Amplitude-based misfit functions in viscoelastic FWI applied to walk-away vertical seismic profile data

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Multiparameter viscoelastic FWI in unconventionals

Multiparameter FWI is a mainline research direction for CREWES: we are pursuing its potential as a means for driving petrophysical interpretation of 3D-3C (and beyond!) data in conventional and unconventional reservoirs. In these efforts Q_P and Q_S are extremely important (see also Keating's work in this year's report). Here, based on the successfuly isotropic elastic FWI efforts of 2017, we present sequential viscoleastic FWI results on data from a producing Western Canadian heavy-oil field (owner/operator anonymous).

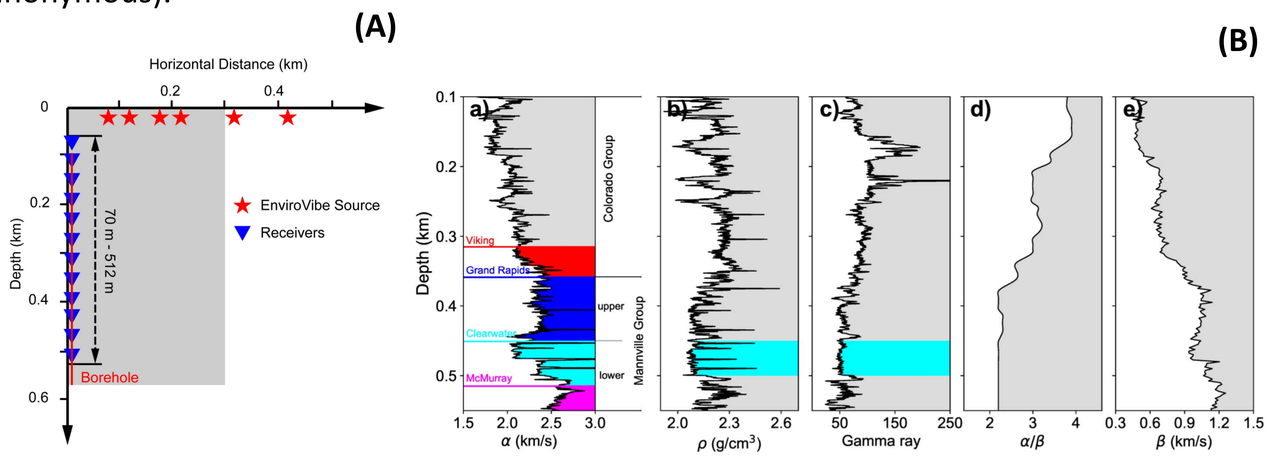

Fig. 1. Experiment & geology: (A) WVSP configuration; (B) well log data.

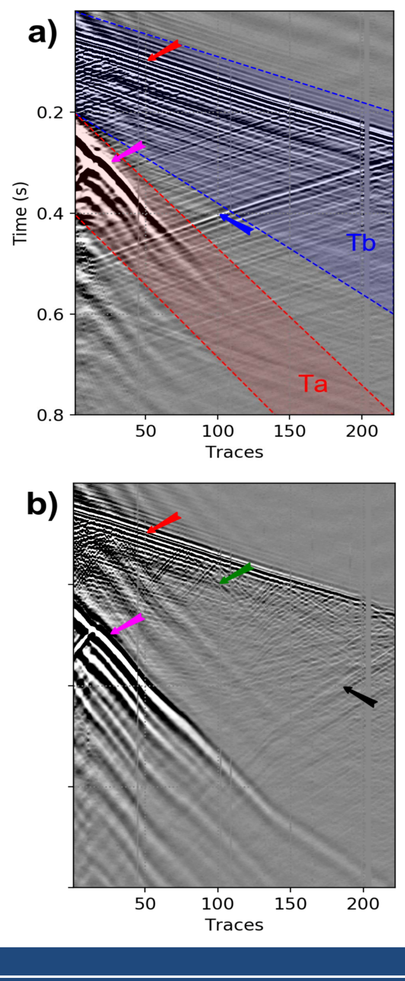

Fig. 2. Field data examples with misfit windowing shown. (a) Zero-offset data, vertical component; (b) zero offset data, radial component.

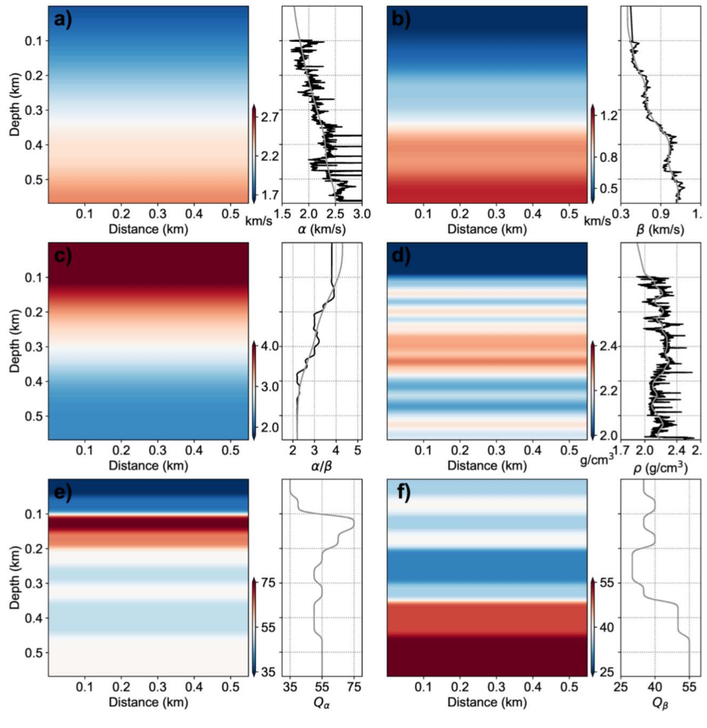

Fig. 3. Starting models for viscoelastic FWI and well-log origins: (a)-(f) V_P, V_S, V_P/V_S, ρ, Q_P, Q_S. Smooth components of well log data used when available.

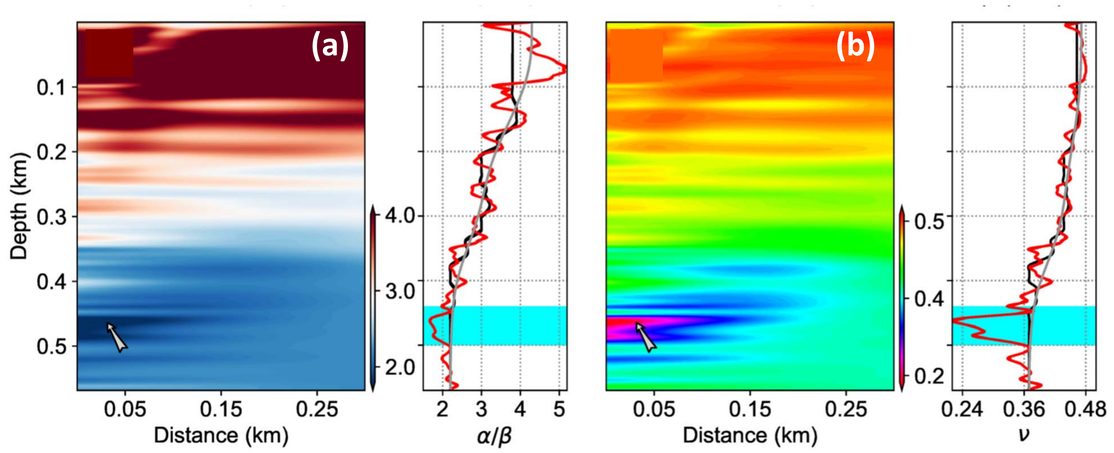

Fig. 4. Stage I results: From V_P, V_S, ρ, similar to 2017, derived VP/VS and Poisson's ratio results both show drops as the shale transitions to the oil sands. These FWI results are used as background models for viscoelastic updating in Stage II.

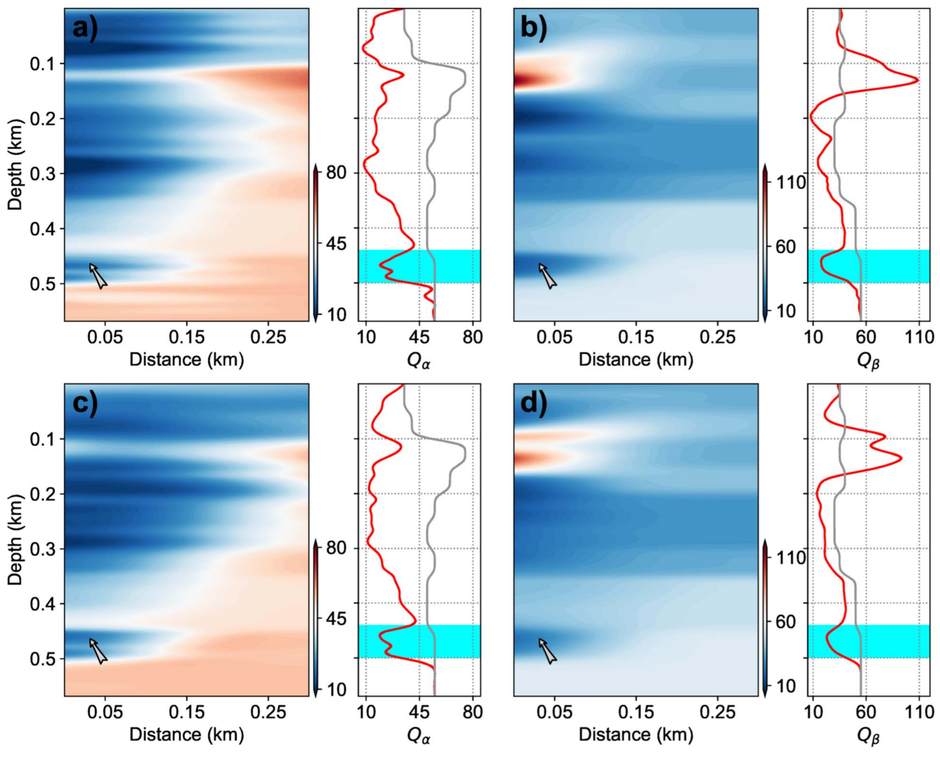

Fig. 5. Stage II results: 2 of the 4 amplitude misfit functions used in standard Q estimation (see report) are shown; these also predict strong drops in Q_P and Q_S transitioning into the oil sand from the shale.

Conclusions

We consider this to be further clear evidence that waveform based methods are a potent route to generating petrophysically interpretable medium estimates in unconventional settings; in this case in heavy-oil reservoirs. The sequential FWI shown here, alongside the purist simultaneous QFWI of Keating, are representatitive of our "toolbox" view of multiparameter viscoelastic FWI.