A Study on Non-NMO Migration

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ABSTRACT

When we do conventional prestack Kirchhoff migration, a normal-moveout correction is automatically included, which results in the stretching of the seismic wavelet. Stretch makes the amplitude of wide-angle reflections questionable. An alternative migration method– the "Non-NMO migration", which is part of wide-angle processing, is studied in this project. The spectrum preservation of the propagating seismic wavelet is evaluated using both Non-NMO migration and conventional migration. Frequency analyses of migrated wavelets from synthetic 2D data show a substantial improvement for Non-NMO migration versus conventional migration.

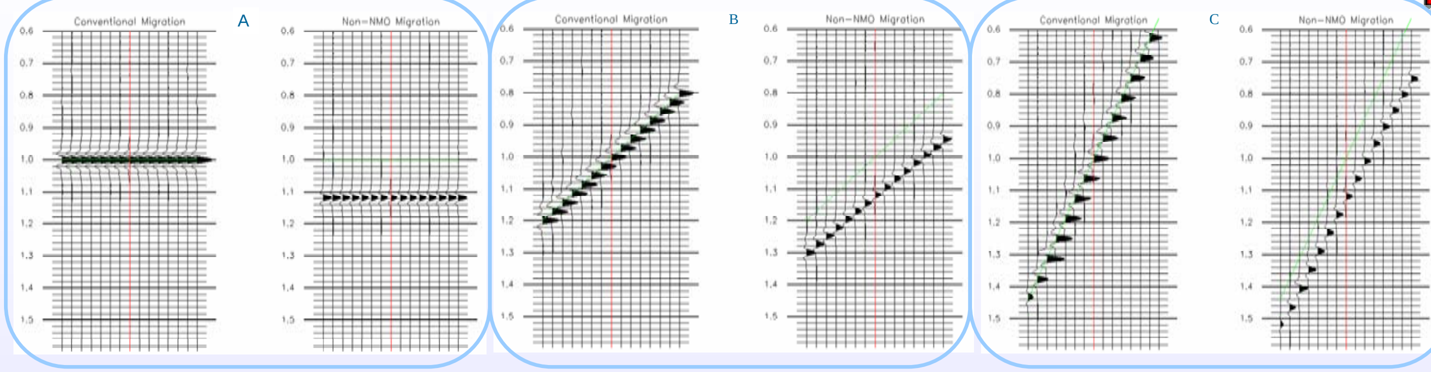

Figure 3. Image traces of conventional migration and Non-NMO migration for different dip models. A) Dip = 0° ; B) Dip = 12° and C) Dip = 25° .

Processing flow of SWAP

- Conventional velocity analysis
- Non-NMO migration
- Import target-horizon t_0 times, and calculate the $t_{NMO}-t_0$
- Static shifts to the target events
- AVO analysis

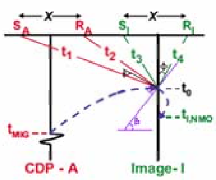

Figure 1. An illustration diagram of the SWAP method (Hilterman,2003)

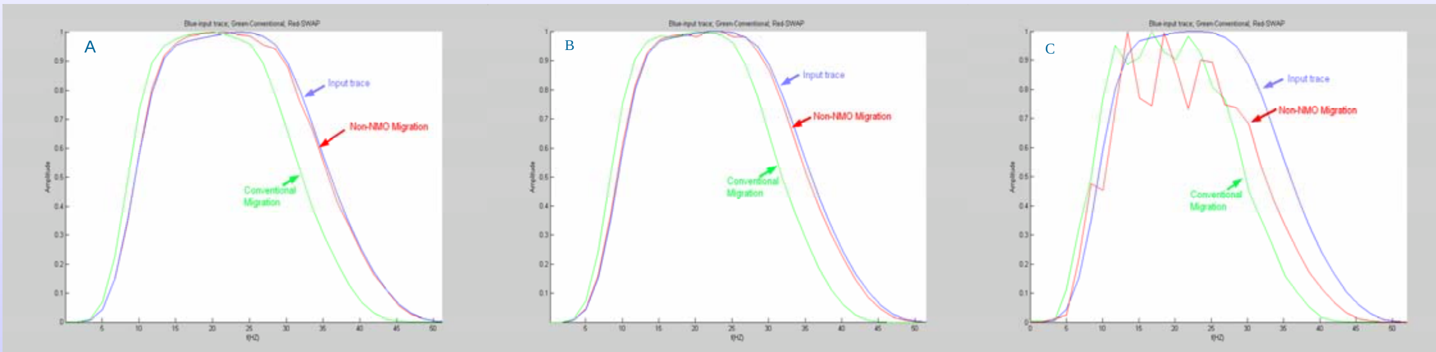

Figure 4. Spectra of the middle image traces in Figure 3 (red line) of both conventional migration and Non-NMO migration for different dip angles. A) Dip = 0° ; B) Dip = 12° and C) Dip = 25° .

- Conventional prestack migration:

  Stretch = $[\cos(\theta)\cos(\beta)]^{-1}$

  (Tygel et al., 1994)

- SWAP:

  Stretch = $\cos(\Phi)/[\cos(\theta)\cos(\beta)]^{-1}$

  $\tan\Phi = (\cos\theta \sin\theta)/(\cos^2\beta - \sin^2\theta)$

  (Hilterman and VanSchuyver, in print)

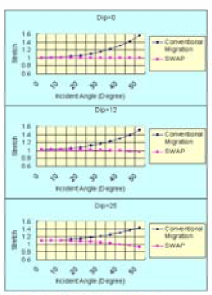

Figure 2. Stretch for Conventional migration and SWAP for dip angles = 0° , 12° and 25° . The incident angle on the horizontal axis refers to Φ.

Question: What causes the distortion in spectra when dip=25° ?

Take a close look at the ray paths, one could have noticed that the middle input trace strikes the dipping reflector about 2000ft to the right of the middle image trace .

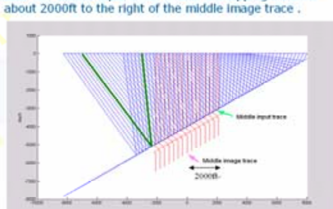

Figure 5. The ray paths for the input traces and the common mid-point positions of the migrated traces.

One could expect from Figure 5, that when the image trace goes from left to right, its spectrum should approach the input trace better.

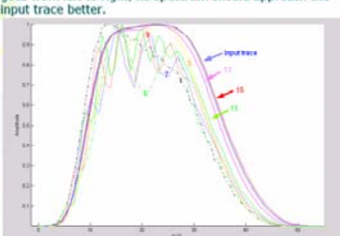

Figure 6. The spectrums for every other image trace in Figure 5. The blue curve is the spectrum of the input wavelet, and the numbers refer to the non-NMO migrated traces. Number 1 is the left most trace, while Number 15 the right most.

Conclusions

Non-NMO migration reduces wavelet stretch compared with conventional migration. The spectra of migrated data are sensitive to dip and both the aperture size and its position relative to the image location.

Acknowledgements

- Dr. Huawei Zhou

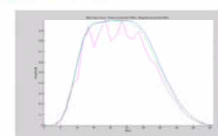

Figure 7. Spectra of input trace and migrated traces. The magenta curve has an increment of 50ft while the green, 100ft.