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Please fill in your abstract title.	Shaping the Velocity Model Beyond the Diving Wave Penetration with Full Waveform Inversion

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Abstract

Objectives/Scope:
To extend conventional full waveform inversion (FWI) beyond the limits of the transmitted energy, we must use reflection data. Field data examples demonstrate that, even in a complex subsalt Gulf of Mexico setting, the background velocity model can be updated from shallow to deep water using conventional FWI followed by reflection-based FWI.

Methods, Procedures, Process:
To achieve kinematic improvements in the image gathers in the deep updates, reflection data must be incorporated. The background velocity change would come from the low wavenumber part of the kernel which can be associated with the backscattering energy from the reflection data rather than the high wave number which is the migration operator.In our proposed reflection FWI approach, long- and short-wavelength model updates are decoupled; the long-wavelength information contributes to background model updates while the short-wavelength content contributes to the reflectivity updates.

Results, Observations, Conclusions:
The field example consists of wide-azimuth (WAZ) data set with 9.6 km maximum offset acquired in the Gulf of Mexico. We elected to start the conventional FWI with the adjustive (cycle-skip mitigated) option was employed from a 1D type of starting velocity field (Figure 1a). First, we used the early arrivals as input to FWI from wide-azimuth data. After the first two frequency bands(1-4Hz and 1-8) using early arrivals for the FWI update (Figure 1c), the updates were limited to 2.7km, When the depth slice difference is interrogated between the starting and the updated model (Figure 1b and Figure 1d) the first obvious conclusion is that FWI picked up the small and medium scale high velocity carbonate carapaces and the low velocity shale bodies from the simple starting velocity field.To extend the updates to the deep part of the basins and under the salt, we switched to the reflection-based FWI.The deep update is demonstrated by mobile shale and subsalt improvements in terms of imaging and velocity update. The initial velocity field was

fine-tuned using reflection-based FWI to achieve the final updated velocity field (Figure 2b). This was used to compare the initial image (Figure 2a) with the final velocity image (Figure 2b) the deep part of the model at the cretaceous depth shows improvements in reflector continuity and focusing after the deep reflection FWI updates in the shale section. The second enhancement was seen subsalt, inputting a simple subsalt velocity trend to the reflection FWI that has changed the shape of the reservoir after of velocity update (Figure 3b versus Figure 3a) and the salt feeder in between two salt-bodies was reinserted by FWI producing the deeper imaging improvement below the reinserted salt feeder.

Novel/Additive Information:

To extend the power of FWI to the deep part of the model reflections should be used with the correct sensitivity kernel.

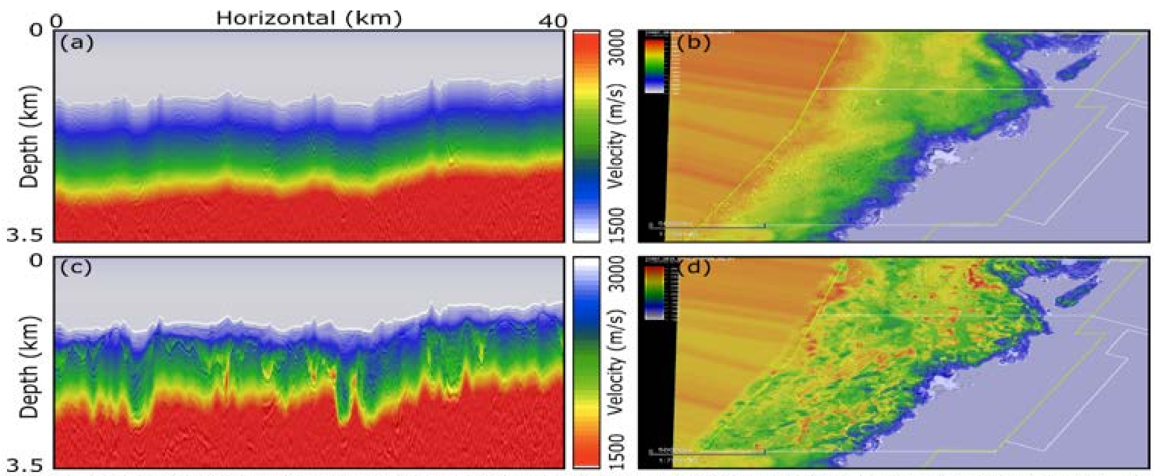

Figure 1. (a) Starting velocity vertical section. (b) Starting velocity horizontal slice at 2 km. (c) FWI-updated velocity vertical section. (d) FWI-updated velocity horizontal slice at 2 km.

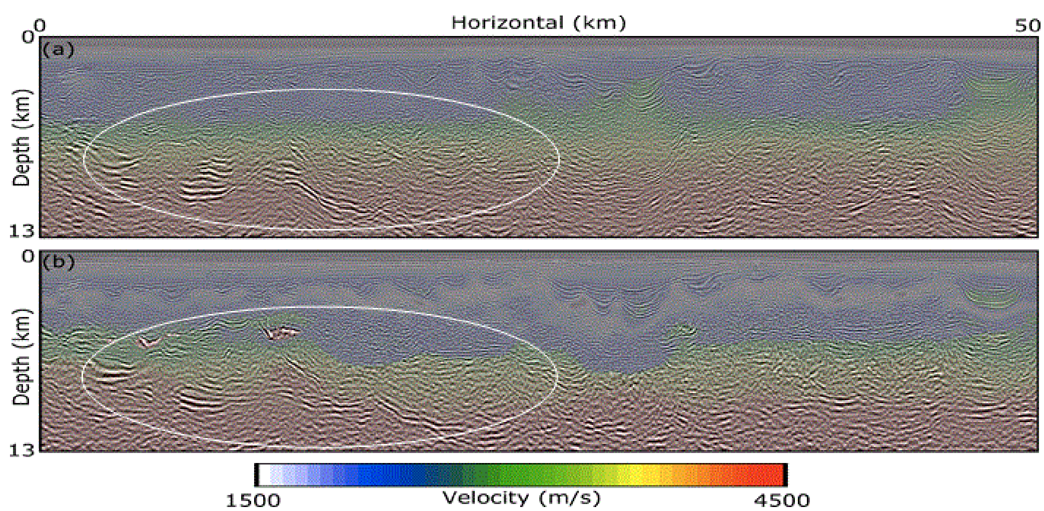

Figure 2. (a) Input model to reflection FWI with image overlay in the shale area, (b) Reflection FWI updated model with image overlay in the shale area.

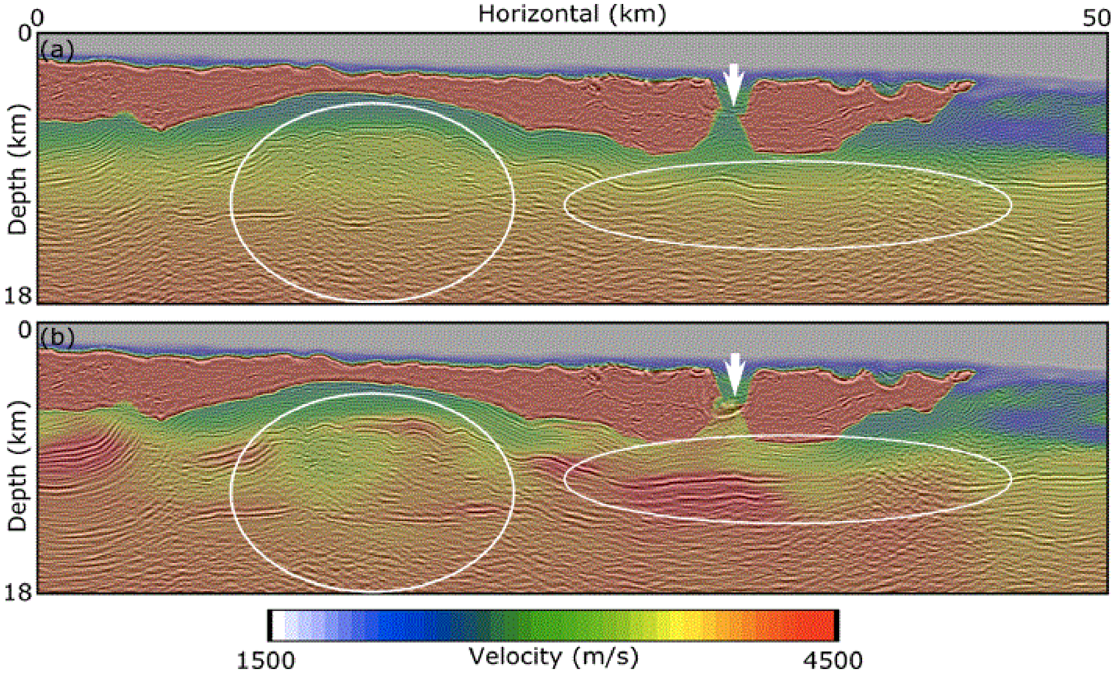

Figure 3. (a) Input model to reflection FWI with image overlay in the subsalt area, (b) Reflection FWI updated model with image overlay in the subsalt area.