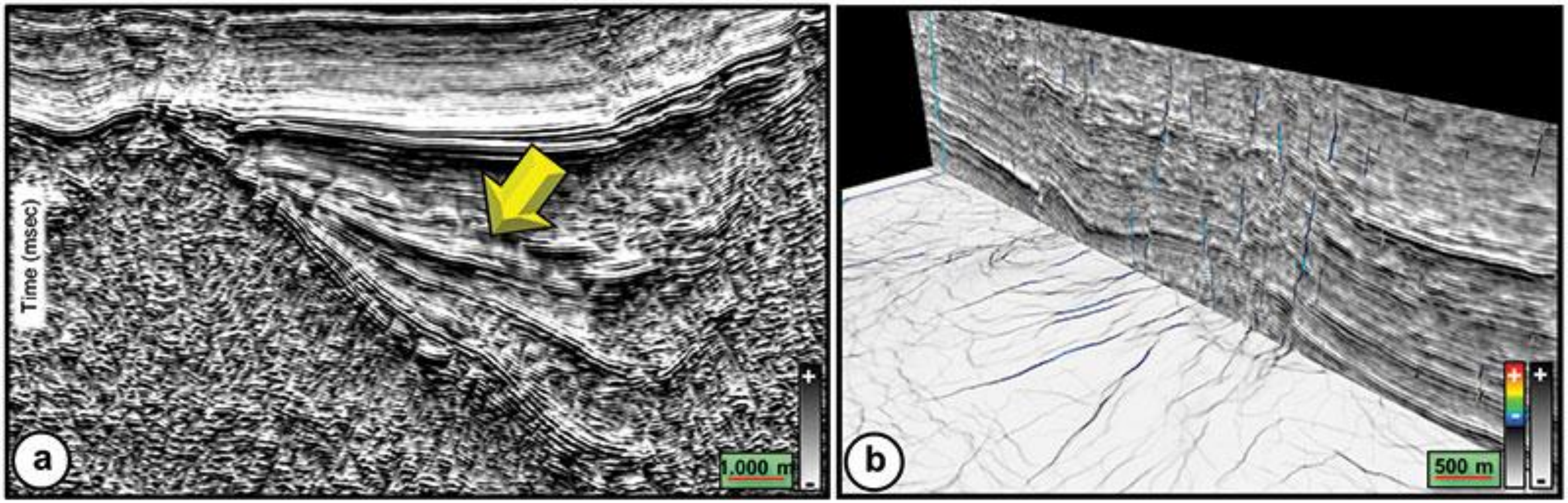

Figure 1. Examples of visual impact of AVTHF sections from Golfo San Jorge Basin, Argentina. (a) Segments of sections showing deep Neocomian deposits (yellow arrow). (b) Chair display with a time slice from coherency and the vertical section from AVTHF co-visualized with coherence using transparency. Notice the clear correlation of the discontinuities on the horizontal and the vertical sections that exhibit the ease with which interpretation can be carried out.

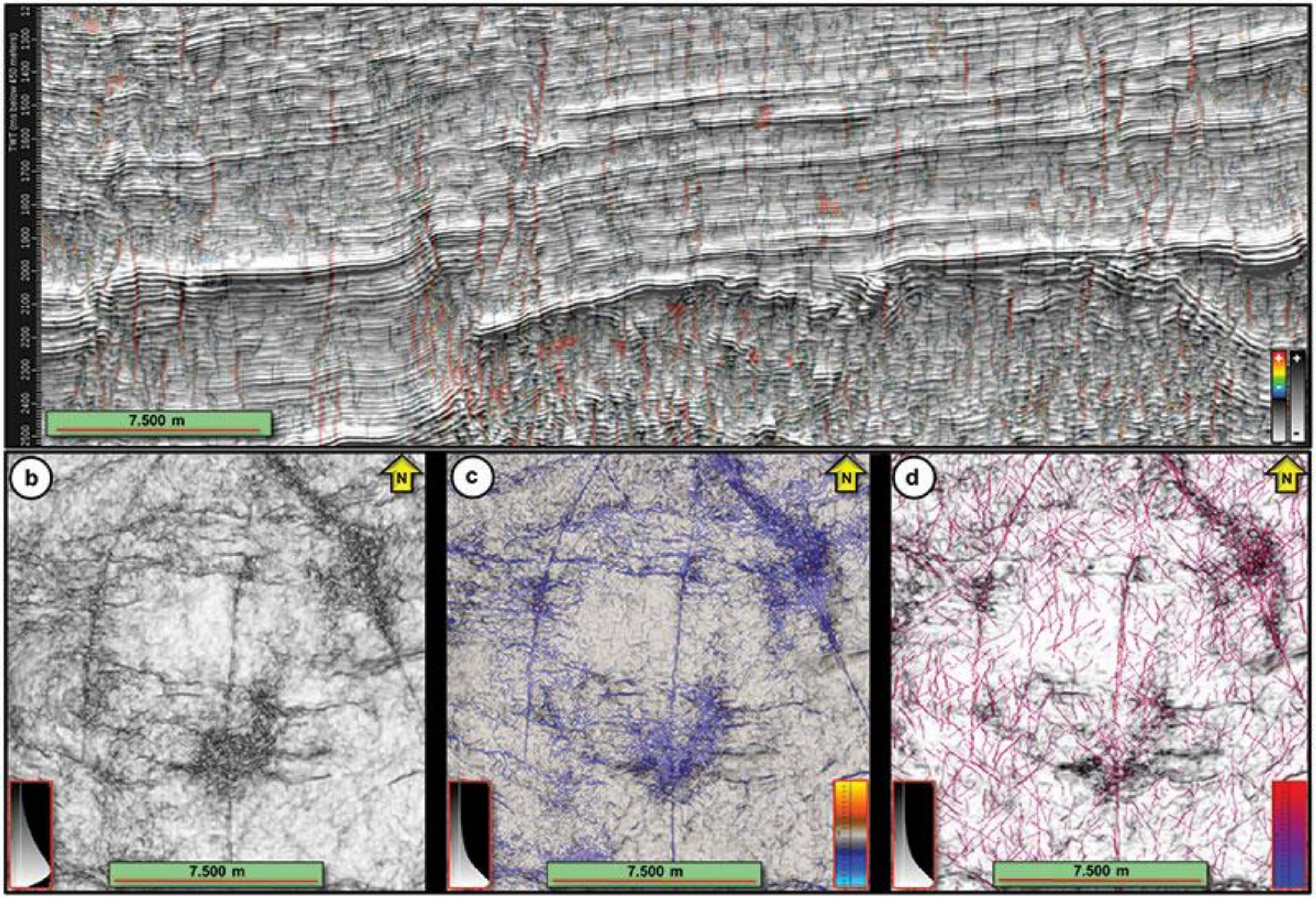

Figure 2. Co-visualization shown in different forms. (a) AVTHF section co-visualized with an equivalent section from ant-tracking attribute. Equivalent time slices (at 700 ms) from (b) coherence attribute run on full stacked data (Coh(AVTHF)), (c) coherence run on AVTHF data (Coh(AVTHF)) and co-visualized with mostnegative curvature attribute run on AVTHF (Curv(AVTHF)), and (d) both attributes run on AVTHF data derived from far angle stack data, 30-45 degrees.

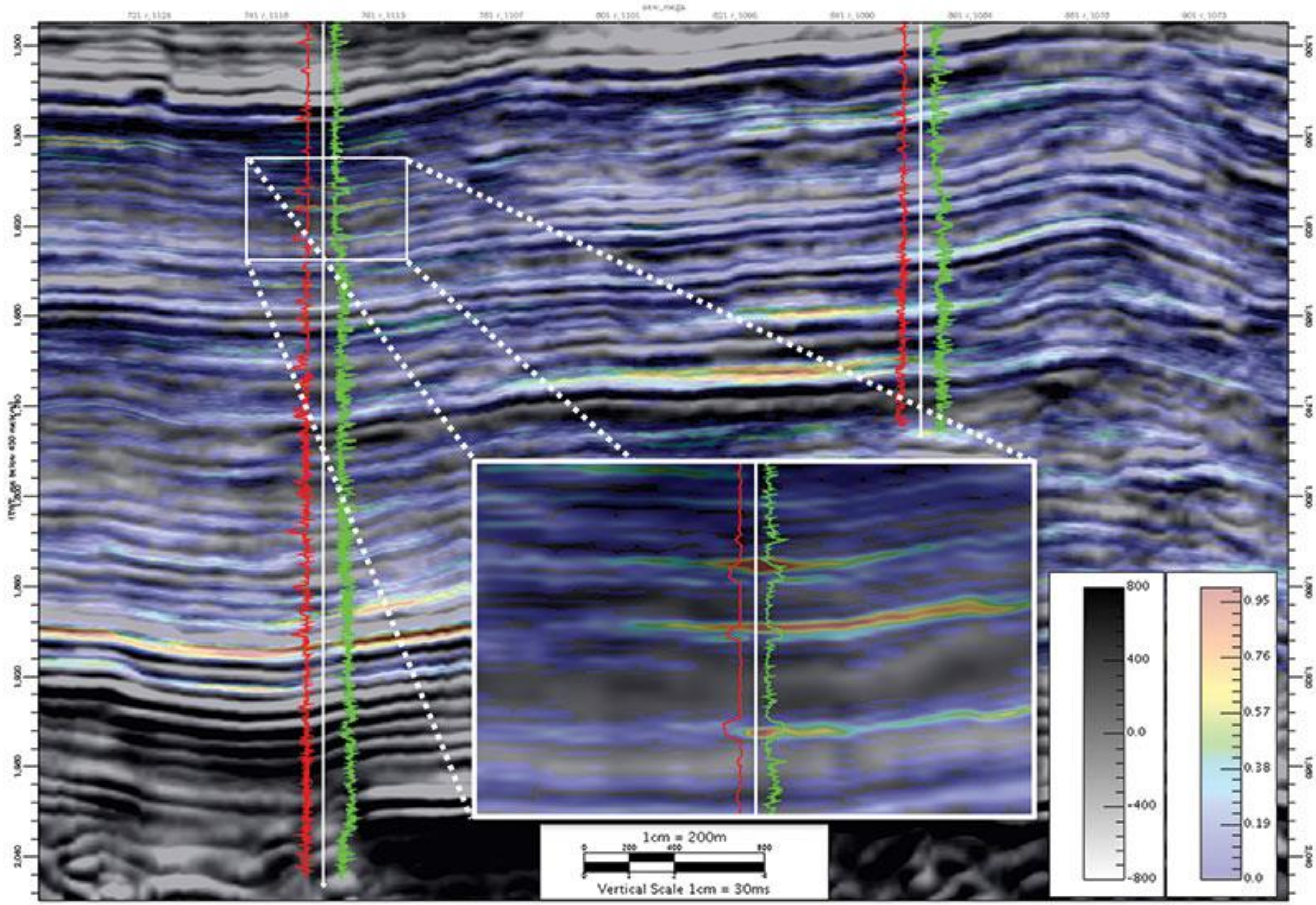

Figure 3. Co-visualization of equivalent sections from the AVTHF volume (in grey) and the probability of pay (reservoir) volume computed using geostatistical inversion in color. The zoom of a small section seen in the foreground exhibits the correlation detail between the co-visualized data and the two well log curves, the spontaneous potential curve in red and the resistivity curve in green.