

Estimating Q

Goal: To characterize the Q profile of a VSP data set for possible use with anacoustic FWI in the future.

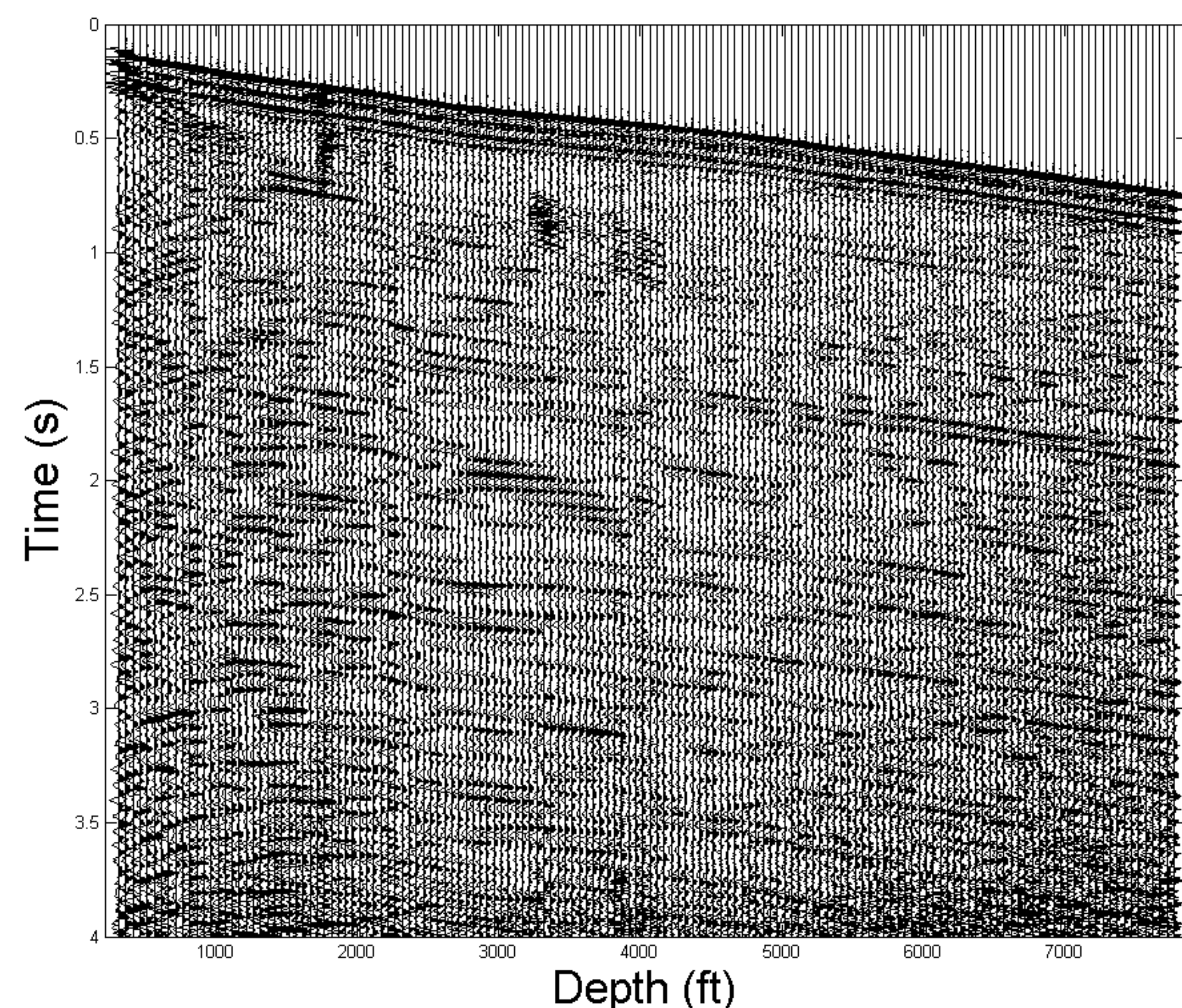


FIG. 1. Measured VSP data from the Chaparral-Farnsworth data set.

- Attenuation is difficult to characterize by overall changes in amplitude, as these can be caused by many other factors.
- The two Q estimation techniques used here recover Q based on changes in the frequency content of the data.
- These were the spectral ratio method and the centroid frequency shift method.

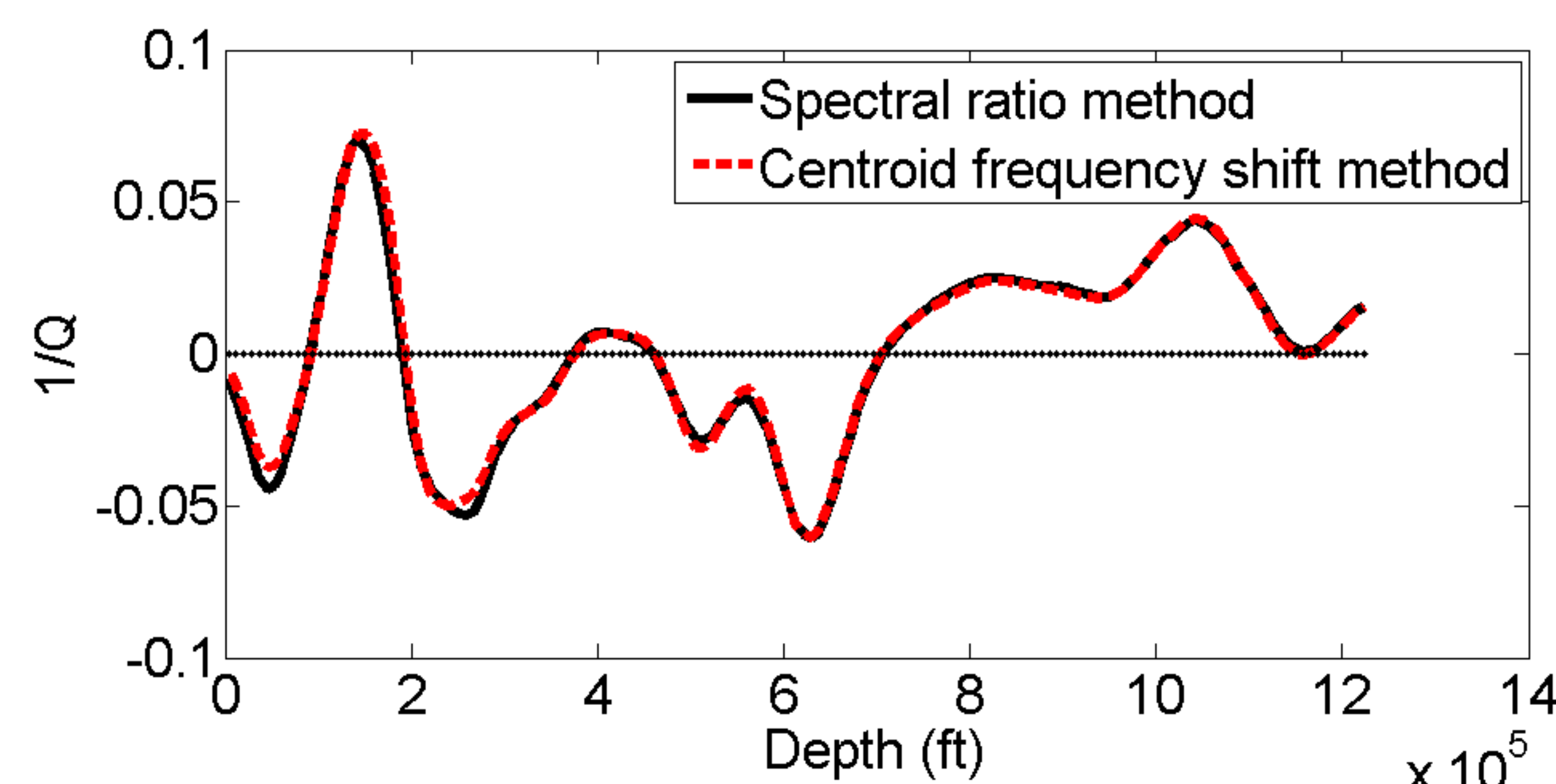


FIG. 2. Q estimate generated using the spectral ratio and centroid frequency shift methods.

Potential causes for negative Q estimates

- Both methods estimate a negative Q value in some parts of the well.
- Negative Q is not a physical phenomenon, and indicates a failure of these Q estimation techniques.
- The details of these techniques differ significantly, this failure must occur in their common assumptions.
- The common assumptions of these methods are:
 1. High frequencies attenuate faster than low frequencies, as described by a nearly constant Q attenuation law.
 2. Changes in the frequency content of the data are induced solely by attenuation.

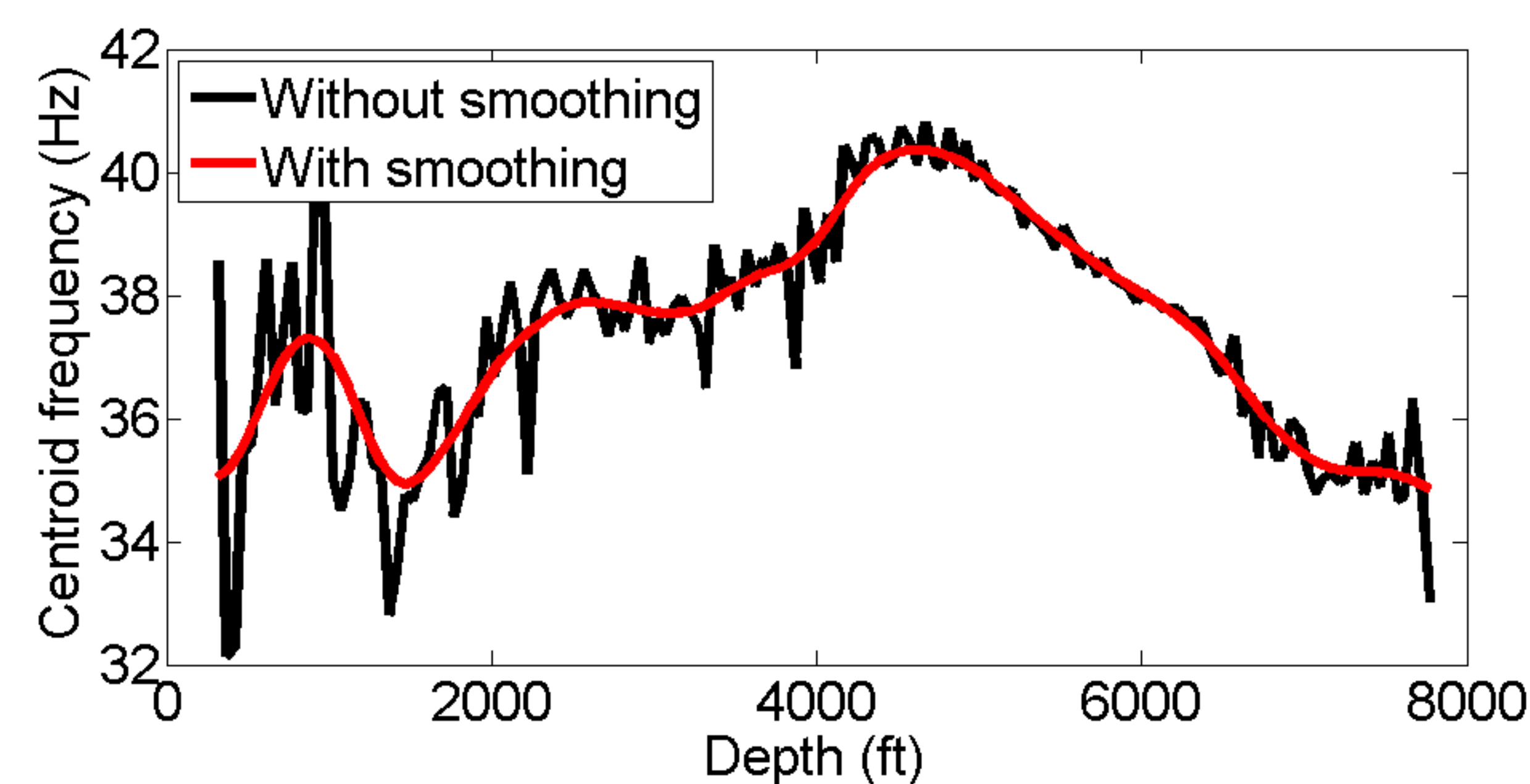


FIG. 3. Centroid frequency (a measure of average frequency) of the measured data.

- The clear trend of increasing centroid frequency in some regions implies that there is relative increase in high frequency content as depth increases.
- No realistic attenuation model predicts greater attenuation at lower frequencies, implying that assumption 1 is not at fault.
- Among the possible mechanisms by which changes in the frequency content can occur, short path multiples are a prominent possibility.
- This can be investigated by creating attenuation free synthetics, using the well logs.
- These synthetics will give an estimate of the multiple induced frequency shift.

Synthetic tests

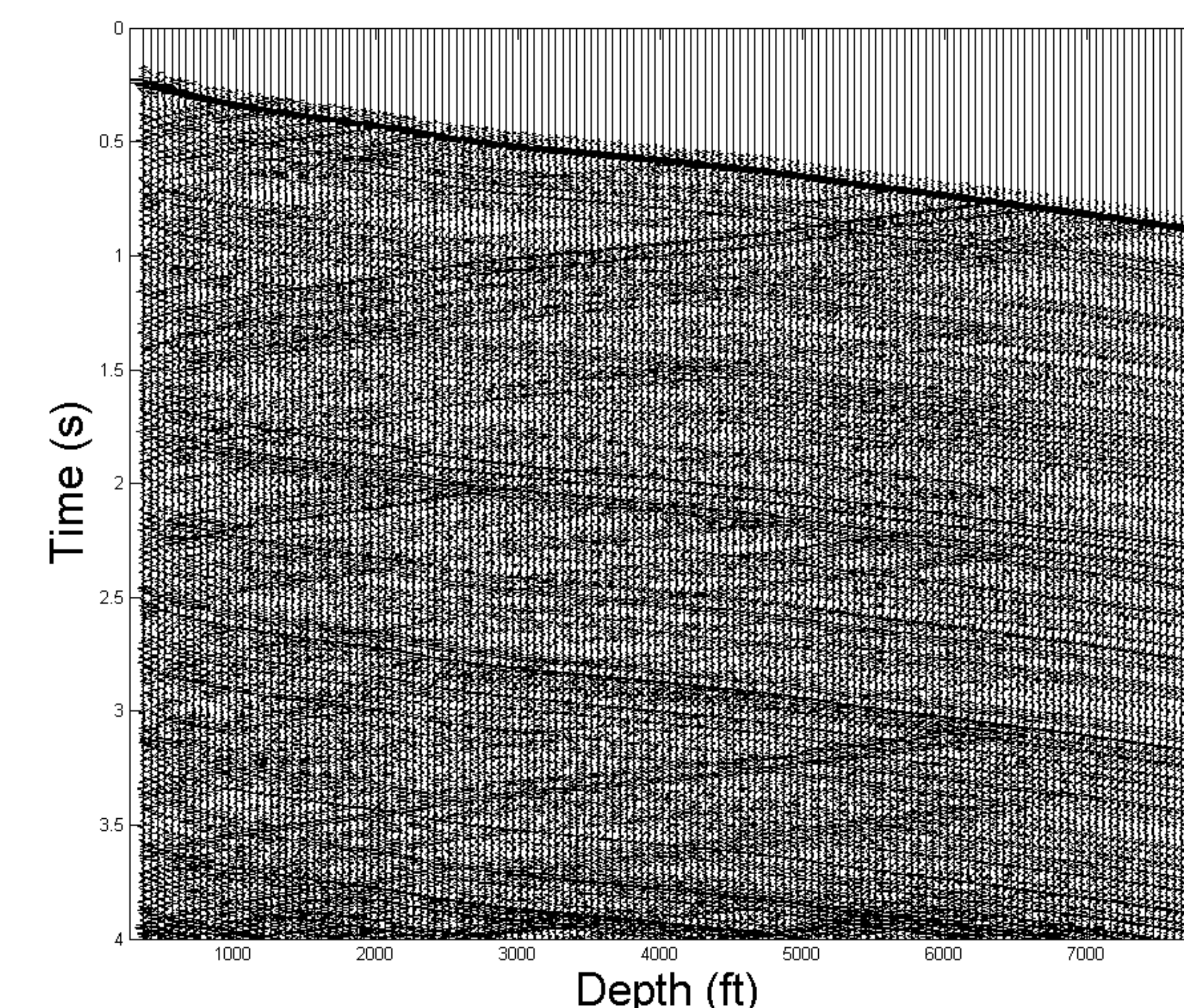


FIG. 4. Synthetic VSP data, generated from well logs.

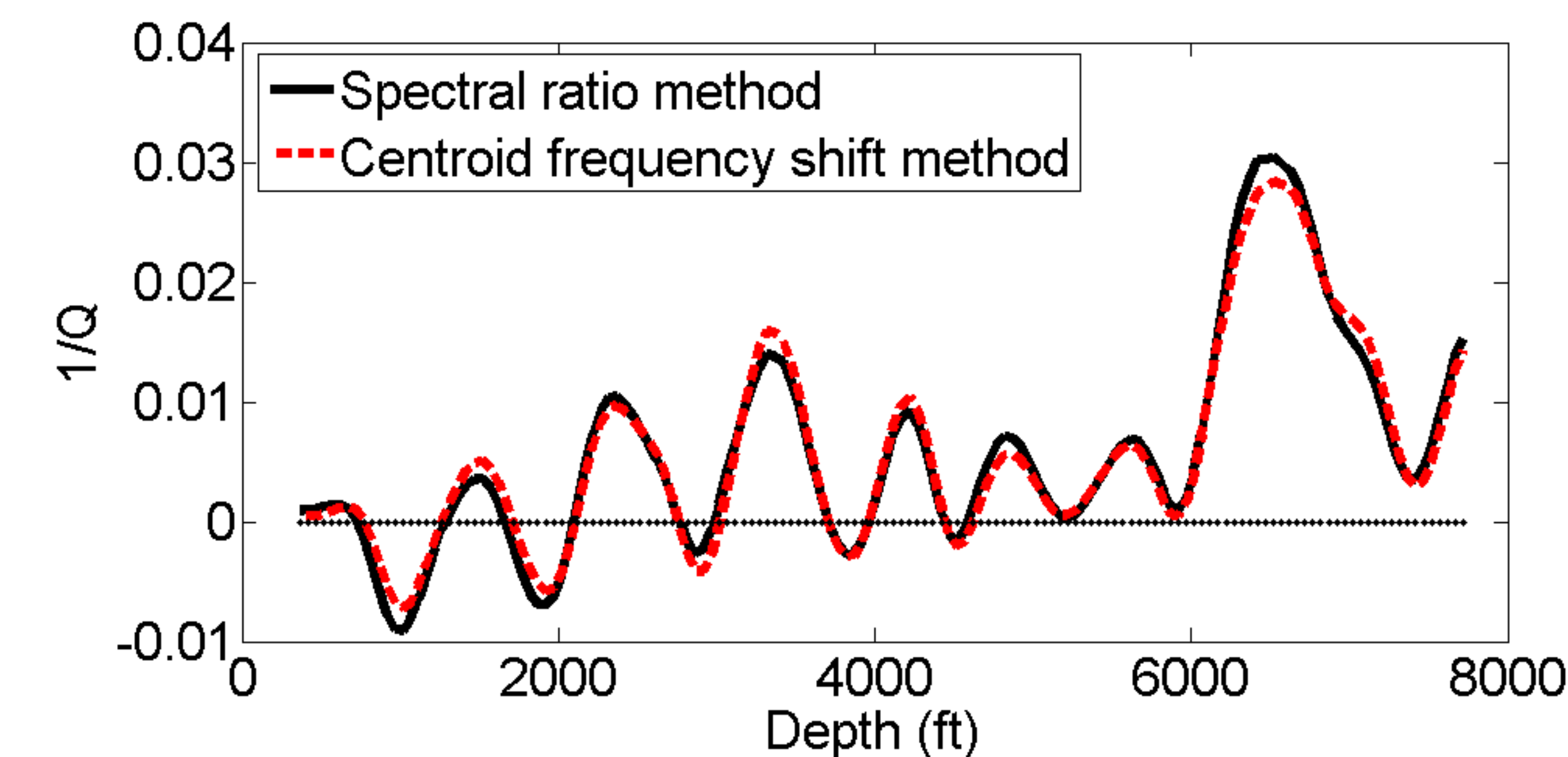


FIG. 5. Synthetic VSP data, generated from well logs.

- Negative Q forcing can be observed in the synthetic data.
- It is not of the correct position or amplitude to explain the effects in the measured data.
- Scattering effects on a scale smaller than the well log sampling remain a possibility for observed behaviour.
- Other potential impacts on the frequency content of the data are being investigated.

Acknowledgments

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