Attribute-assisted data conditioning and karst recognition

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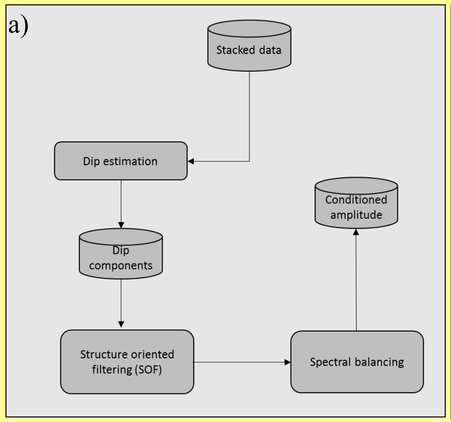
1. Introduction:

A common spectral balancing approach is to estimate the coherent (signal) part of the seismic trace as that which crosscorrelates with neighboring traces. We estimate the coherent part of the seismic trace using two passes of a nine-trace structure-oriented filter. To minimize the risk of impact of removing geology, we then apply a single time-variant spectral balancing operator to the entire volume. This data-conditioning routing focuses on improving the resolution in the thin Barnett Shale and the Ellenburger Group.



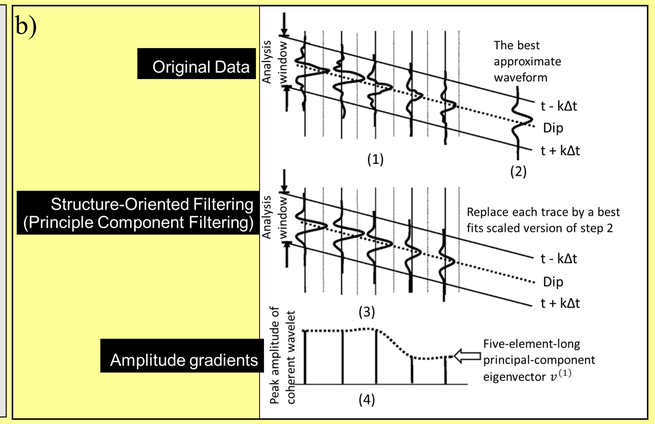


Figure 1. Workflow (a) to precondition the seismic data prior to attribute computation and (b) illustrating the steps for SOF based on principal component analysis (modified after Marfurt, 2006).

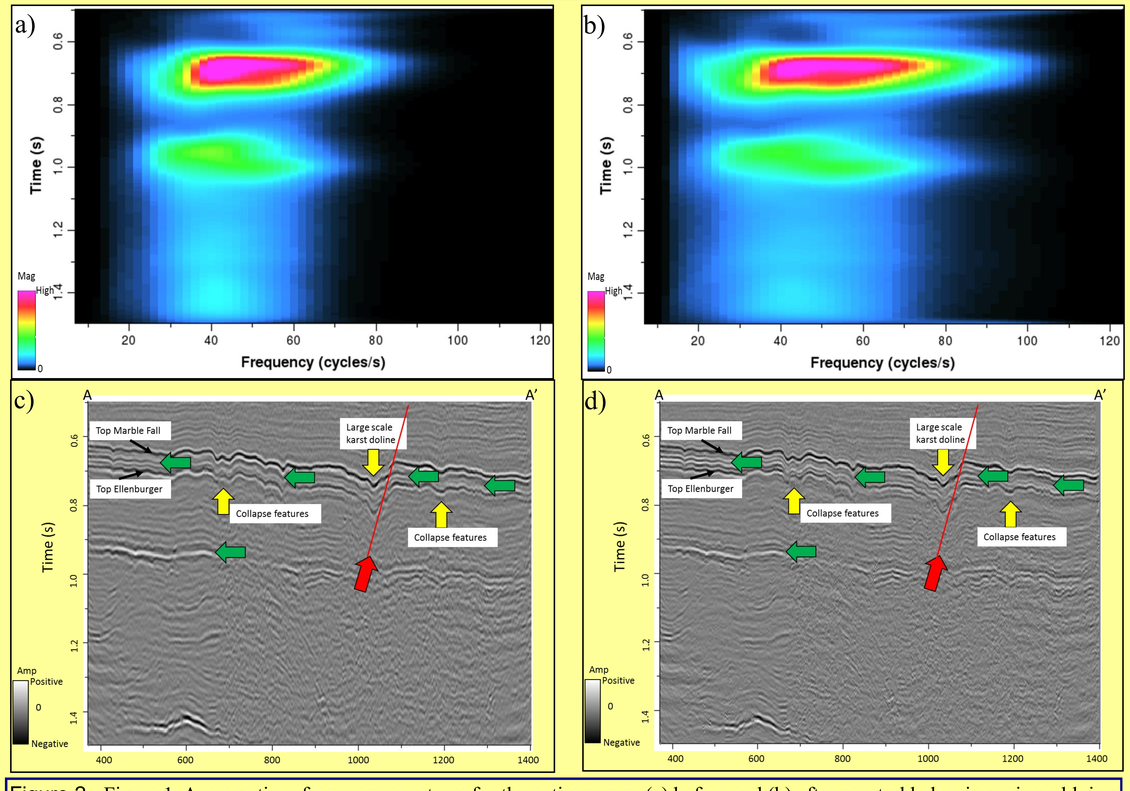


Figure 2. Figure 1. Average time-frequency spectrum for the entire survey (a) before and (b) after spectral balancing using a bluing factor of f β, where β =0.3. Note the increase in frequency content between t = 0.6 and t =0.8 s. Line AA′ (c) before and (d) after time variant spectral balancing. Note the increase in frequency content within the target Barnett Shale interval between t =0.6 and t = 0.8 s as well as the interval above the top basement.

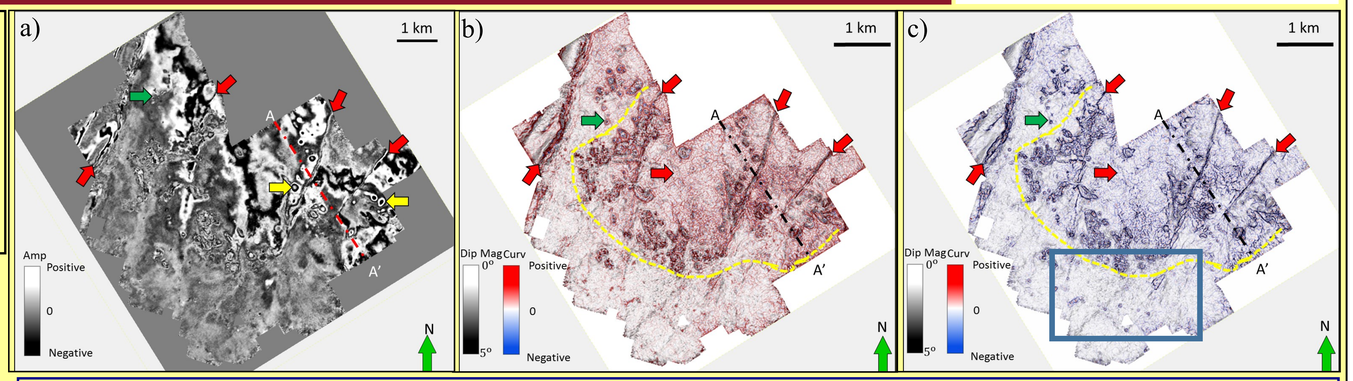
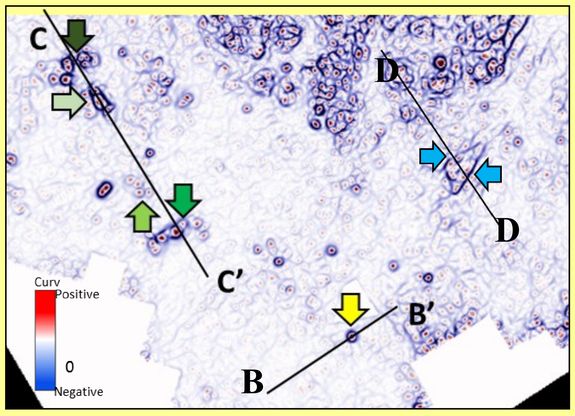
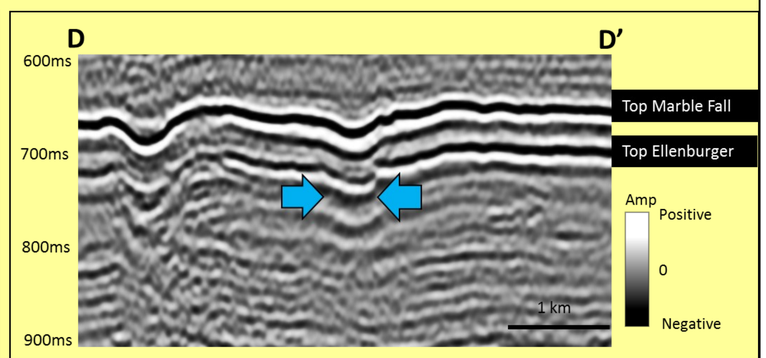


Figure 3. Time slices at t=0.750 s through (a) the seismic amplitude volume at the approximate top Ellenburger, and (c) most-positive and (d) most-negative amplitude curvature volumes co-rendered with dip magnitude volumes.





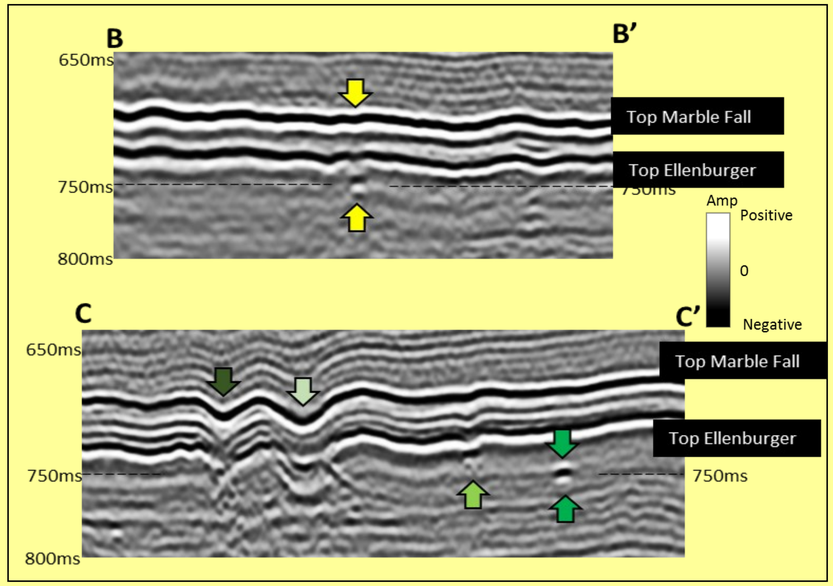


Figure 4. Time slice at t=0.750s through most-negative amplitude curvature, and zoomed in zone; (b), (c), and (d) are seismic section view of line BB',CC', and DD'. Notice that those vertical "strings of pearls" shown on seismic section are subtle karst caves.

2. Background:

A 3D seismic acquisition program was undertaken in 2006 by Marathon Oil Company using 16 live receiver lines forming a wide-azimuth survey with a nominal 16 × 16 m (55 × 55 ft) CDP bin size to image the Barnett Shale at approximately 914 m (3000 ft) true vertical depth subsea (TVDSS) or 0.7 s two-way time (TWT).

3.Conclusion:

The chaotic nature of reflectors internal to the karst features, such as paleocavern fill, often result in low-frequency anomalies. The loss of higher frequencies has two possible causes: the existence of fluid-filled fractures and cracks within the karst collapse features giving rise to intrinsic attenuation, and scattering from the chaotic infill giving rise to geometric attenuation. In this survey area, and throughout much of the Fort Worth Basin, wells that penetrate karst features or coincident fault and fracture system will produce water from the Ellenburger Group and thus, are not intentionally drilled.

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