Postack time-migration imaging of the Mississippi Lime

Benjamin L. Dowdell* & Kurt J. Marfurt, The University of Oklahoma

ConocoPhillips SCHOOL OF GEOLOGY & GEOPHYSICS The University of Oklahoma

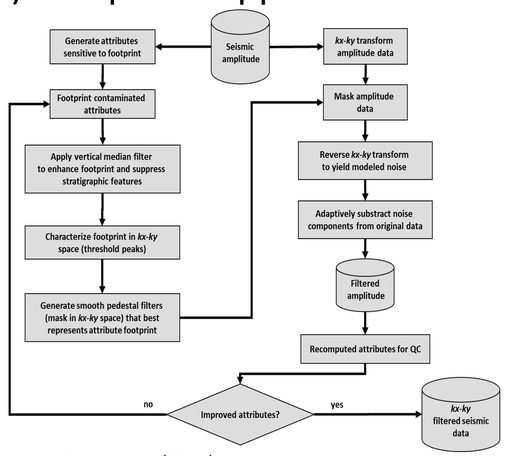
1. Abstract

The Mississippi Lime, located in parts of Oklahoma, Kansas, Arkansas and Missouri is one of the most recent unconventional plays, and is characterized by tight limestone, fractured chert, and high porosity tripolitic chert sweet spots. Exploited since the early 1920s, this formation has been rejuvenated by the advent of horizontal drilling, hydraulic fracturing, and efficient water disposal into the deeper karsted Arbuckle Formation.

Seismic attributes exacerbate the effect of footprint on seismic data. For postack migrated data, acquisition geometry is no longer contained in the trace headers. By taking the k_xk_y transform of a similarity attribute, such as Sobel filter, and the k_xk_y transform of the seismic volume, a noise filter can be designed in k_xk_y space, which gives rise to an estimated noise pattern. This noise pattern can then be adaptively subtracted from the seismic volume, resulting in a reduction of the footprint signature. Further improvements can then be made by structure-oriented filtering coupled with spectral balancing.

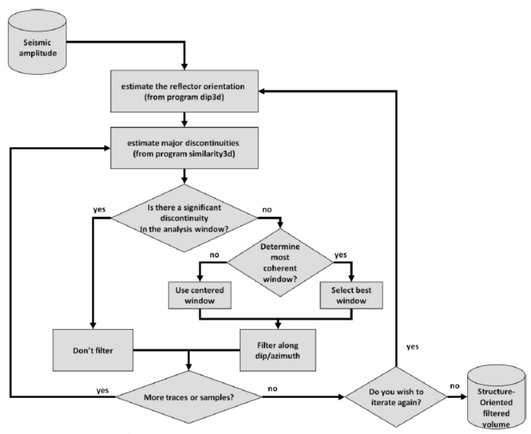
2. Workflow

1) Footprint Suppression



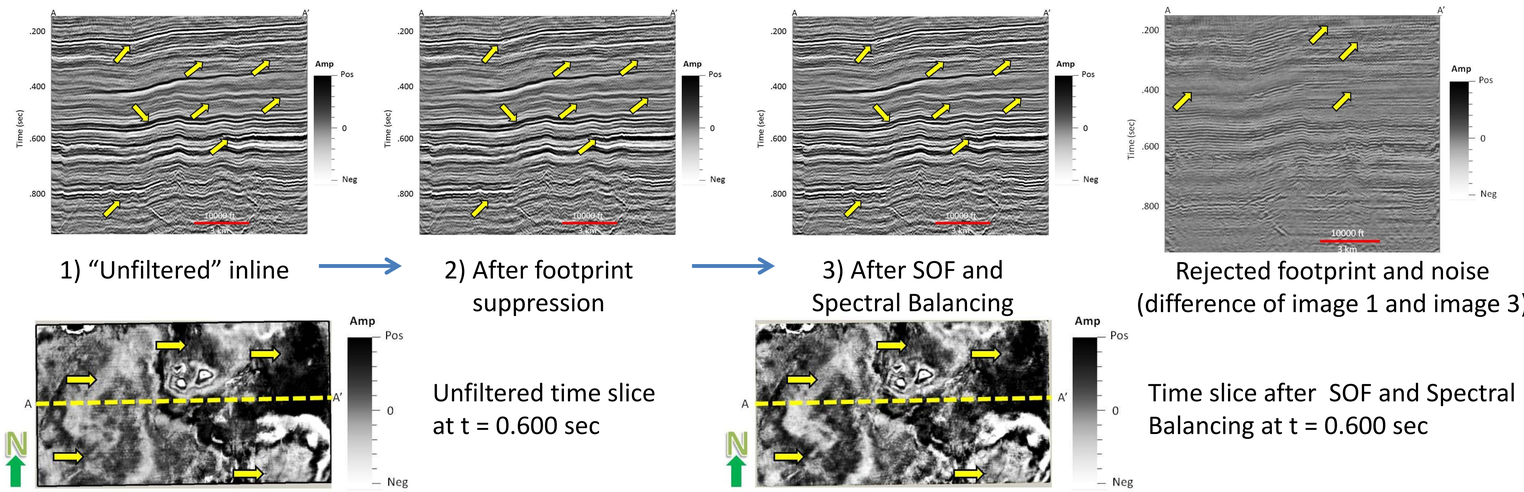
From Davogustto (2011)

2) Structure-oriented filtering



From Marfurt (2006)

3. Footprint Suppression & Structure-oriented filtering



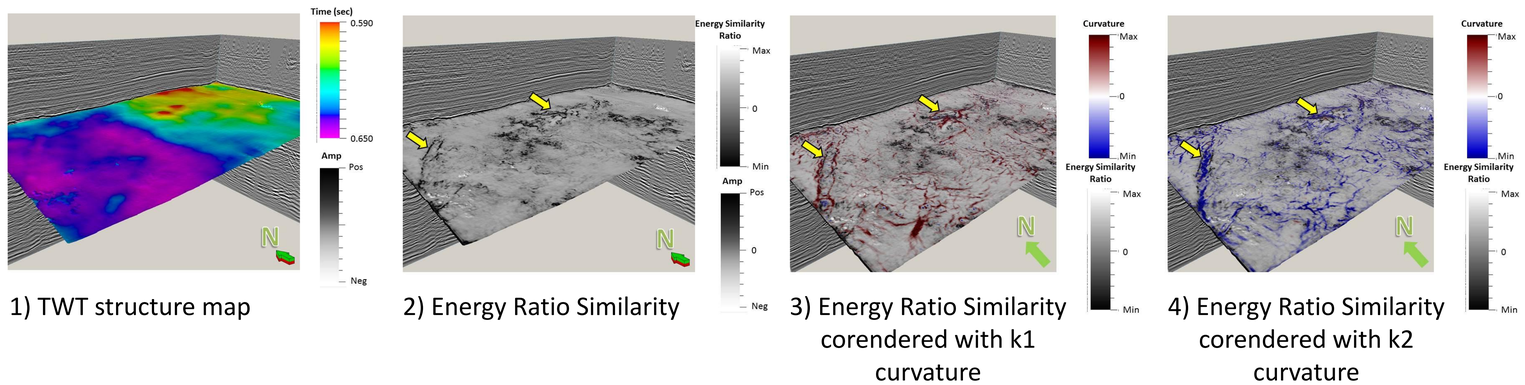
1) "Unfiltered" inline → 2) After footprint suppression → 3) After SOF and Spectral Balancing

Rejected footprint and noise (difference of image 1 and image 3)

Unfiltered time slice at t = 0.600 sec

Time slice after SOF and Spectral Balancing at t = 0.600 sec

4. Mapping Paleotopography – Top of Mississippi Lime



1) TWT structure map

2) Energy Ratio Similarity

3) Energy Ratio Similarity corendered with k1 curvature

4) Energy Ratio Similarity corendered with k2 curvature

5)

6)

5 and 6 show Energy Ratio Similarity corendered with k1 and k2 curvature. Together, these three attributes effectively map paleotopography across the top of the Mississippi Lime

5. Conclusions

- Footprint suppression coupled together with structure-oriented filtering and spectral balancing improve the quality of the postack time migrated survey
- Energy Ratio Similarity corendered with k1 and k2 curvature is an effective means for mapping paleotopography

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References: Davogustto, O., 2011, Removing footprint from legacy seismic volumes: M.Sc. Thesis, University o Oklahoma, Davogustto, O., and K. J. Marfurt, 2011, Footprint suppression applied to legacy seismic data volumes: to appear in the GCSSEPM 31st Annual Bob. F. Perkins Research Conference., Elebiju, O.O., S. Matson, G.R. Keller, and K.J. Marfurt, 2011, Integrated geophysical studies of the basement structures, the Mississippian chert, and the Arbuckle group of Osage County region, Oklahoma: AAPG Bulletin, **95**, 371-393., Marfurt, K. J., 2006, Robust estimates of reflector dip and azimuth: Geophysics, **71**, 29–40., Reeves, T.K., W.I. Johnson, G. Guo, B. Sharma, K.C. Chen, and H.B. Carroll, 1995, Status report - Exploration 3d seismic field test/native tribes initiative: U.S. Dept. of Energy contract no. DE-AC22-94PC91008.