GC'Unfolding/Unfaulting' Seismic Sections Yields New Interpretations*

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*Adapted from the Geophysical Corner column, prepared by the author and editor, in AAPG Explorer, April, 2010, and entitled "'Unfolding' Yields New Interpretations." Editor of Geophysical Corner is Bob A. Hardage (**bob.hardage@beg.utexas.edu**). Managing Editor of AAPG Explorer is Vern Stefanic; Larry Nation is Communications Director.

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Background

A pair of scissors always sat next to the box of colored pencils on Kees Rutten's desk, littered with seismic sections, time-to-depth curves and well logs. The scissors were used to cut up seismic sections and shift the pieces along faults to check correlations and to see the seismic-character variation across faults. One of his successful, scissors-generated well proposals was an oil field trapped laterally against a clay-filled slump scar on a shelf edge in the middle of heavy faulting.

On retirement from Shell, Kees started developing software to replace his scissors. The computer enables him to deal with more complex geology than was possible by shifting rigid pieces of paper. Variation of slip along syn-sedimentary faults and topological problems, such as branching faults and crossing faults, are now done on a workstation. Kees uses the terms "unfaulting" and "unfolding" to distinguish his technology from palinspastic restoration technology that is more suitable for structural geological studies.

Kees is passionate about placing his technology in the hands of seismic interpreters and has teamed with Halliburton/Landmark to bring it to the desks of mainstream seismic interpreters under the name "ezValidator." The two examples in this article speak for themselves: Both sections are from deltaic areas and exhibit growth faults, branching faults and crossing faults. Each section has 15 to 50 stacked reservoir sands filled with oil and gas.

Examples

The first example shows a structure with two large growth faults that are fairly easy to interpret (Figure 1). Seismic character is in general continuous across the faults – even in the deeper sector where growth factors are appreciable. The surprise is in the unfaulted/ unfolded section, where there are several black events (yellow arrows) that terminate halfway along the section. These are oil-filled sands that thin

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dramatically across the section. This thinning was originally not noticed; it became obvious only after a costly multi-well appraisal campaign. The structure in the second example (Figure 2) is complex, and even after numerous wells were drilled, the fault pattern remained uncertain, leading to two blow-outs. Using unfaulting technology, a fault interpretation was done in several small steps, validating each step during the process. The end result shows the structural interpretation is correct, and that there are subtle truncations (yellow arrows) against intra-formational unconformities in the upper part of the section, which made log correlations difficult during field development. Originally, the cut-outs caused by these unconformities were interpreted as fault cut-outs.

Conclusions

The unfaulting algorithm is based on elastic deformation. You can think of a beam passing along the seismic profile with one end clamped far away. You press the free end down to mimic the fault throw at a horizon correlation across a fault.

Neither the unfaulting algorithm nor the unfolding algorithm requires information not found in the seismic data being interpreted, but use the faults and horizons that are present in an interpretation. Fault blocks and fault hierarchy are not required. The algorithms are fast and allow seismic data to be moved interactively even with 50 or more faults.

This real-time interaction contrasts with earlier software that required two-to-five days to massage fault blocks on a section and to establish fault hierarchy, with 30 minutes of CPU time needed for each change. There is an early release of the technology in Landmark's PowerView/ezValidator that can be evaluated. A full release is slated for 2010 in the DecisionSpace Desktop.

Additional Personal Comments

Kees lost one leg due to thrombosis on a long flight to Houston five years ago, but is still skiing in the Alps and sailing his legendary flat-bottom boat on the mudflats in the north of Holland. He is thinking about a new project using an old seismic vibrator source and EM technology to trip land mines left behind in the Balkan states.

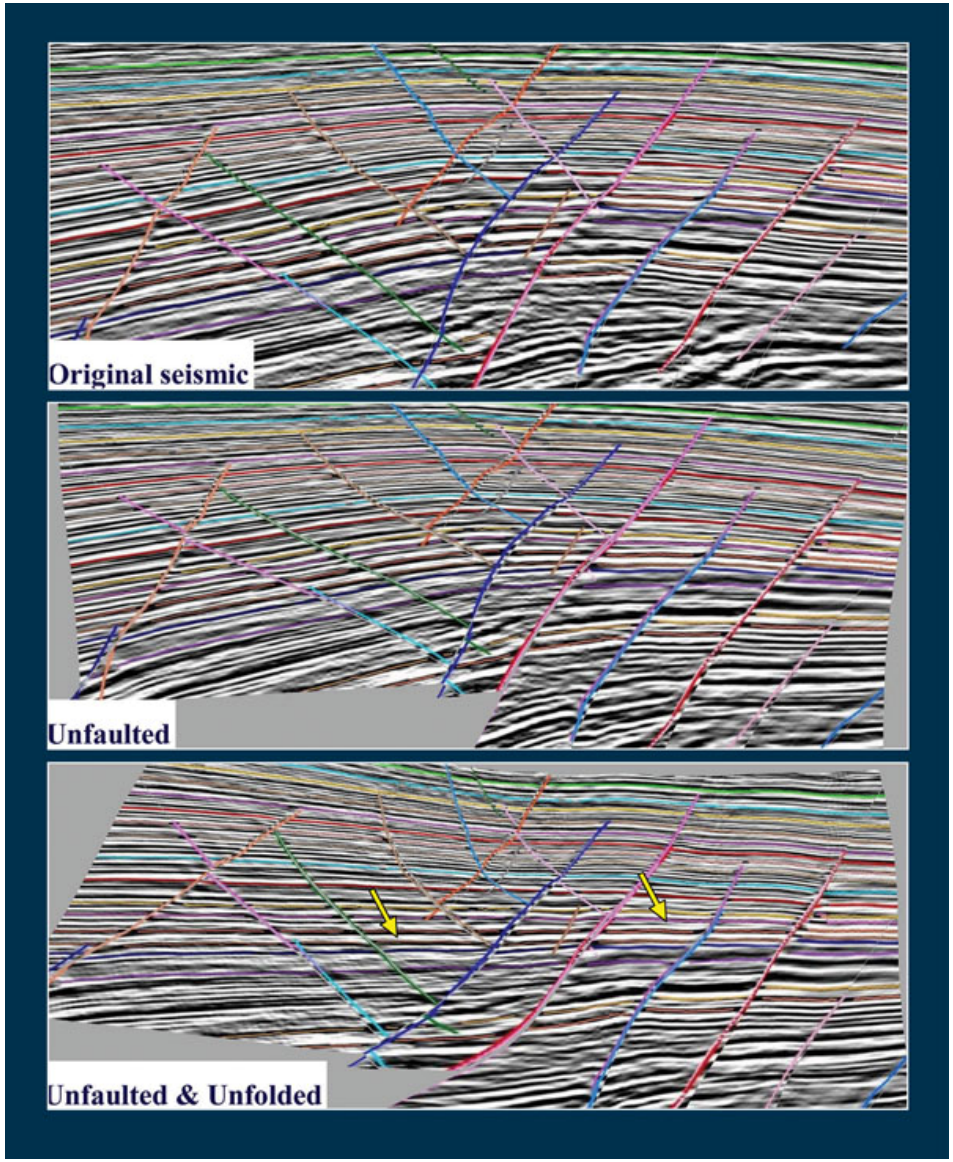

Figure 1. Data example 1; vertical and horizontal scales are not defined. Yellow arrows indicate thinning oil-filled sands.

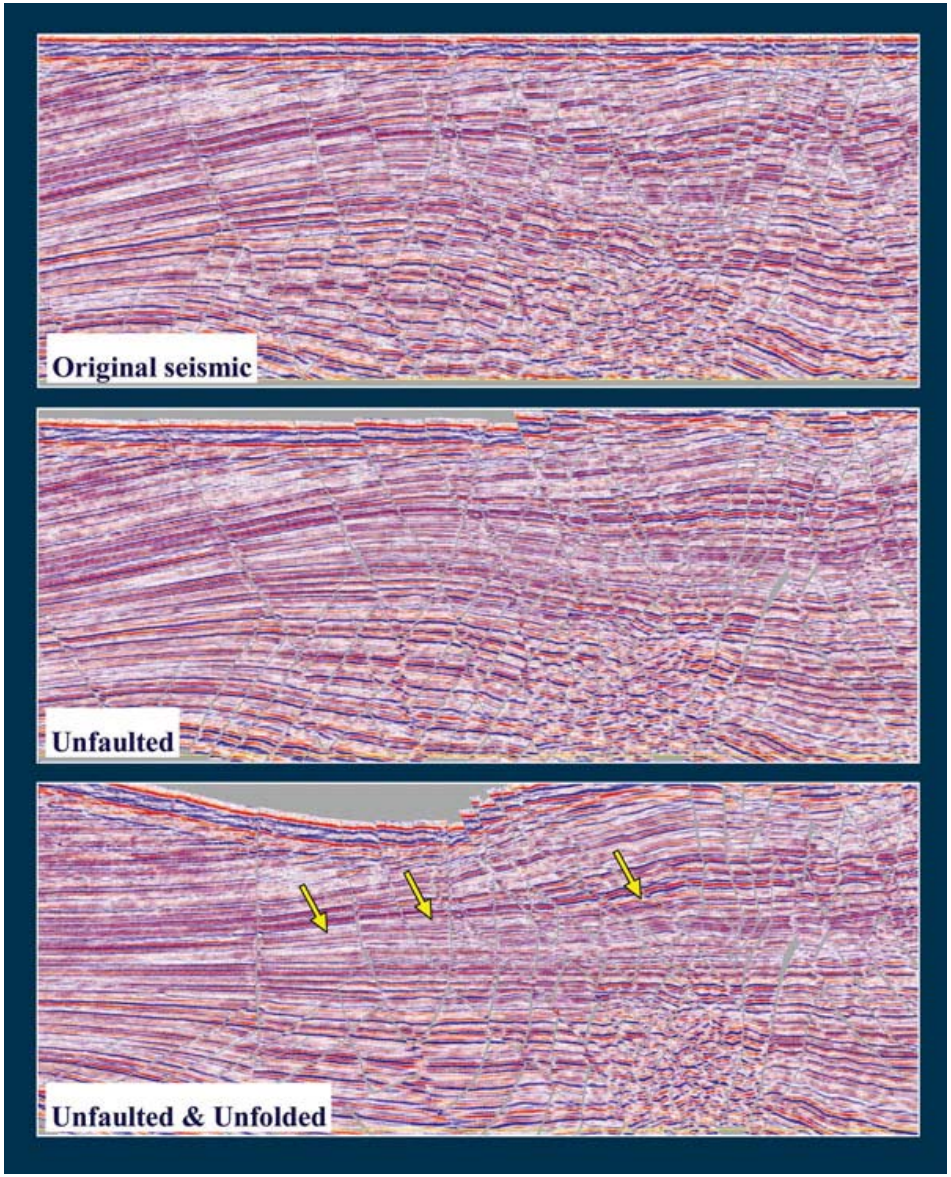

Figure 2. Data example 2; vertical and horizontal scales are not defined. Yellow arrows indicate truncations against intra-formation unconformities.