

A modeling and migration study of fault shadows: A synthetic example

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❖ **Introduction**

❖ **Theory and Methodology**

❖ **Finite difference modeling**

❖ **Phase-shift-plus-Interpolation**

❖ **Time migration or Depth migration**

❖ **Brief Methodology**

❖ **Synthetic examples**

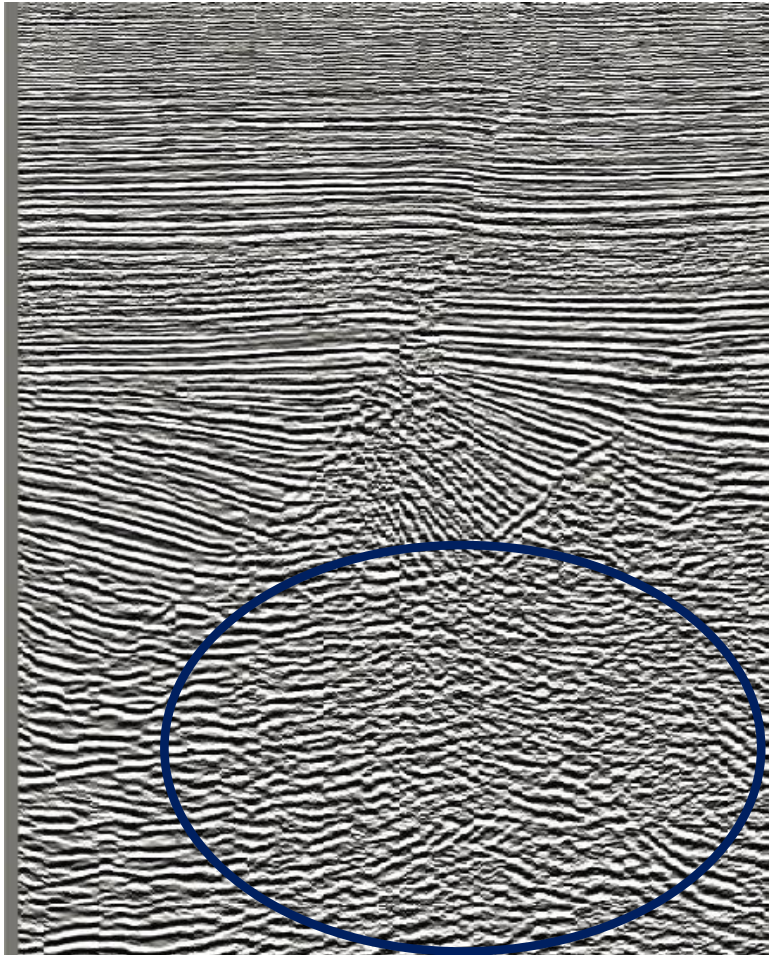
❖ **Conclusions**

❖ **Questions**

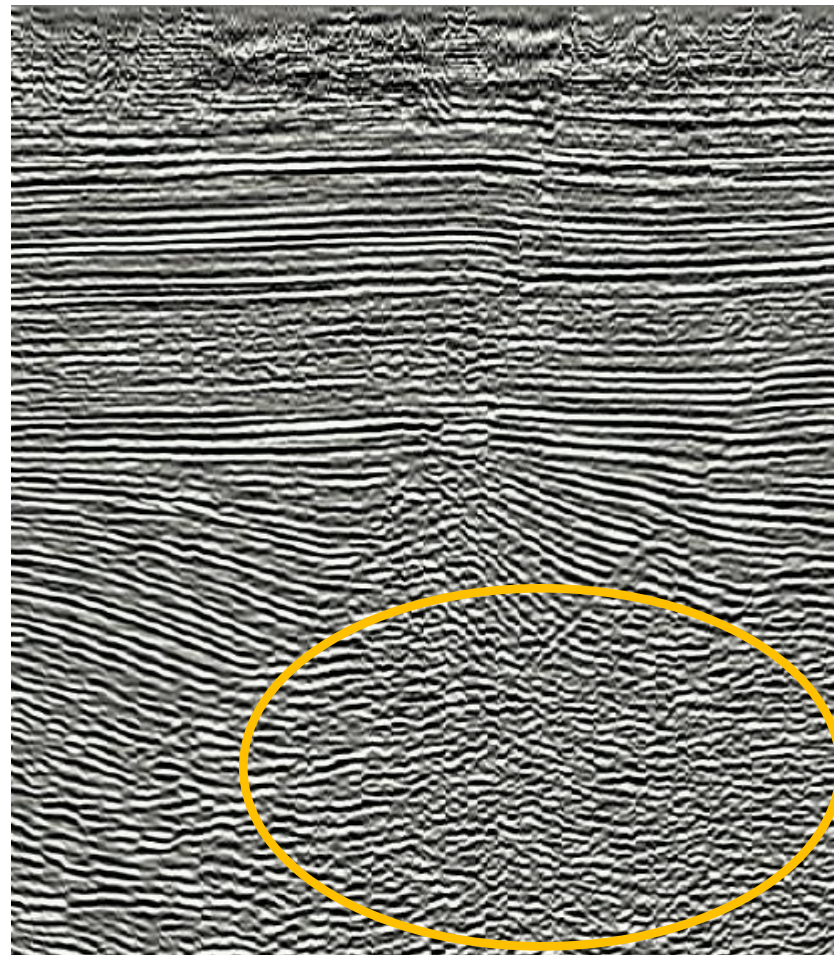
Introduction

- ❖ These are zones of unreliable imaging in footwalls
- ❖ Appear as anticlines (or synclines) behind fault, may be false or real
- ❖ Exist in extensional and compressive faulted regime
- ❖ Reported cases are in the land datasets of South Texas and the Gulf of Mexico, tertiary graben of onshore Poland , the permafrost region of Siberia (Stuart, 1999), and the Gulf of Guinea in the Niger Delta sedimentary basin of Nigeria (Schultz, 1999)

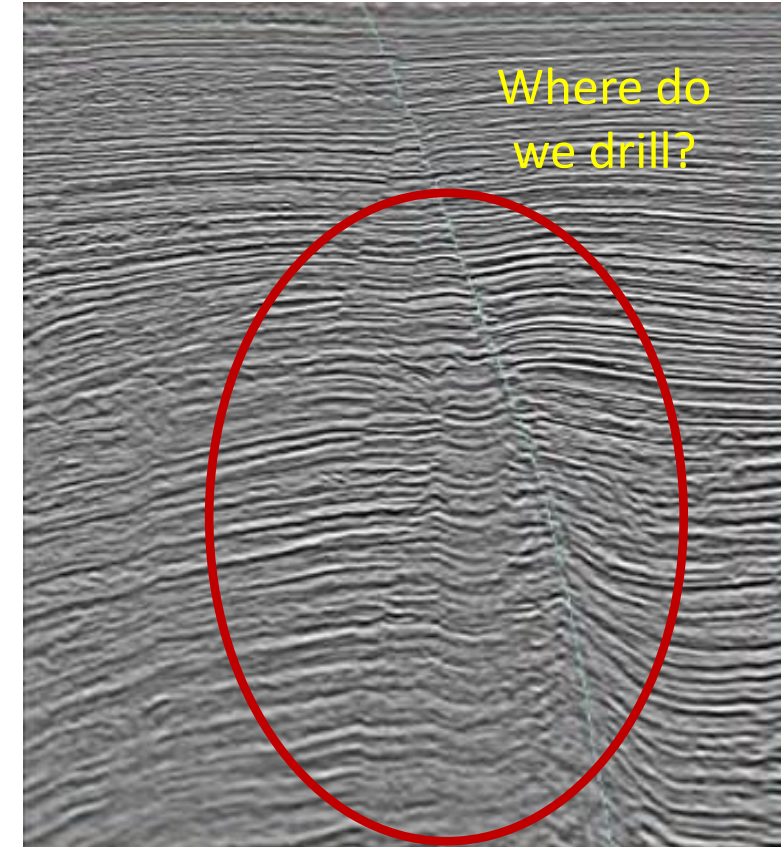
Fault shadows on typical real seismic dataset



Kirckhoff depth migration of the South Texas
(Bednar et.al.)



Reverse Time Migration of the South Texas
(Bednar et.al.)



common offset poststack depth
migration of the Permafrost of Siberia
(Quigley et.al.)

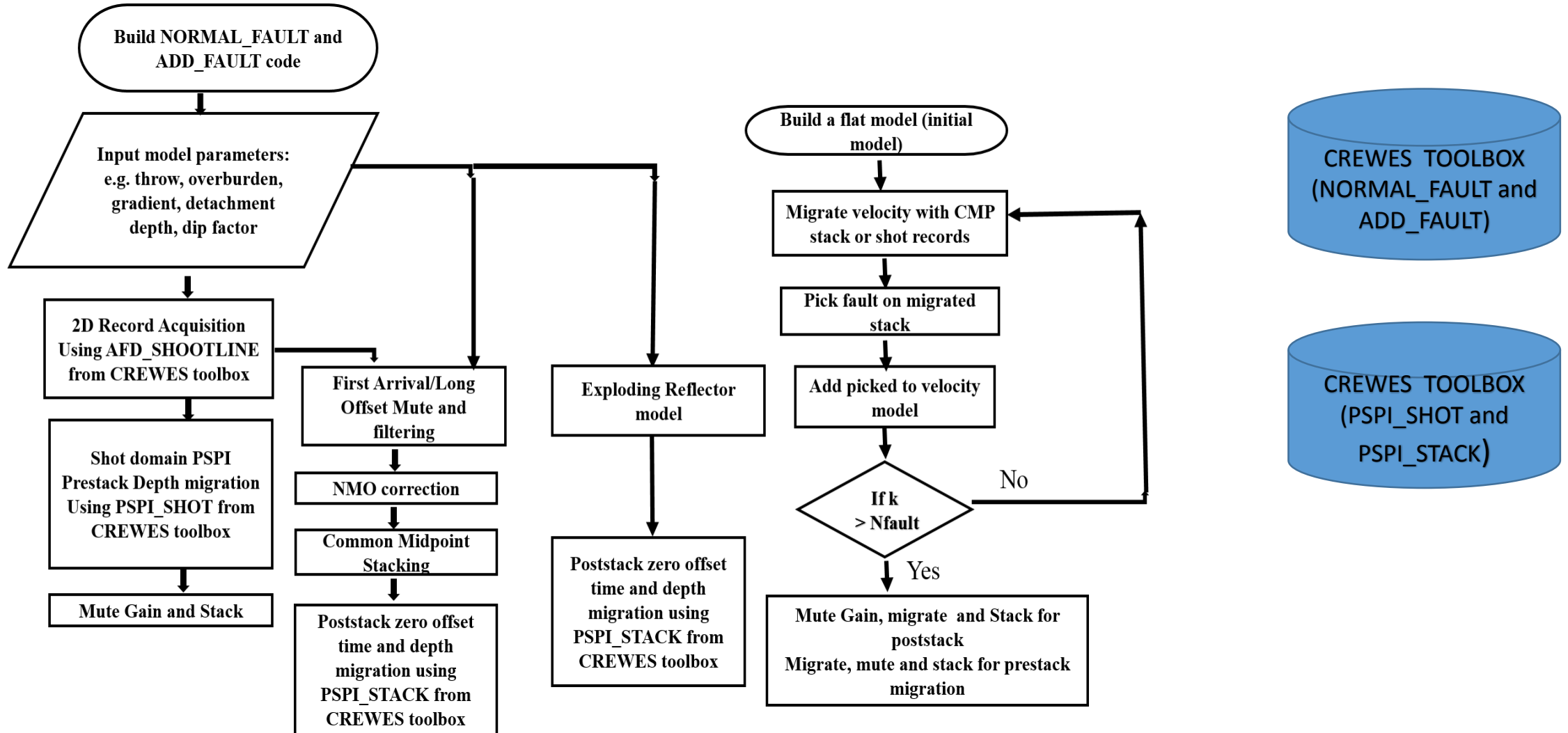
Challenges

- ❖ Obscure deep targets
- ❖ Interpretation challenges
- ❖ Requires accurate knowledge of the geology and velocities

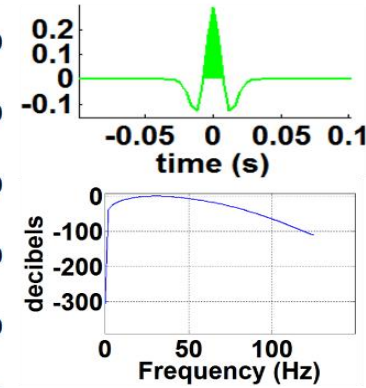
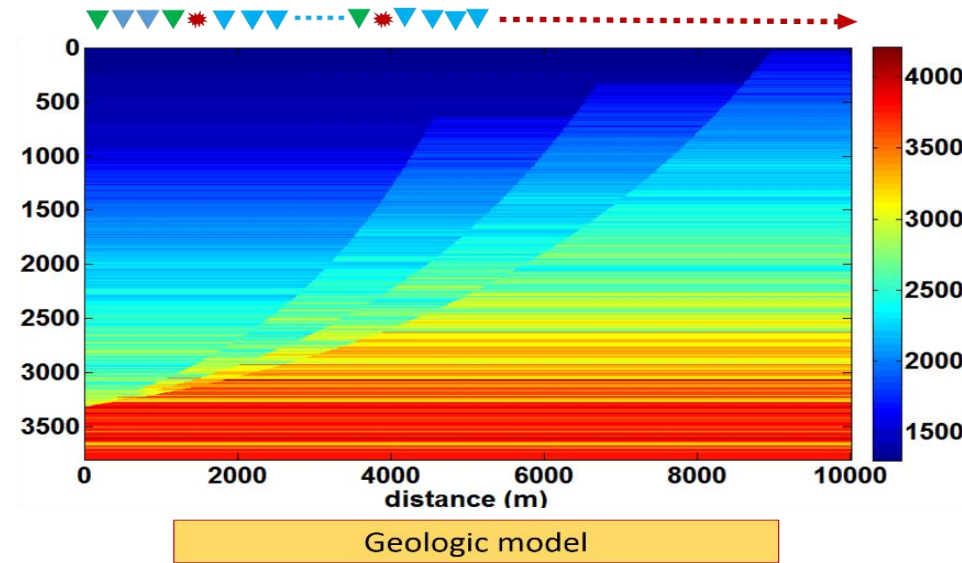
Approaches taken so far

- ❖ Velocity Model Update (common): tomographic inversion, FWI, MVA
 - ❖ Post-SDMs, Pre-SDMs
 - ❖ Anisotropic studies
 - ❖ Seismic experiment

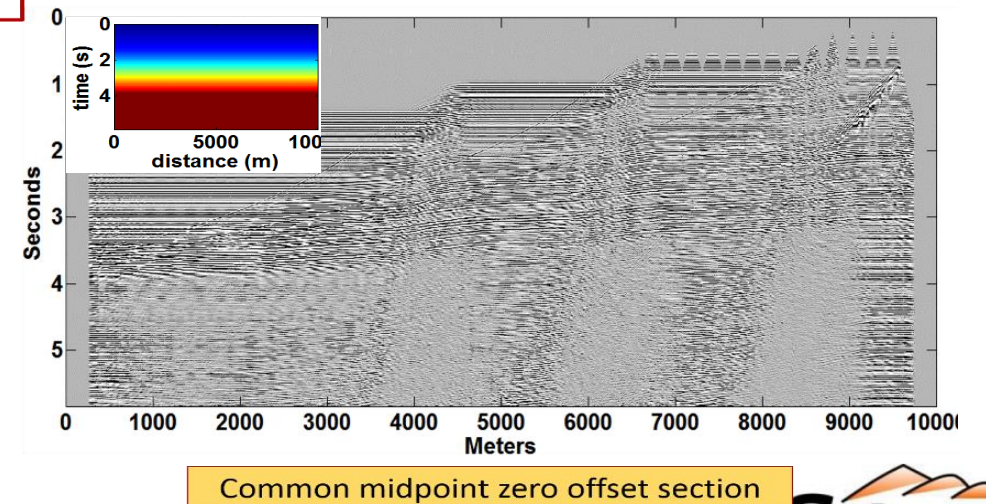
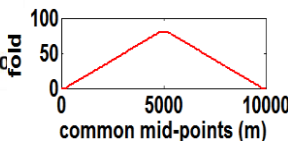
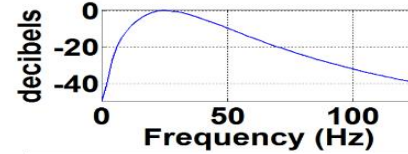
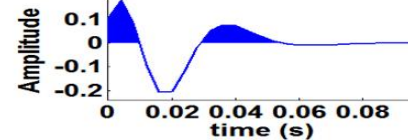
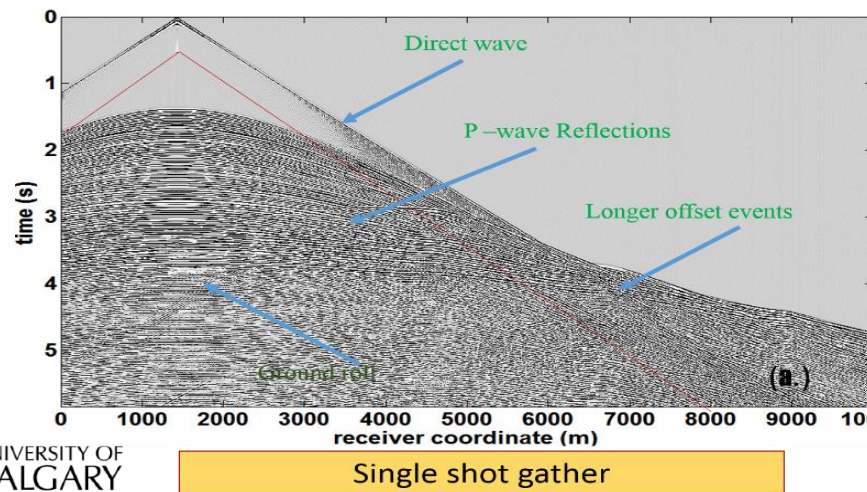
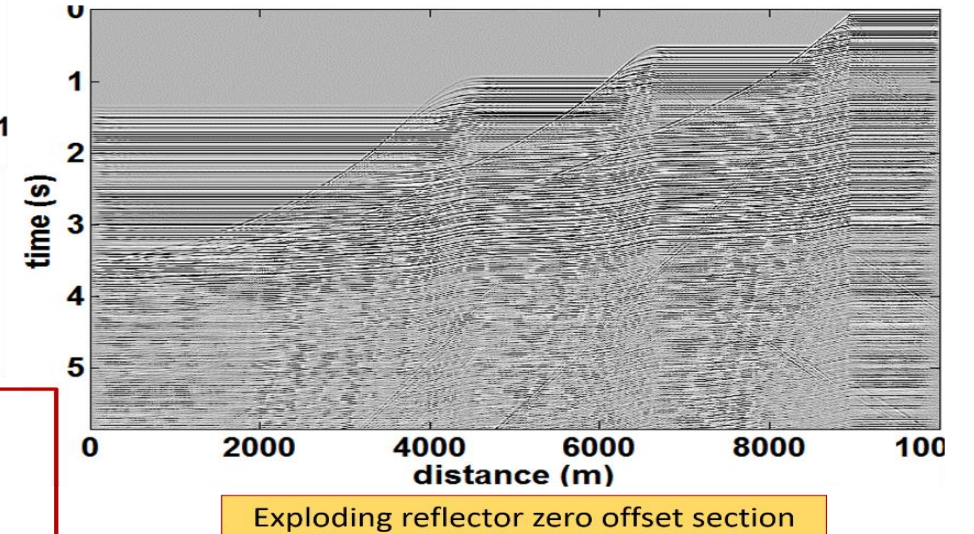
Brief Methodology



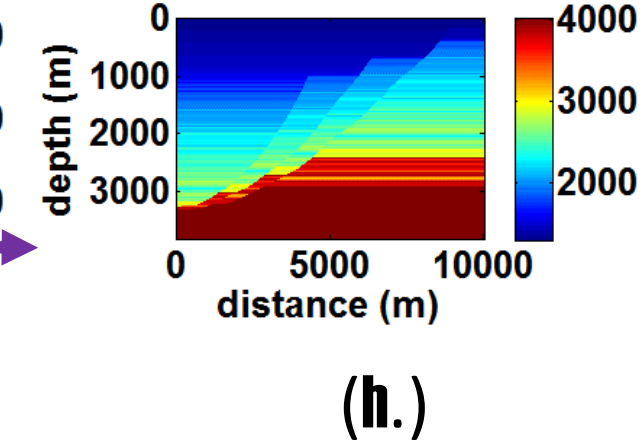
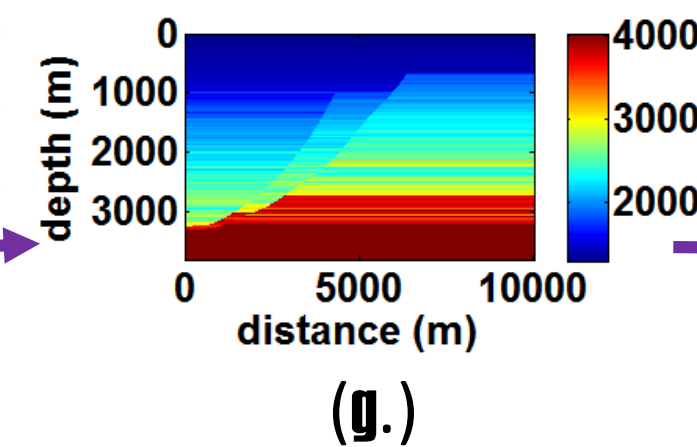
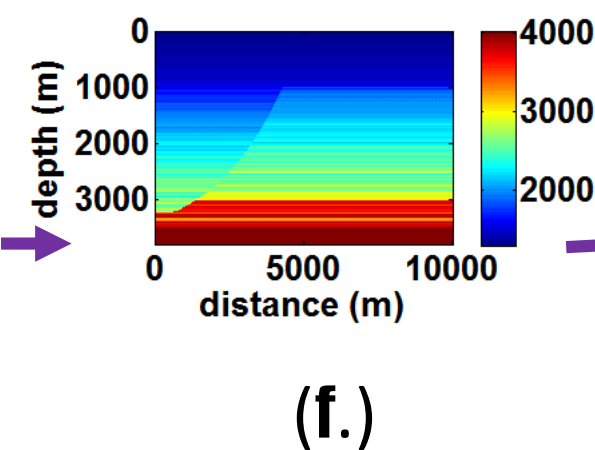
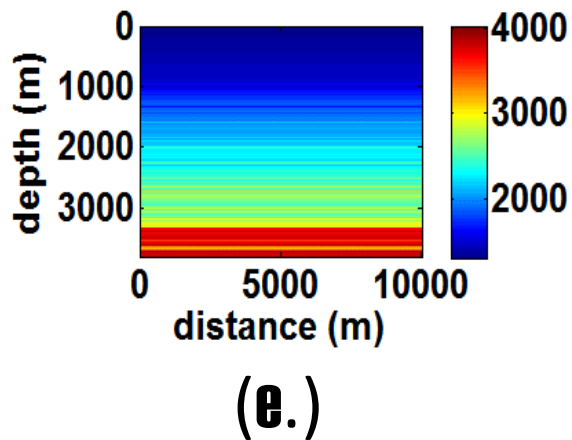
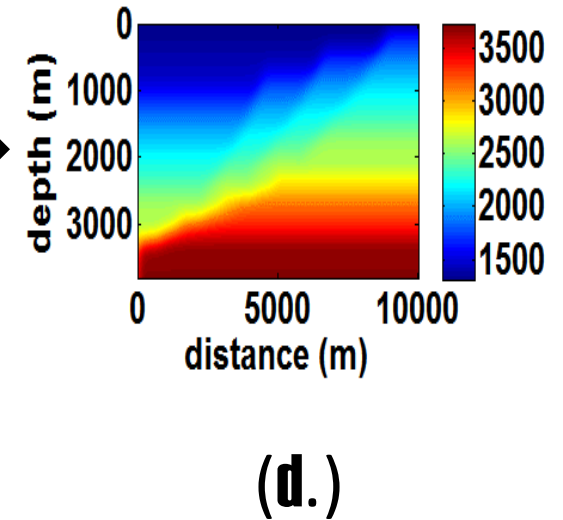
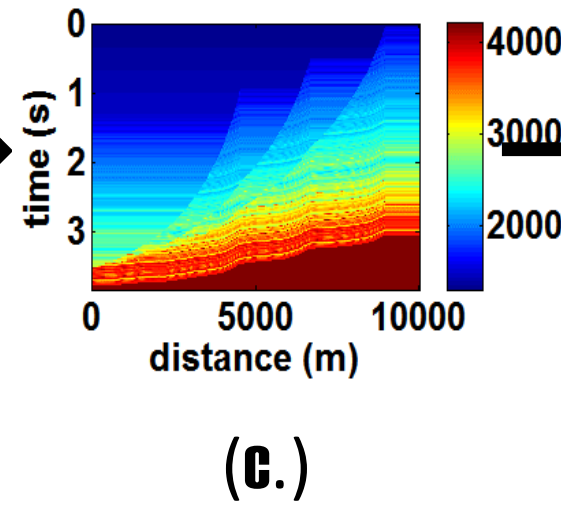
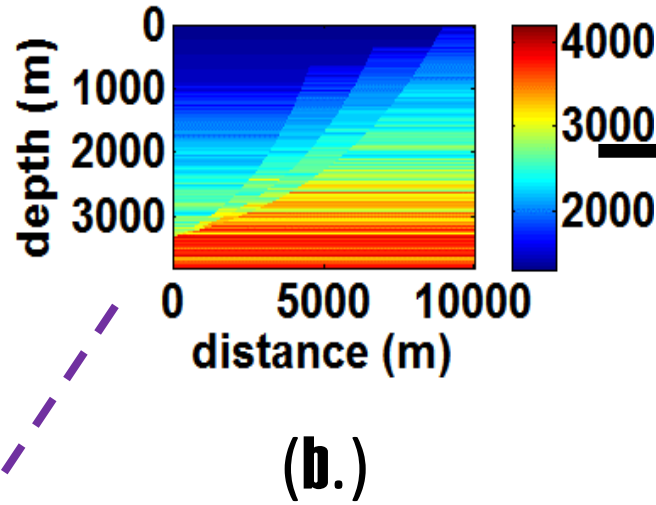
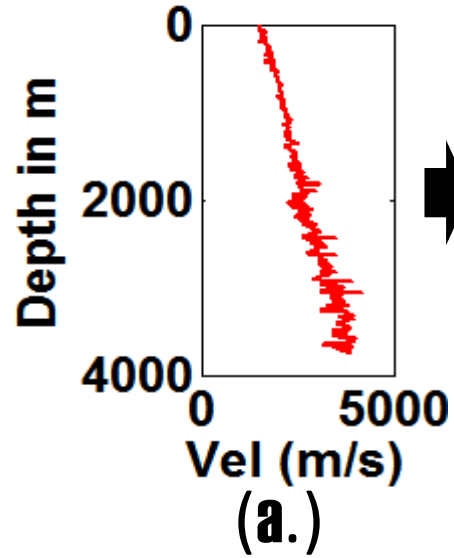
Brief Methodology ...



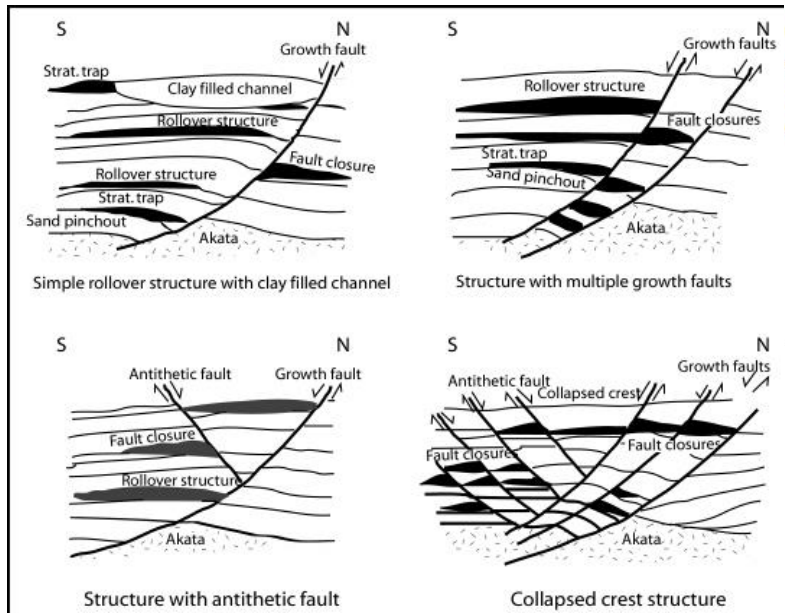
Spatial sampling = 5m
 Temporal sampling = 4ms
 Num shots = 40 Shots
 Num receivers = 1800
 Throw = 300m
 Max steepness = about 70 degrees
 Fold = 80



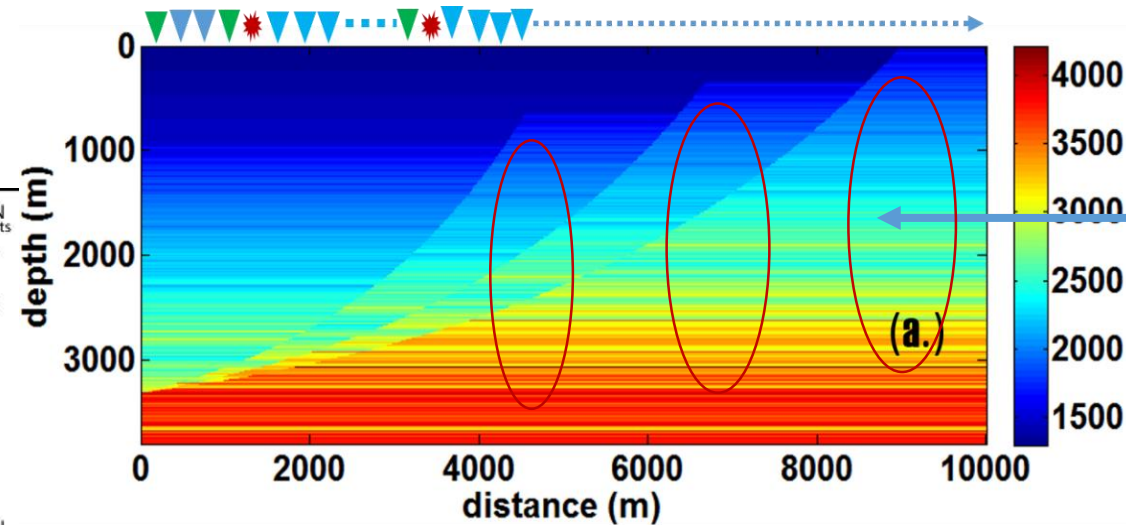
Velocities descriptions



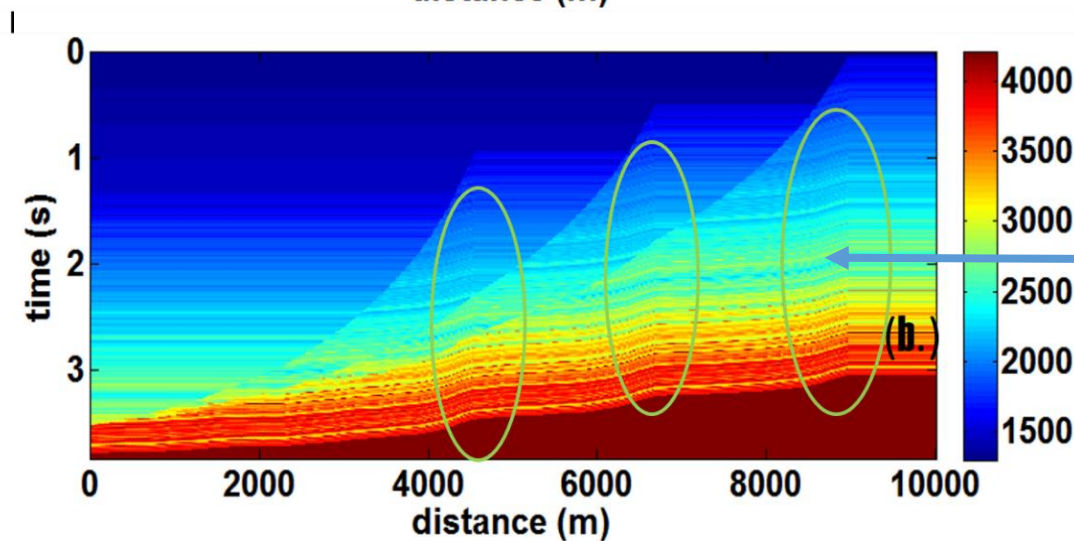
Time anomalies in velocity model



Gulf of Guinea oil field structure and associated trap (Doust and Omatsola, 1990)

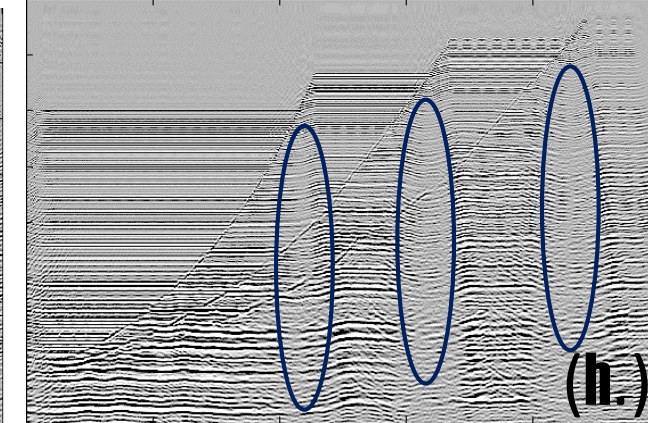
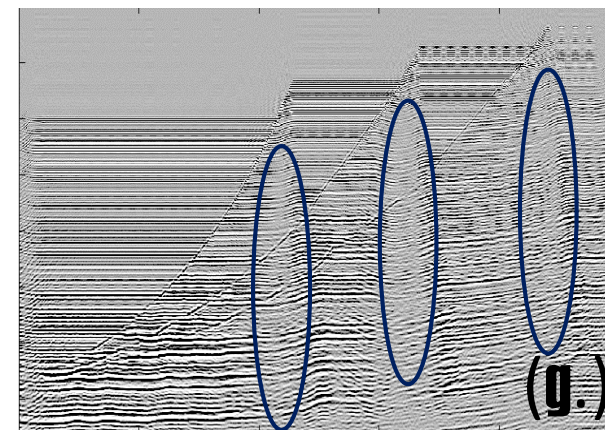
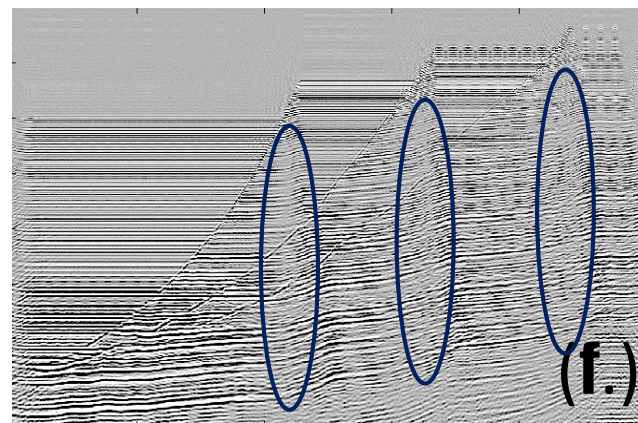
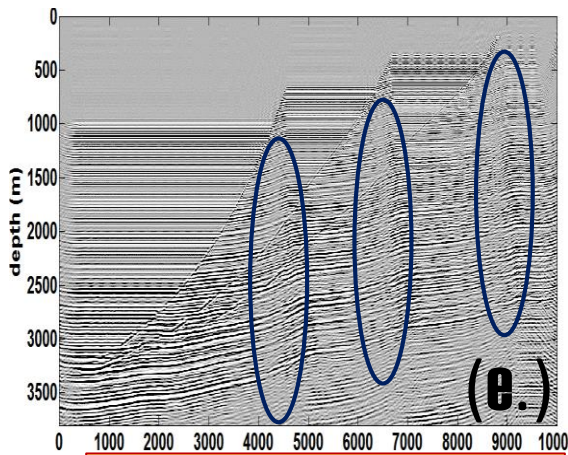
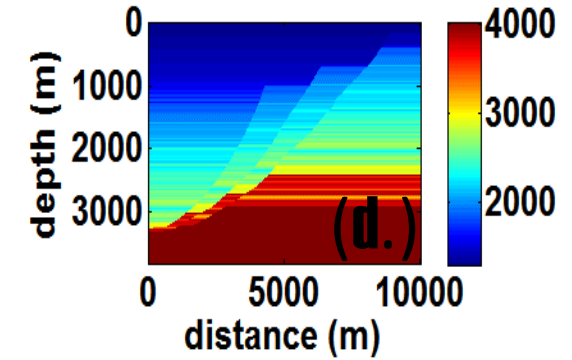
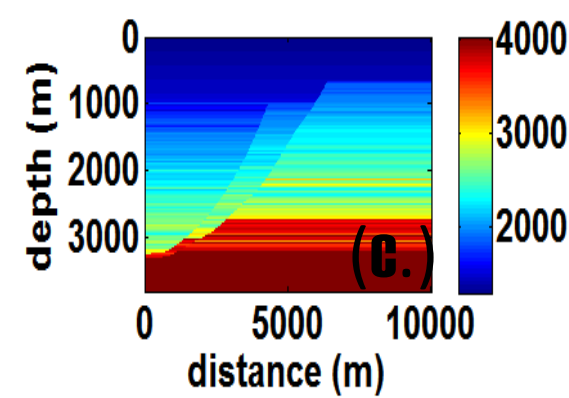
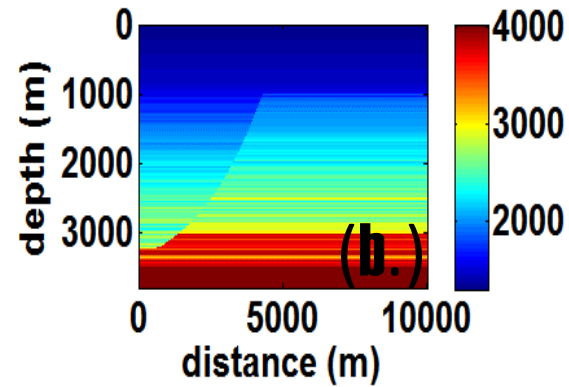
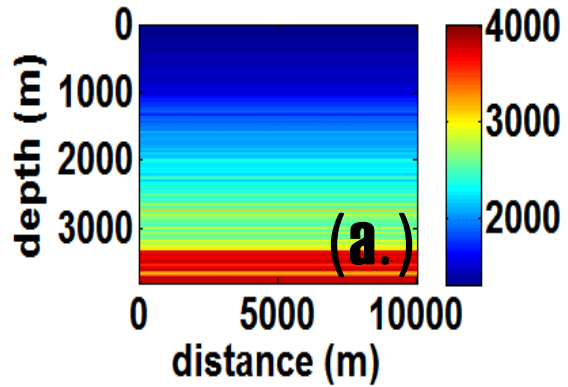


Flat and continuous behind fault



- ❖ Distorted reflectors
- ❖ Time pull up seen at termination of fault throw
- ❖ Time sags between fault heaves

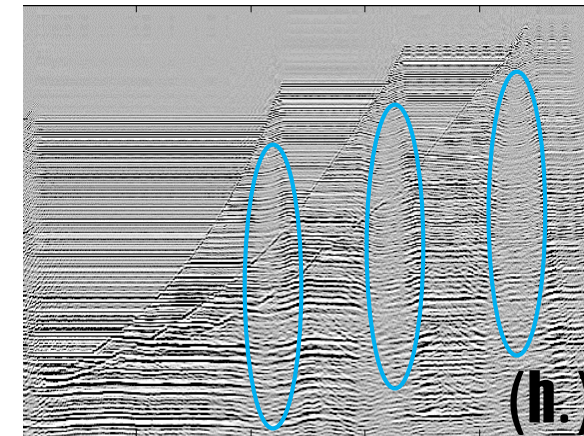
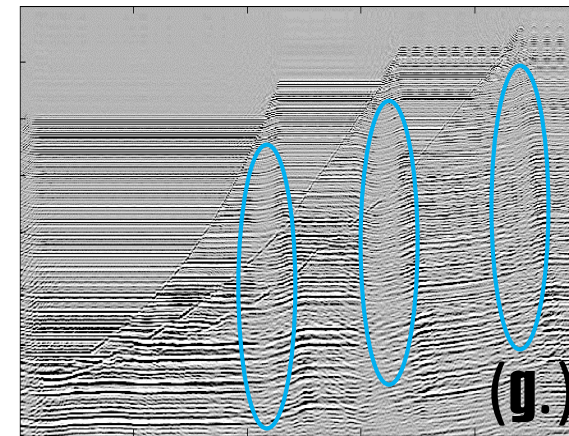
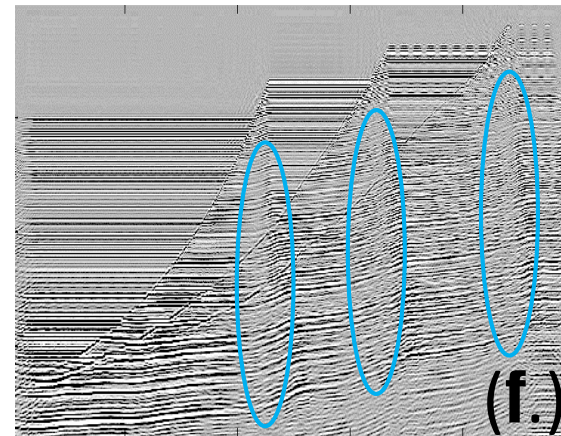
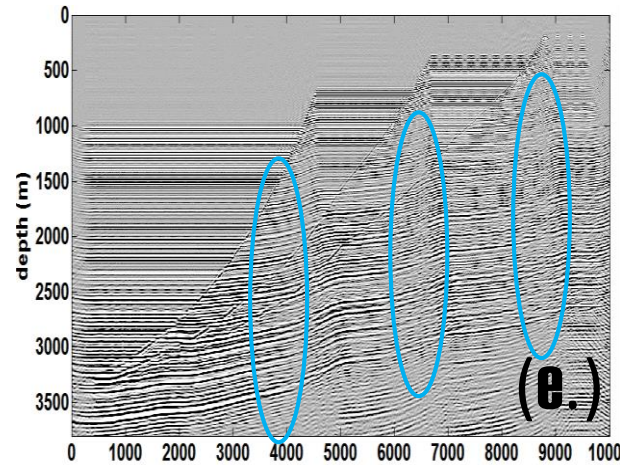
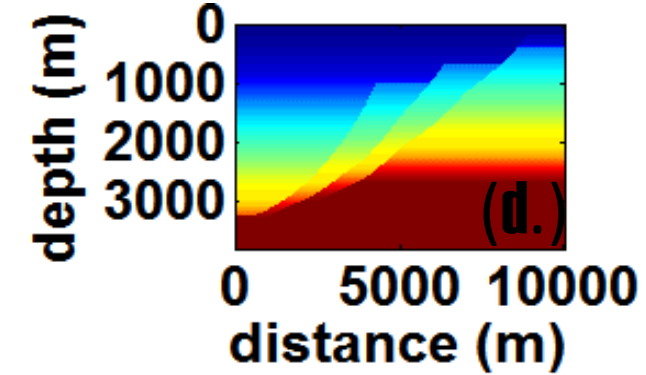
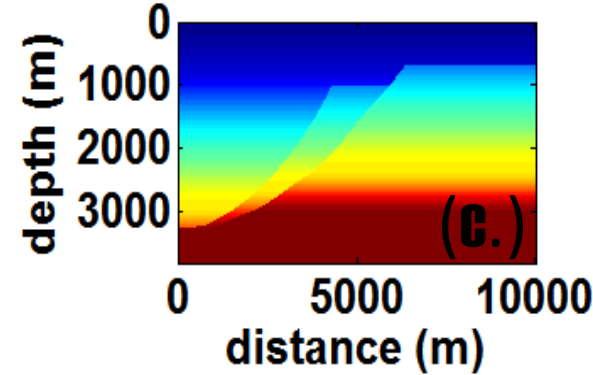
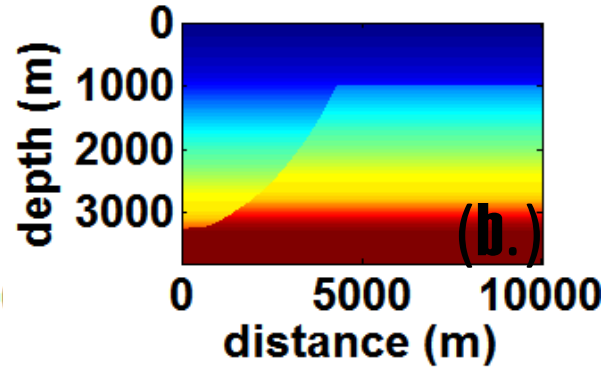
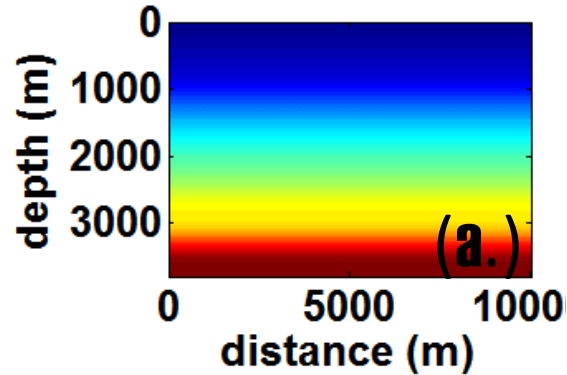
Iterated poststack depth migration ... exact velocities



Depth Migration
(flat stratigraphy)

Iterated migrations

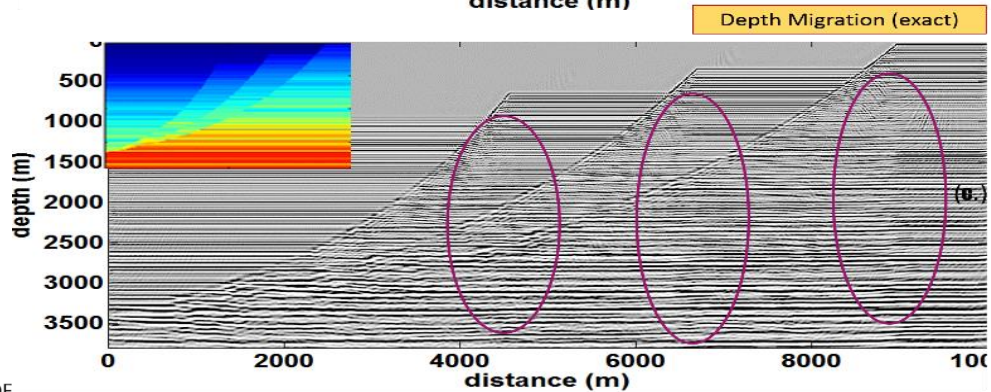
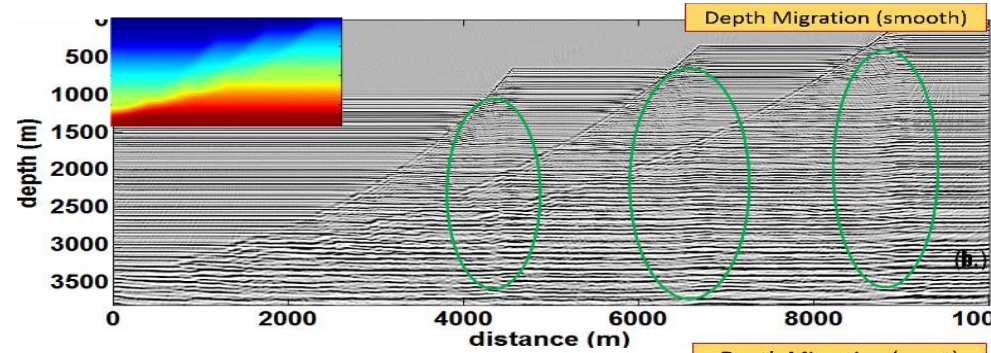
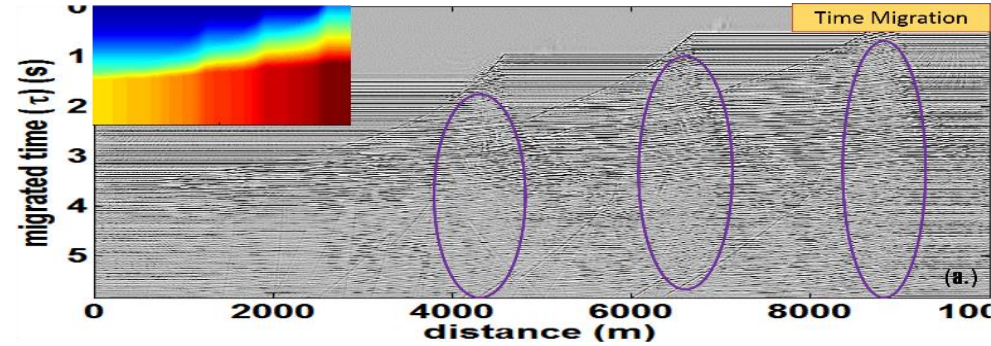
Iterated poststack depth migration ... gaussian smoothed velocities



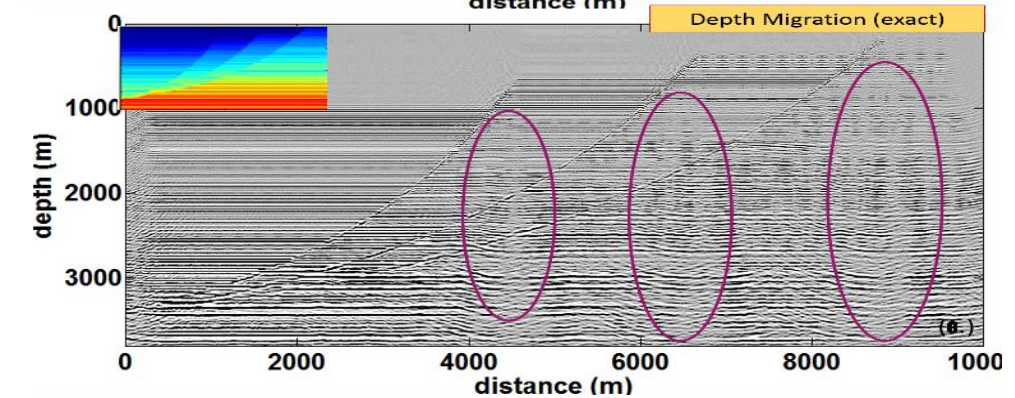
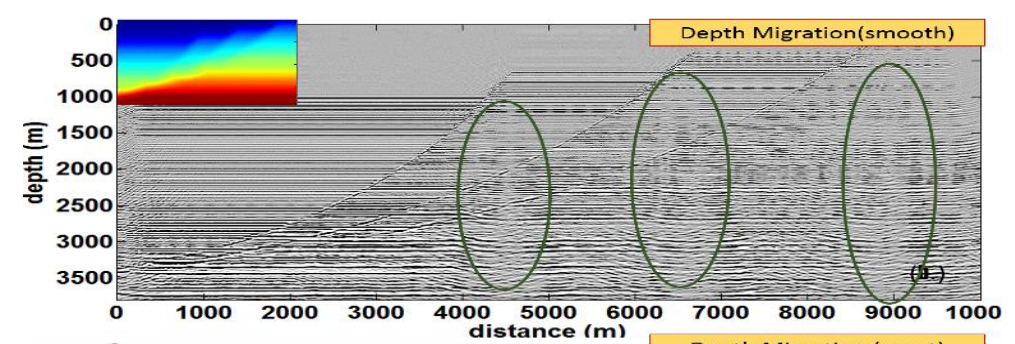
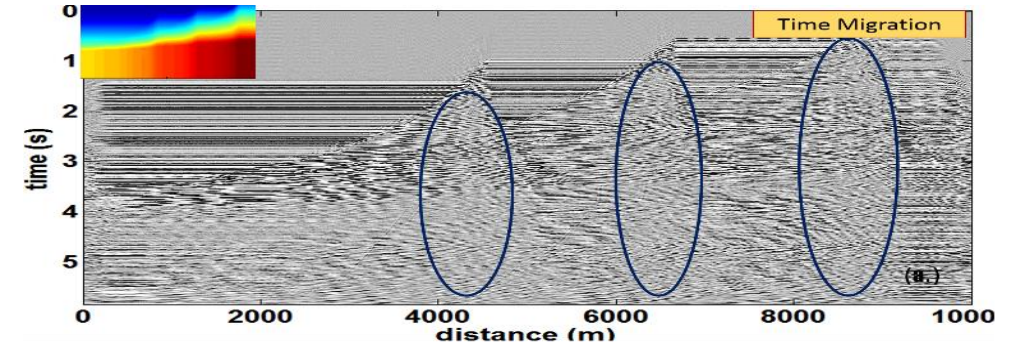
Depth Migration
(flat stratigraphy)

Iterated migrations

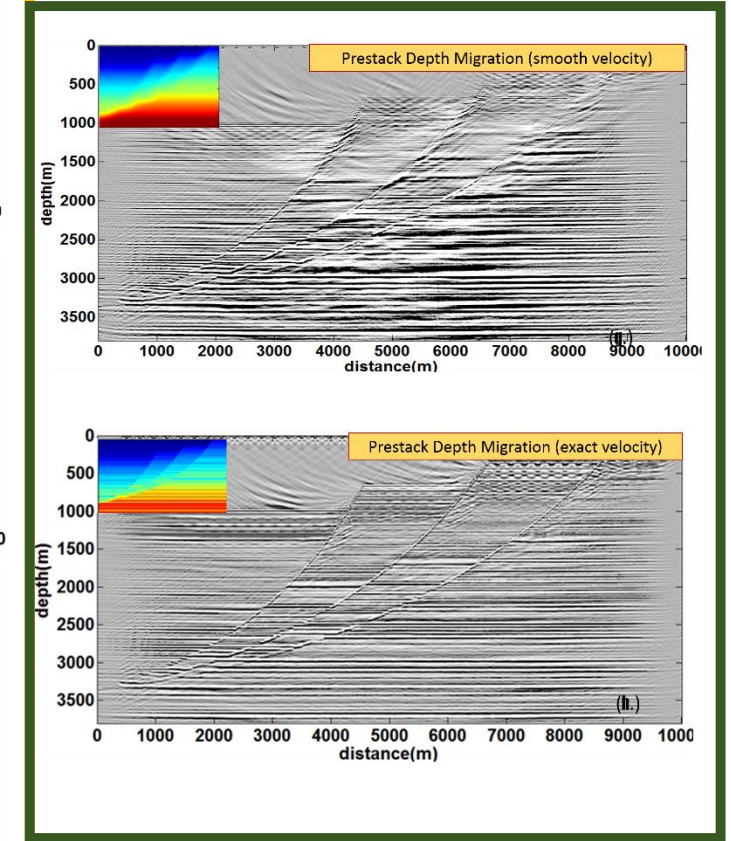
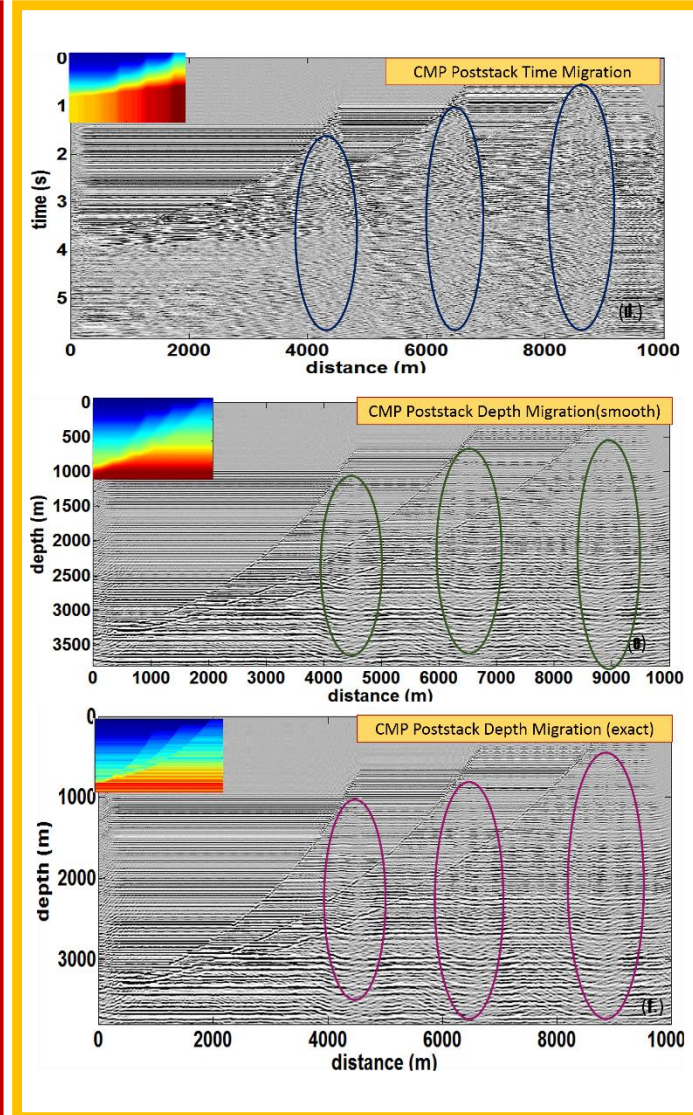
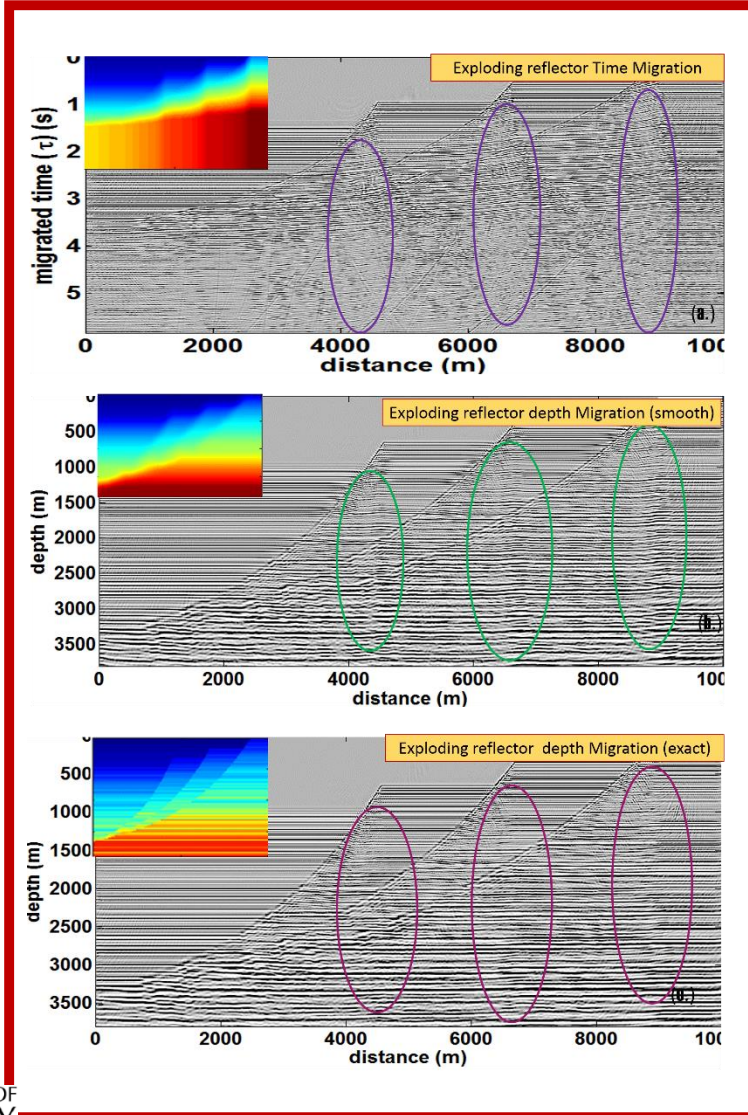
True zero offset migration



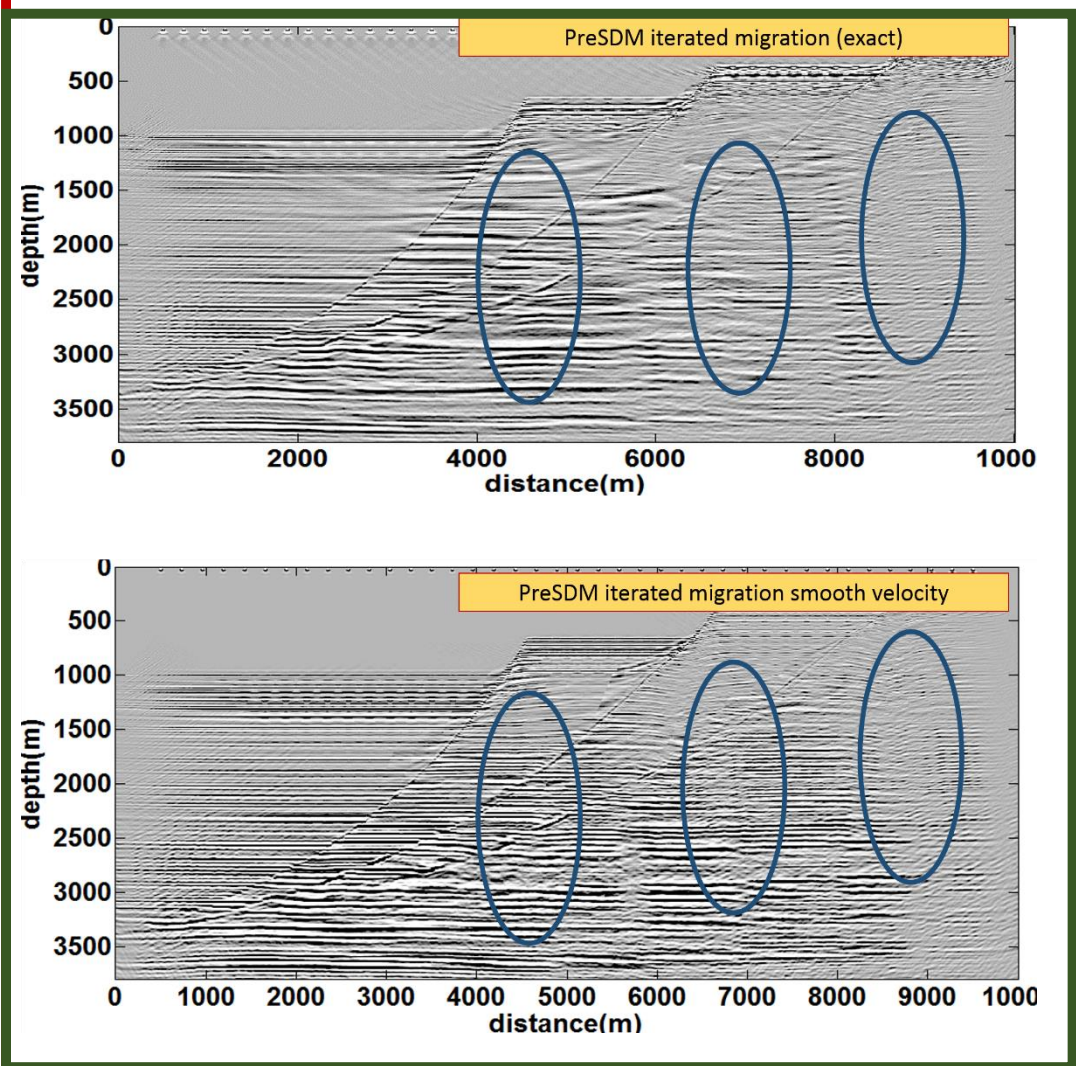
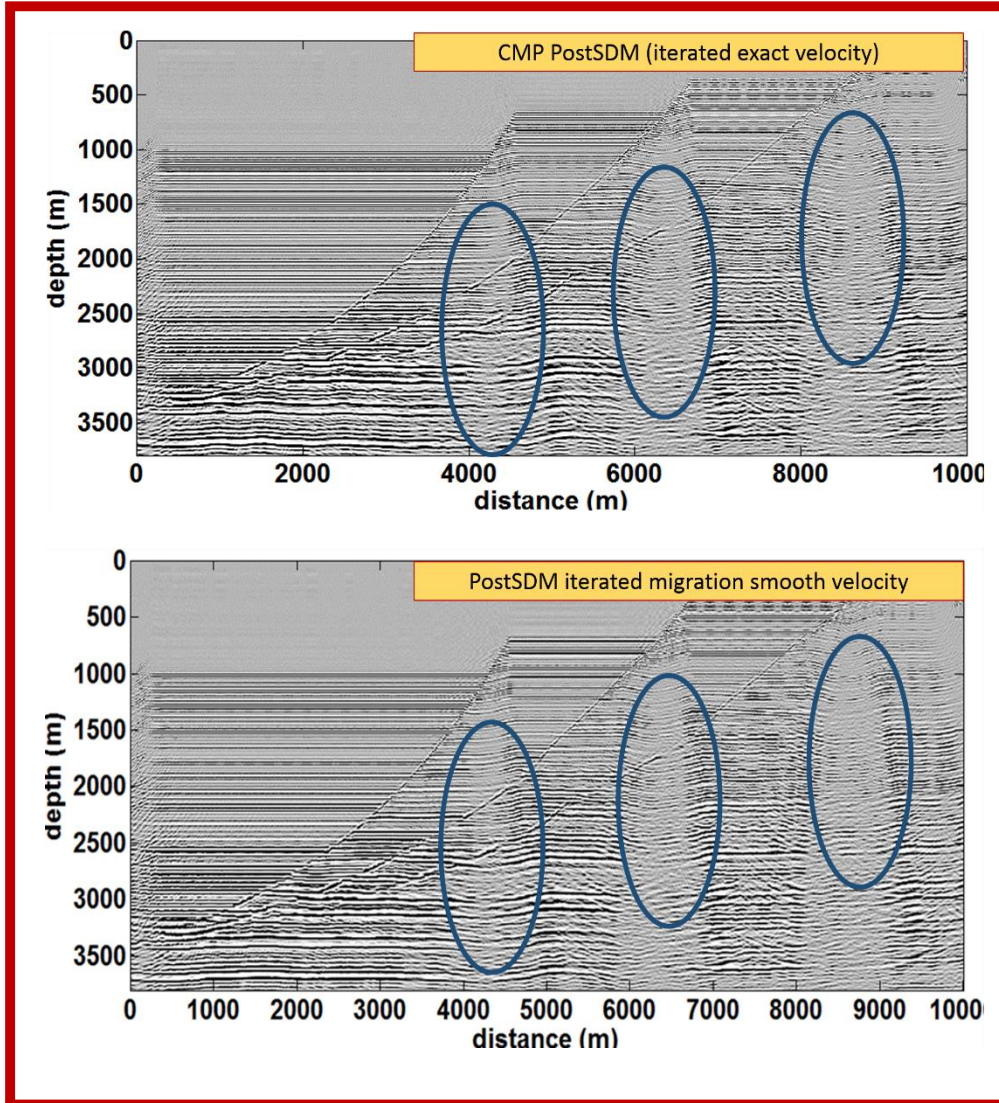
Common Midpoint zero offset migration



Depth image comparison



Iterative migration depth image comparison



Conclusion

- ❖ Fault shadows are caused by velocity variation due to stratigraphy truncation by fault
- ❖ This causes geometric and travelttime distortion
- ❖ Fault shadows are seem as footwall anticlines and synclines or cone of poor illumination on migrated sections and as conflicting dips in prestack migrations
- ❖ Could be false or real.
- ❖ Migration with approximate velocity models indicates the susceptibility of faulted geology to fault shadows.
- ❖ Footwall reflection deteriorates with further updating of faults into approximate models.
- ❖ Time migration is inherently limited in imaging footwall reflectors
- ❖ Dip dependence of NMO prior to poststack migration is an issue.
- ❖ Depth migration is promising, yet plagued with the minimum velocity error requirement of FWI
- ❖ **Caution: Fault shadowed area should be avoid for overpressured regime until adequately preparations are carried out.**

Future work

In the future, we will work on

- ❖ building effective migration velocity models
- ❖ and incorporate seismic attenuation and anisotropy.

Acknowledgements

- All CREWES Sponsor
- Gary Margrave
- John Bancroft
- All CREWES Staff and CREWES Students

Thank you

I will now take your Questions

References

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