Reflectivity and Related *Matlab* Software

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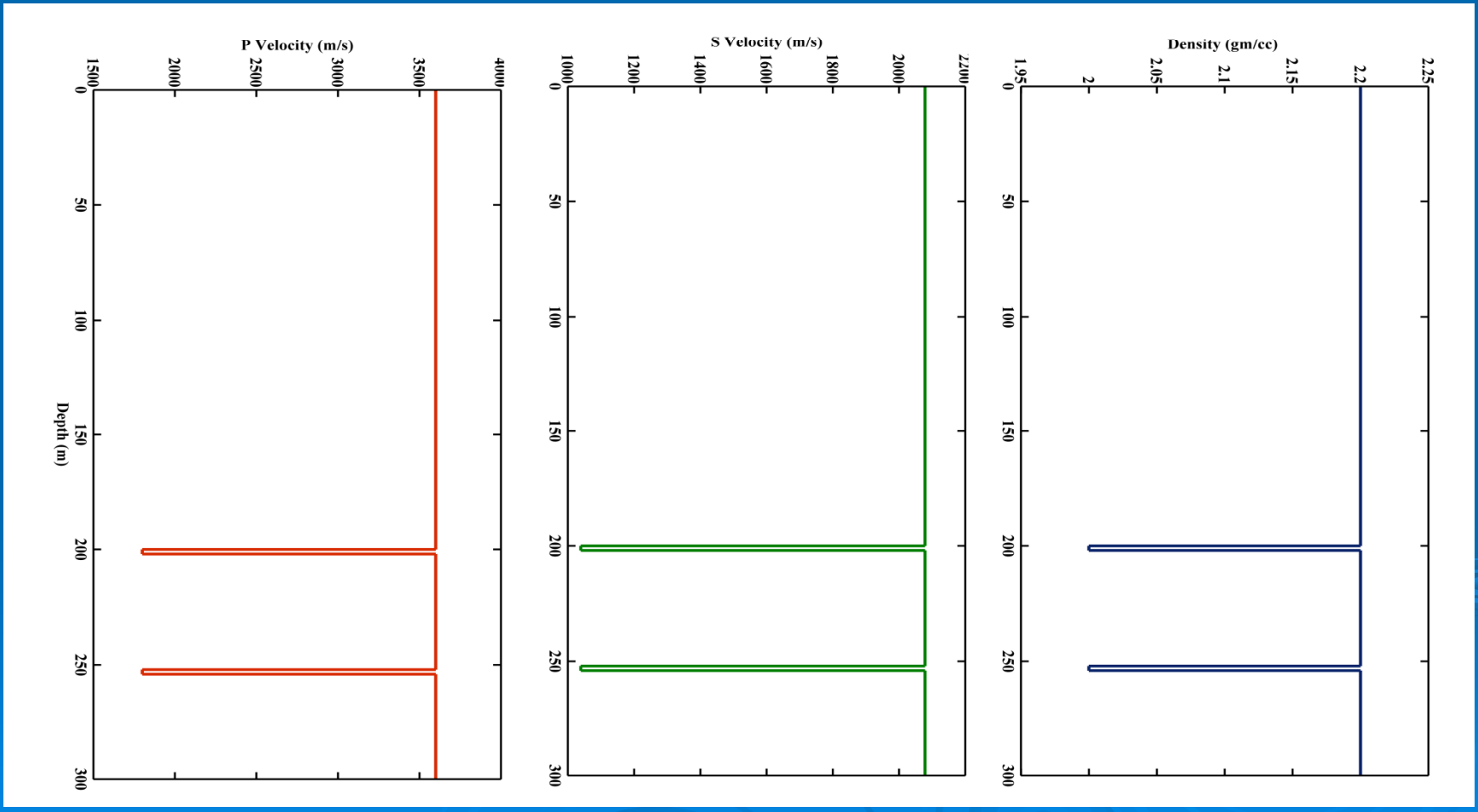
Introduction

- **Reflectivity Theory may be found in numerous works – tutorial of Müller (1985) and cited works.**
- **Also, quite a number of free Reflectivity (Fortran) programs available.**
- **One used here is from *FreeUSP* as it was the best suited for translation to *Matlab*.**
- **CREWES also has “reflectivity.m” by Loures, Ma, and Cheng in Matlab toolbox**

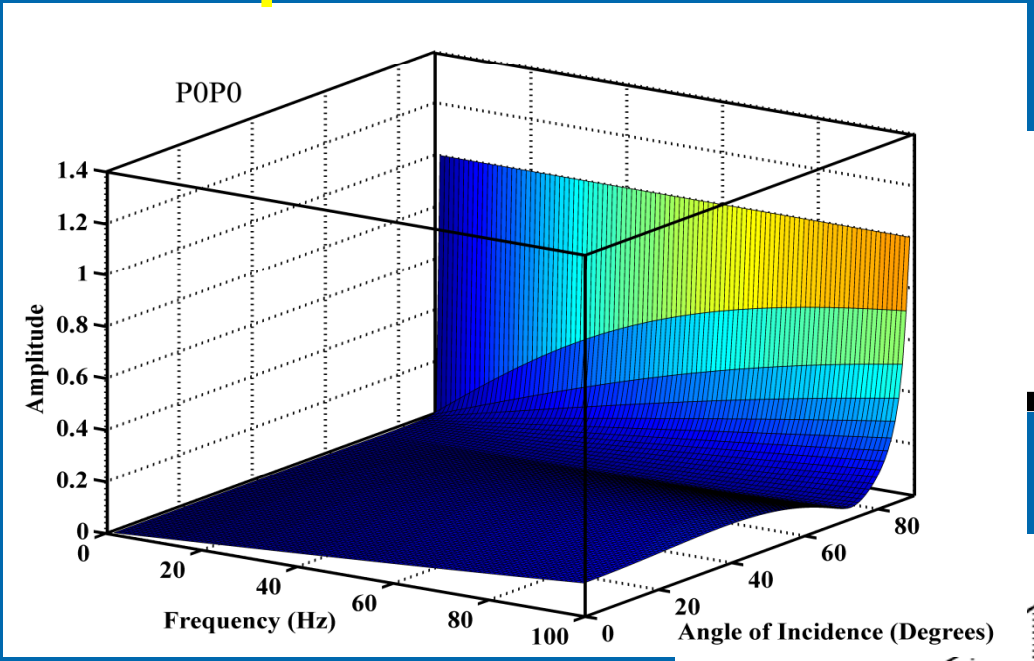
Ray – Reflectivity Method (RRM)

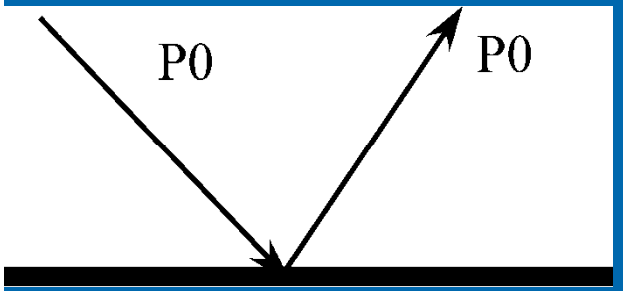
- Combine the “best” attributes of Asymptotic Ray Theory (ART) and the Reflectivity Method (RM).
- ART in thick layers.
- RM in thin layered zones, which are then treated as quasi interfaces.
- Report from 2009 Meeting

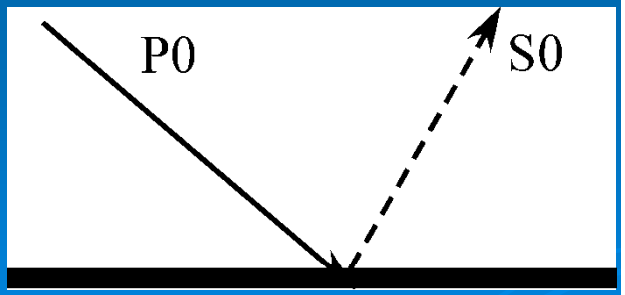
Simple 2 Layer Model

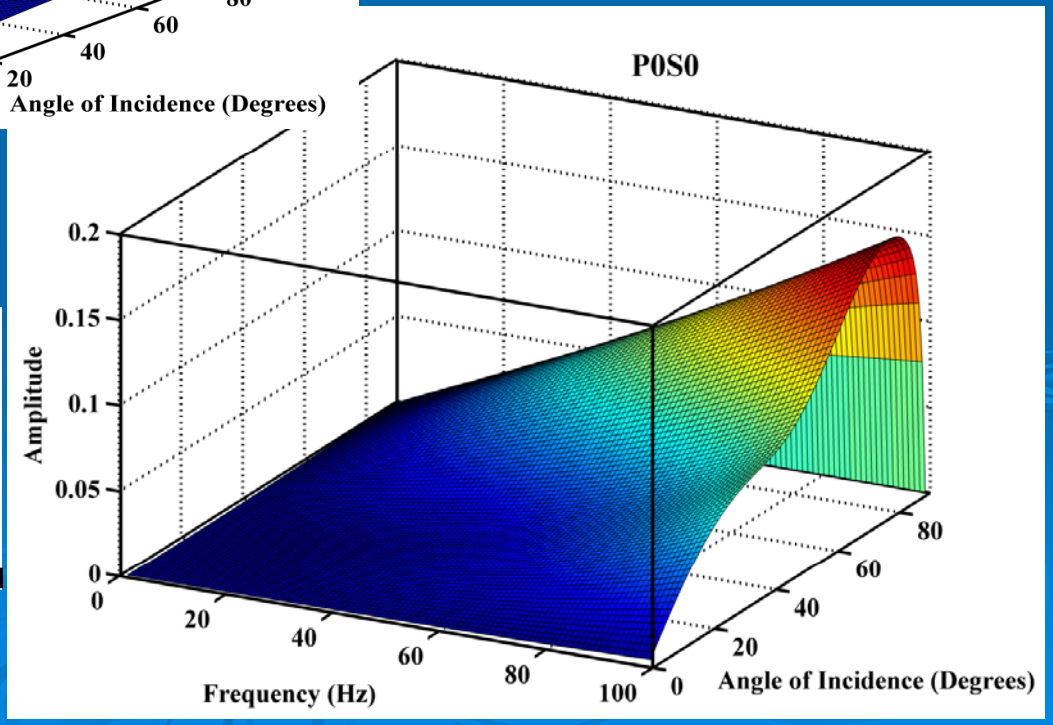


Composite reflection coefficients



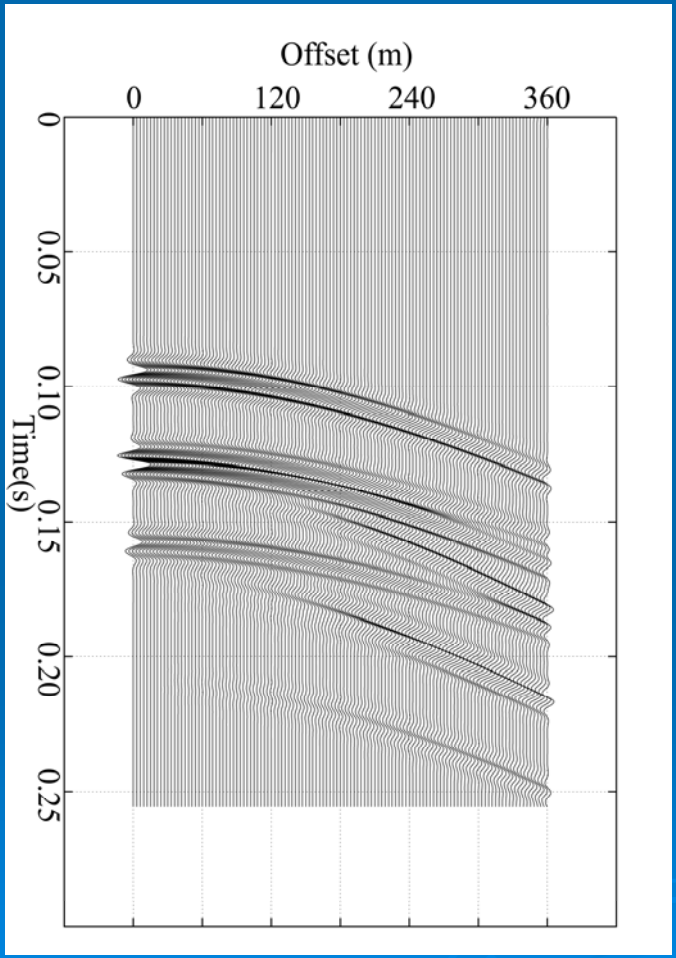




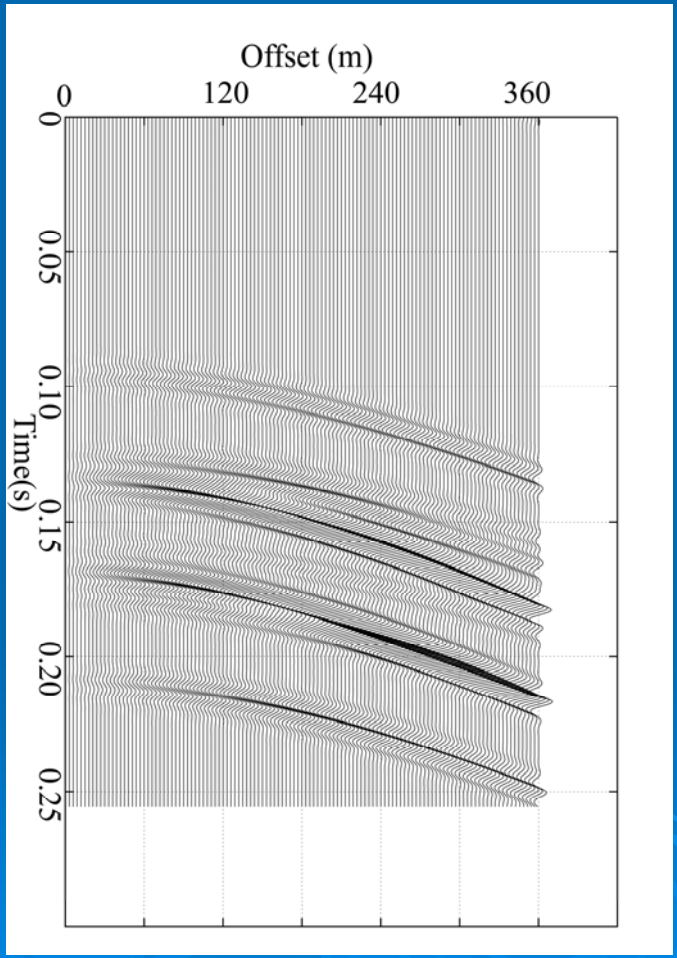


RRM Synthetics

Vertical Component



Horizontal Component



No Scaling

Reflectivity Method Basics

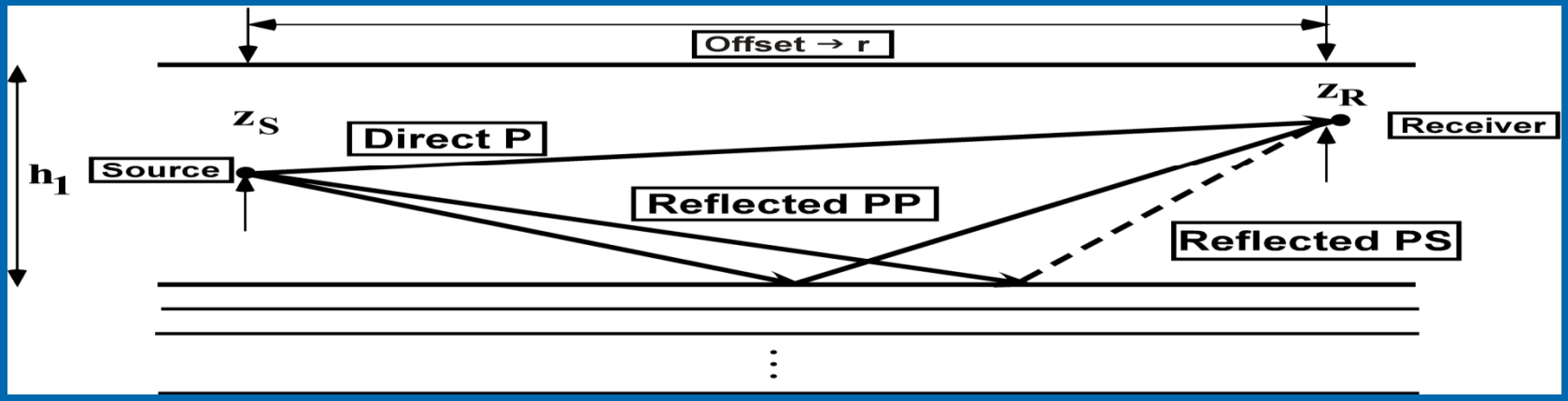
Numerical Integration Over Horizontal Component of Slowness Vector - *p*

$$K(r,\omega)=\omega^2\int_0^{\infty}K(p,\omega)J_n(\omega pr)\,p\,dp$$

Infinite Integration Replaced by a Wave Number Summation Over Some Finite Interval

$$(0,\infty)\ \rightarrow\ (0,p_{Max})$$

Standard Geometry for RM



Integration Kernel

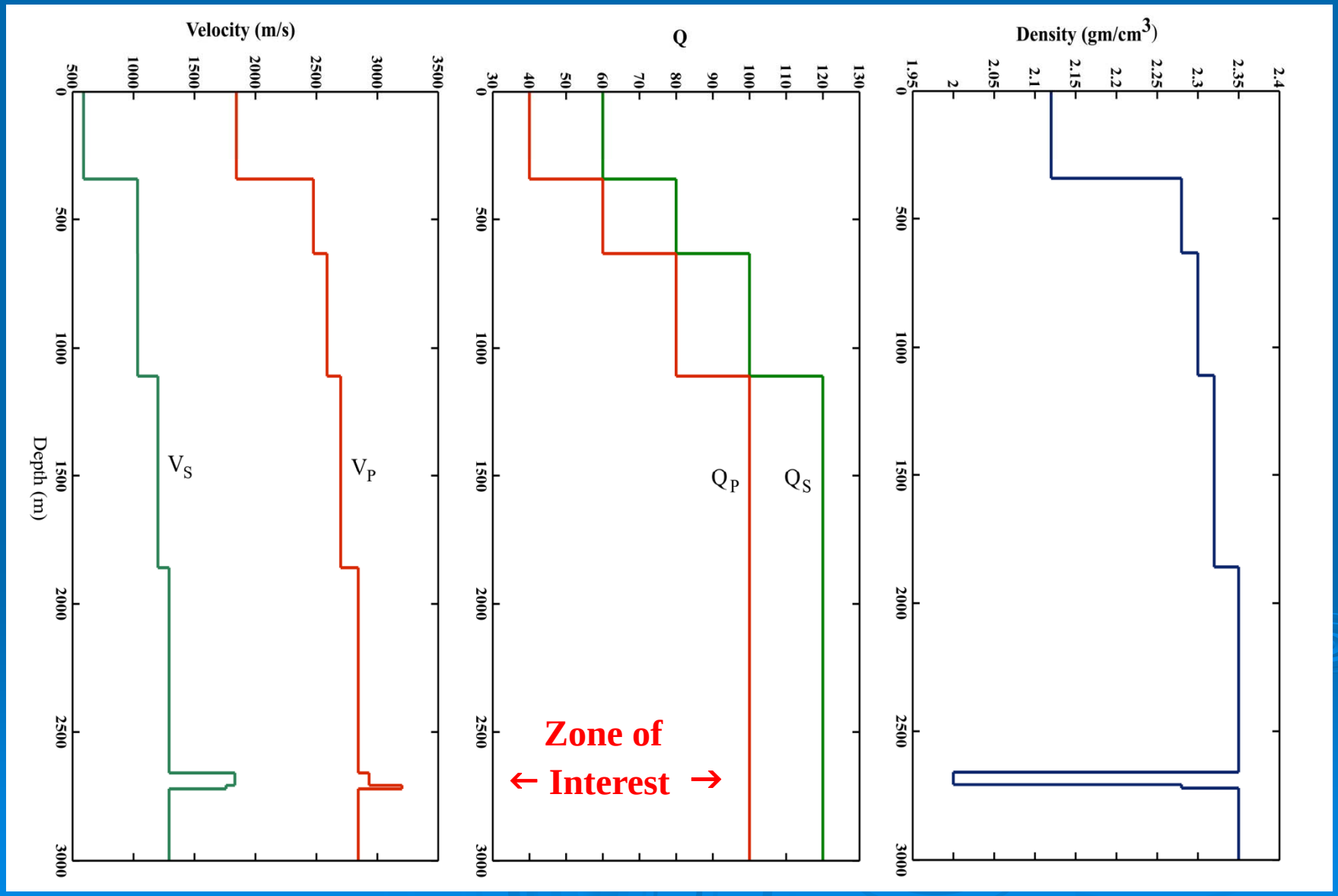
$$\eta_1 = \left(1/\beta_1^2 - p^2\right)^{1/2} \qquad \xi_1 = \left(1/\alpha_1^2 - p^2\right)^{1/2}$$

$$K(p,\omega) = \exp\left[-i\omega\left(t - \left|z_S - z_B\right|\xi_1\right)\right] +$$

$$R_{PP}(p,\omega)\exp\left[-i\omega\left(t - \left(2h_1 - z_S - z_R\right)\right)\right] +$$

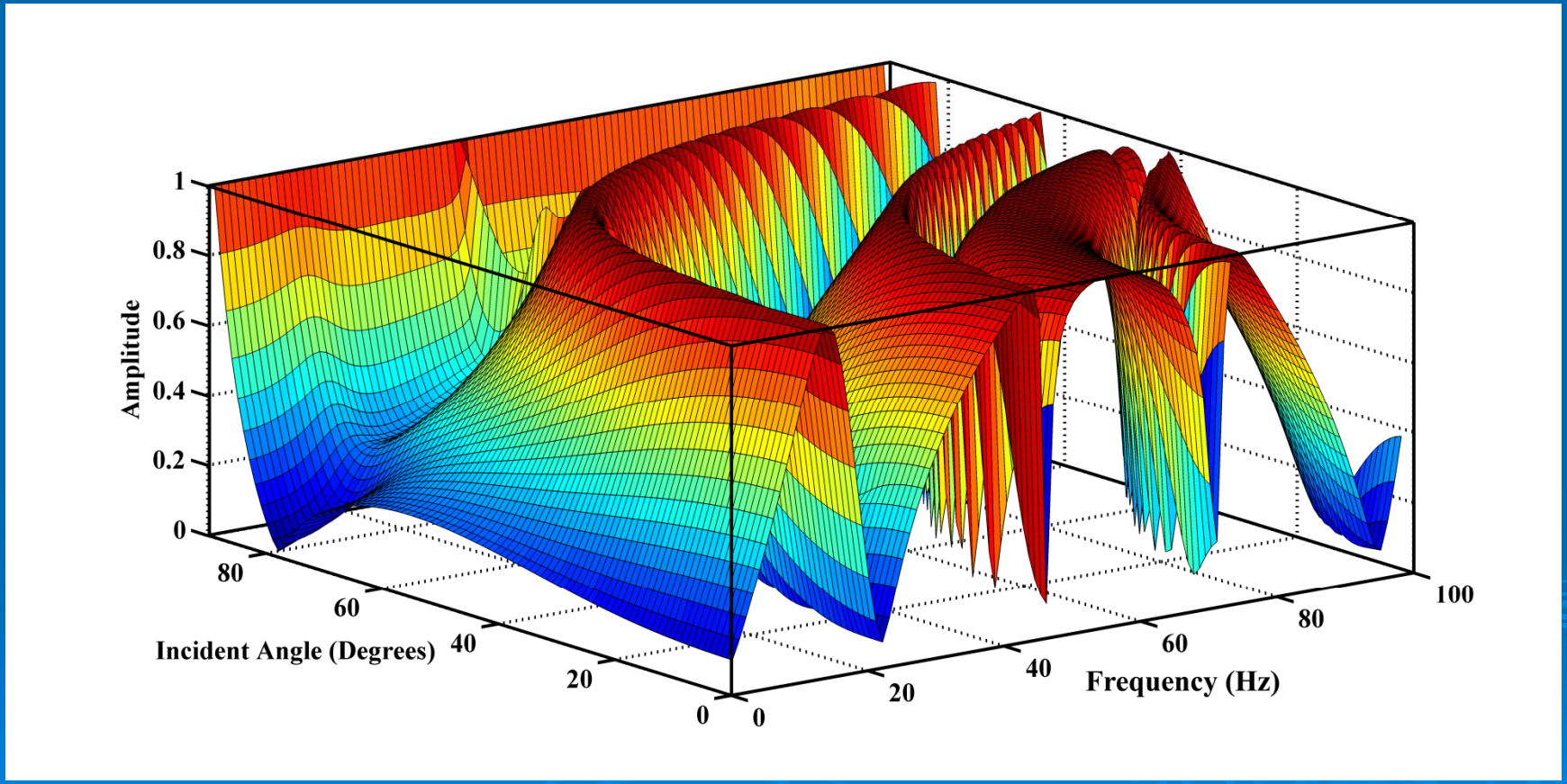
$$R_{PS}(p,\omega)\exp\left[-i\omega\left(t - \left(h_1 - z_S\right)\xi_1 - \left(h_1 - z_R\right)\eta_1\right)\right]$$

A Realistic Model

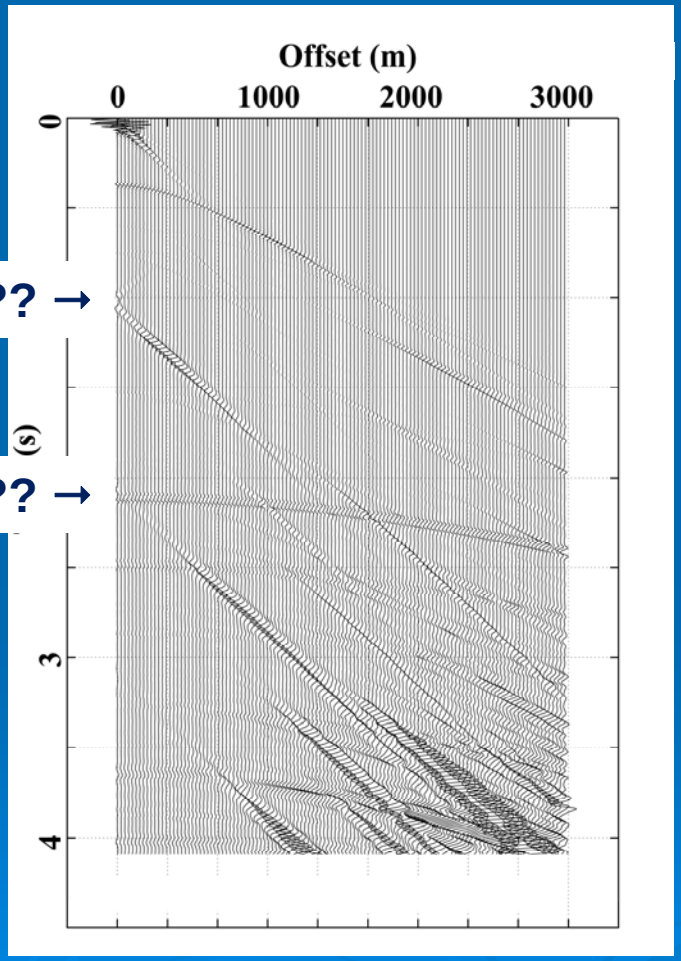


P1P1 Reflectivity

(From Zone of Interest)

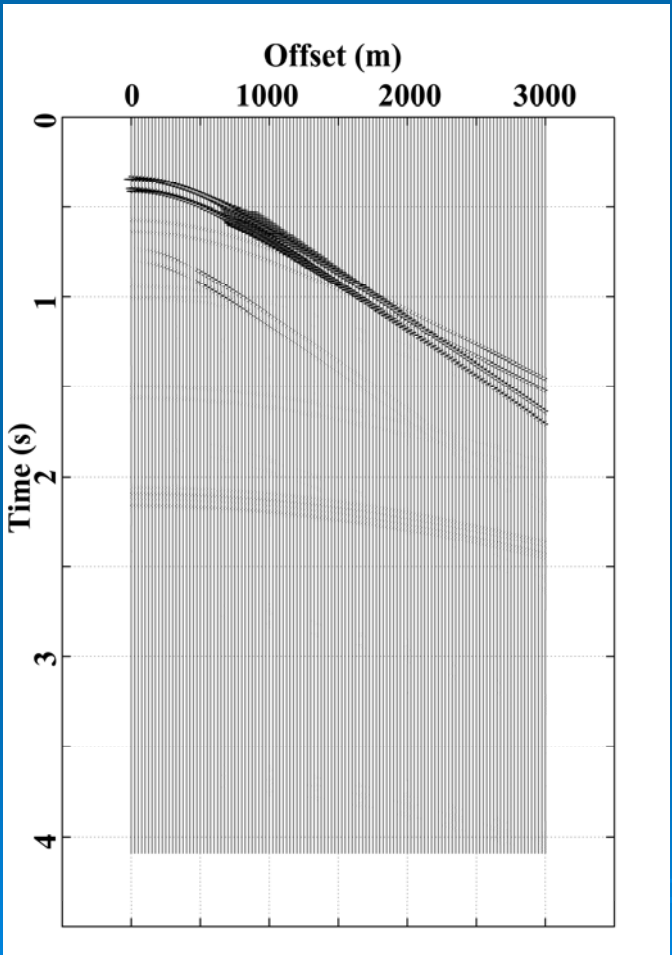


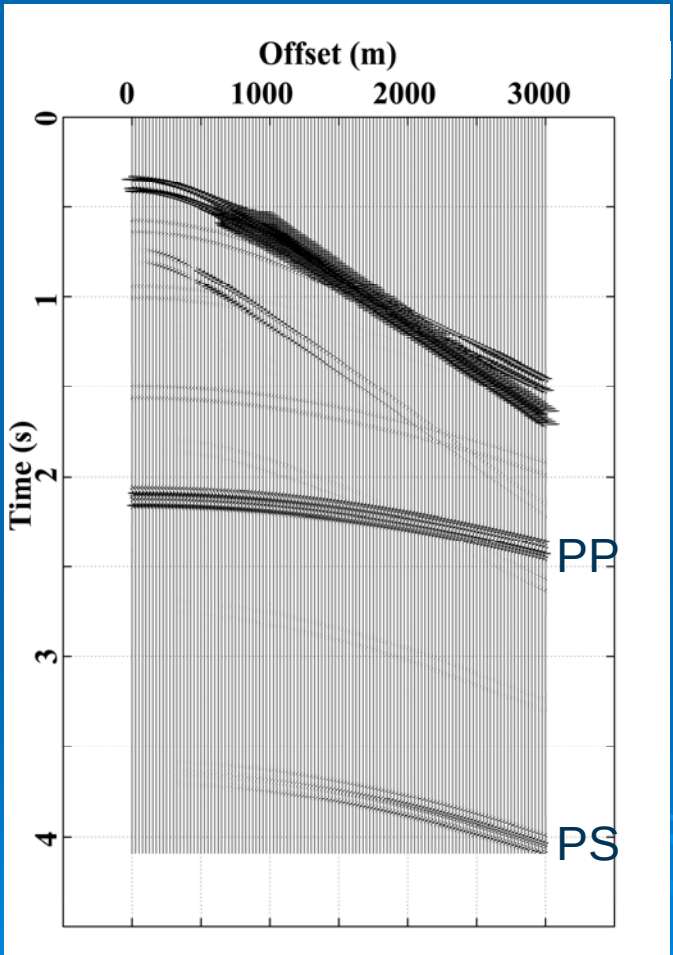
Reflectivity
Vertical Component



Exponential Scaling

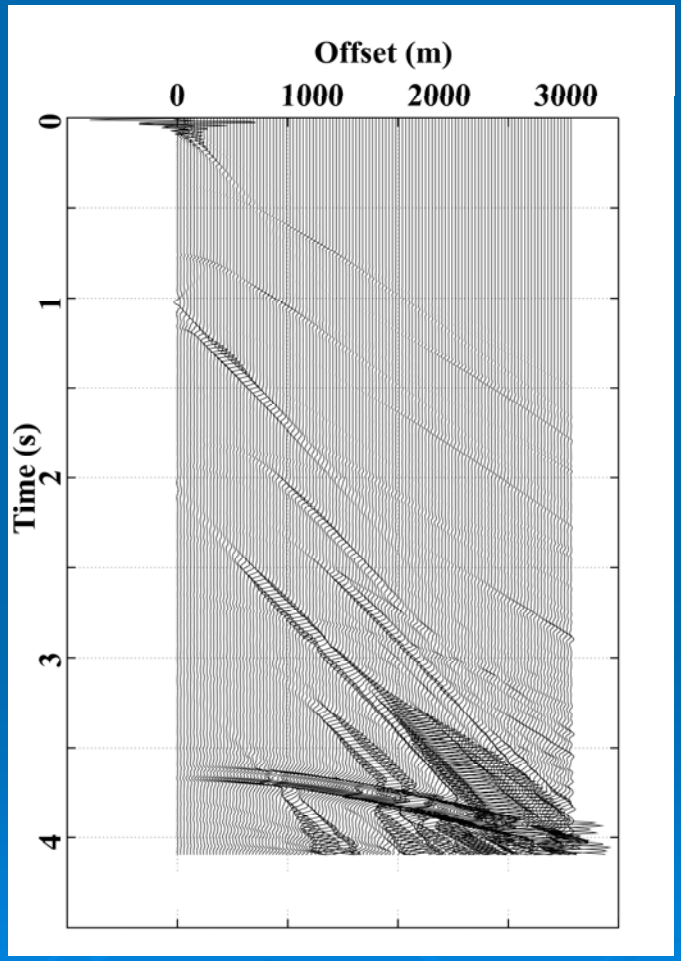
Ray – Reflectivity
Vertical Component





Exponential Scaling

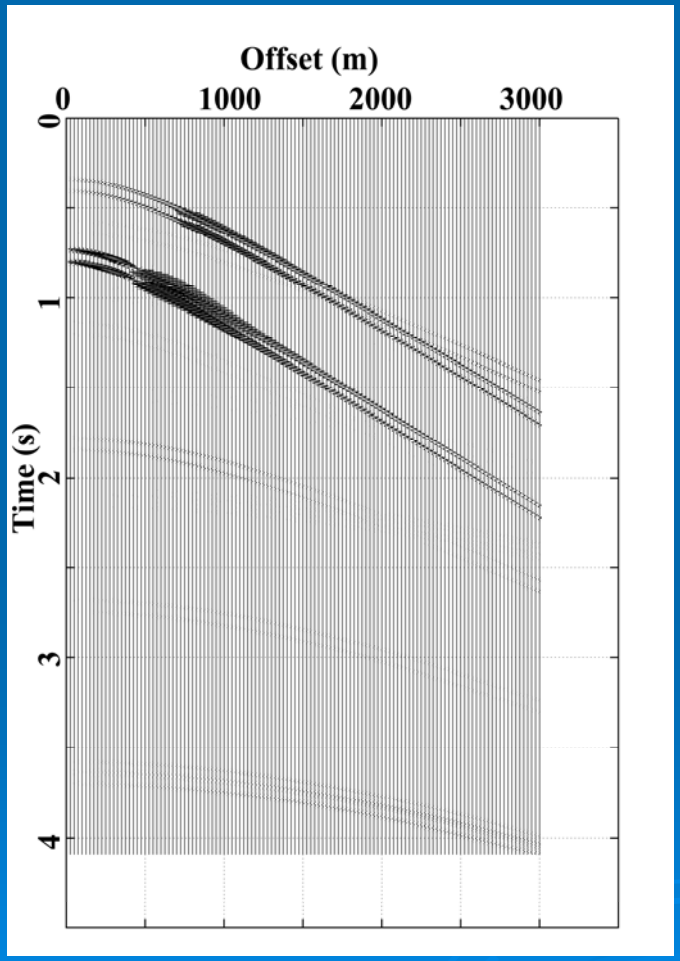
Reflectivity
Horizontal Component

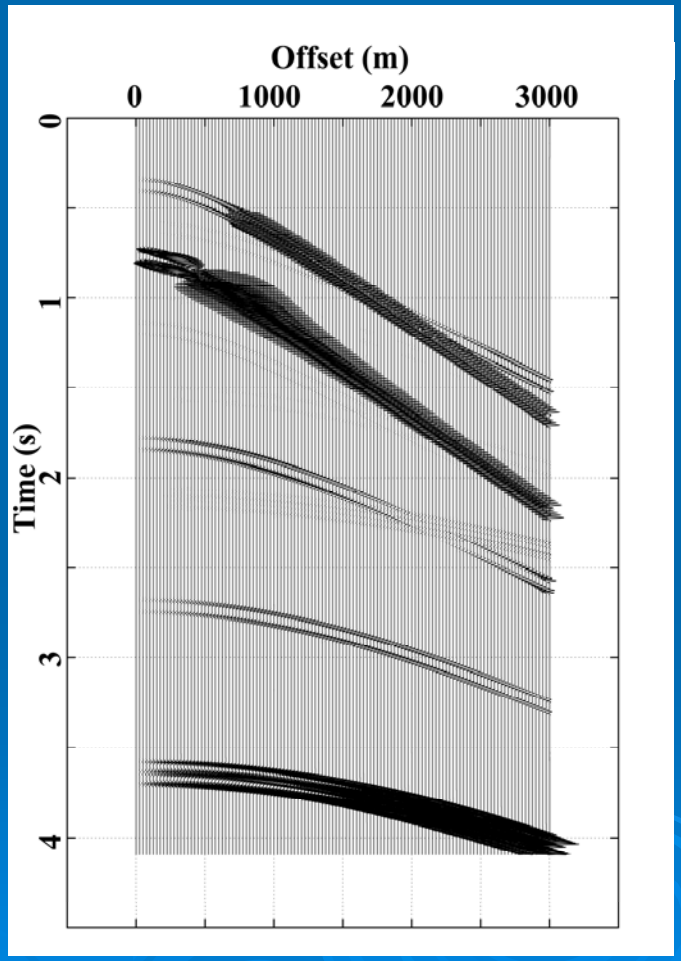


Event of interest obscured by reverberations from overburden.

Exponential Scaling

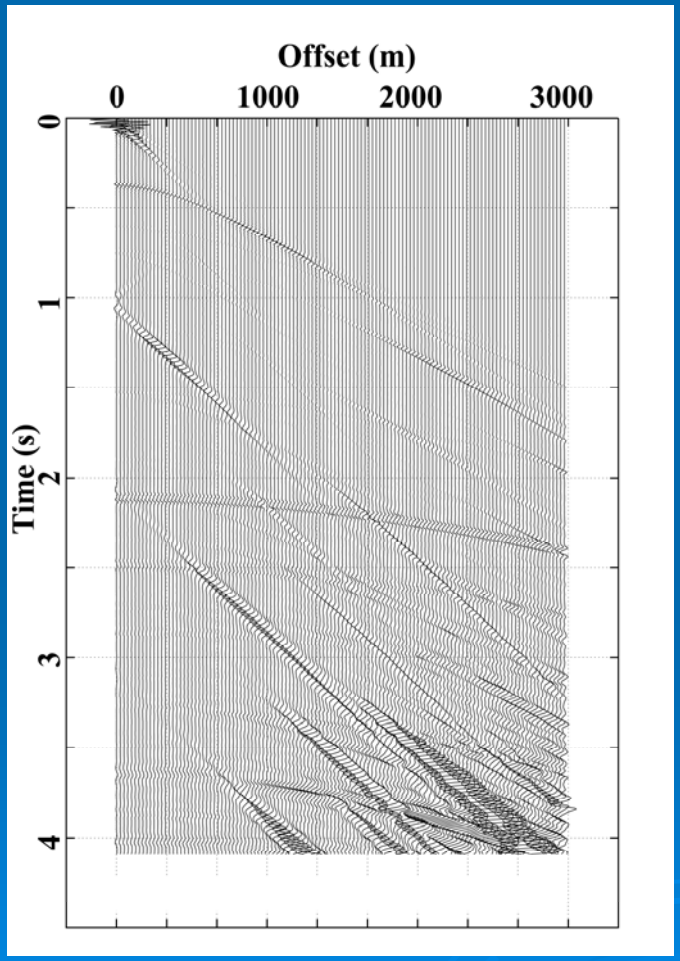
Ray – Reflectivity Horizontal Component

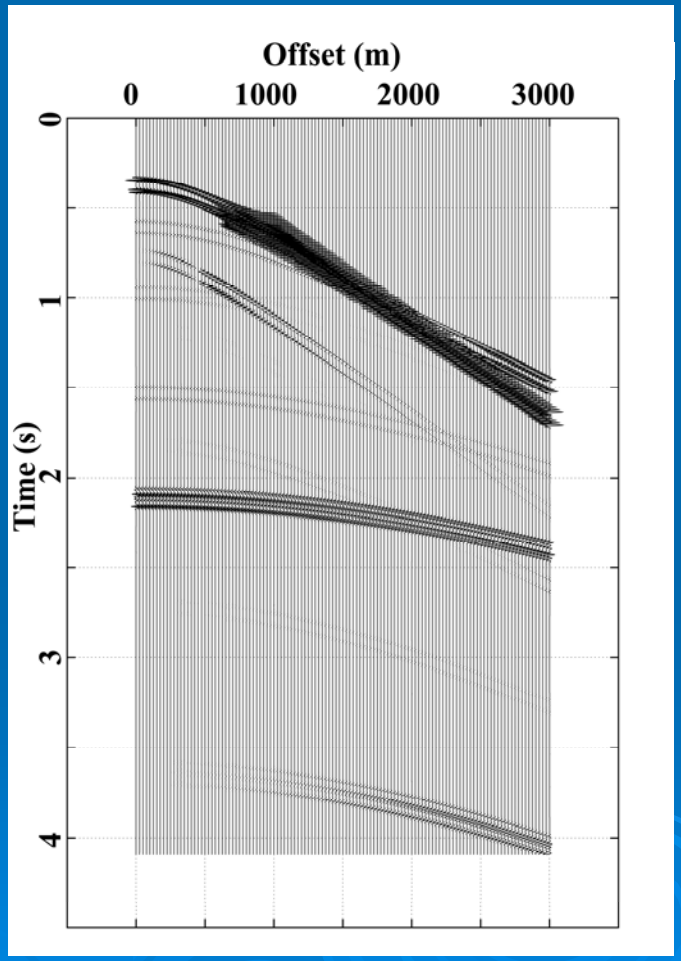




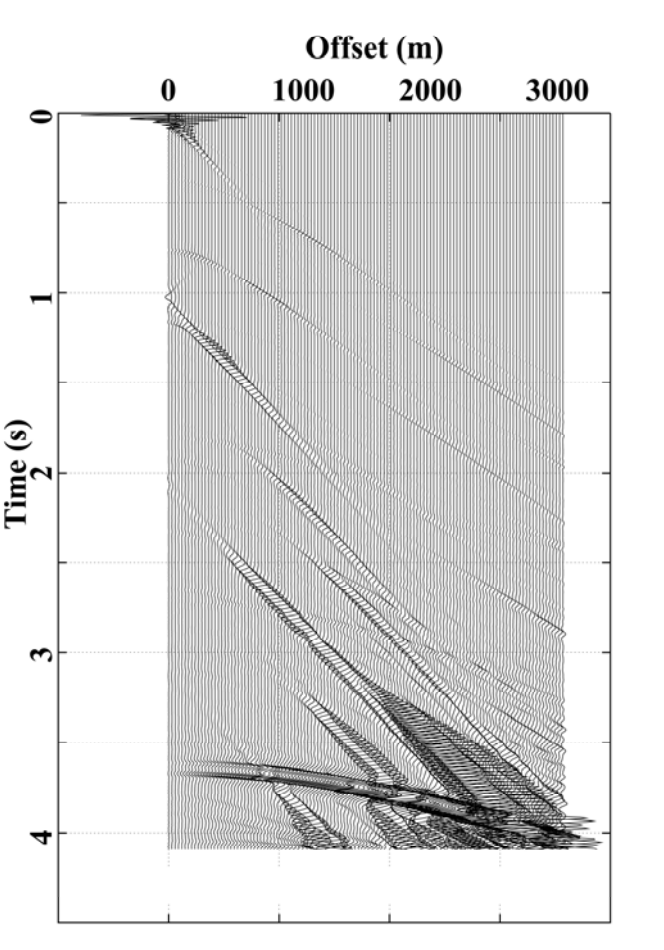
Exponential Scaling

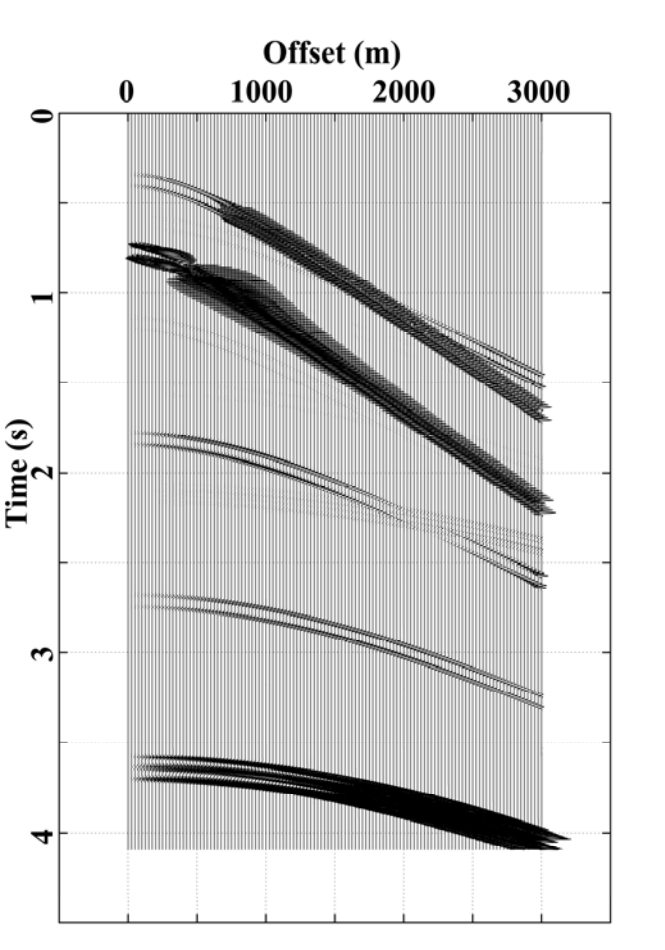
Compare Vertical





Compare Horizontal





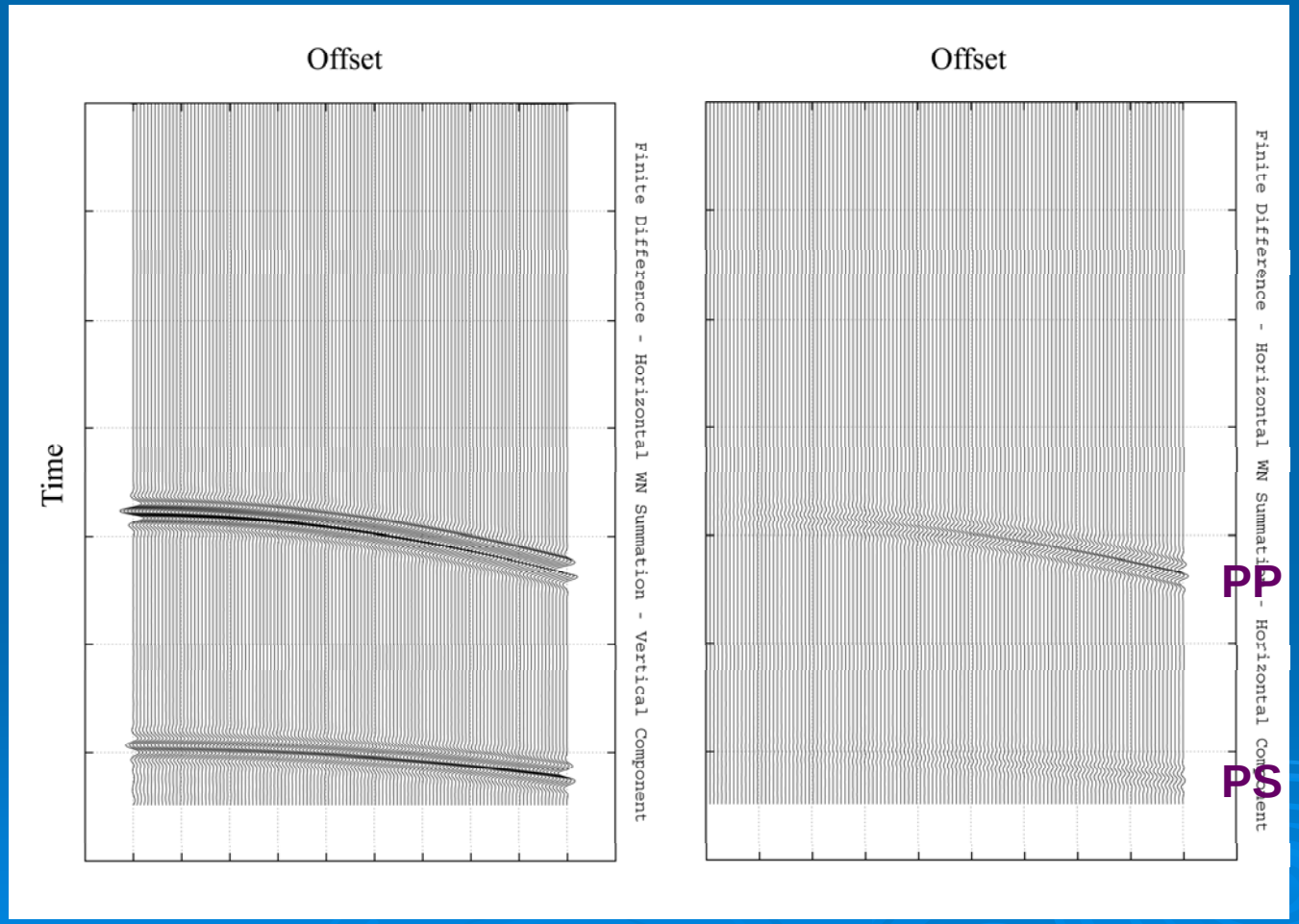
Comments

- Reflectivity results are not as good as should be expected. A comparison with another Fortran program, however, produced similar results.
- Alternative Ray Ref seems to produce better results with fewer artifacts.
- Rewrite program using Finite Integral Transforms?
- Use a similar wave number summation method which employs FD as opposed to NI?

Re: Use a similar wave number summation method which employs FD as opposed to NI?

- Still has some artifacts but improved speed allows for *messing* about.
- Focus on the “zone of interest” using this method.
- Requires the model to be run 2 times but 3 times would be a more accurate estimate.

Finite Difference (Extreme Mode) with Wave Number Summation in the Radial Direction



Exponential Scaling

Acknowledgements

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