

Viscoelastic FWI: solving for Q_P , Q_S , V_P , V_S and density

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- FWI seeks the model which best describes the data
- In principle, this procedure involves all the data
- In practice, amplitude information is often neglected in FWI
- Both elastic and attenuative effects are crucial for amplitude

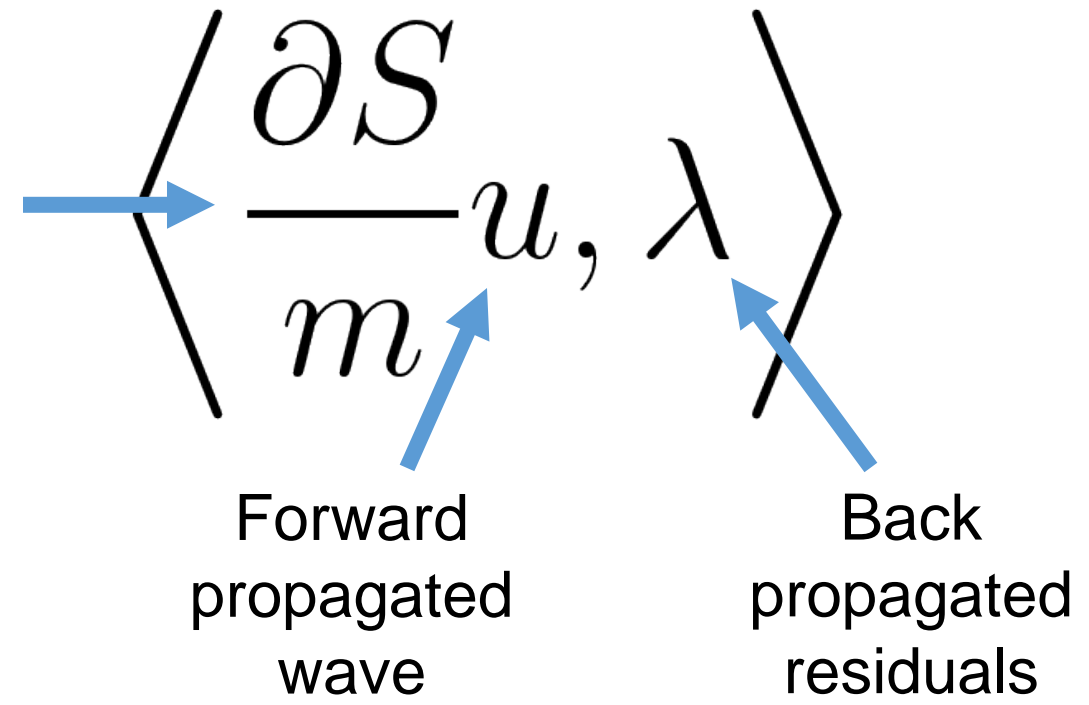


- Wave propagation can be modeled with a finite difference approximation

$$Su = f$$

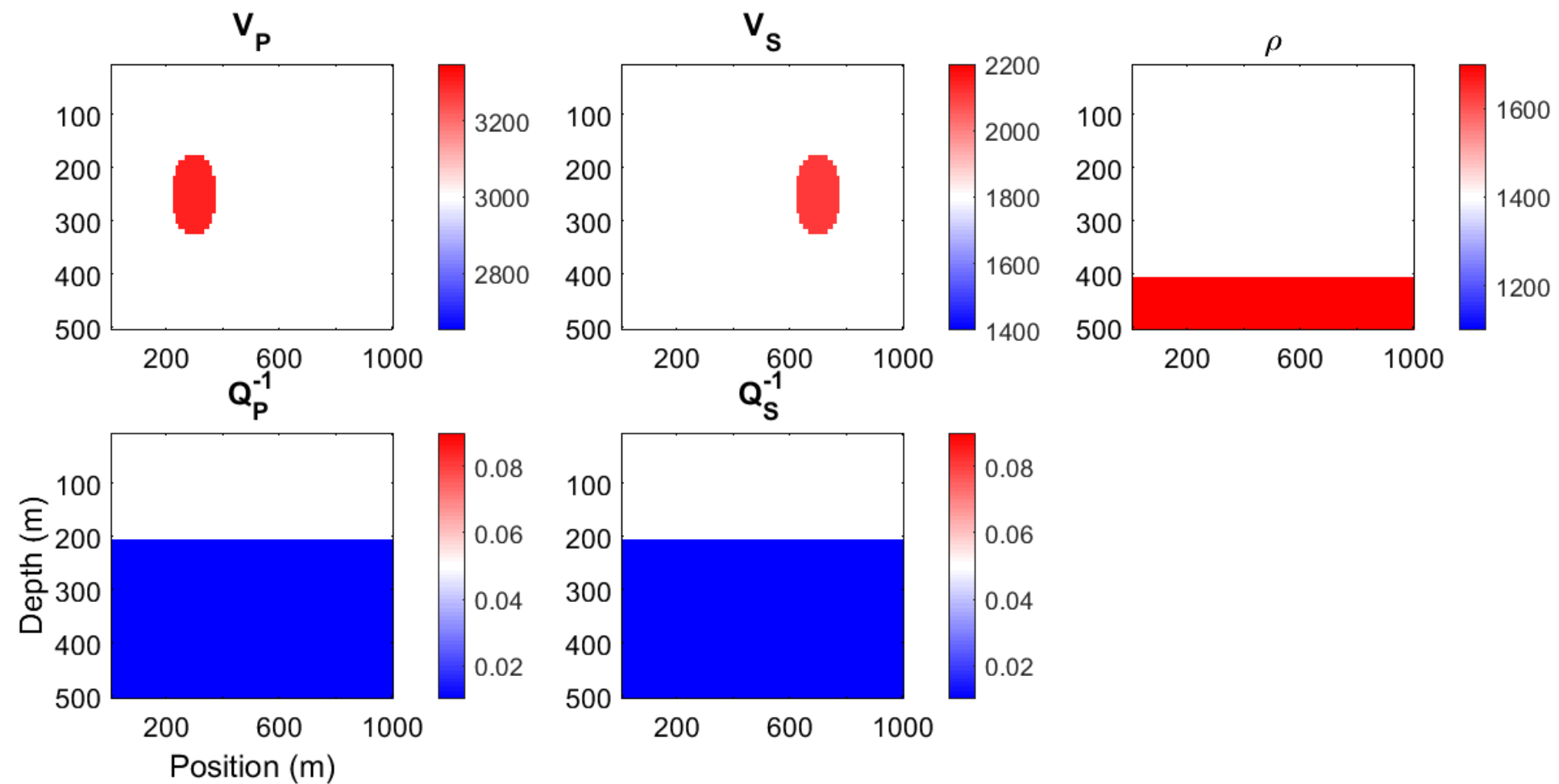
- The gradient for conventional FWI is the cross correlation of two wavefields

This is the only term which changes when different parameterizations are used



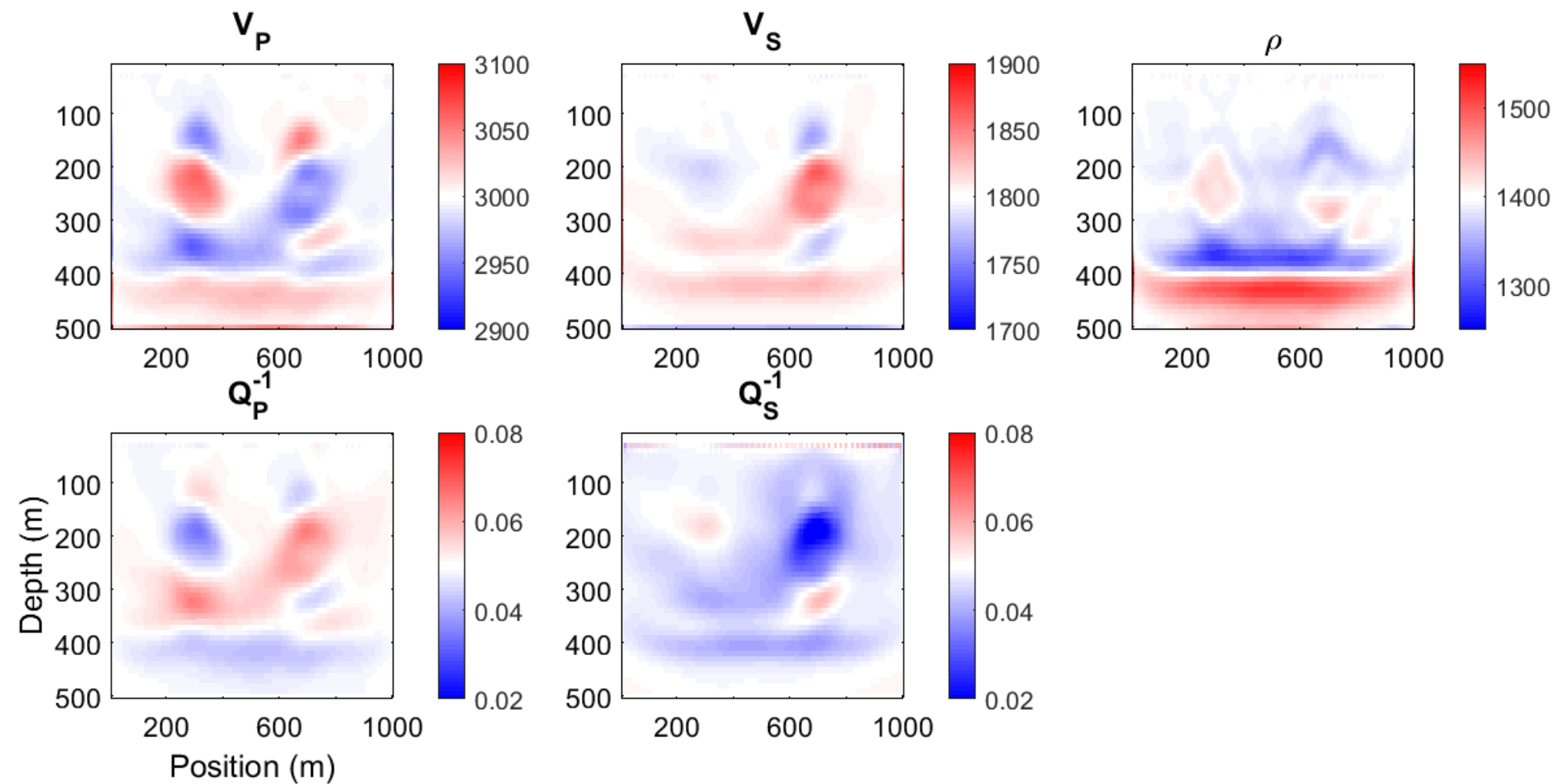


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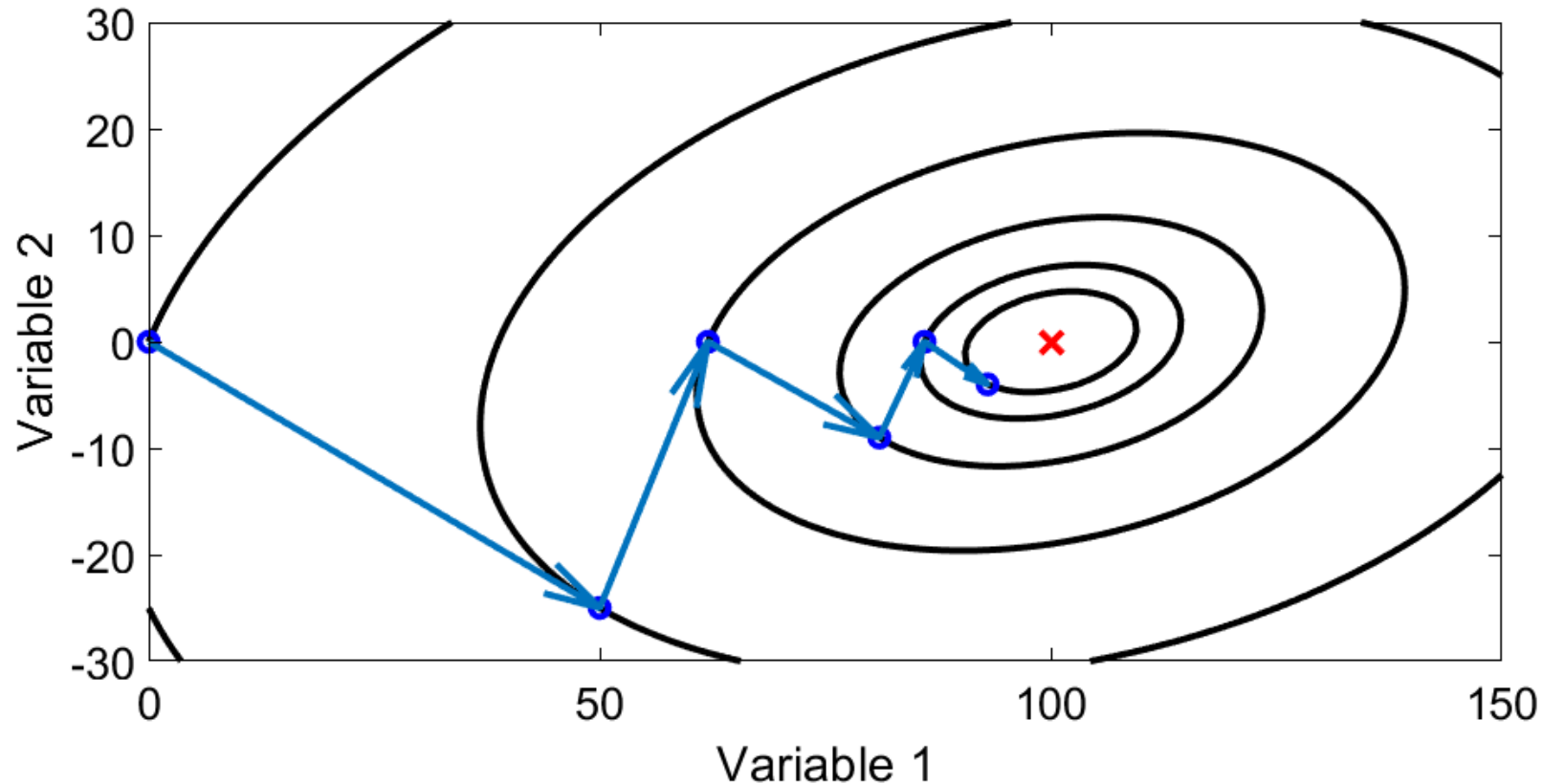


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- Inadequate numerical optimization is usually the cause of cross-talk



Strategies for cross-talk reduction

- Usually, there are sufficient data that cross-talk doesn't arise from genuine ambiguity
- Inadequate numerical optimization is usually the cause of cross-talk

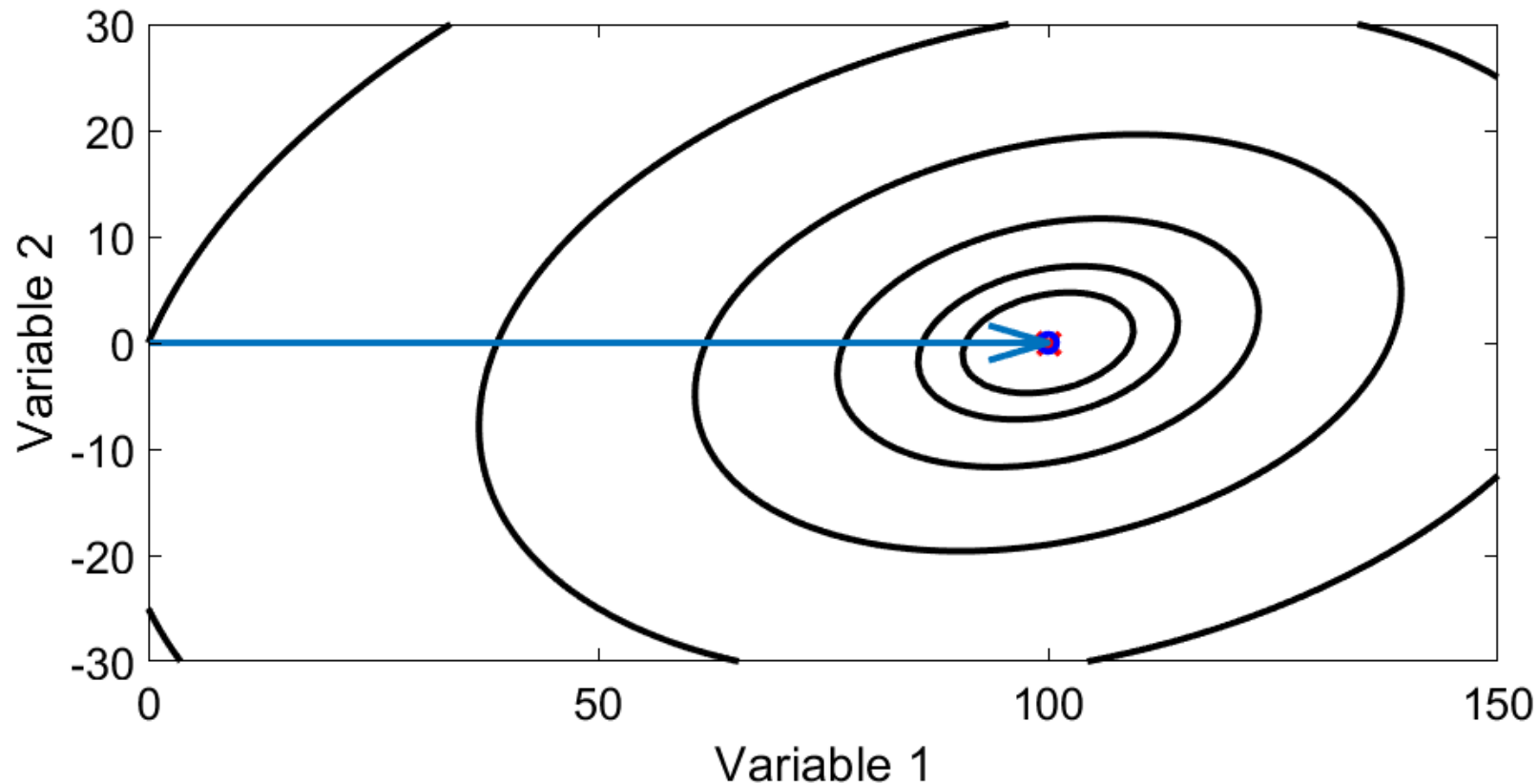




- Usually, there are sufficient data that cross-talk doesn't arise from genuine ambiguity
- Inadequate numerical optimization is usually the cause of cross-talk
- We implement three strategies for reducing cross talk
 1. Improved optimization strategies – Identify and avoid cross-talk
 2. Regularization – Penalize regions of model space which are undesirable
 3. Parameterization – Frame the problem with lower cross-talk variables



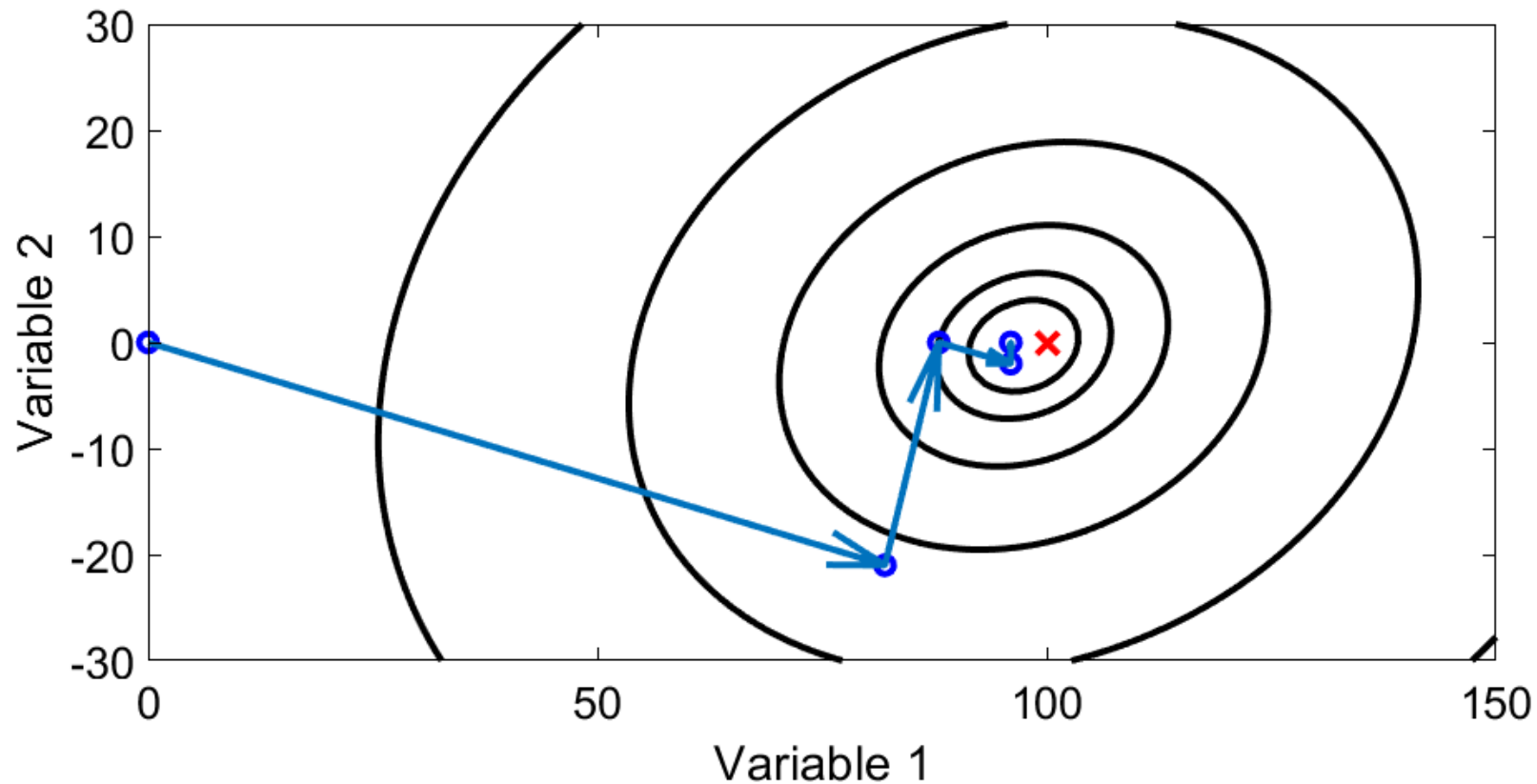
- Cross-talk can be avoided if it is known how the derivative with respect to each variable changes as the other variables change
- This information can be expensive to calculate





Regularization

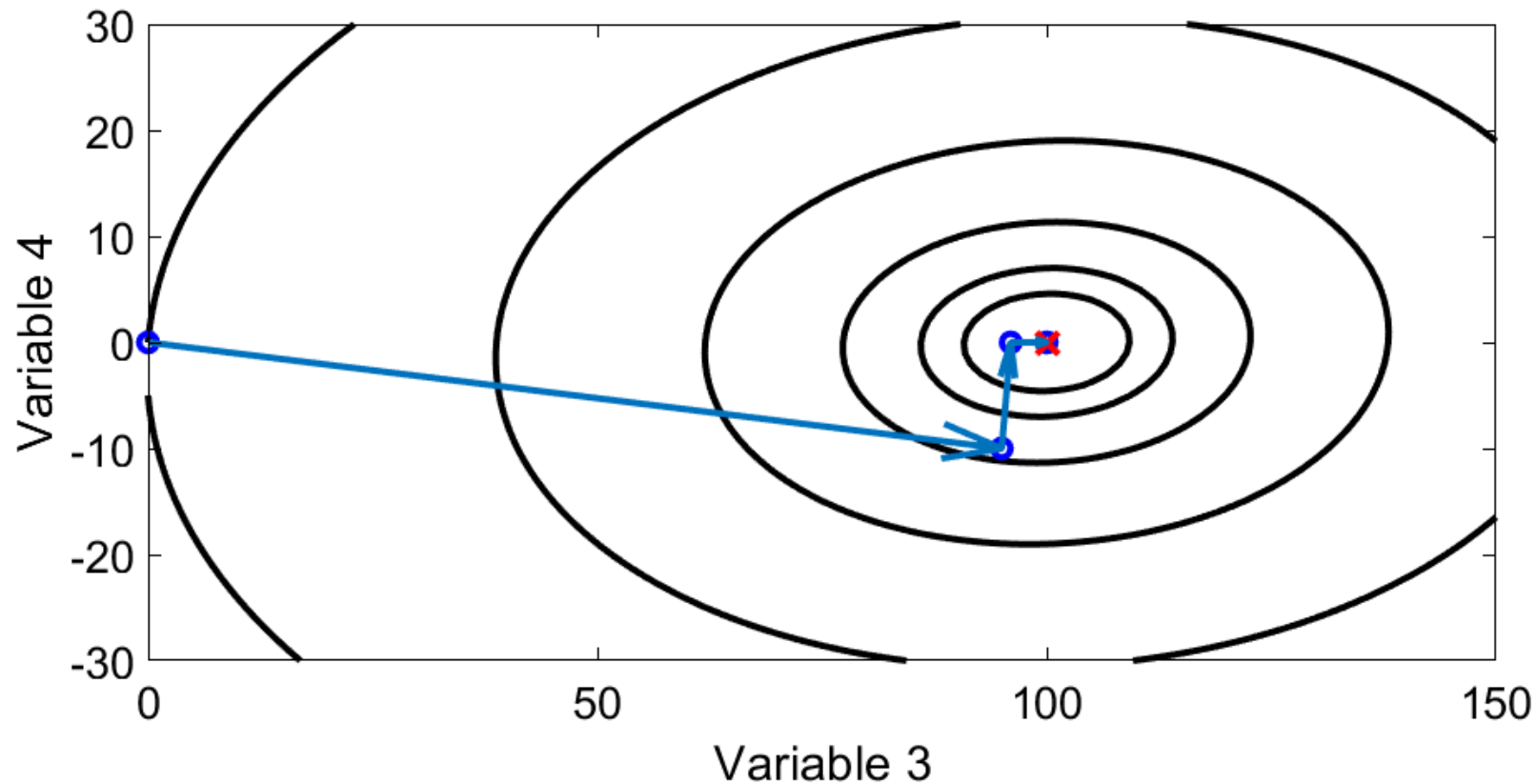
- Regularization terms can be added to penalize non-physical models
- This prevents the inversion from exploring unreasonable model space
- It can also slow convergence or bias results





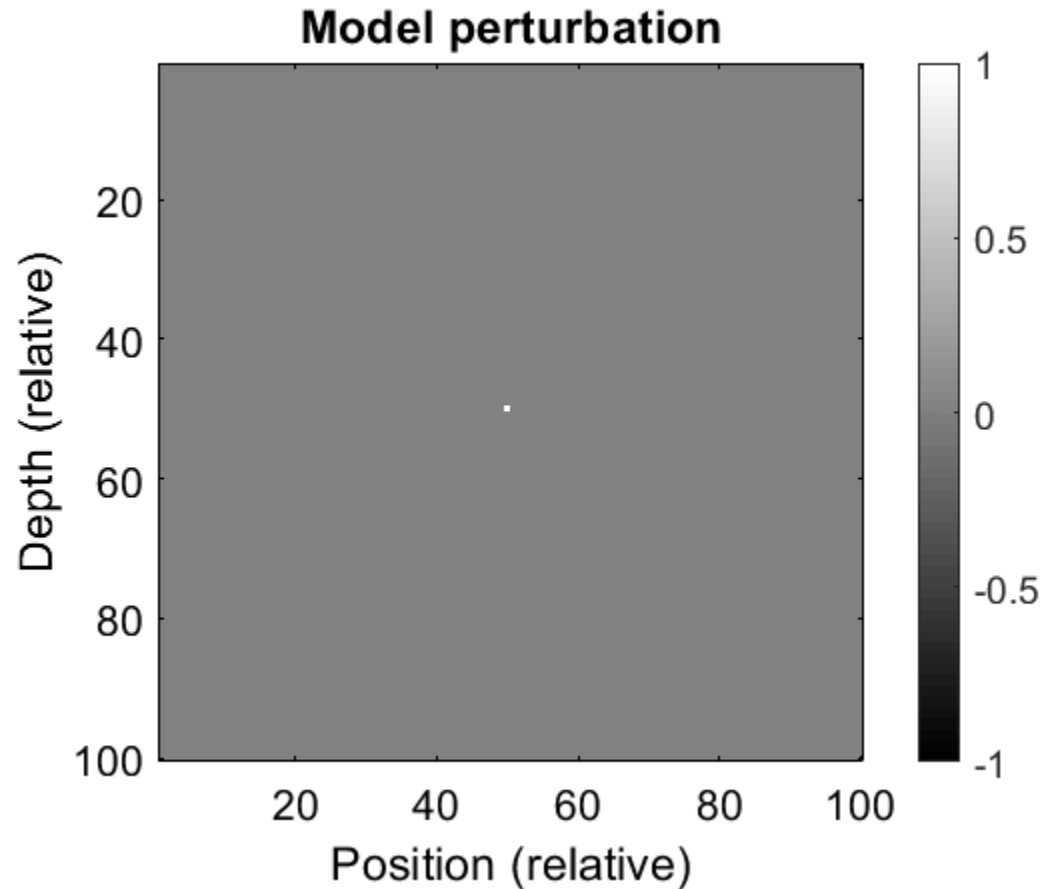
Parameterization

- Variables which cannot produce similar data won't be confused in the inversion
- If appropriate variables can be identified, they can substantially reduce cross-talk

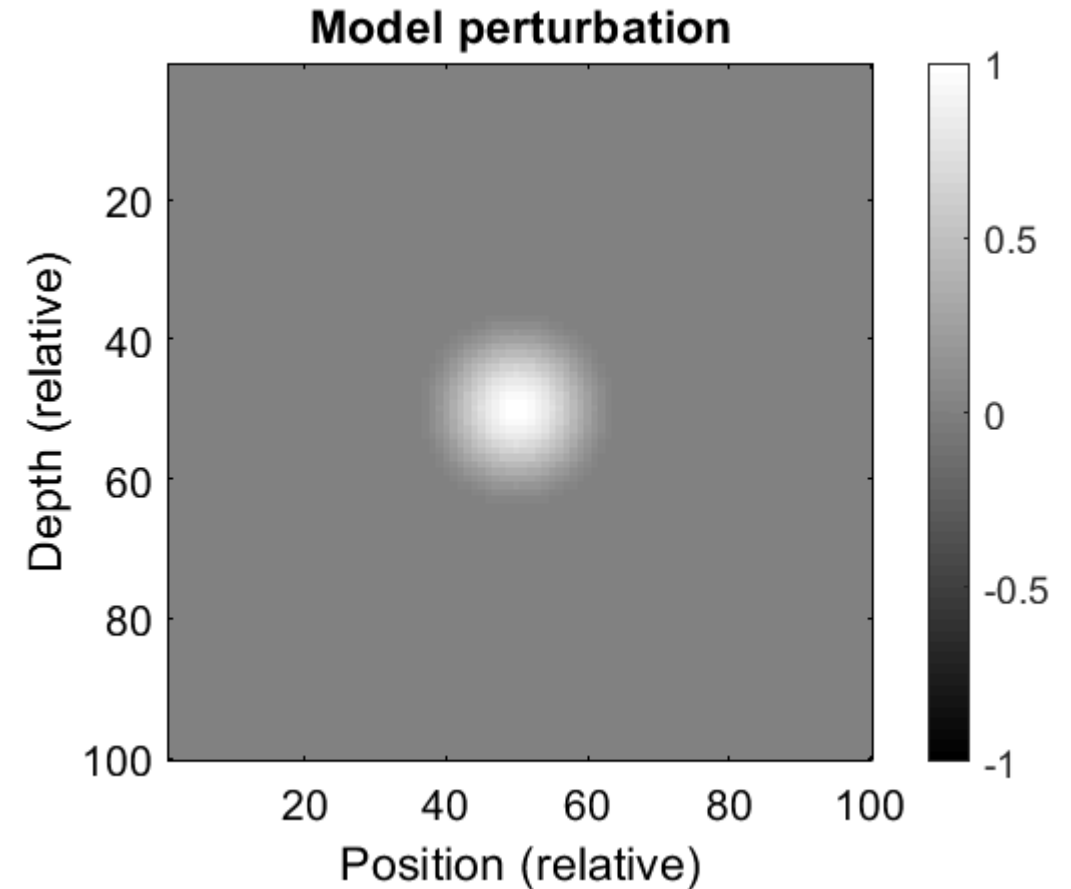




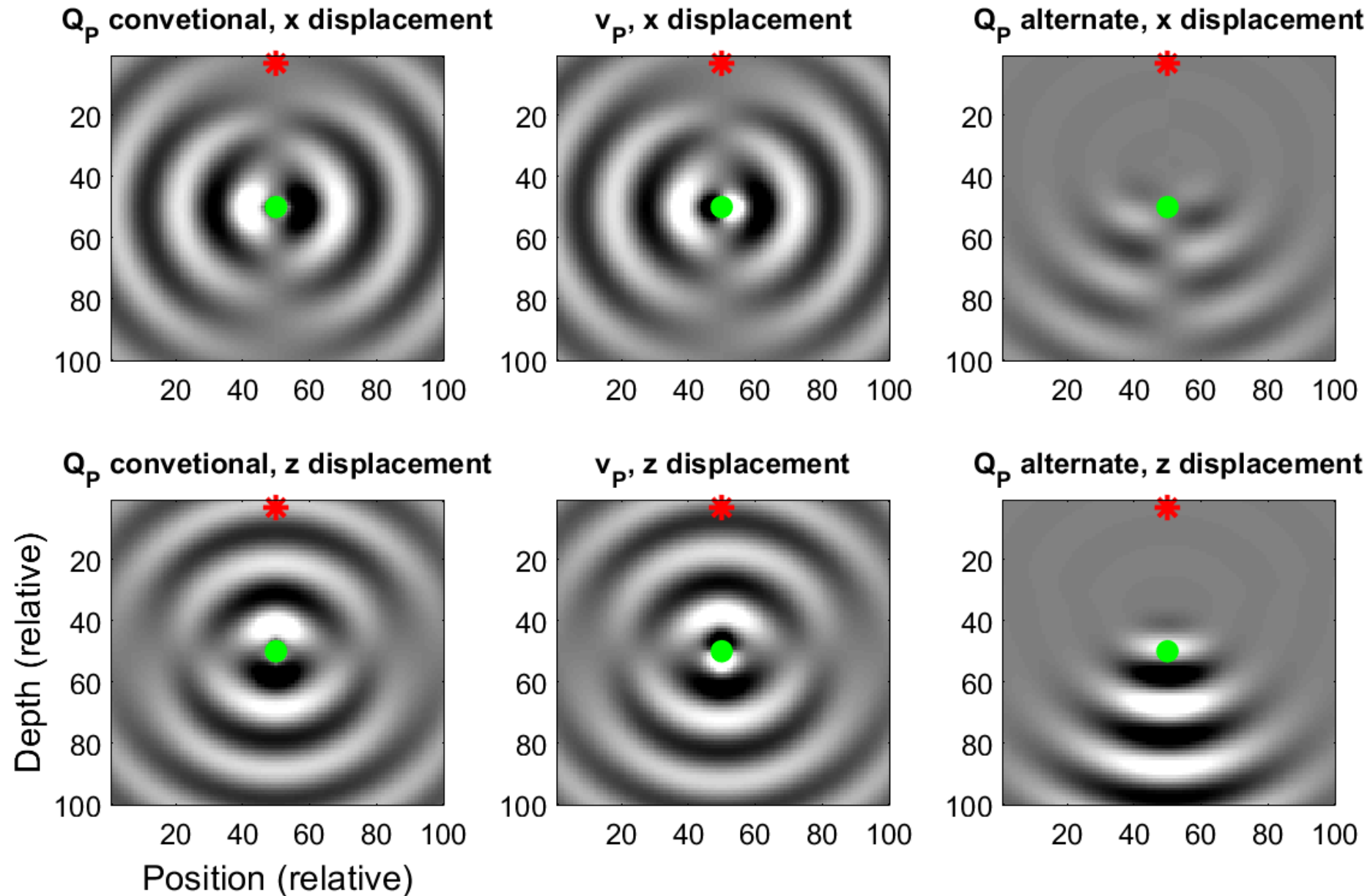
Low cross-talk parameterization for Q



- Conventional FWI parameterization
- Introduces significant reflection energy

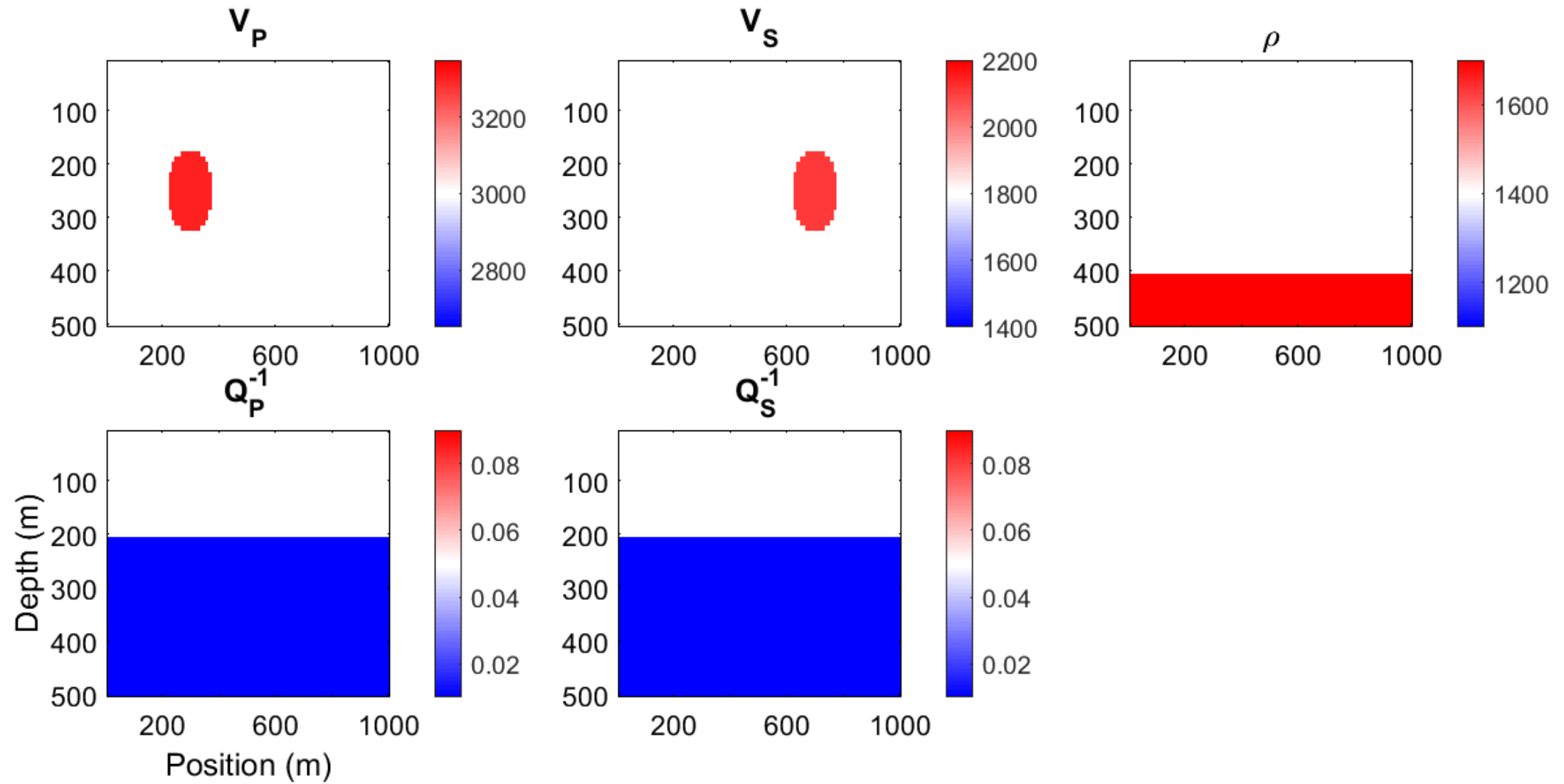


- Alternate Q parameterization
- Introduces minimal reflection energy, reduced cross-talk with V



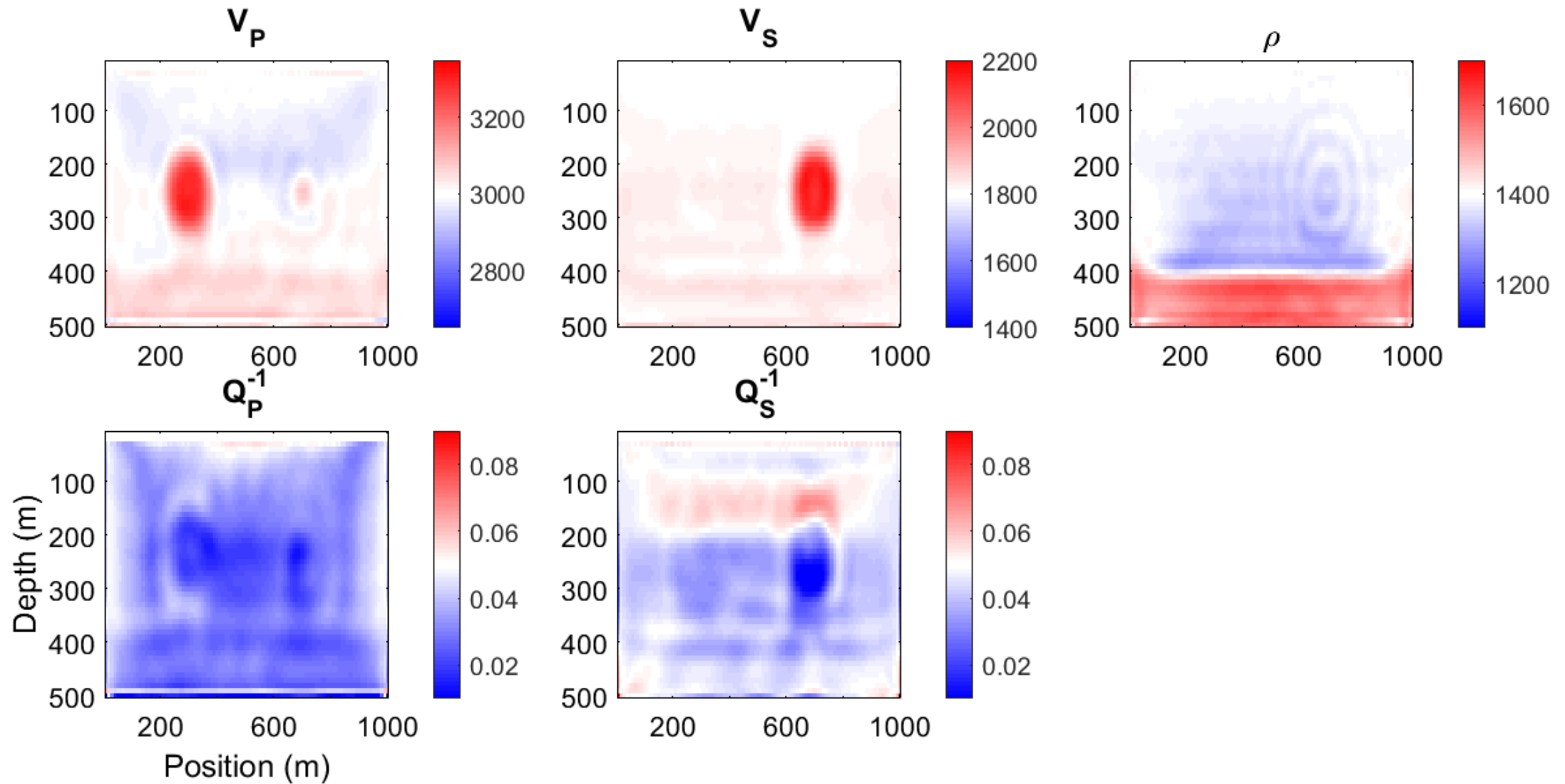


Toy example



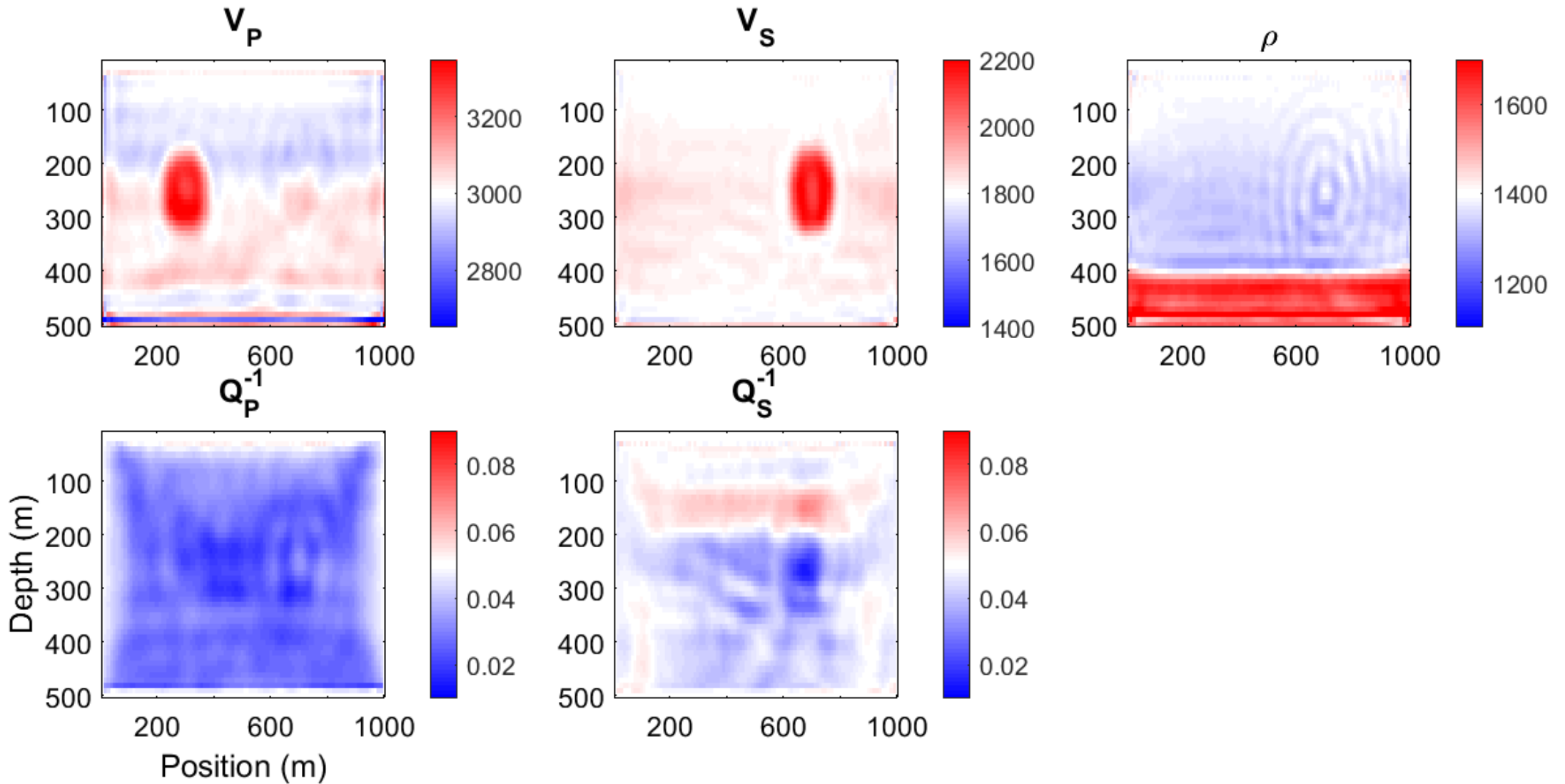


Reflection and transmission survey, low cost TGN



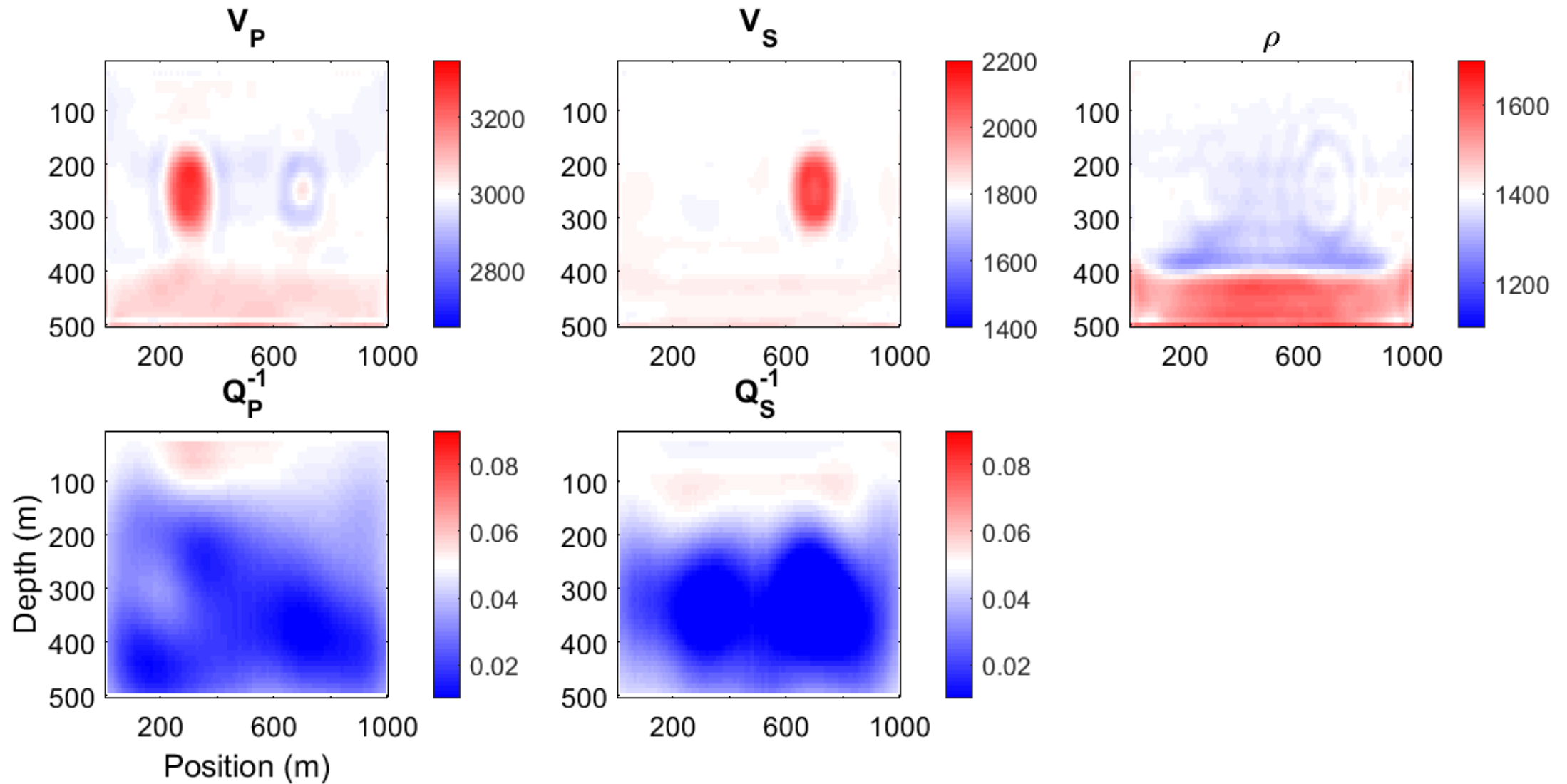


Reflection and transmission survey, high cost TGN





Reflection and transmission survey, low cost TGN





- Anelastic formulations of FWI are heavily influenced by cross-talk
- Regularization, parameterization and optimization strategy are important factors in reducing cross-talk
- In transmission experiments, cross-talk with Q can be reduced through variable choice



- CREWES sponsors, staff and students
- SEG and CSEGF



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