Challenges in implementing anacoustic FWI

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Multiscale updating

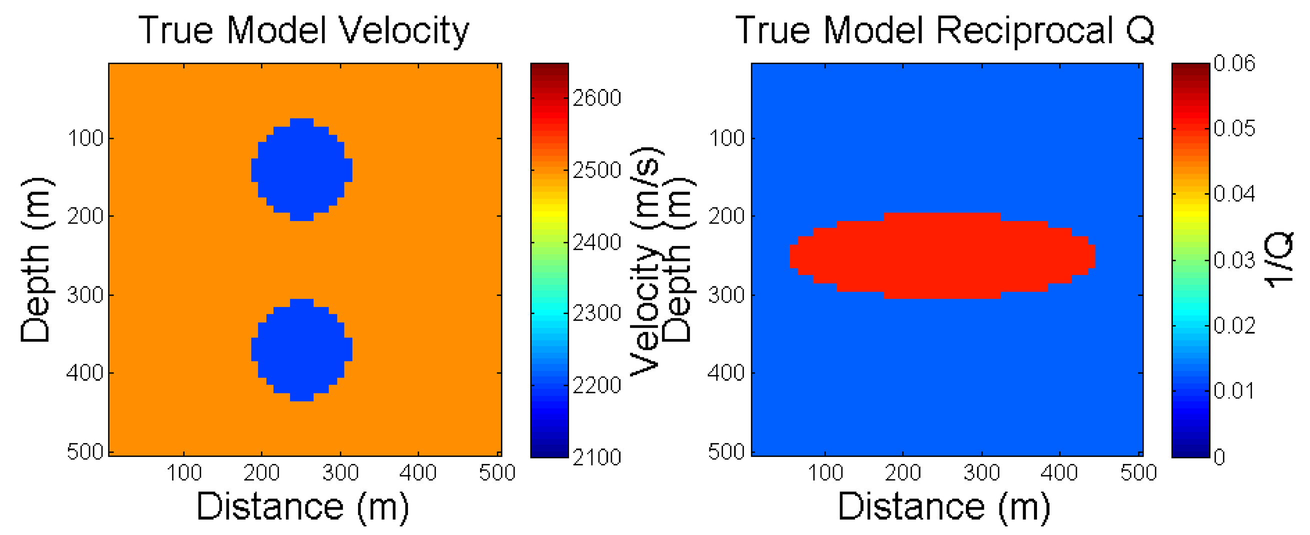

FIG. 1. Velocity (left) and reciprocal Q (right) of the true model, used to generate data.

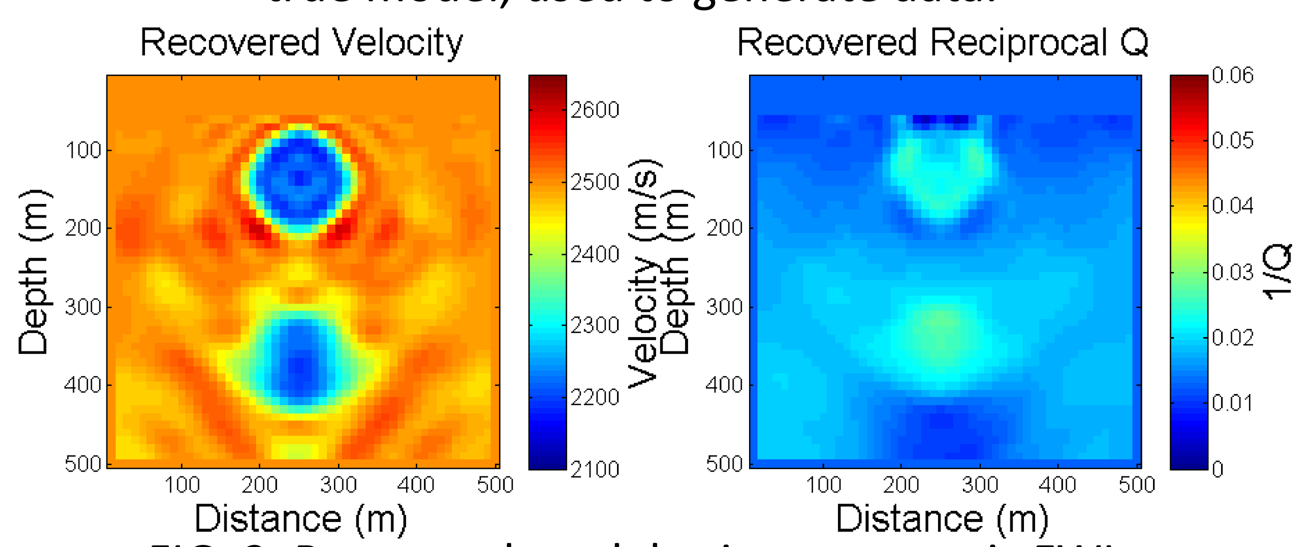

FIG. 2. Recovered model using anacoustic FWI with only **one frequency inverted** at each iteration.

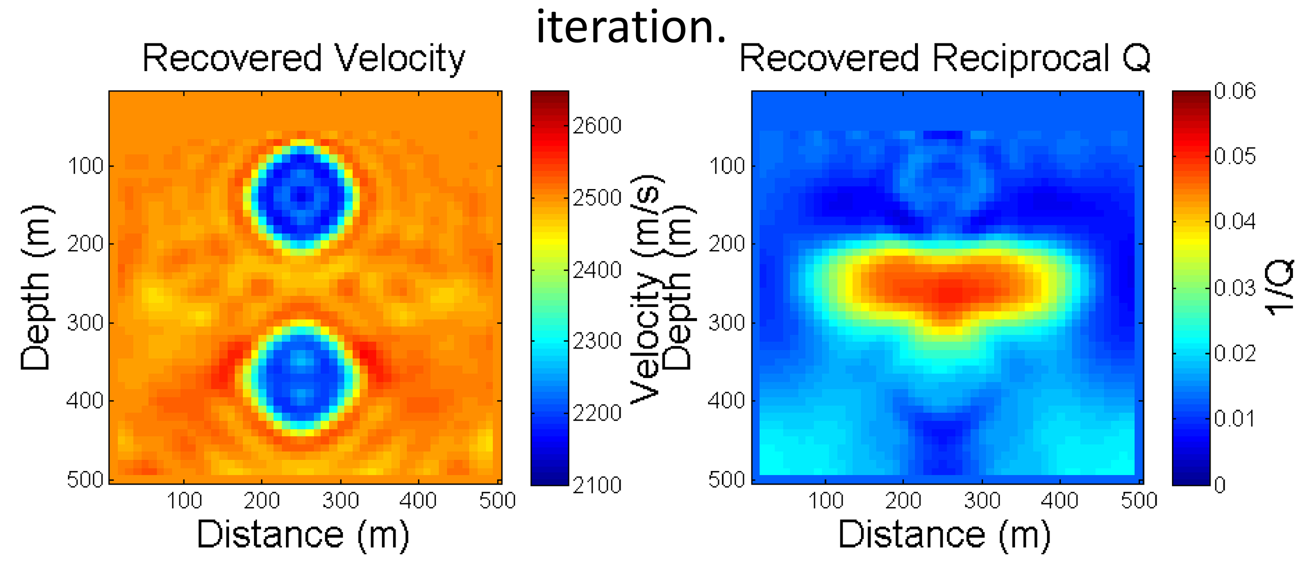

FIG. 3. Recovered model using anacoustic FWI with a **small range of frequencies inverted** at each iteration.

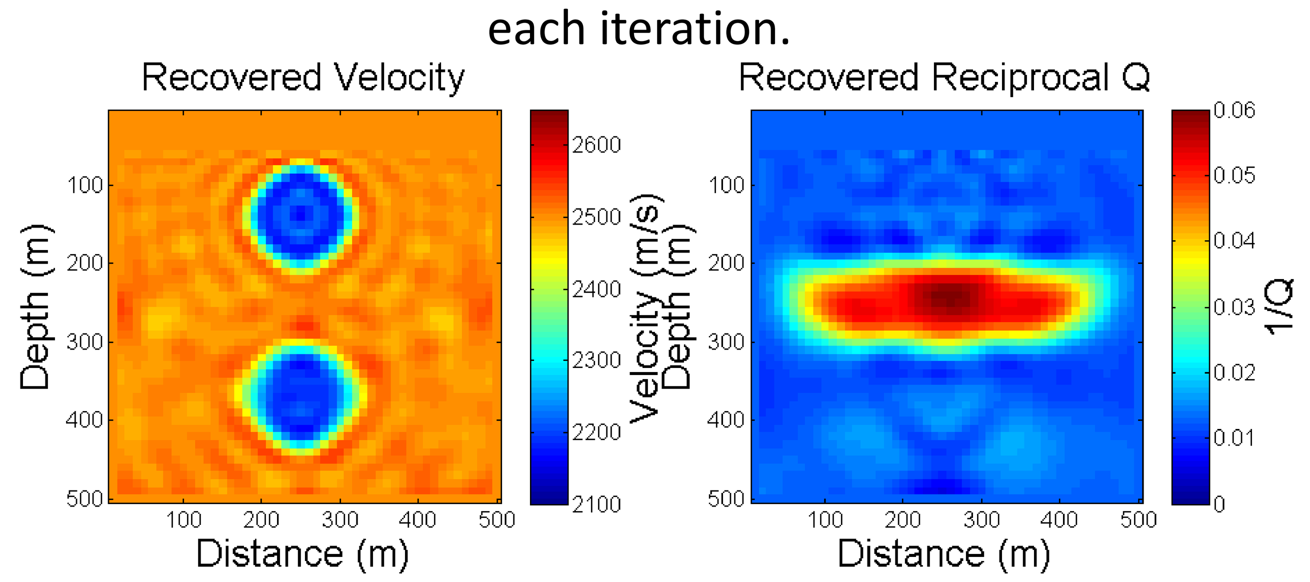

FIG. 4. Recovered model using anacoustic FWI with a **large range of frequencies inverted** at each iteration.

- Increasing bandwidth used in anacoustic FWI is necessary to avoid cross-talk effects.

Optimization

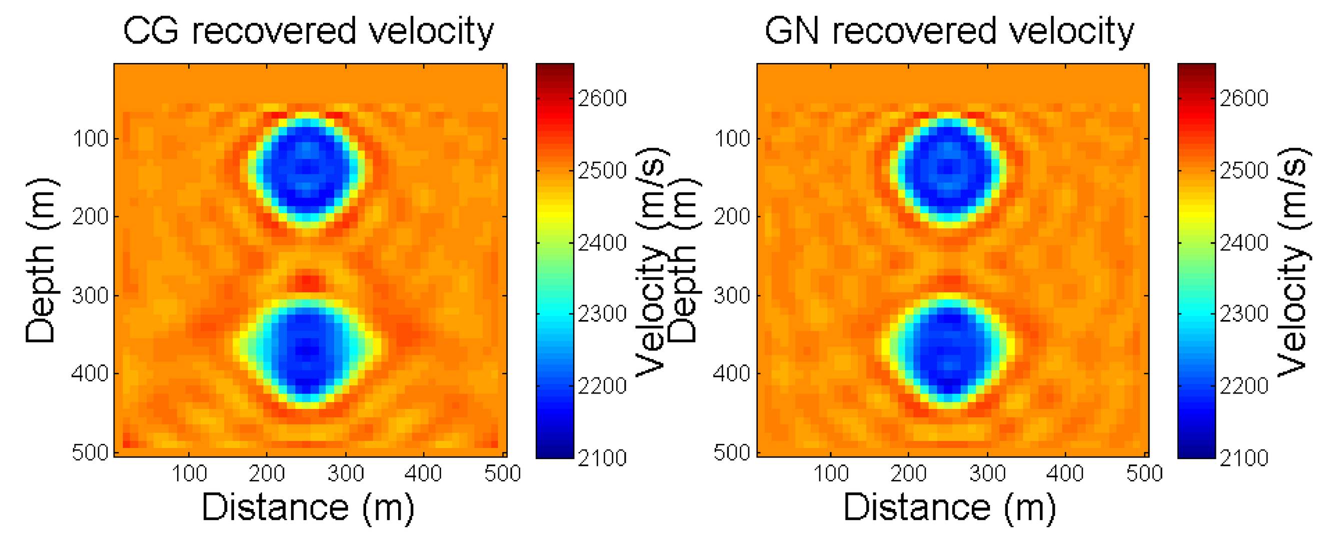

FIG. 5. Recovered velocity using **conjugate gradient** (left) and **Gauss Newton** (right) optimization in the acoustic case.

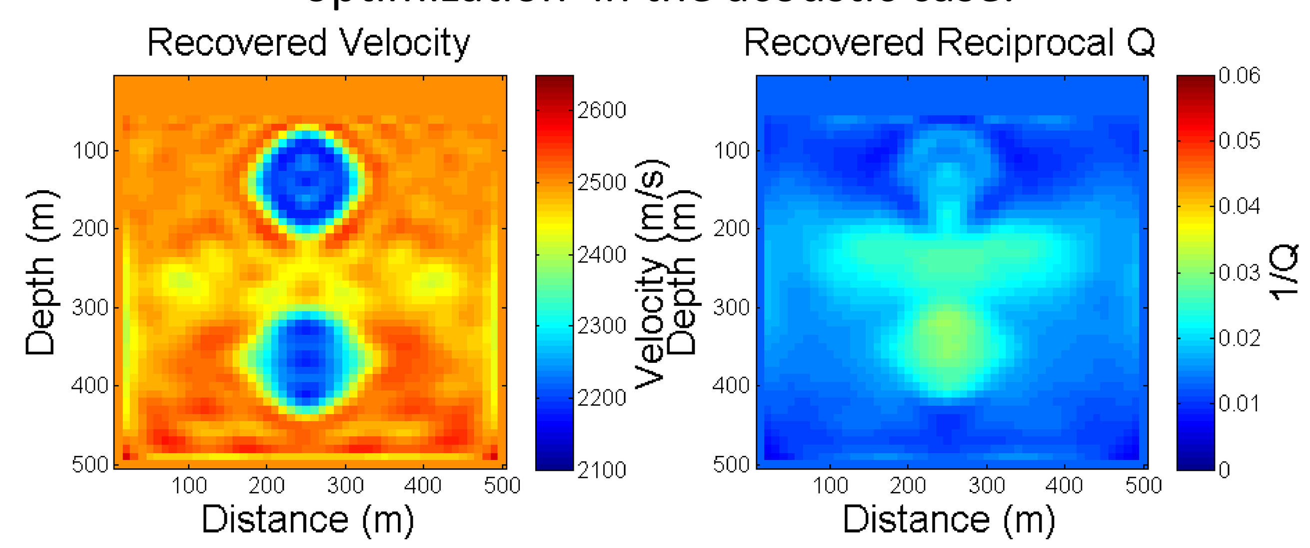

FIG. 6. Recovered model using **conjugate gradient** optimization in the anacoustic case case.

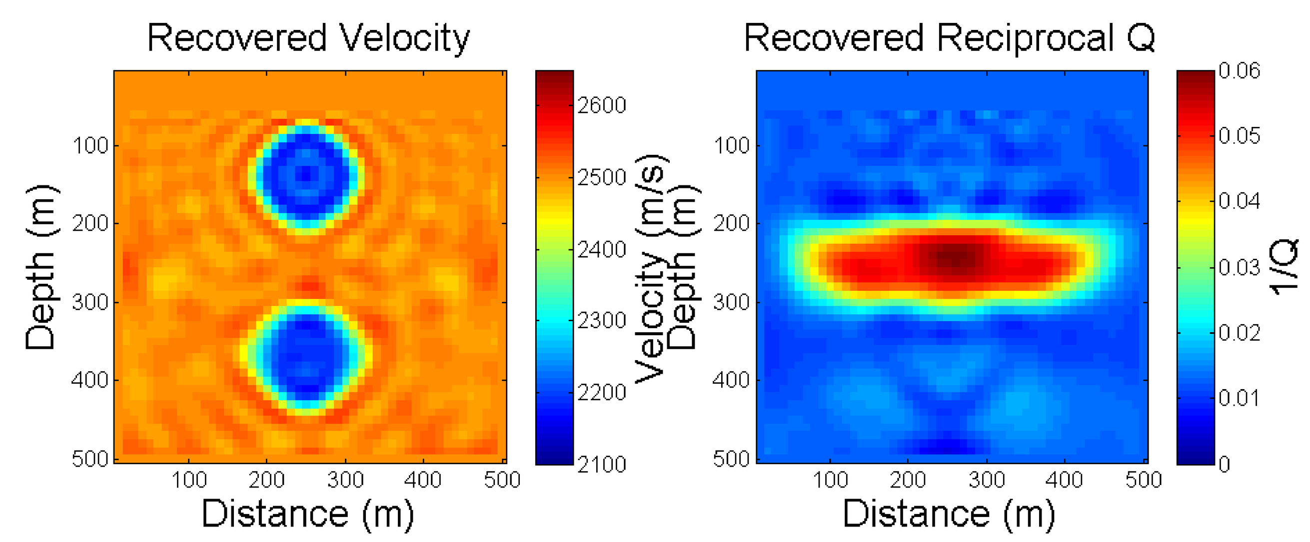

FIG. 7. Recovered model using **Gauss Newton** optimization in the anacoustic case.

- Optimization methods which neglect the Hessian, like steepest descent or conjugate gradient can be effective strategies in acoustic FWI.
- In anacoustic FWI, such strategies discard important information about trade-offs between parameters.
- Methods which include Hessian information, like Newton, Truncated Newton or quasi-Newton methods are preferable in the anacoustic case.

Regularization

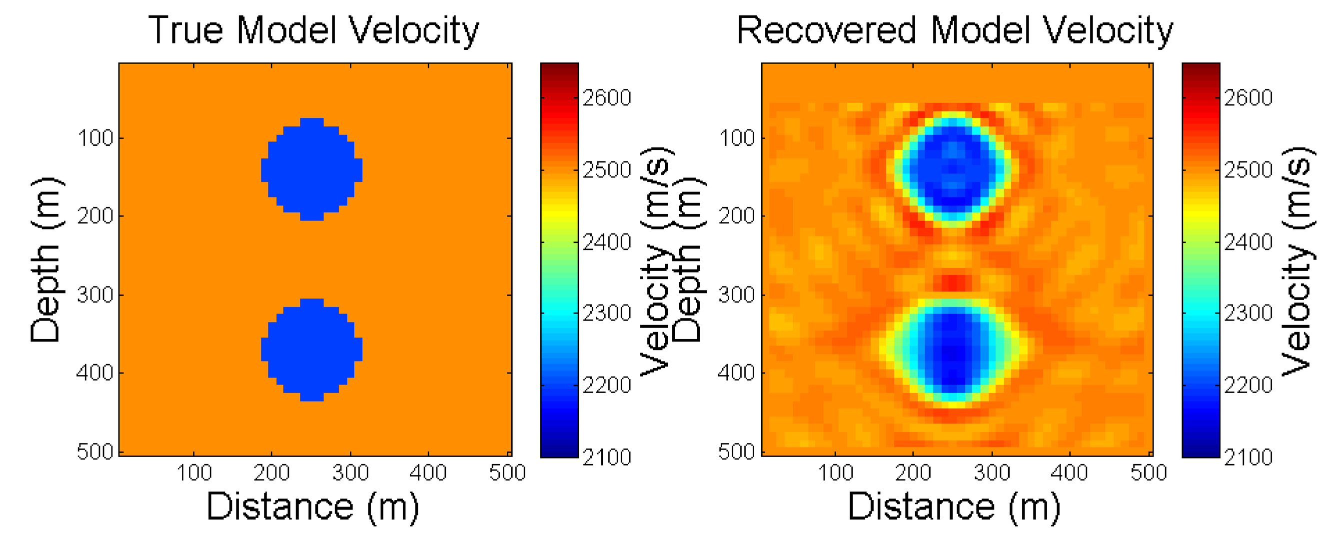

FIG. 8. A large regularization factor in acoustic FWI has limited unwanted consequences.

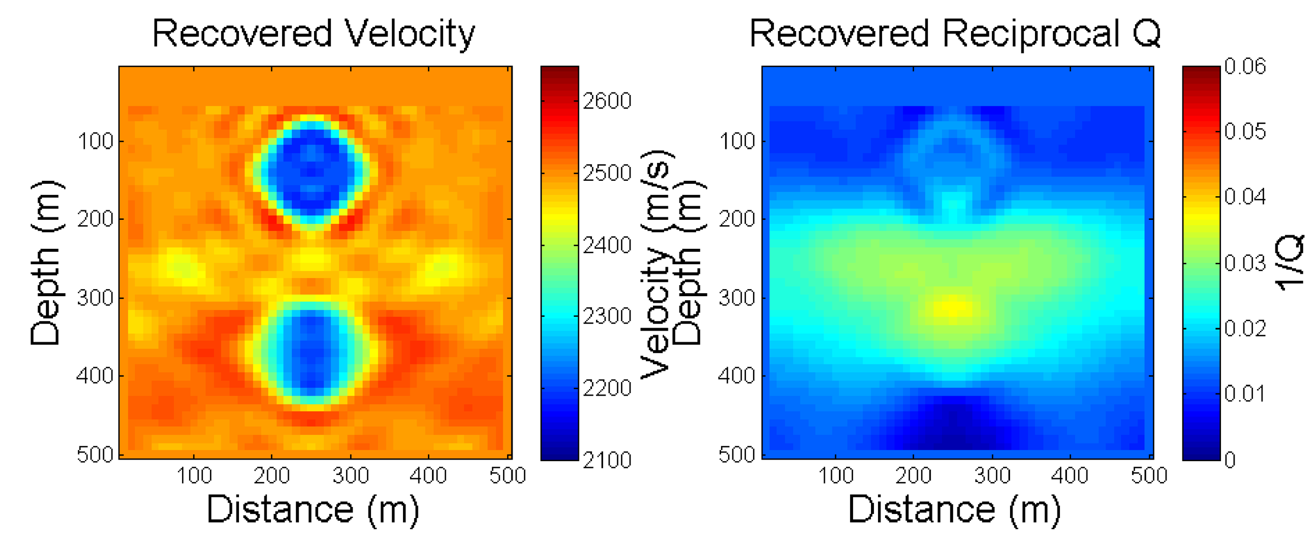

FIG. 9. A large regularization factor in anacoustic FWI introduces significant cross-talk.

- FWI is ill conditioned, and requires a regularization for stability.
- Regularization terms shift the minimum of the objective function.
- This has limited unwanted consequences in the acoustic FWI case, but severe cross-talk consequences in anacoustic FWI.
- A promising alternative to regularization is to maintain stability by introducing constraints, which should not shift the minimum of the objective.

Acknowledgments

The authors thank the sponsors of CREWES for continued support. This work was funded by CREWES industrial sponsors and NSERC (Natural Science and Engineering Research Council of Canada) through the grant CRDPJ 461179-13. Scott Keating was also supported by the Queen Elizabeth II scholarship.