Automatic NMO correction in Anisotropic media and Non-Hyperbolic NMO Velocity Field Estimation

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Abstract

Managing seismic anisotropy is one of the major aspects in seismic data processing. Seismic anisotropy describes how the seismic wave velocity changes with distances or angles and is dependent on the geology and the nature of the depositional environment. Causes can include fractures, fluids, hydrocarbon, facies or lithology change.

Pre-stack seismic reflection data in isotropic media take a hyperbolic shape, (Figure 1a and c), where the NMO velocity is the same at every offset/azimuth, and the only parameter that actually causes the normal move-out effect is the offset or the distance between the seismic source and the receiver. In anisotropic media, seismic reflection data takes a non-hyperbolic shape (Figure 1b and d) as an indicator for a velocity variation with offset or azimuth.

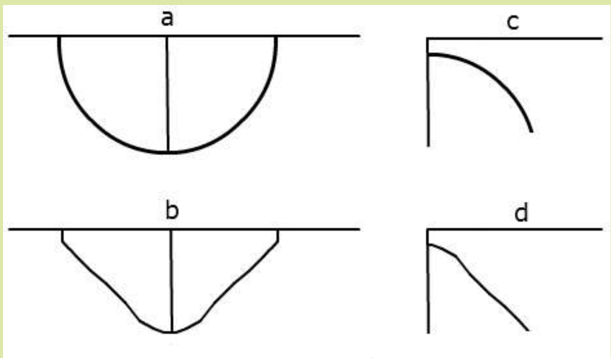

Figure 1: a) Isotropic wave propagation b) Anisotropic wave propagation c) Hyperbolic curve shape d)Non-hyperbolic curve shape

Application and Results

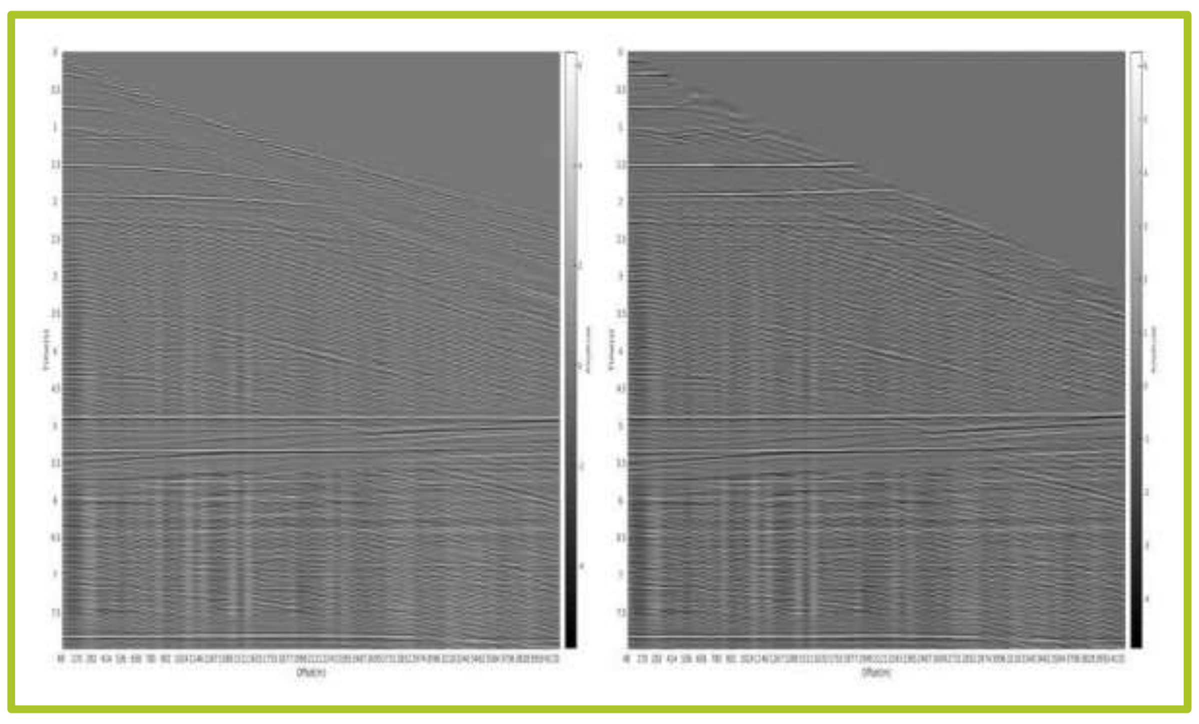

Figure 2: HESS (VTI) synthetic seismic model. Created by Hess Corporation

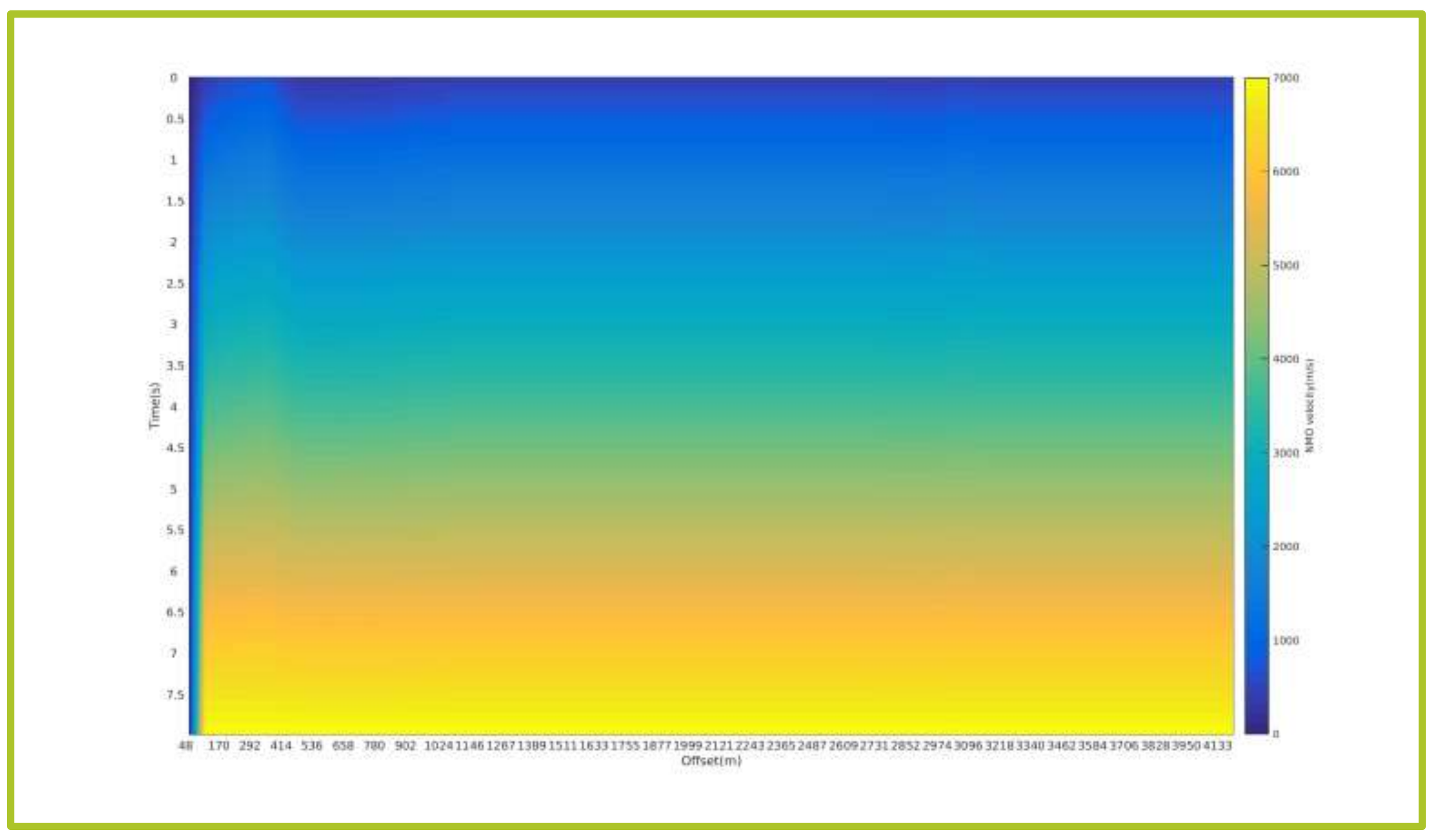

Figure 3: Full NMO velocity field that varies instantaneously

Auto-tracking

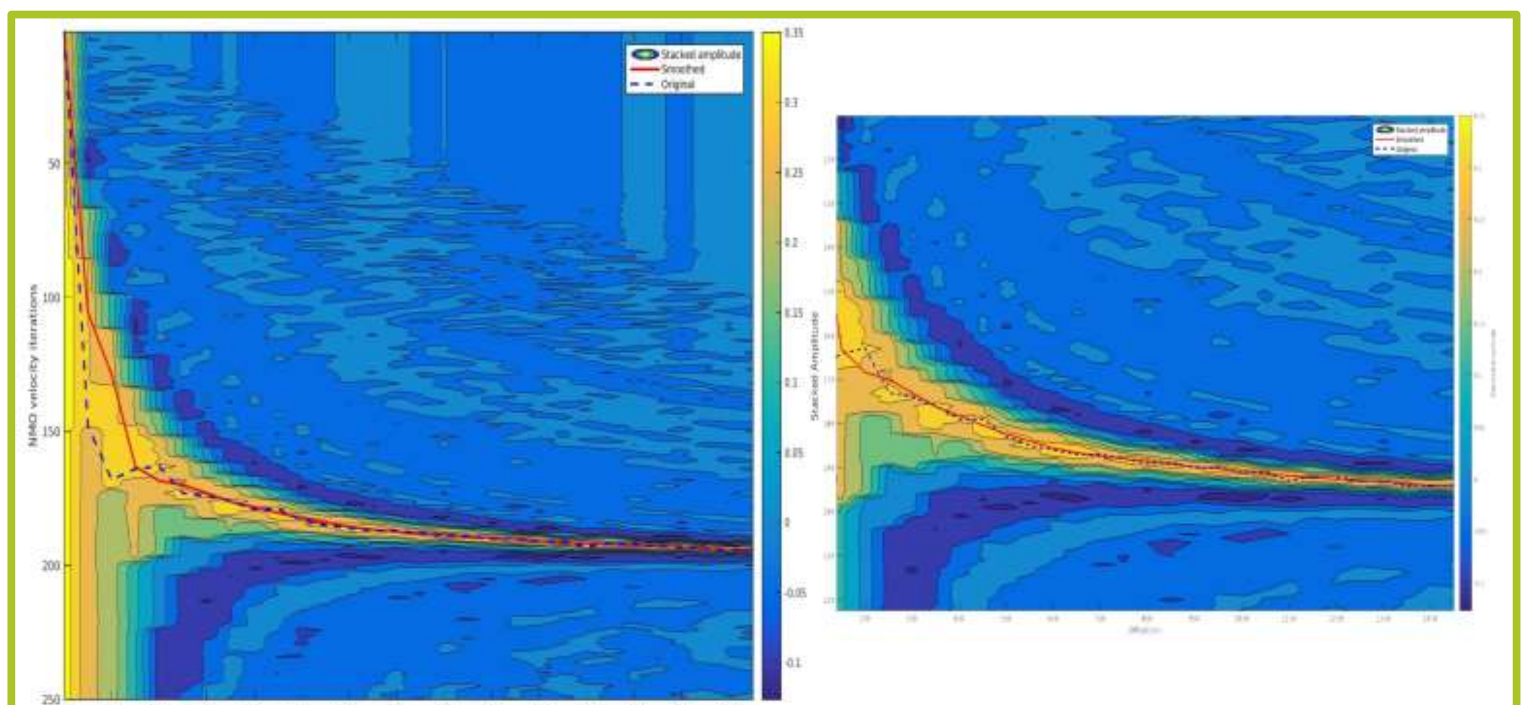

Figure 4: Tracking plot showing both the default and smoothed tracks

Conventional manual technique

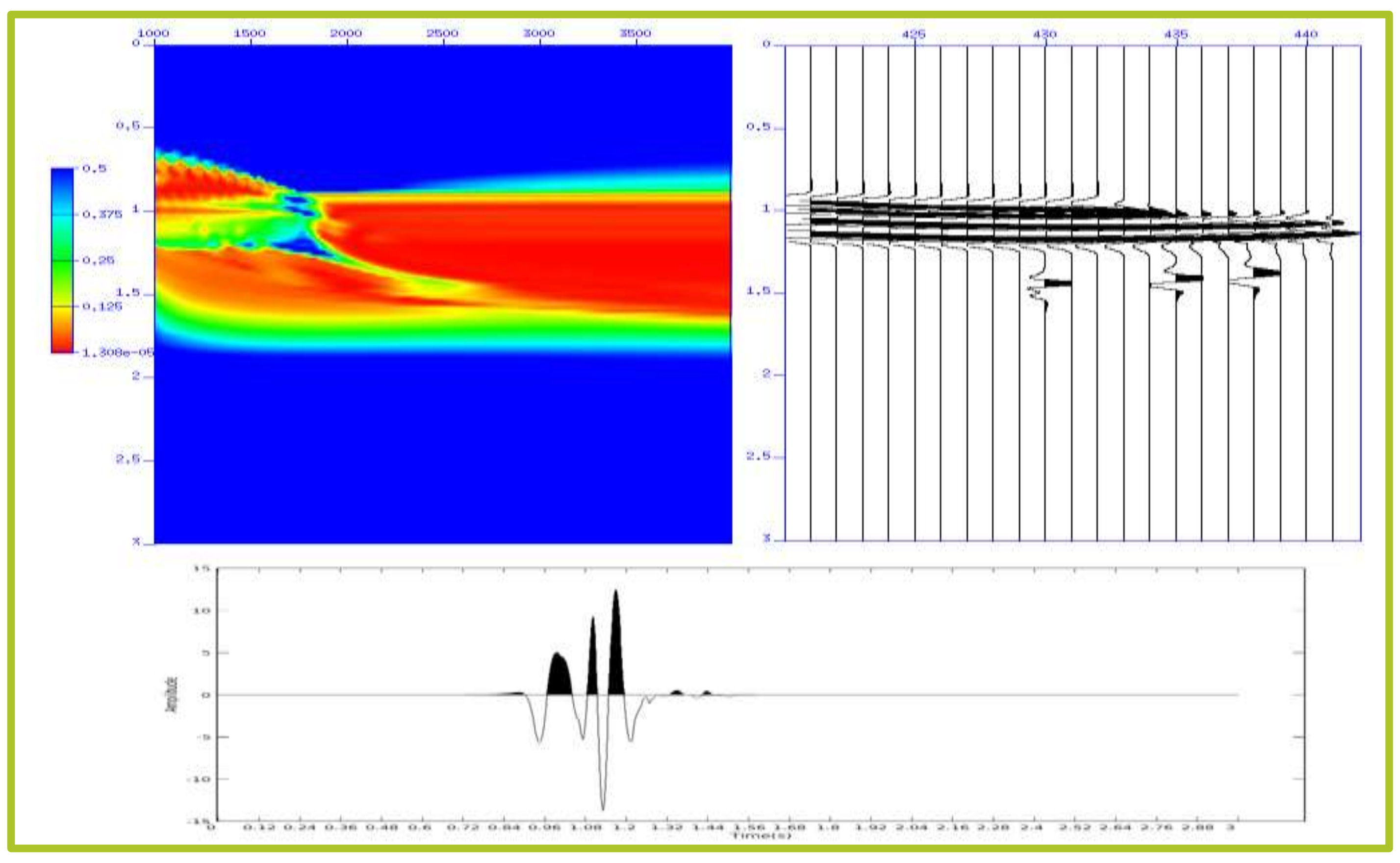

Figure 5: Conventional semblance analysis (left) and the conventional manual NMO correction (right).

New NMO Automatic technique

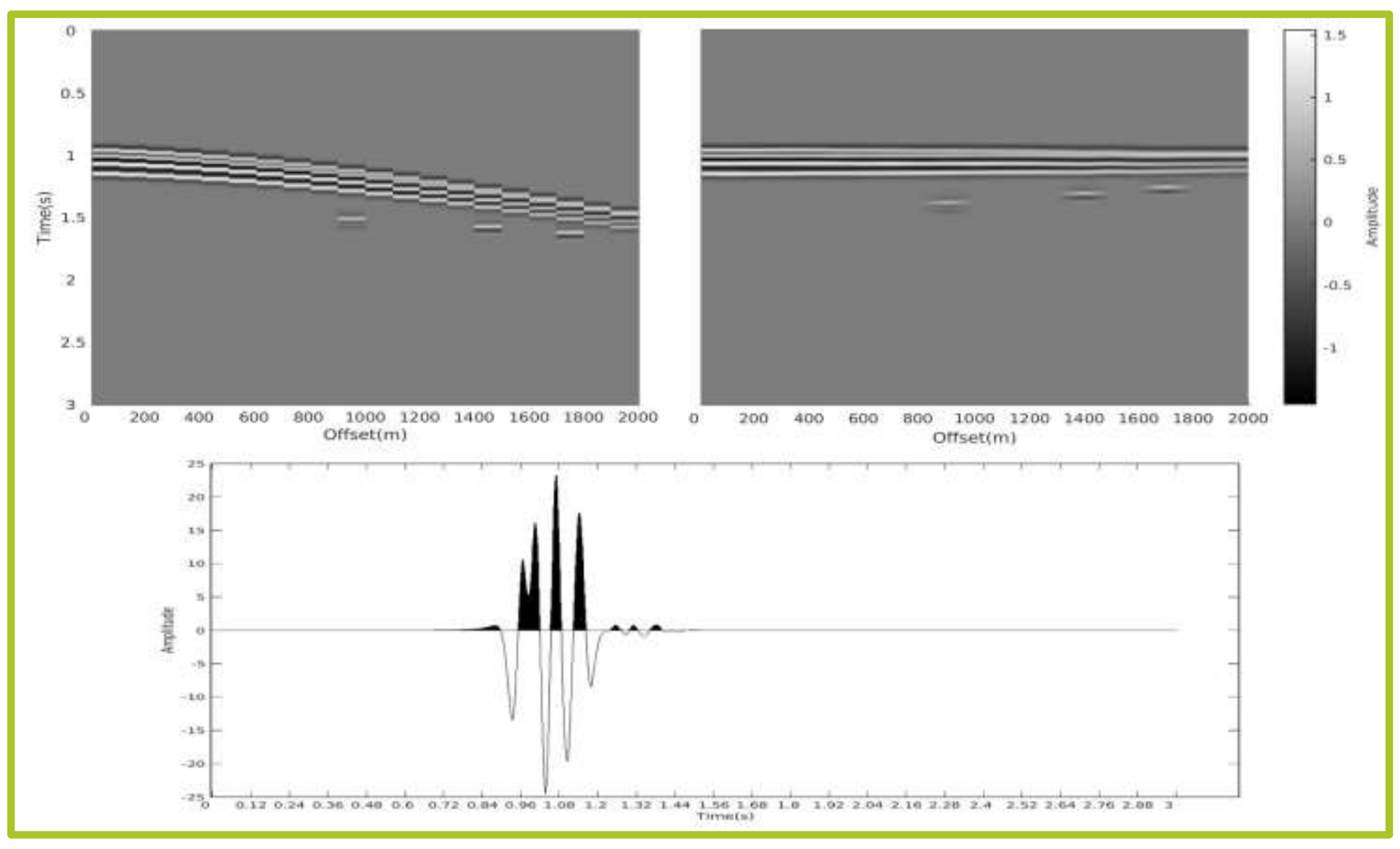

Figure 6: Anisotropic synthetic CDP example (left) and the automatic anisotropic NMO correction (right).

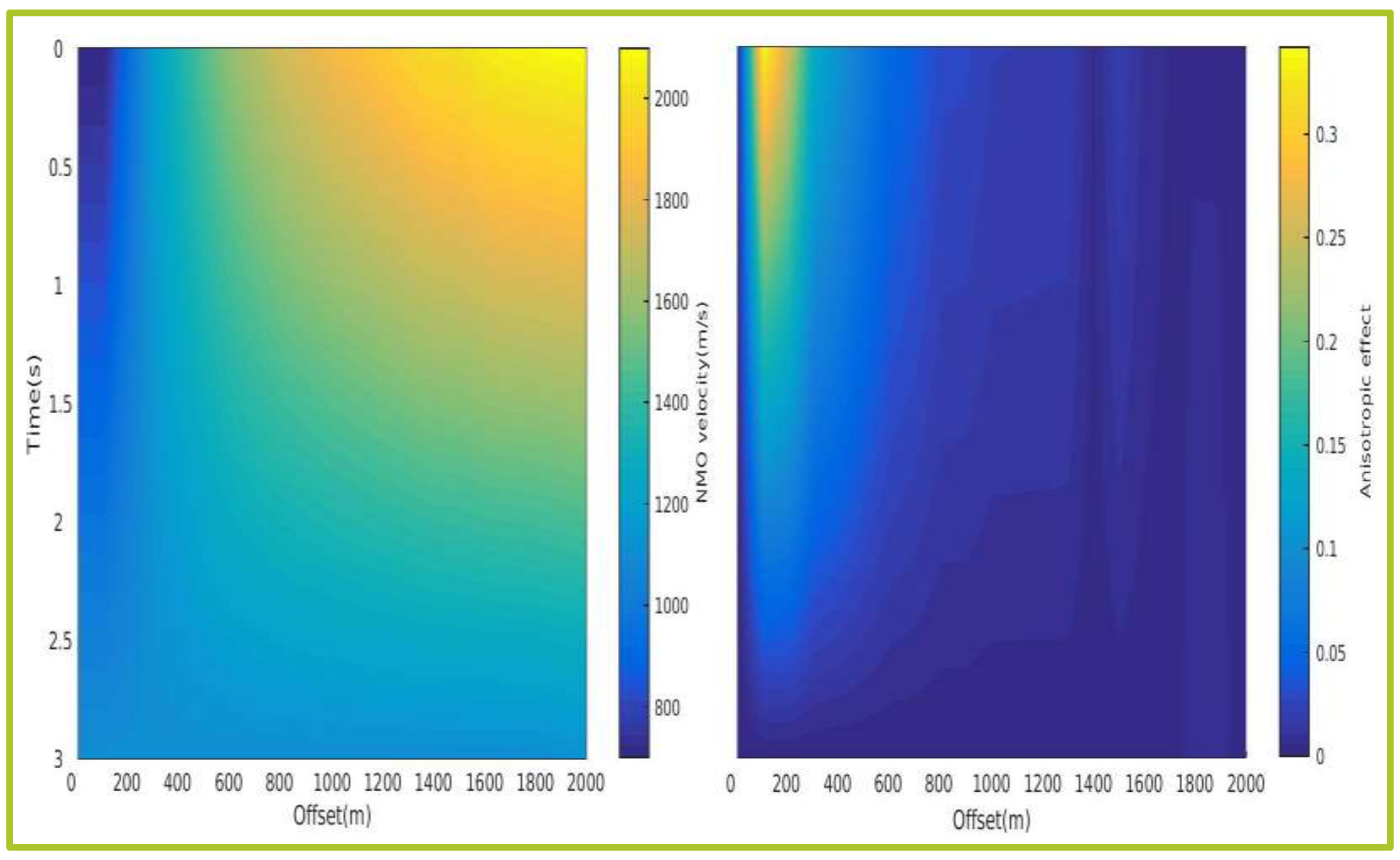

Figure 7: Full velocity field for the synthetic CDP (left) and the anisotropic effect (right).

Conclusions

This work introduces a new method to automatically NMO correct seismic reflection events. The method works without a need to predefine the anisotropic parameters and rather, provides the anisotropic effect after the NMO correction.

The method involves calculating the spatial variation of the seismic reflectors NMO velocities at each offset or azimuth and finding the ratio between these variations, which makes it possible to invert the seismic anisotropy as a factor that defines how the velocity is changing with different azimuths. The outputs are the anisotropic effect and a full NMO velocity field, in addition to the NMO correction.

Benefits include:

- Decreased time to find the anisotropic parameters and apply it to the seismic data
- Provision of a dense velocity information, which is not available using the current techniques
- Automatic exclusion of multiple signals
- Introduction of the potential to detect and interpret the lateral changes in velocity (e.g. due to gas, fluids, fractures, faces change, etc.) as the extracted high dense velocity field covers all the possible azimuths and offsets.