Spherical-wave AVO modeling in isotropic media

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Outline

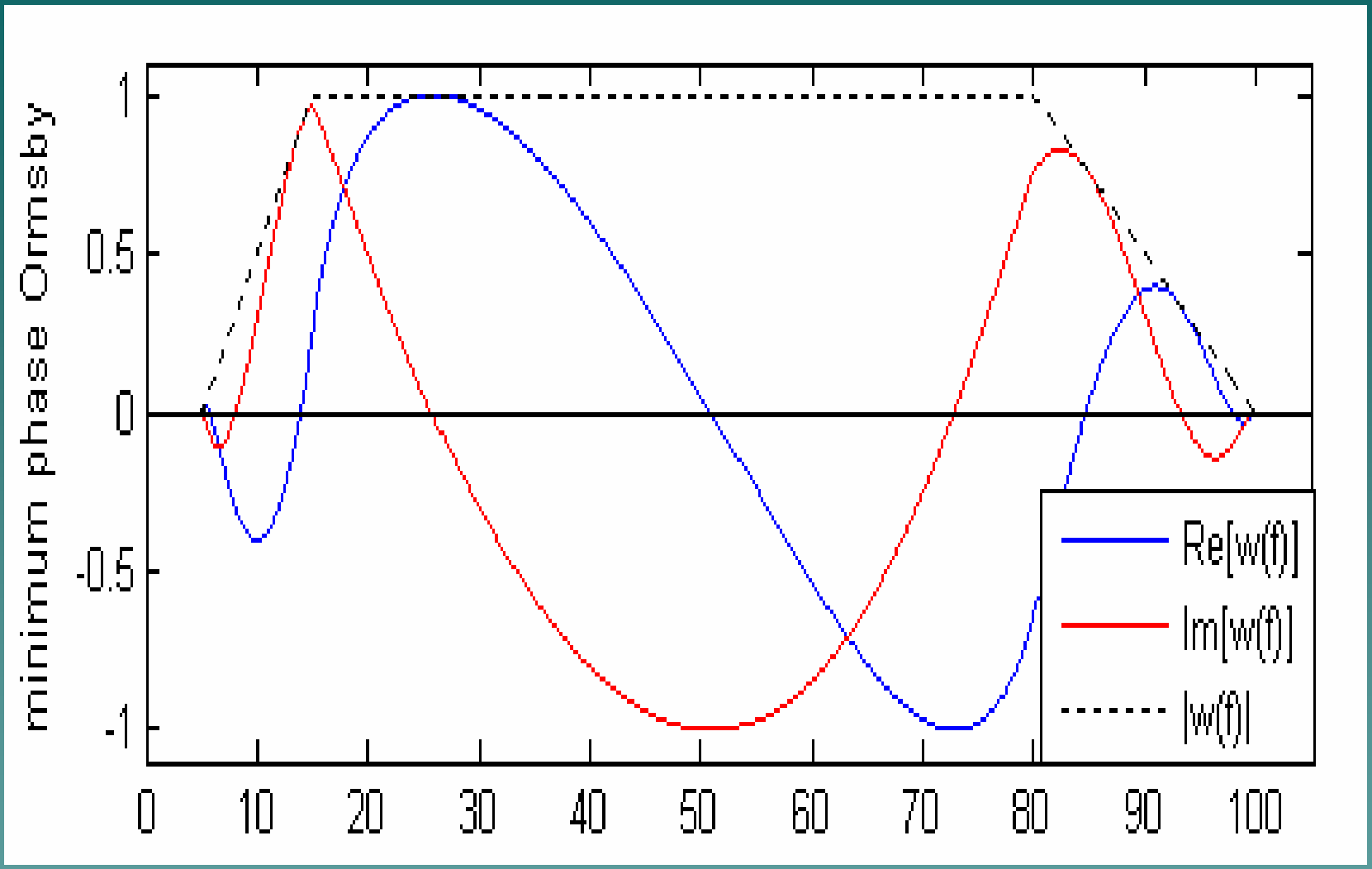
- Introduction
- Potentials and displacements
- Trace examples
- Scaling issues of AVO displays
- Elastic AVO examples
- Attenuation and dispersion
- Anelastic AVO examples
- Conclusions
- Acknowledgements

$$\Phi = Ai\omega e^{-i\omega t}\int_0^{\infty} R_{pp}\frac{p}{\xi}J_0(\omega pr)e^{i\omega\xi(z+h)}dp$$

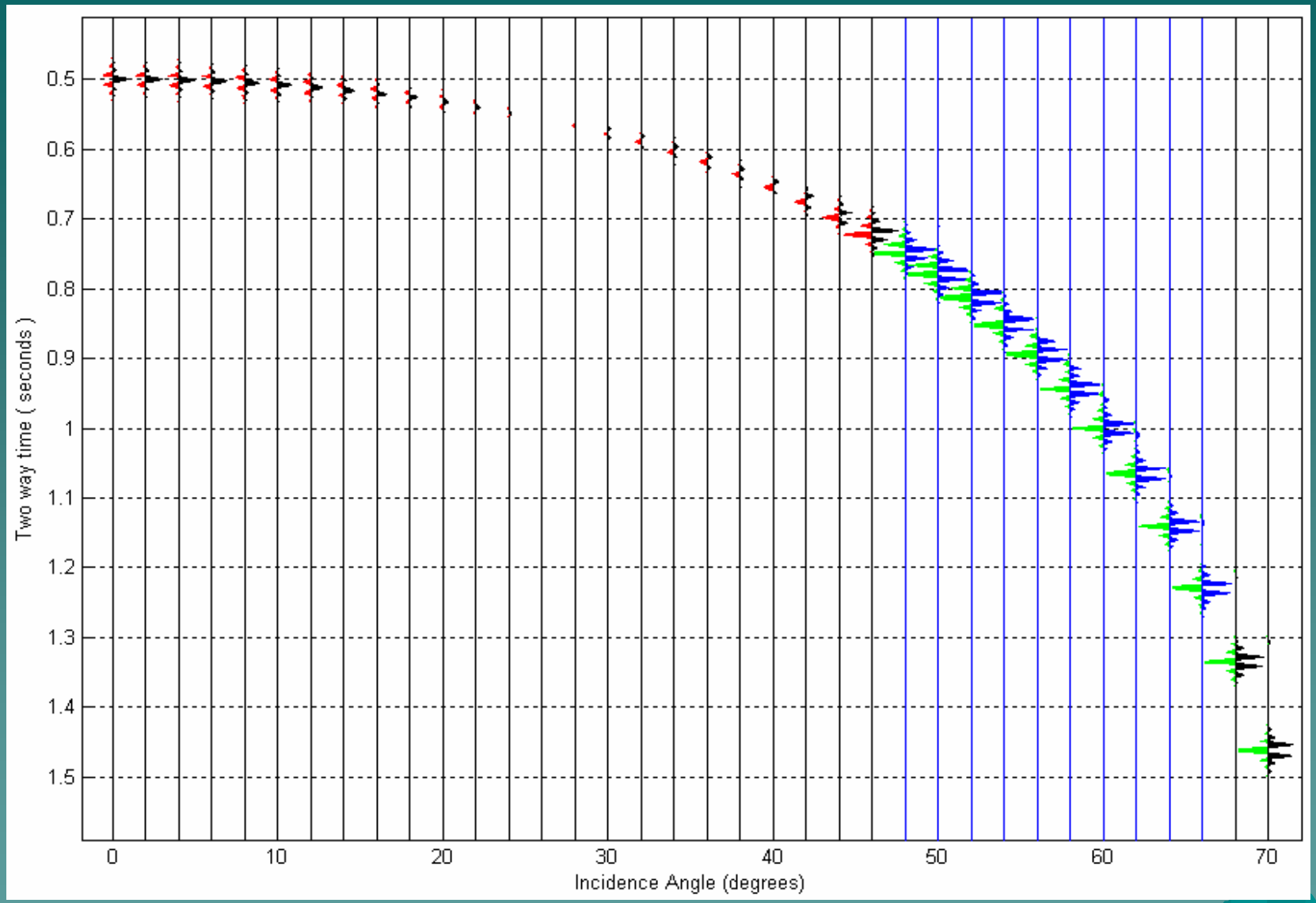
$$\Psi = Ai\omega e^{-i\omega t}\int_0^{\infty}\left(\frac{1}{i\omega p}\frac{\beta}{\alpha}R_{ps}\right)\frac{p}{\xi}J_0(\omega pr)e^{i\omega(\xi h+\eta z)}dp$$

$$u = \nabla\Phi + \nabla\times\nabla\times(0,0,\Psi)$$

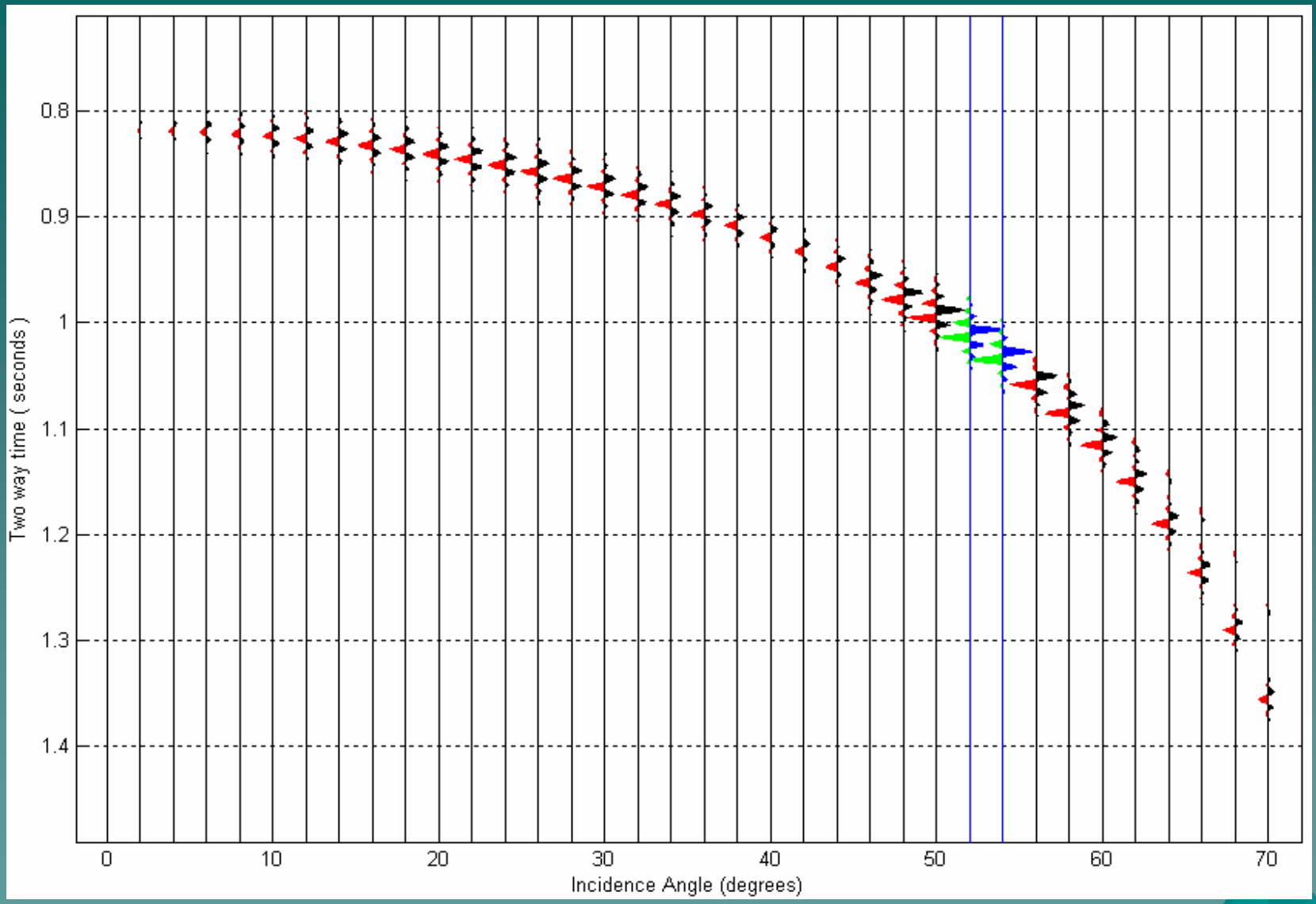
Sommerfeld integral (Aki and Richards, 1980)



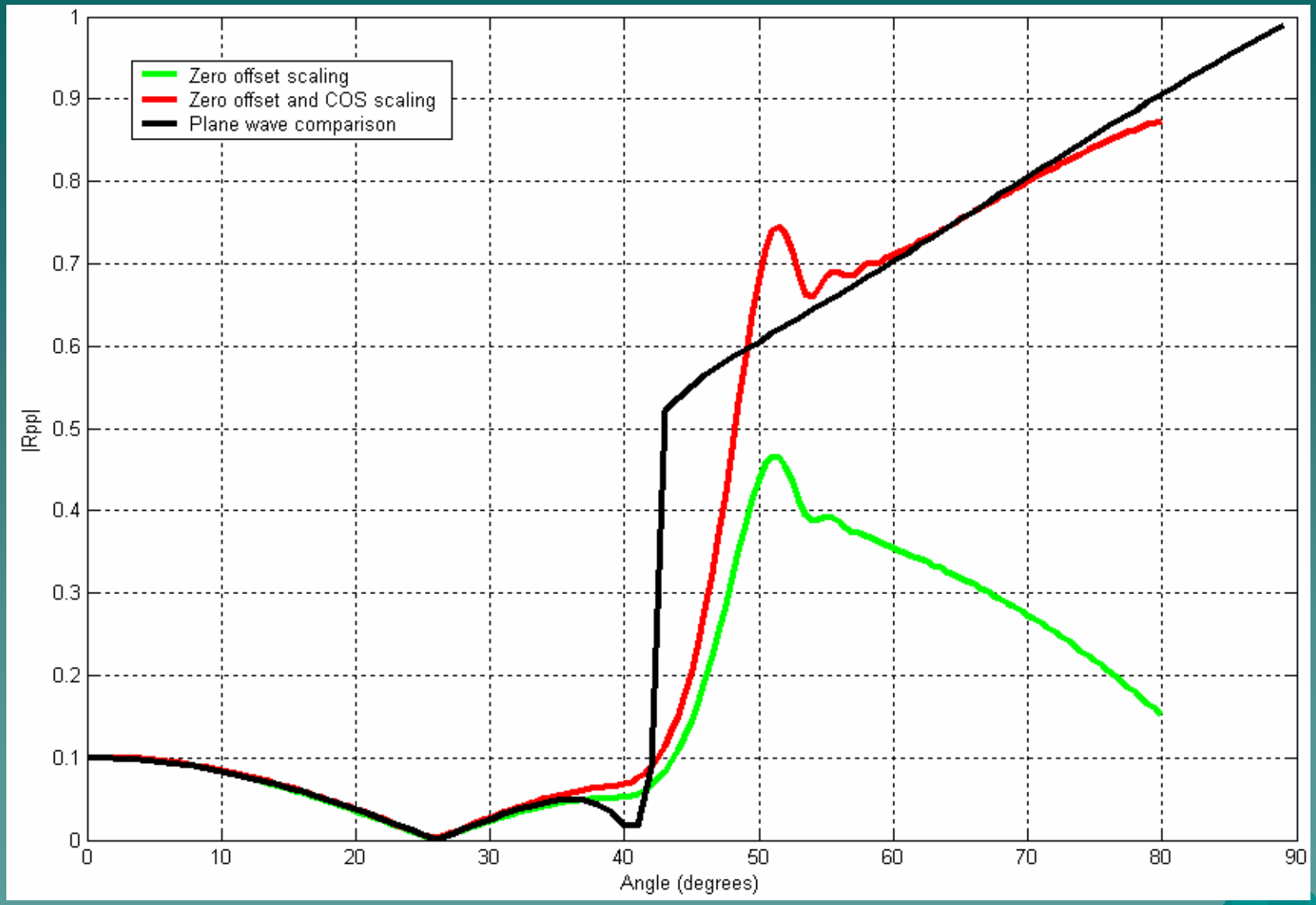
Spectrum of zero-phase and minimum-phase Ormsby wavelet



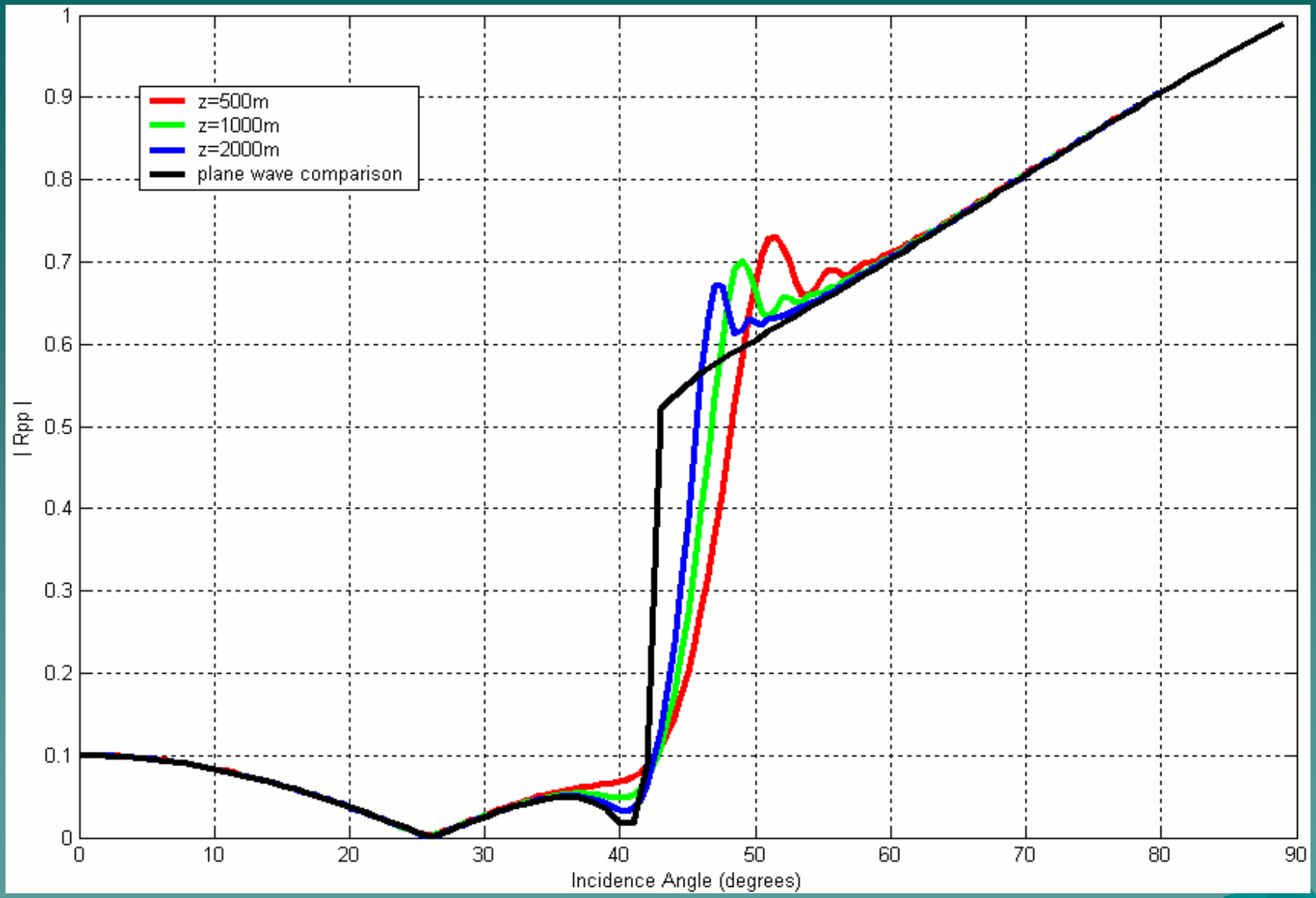
Class 1 spherical wave PP reflection traces (z=500m)



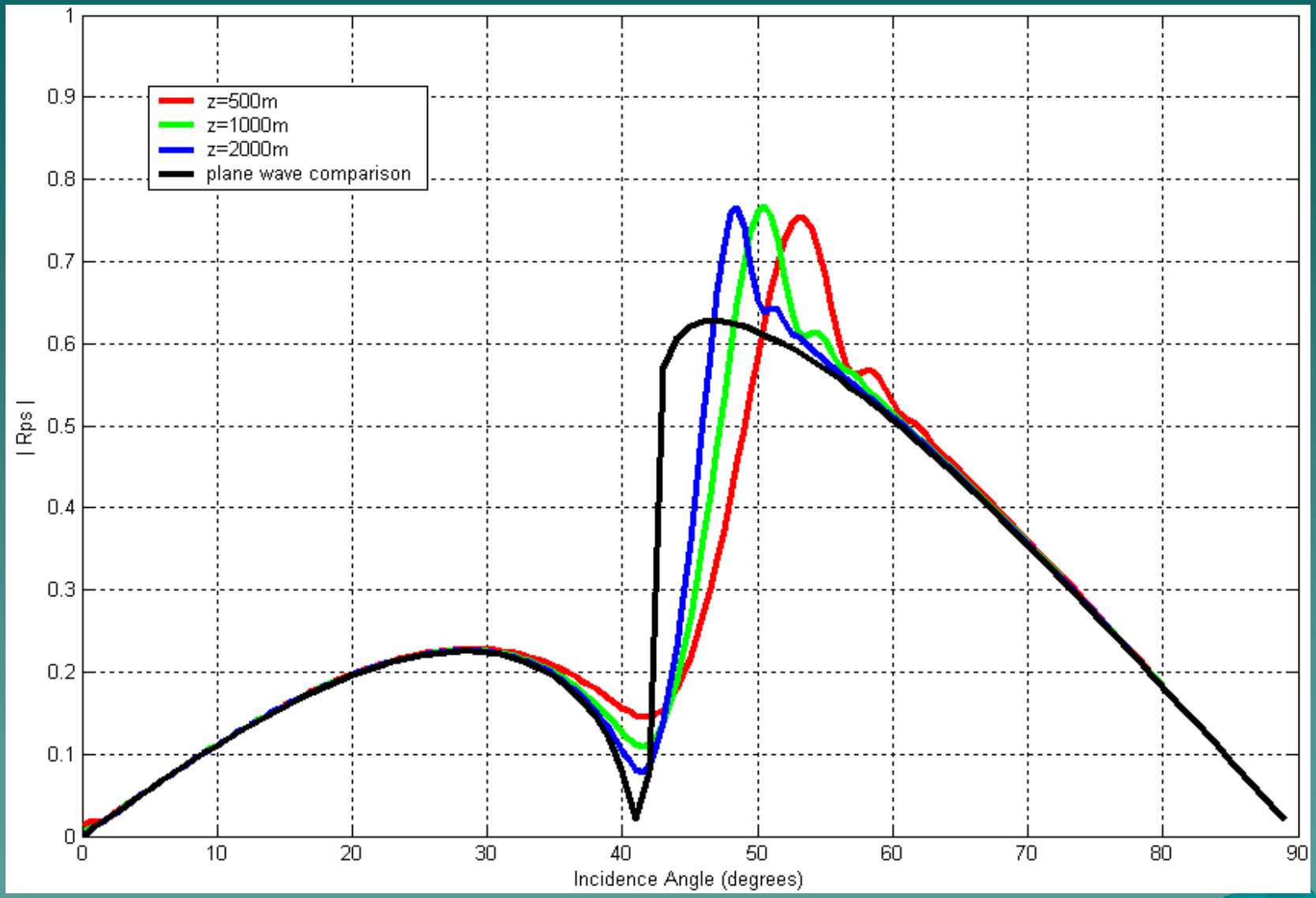
Class 1 spherical wave PS reflection traces (z=500m)



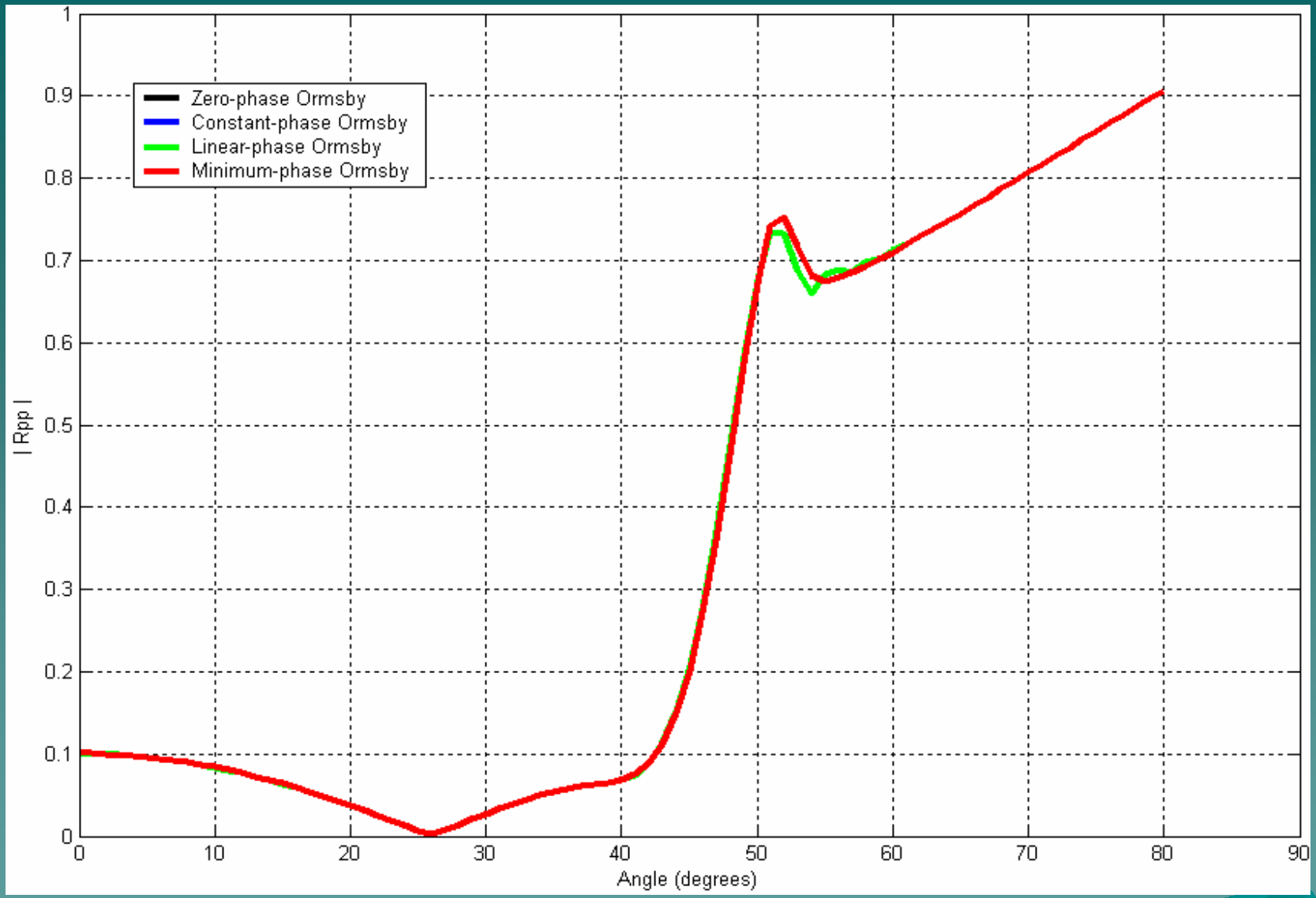
AVO Class 1 spherical PP wave scaling



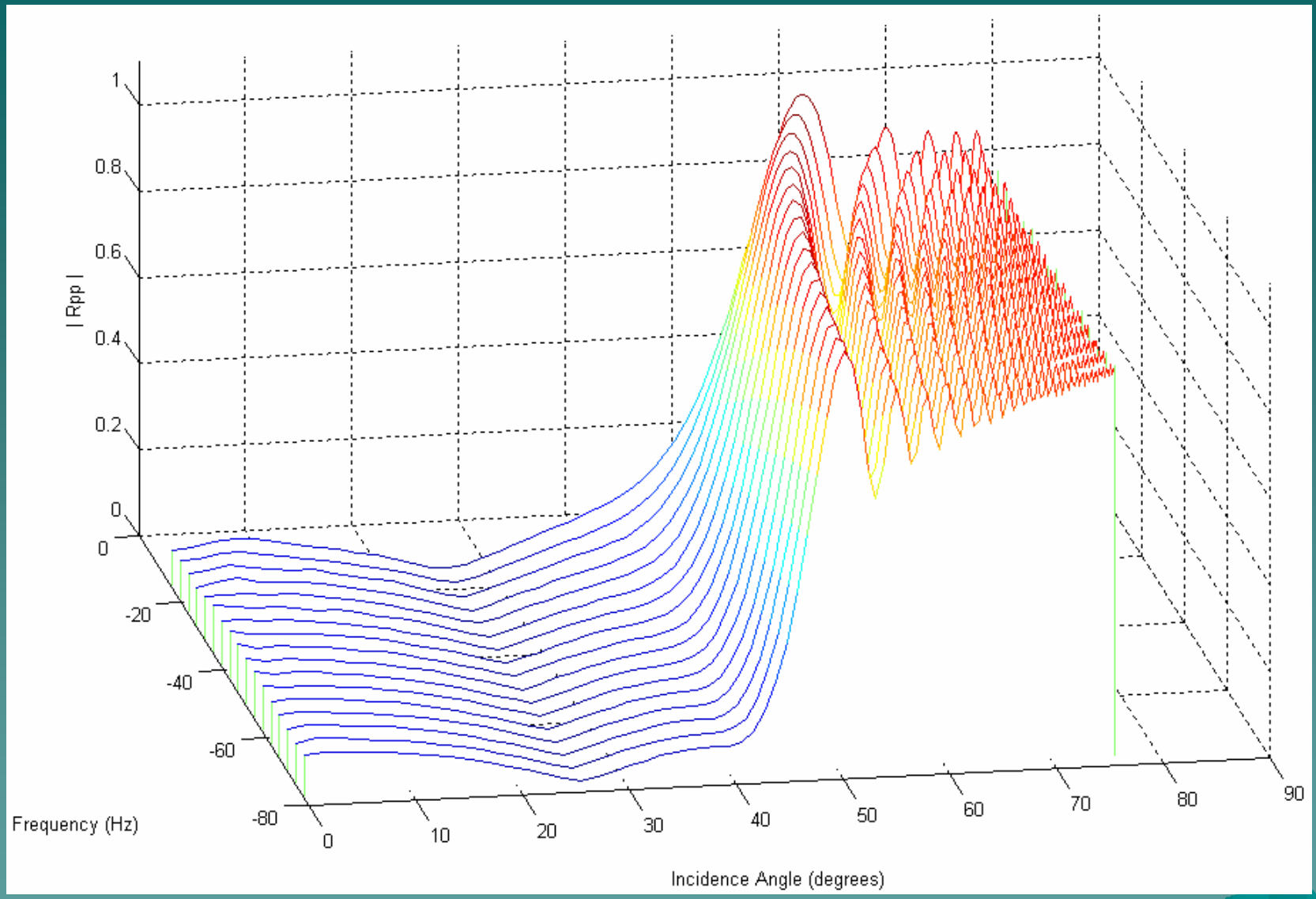
AVO Class 1 spherical wave PP reflection coefficients



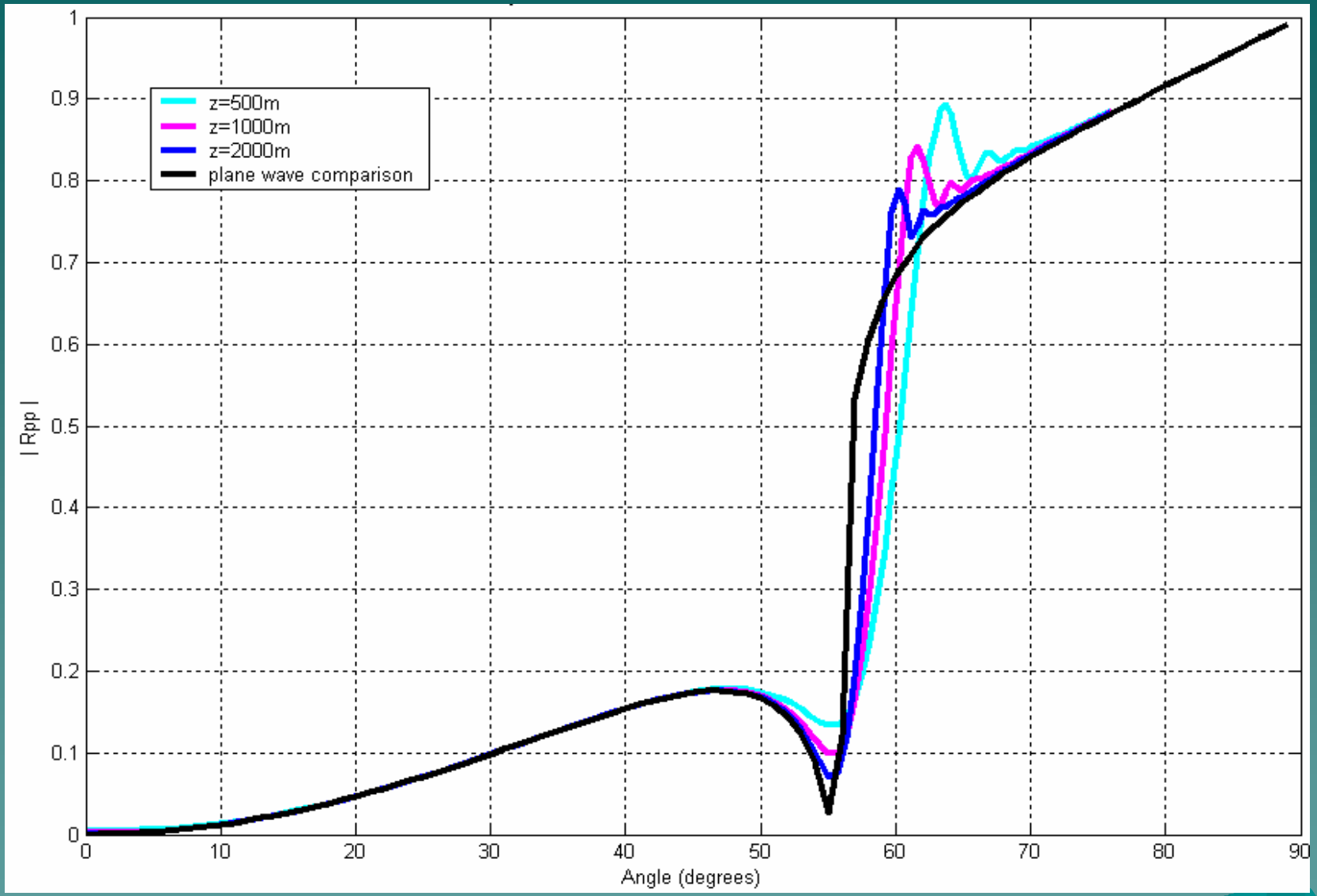
AVO Class 1 spherical wave PS reflection coefficients



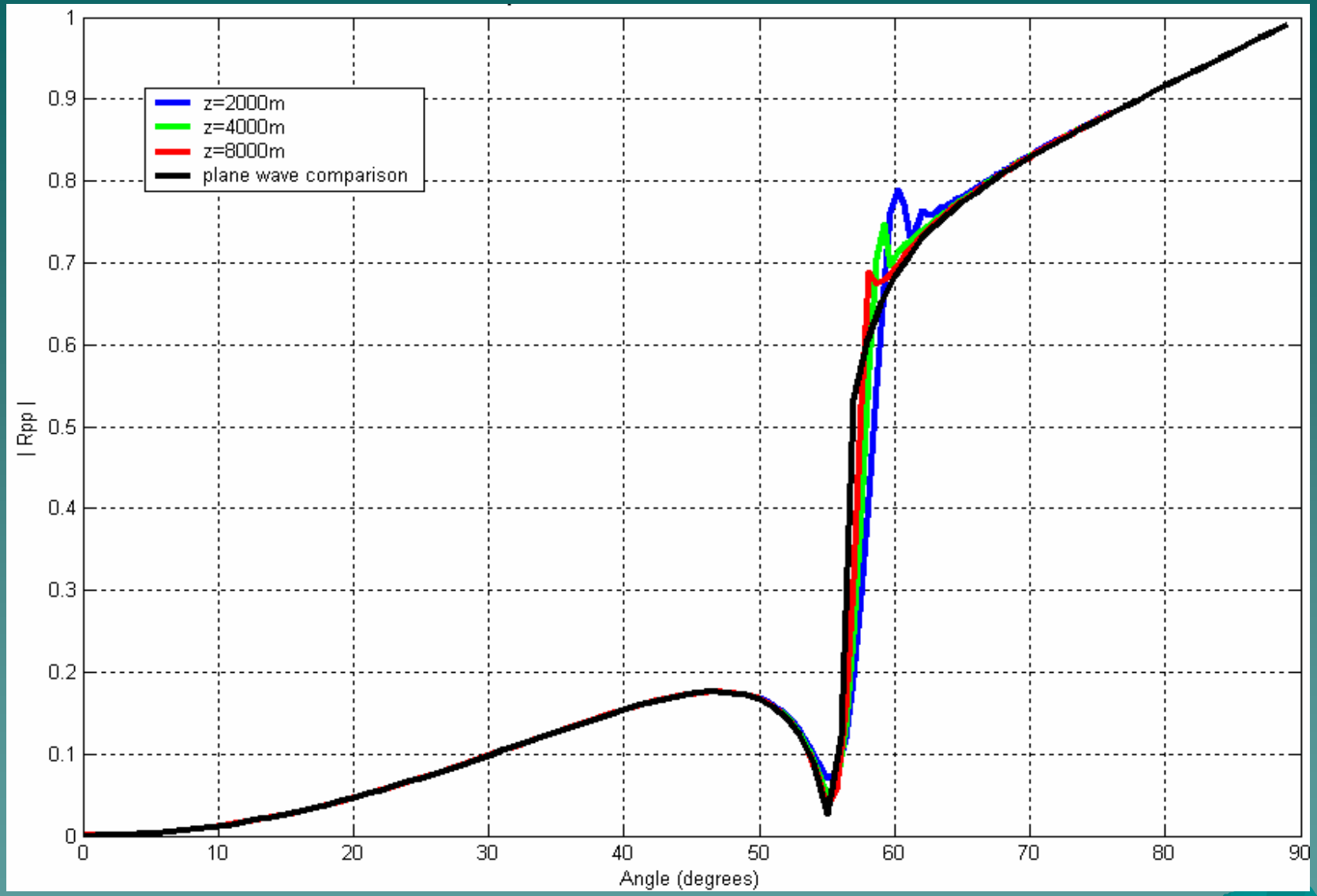
Class 1 spherical wave PP reflection coeffs. (z=500m)



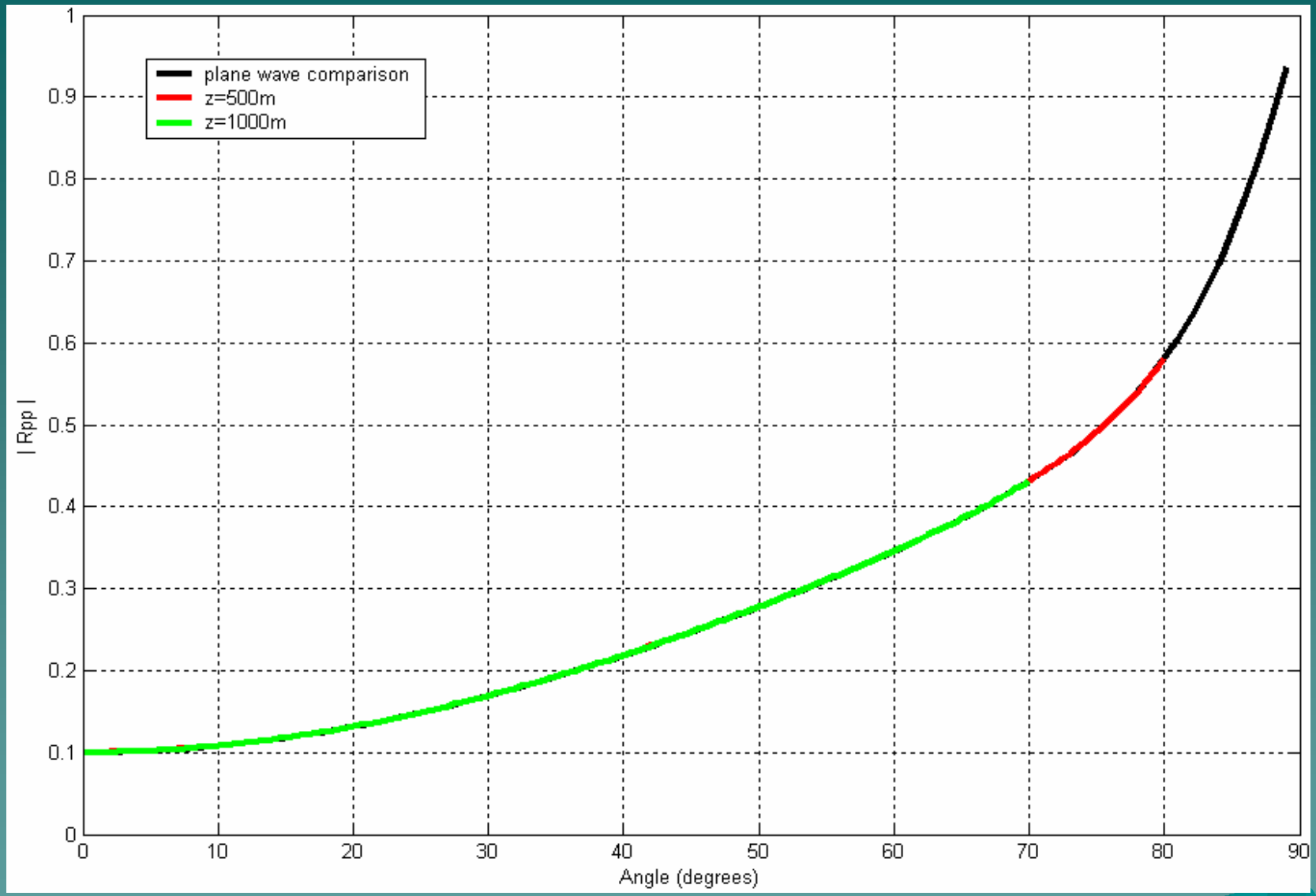
Class 1 PP refl. coeff. as function of frequ. (z=500m)



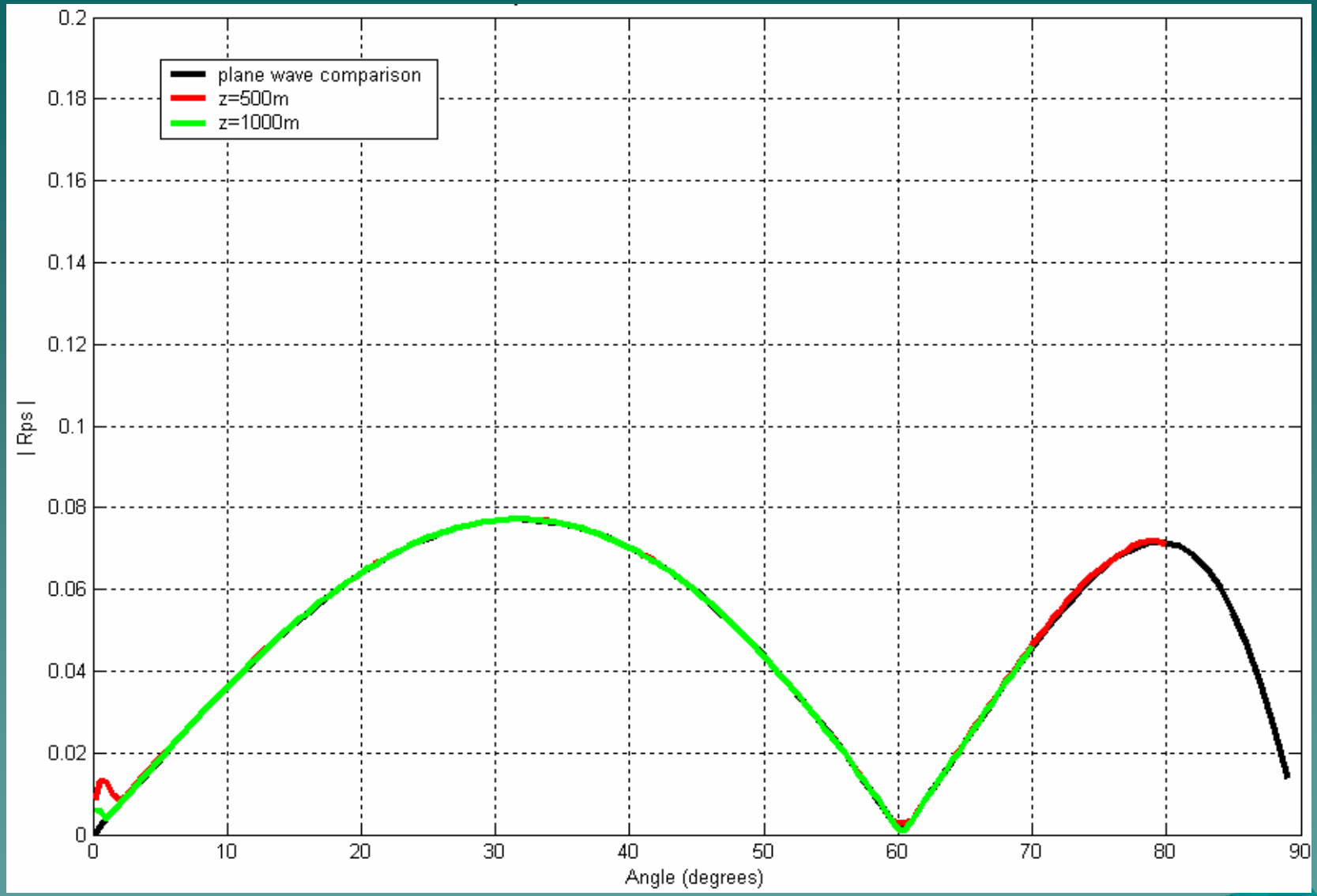
AVO Class 2 spherical wave PP reflection coefficient



AVO Class 2 spherical wave PP reflection coefficient



AVO Class 3 spherical wave PP reflection coefficient

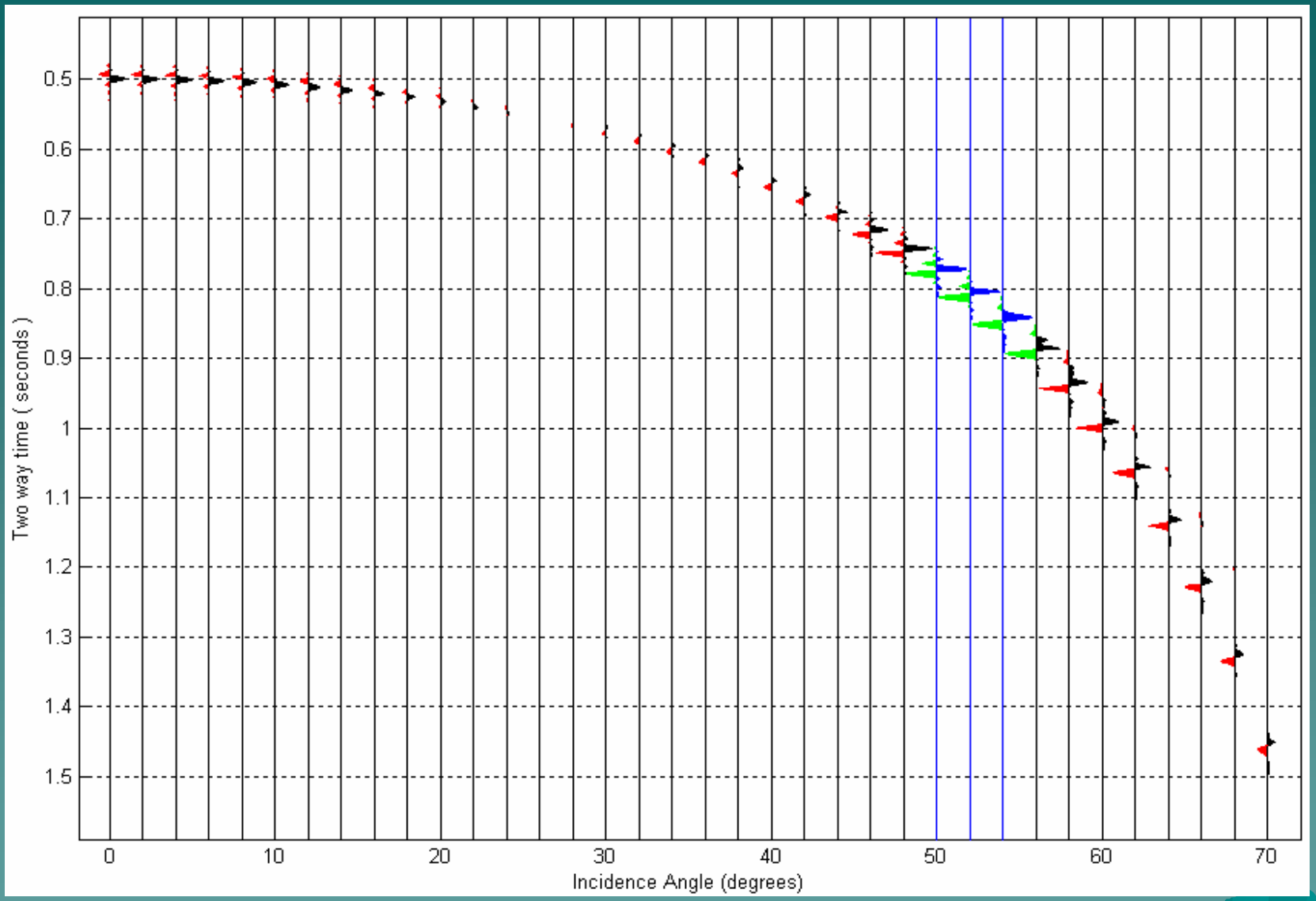


AVO Class 3 spherical wave PS reflection coefficient

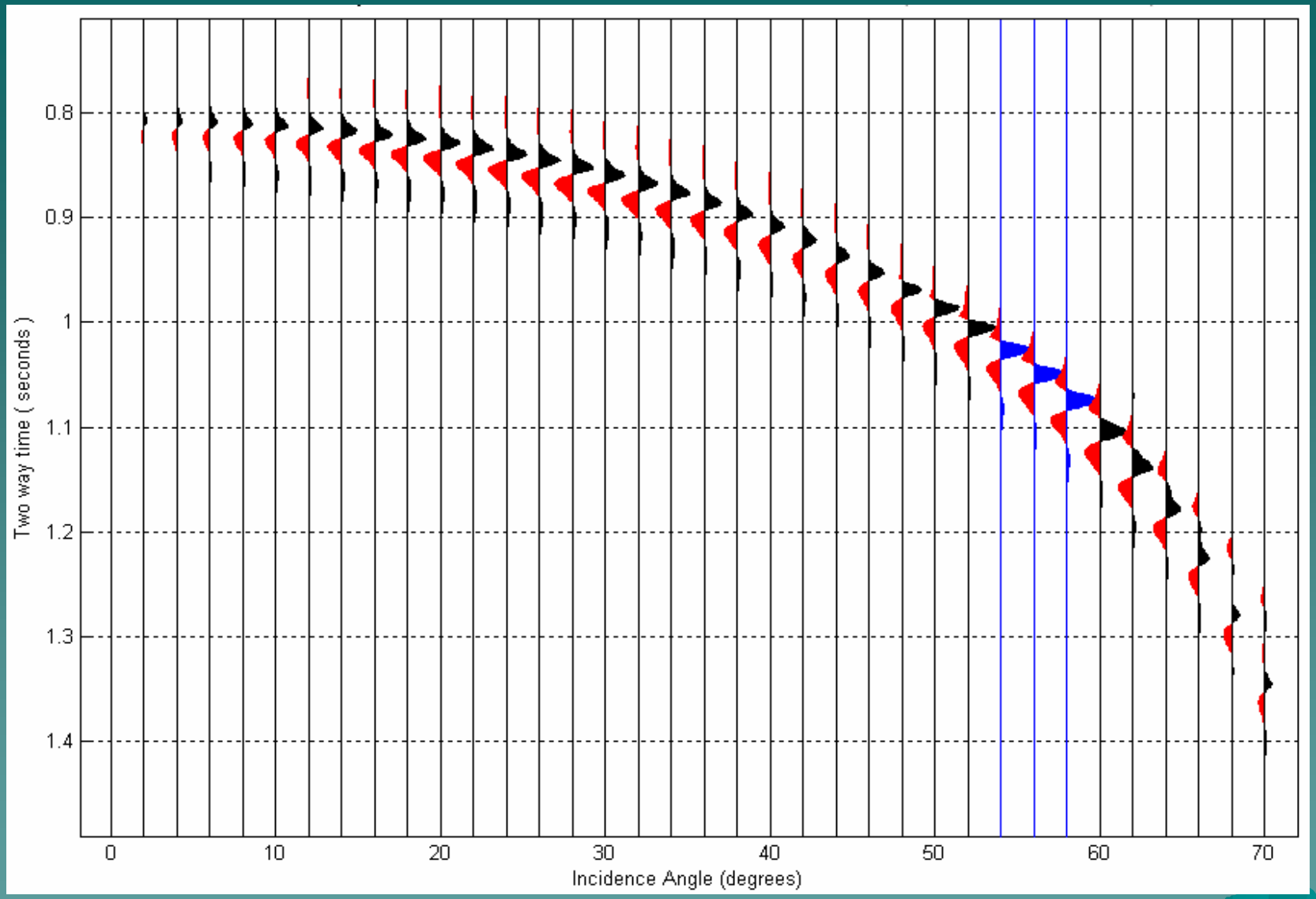
$$v(\omega) = v_{ref}\left(1 + \frac{\ln\left(\omega/\omega_{ref}\right)}{\pi Q} - \frac{i}{2Q}\right)$$

$$1/Q_P = \left(\frac{const}{V_P}\right)^2 \qquad Q_S = Q_P \frac{4}{3}\left(\frac{V_S}{V_P}\right)^2$$

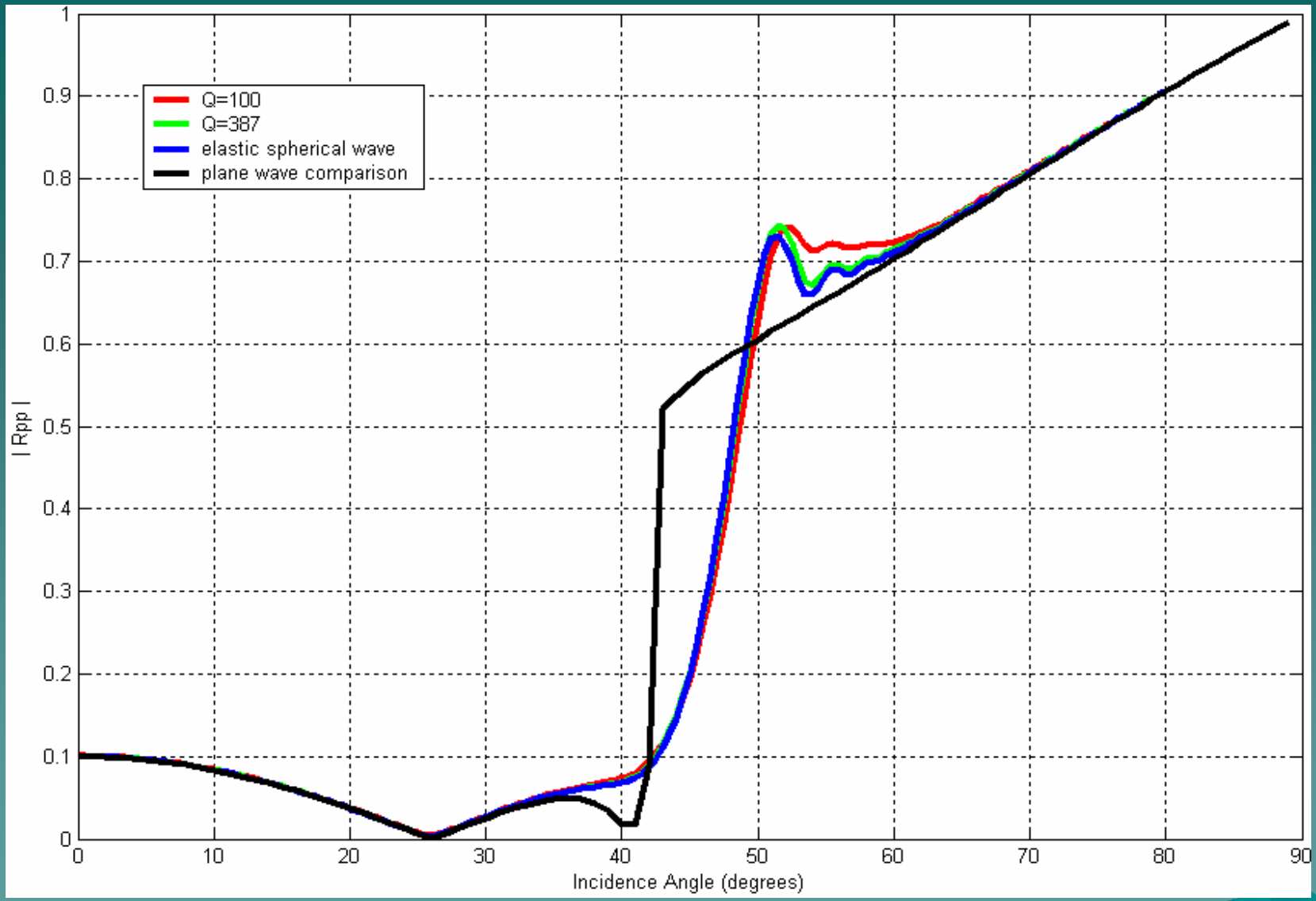
Velocity dispersion and empirical Q-equations



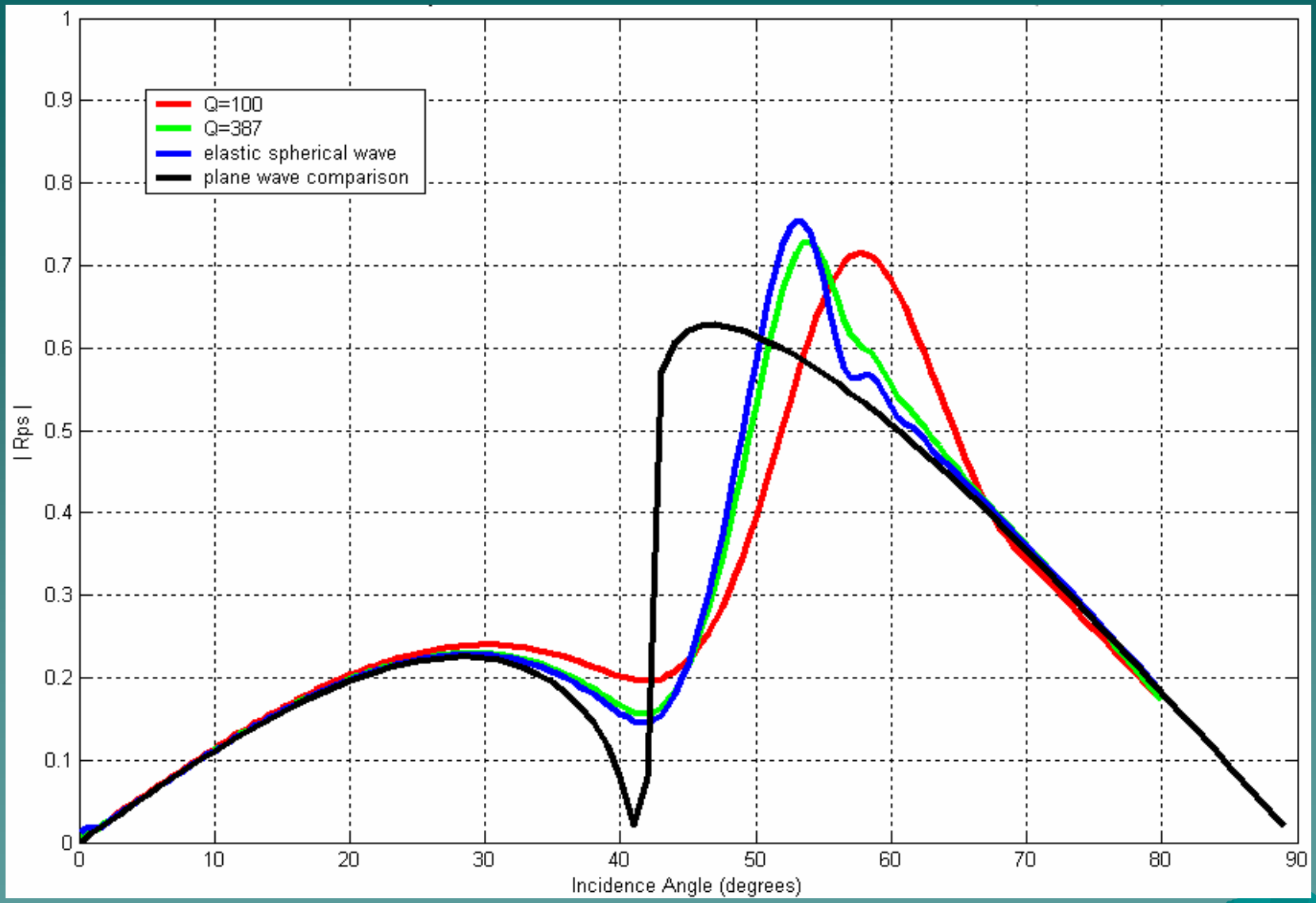
Class 1 spher. wave PP refl. traces (Q=100, z=500m)



Class 1 spher. wave PS refl. traces (Q=100, z=500m)



Anelastic Class 1 spher. wave PP refl. coeffs. (z=500m)



Anelastic Class 1 spher. wave PS refl. coeffs. (z=500m)

Conclusions

- Class 1 and Class 2 models show significant amplitude deviations near the critical angle even at 2000m depth
- Class 3 models, which have no P-wave critical angle, show no fundamental deviation from plane wave behaviour
- Q-dependence of normalized AVO responses mimics depth dependence to some degree
- Wavelet phase has a minor post-critical influence

Acknowledgements

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