Q-estimation from uncorrelated Vibroseis VSP model data

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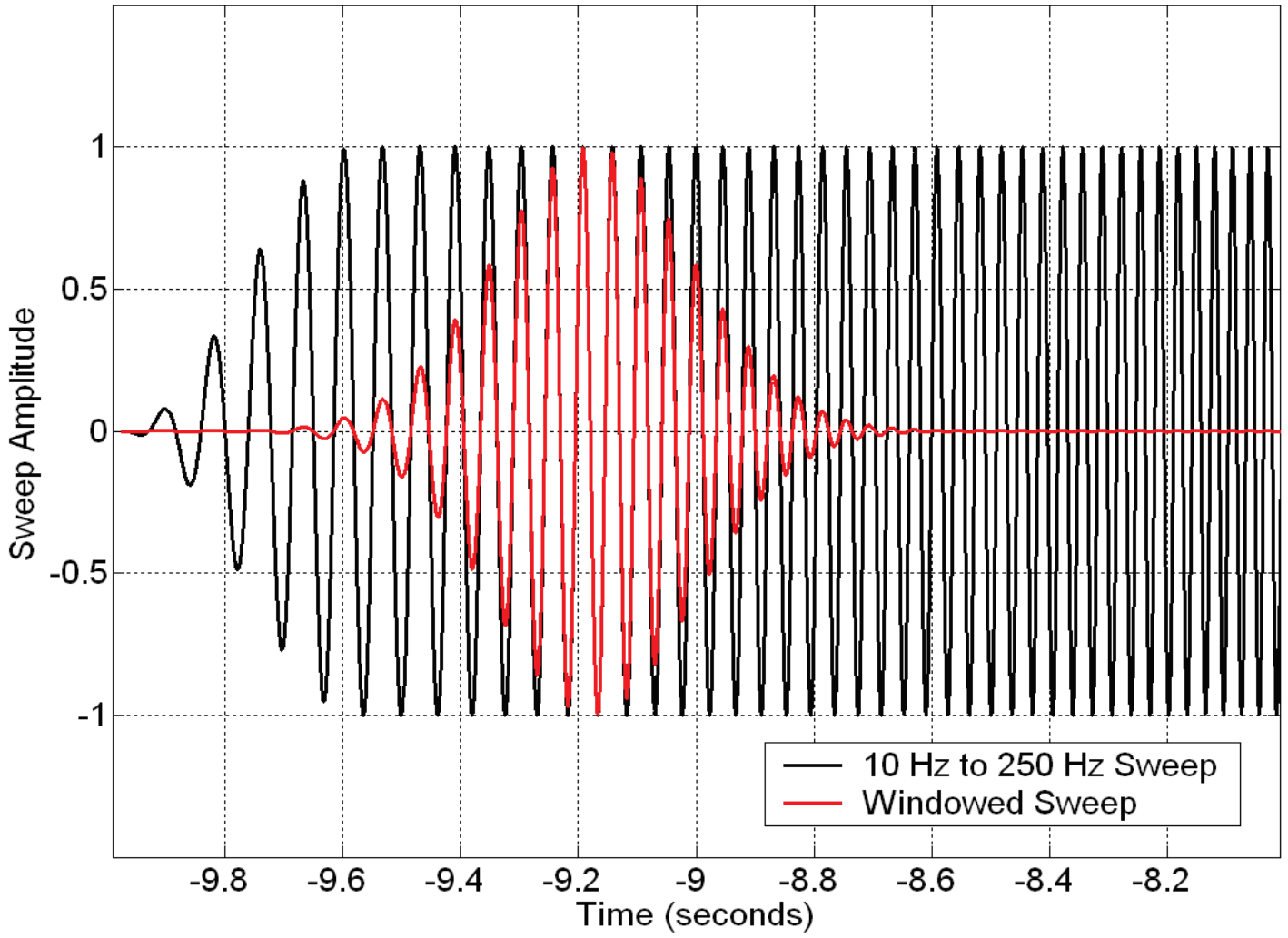
Outline

- Introduction
- Velocity dispersion (frequency dependent velocities V(f))
- Moving window cross-correlation
- The role of sample interval Δt
- A homogeneous earth model
- The well-log derived model and stratigraphic attenuation/amplification
- Conclusions
- Acknowledgements

$$\frac{V(f_2)}{V(f_1)} \approx 1 + \frac{\ln\left(f_2/f_1\right)}{\pi Q}$$

$$Q = \frac{\ln\left(f_2/f_1\right)}{\pi\left(\frac{V(f_2)}{V(f_1)} - 1\right)}$$

Velocity dispersion and Q-extraction

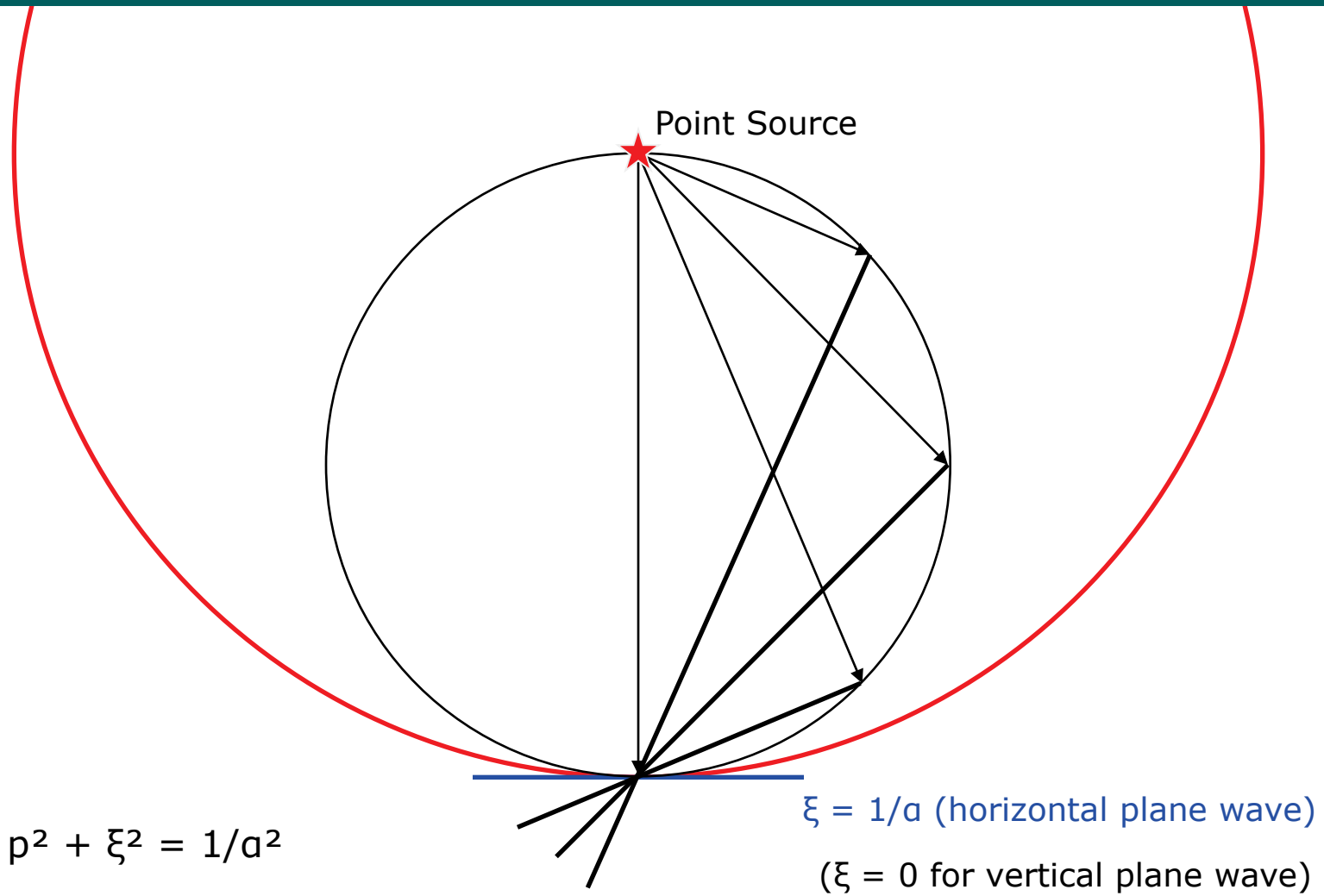


First part of a synthetic pilot sweep

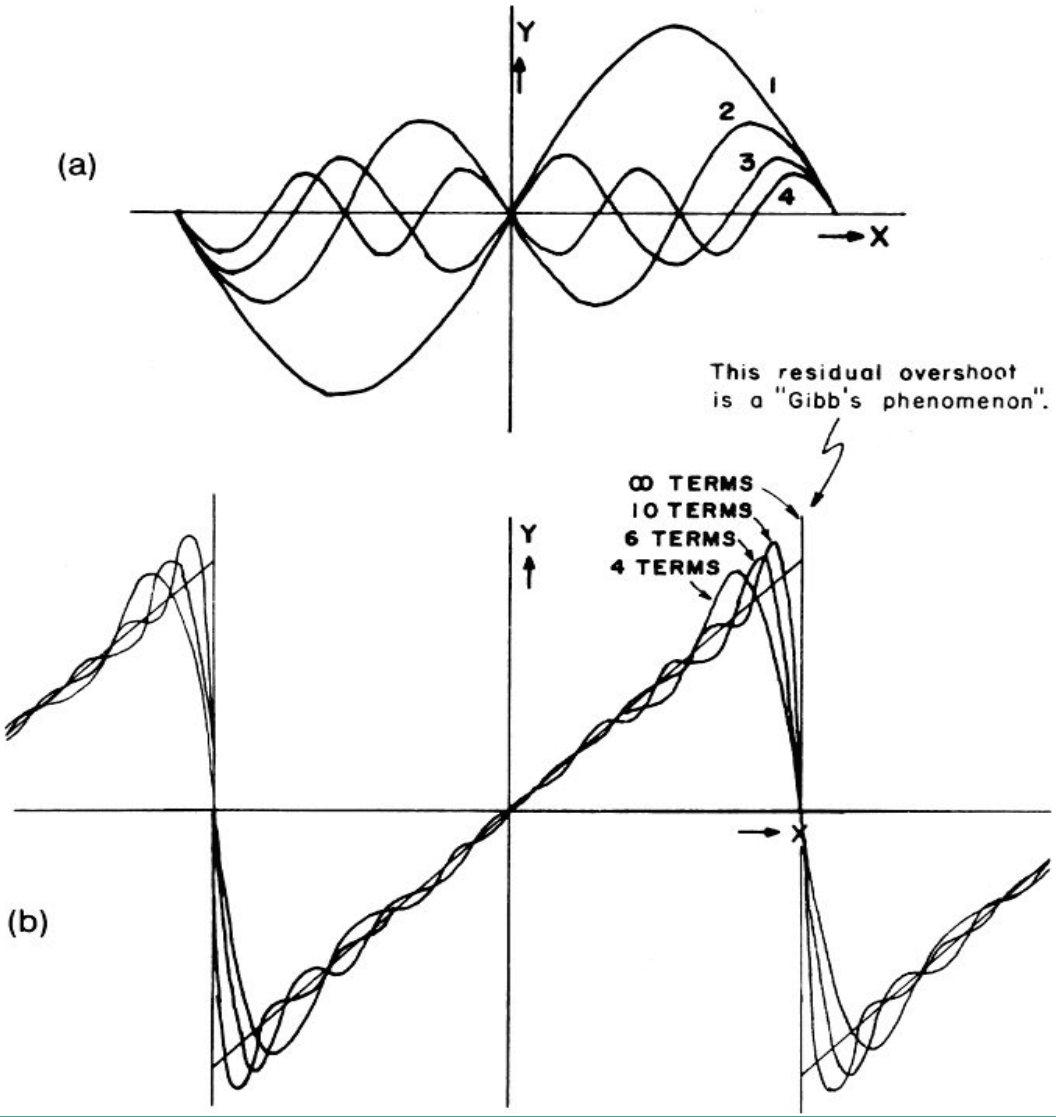
$$\varphi_j = \int_0^\infty Q_j' J_0(kr) e^{-\nu_j z} dk + \int_0^\infty Q_j'' J_0(kr) e^{\nu_j z} dk$$

$$\psi_j = \int_0^\infty S_j' J_0(kr) e^{-\nu_j' z} dk + \int_0^\infty S_j'' J_0(kr) e^{\nu_j' z} dk$$

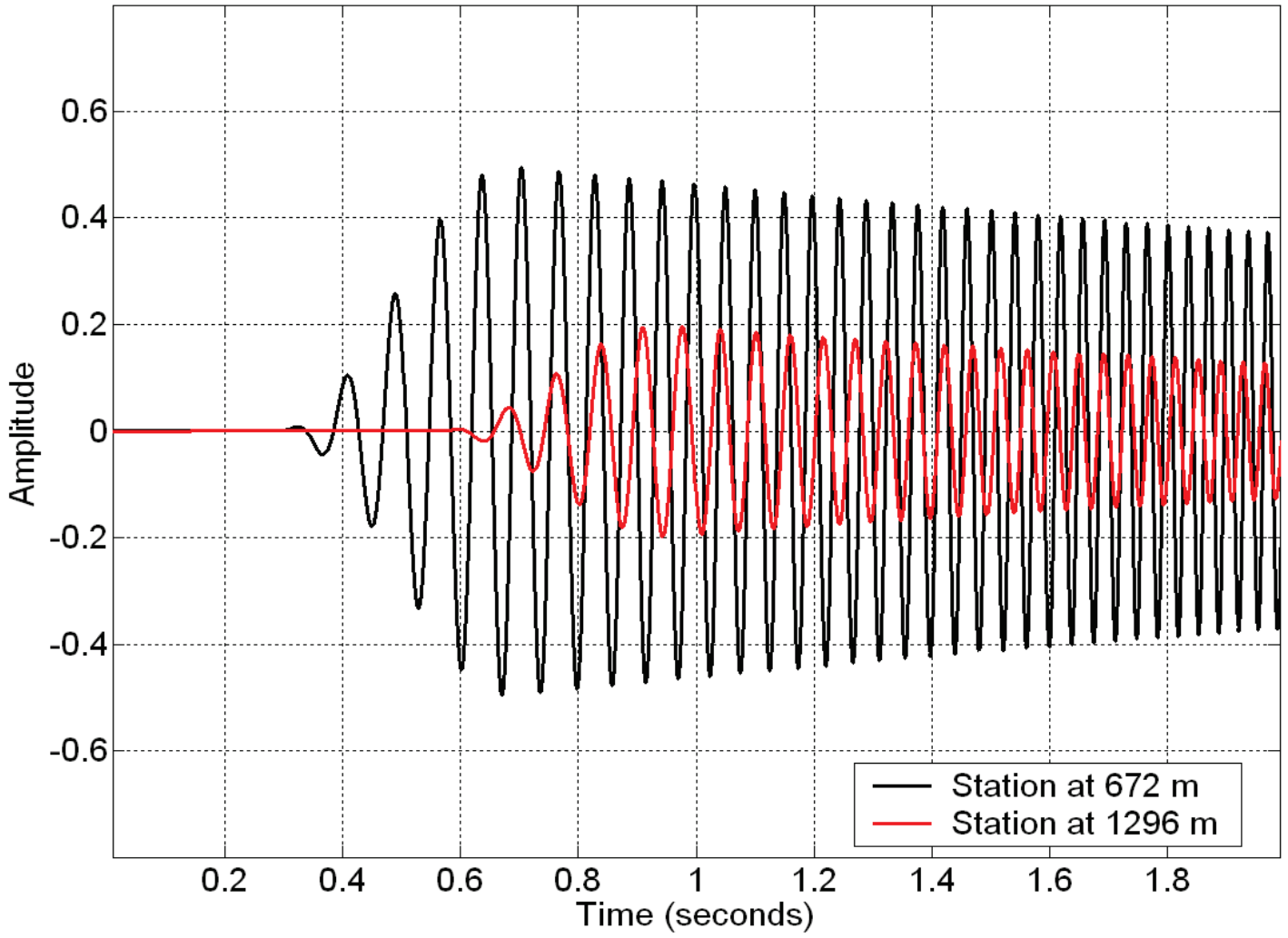
Potential of Down-Going and Up-Going Waves in Layer *j* (Ewing, Jardetzky and Press, 1957)



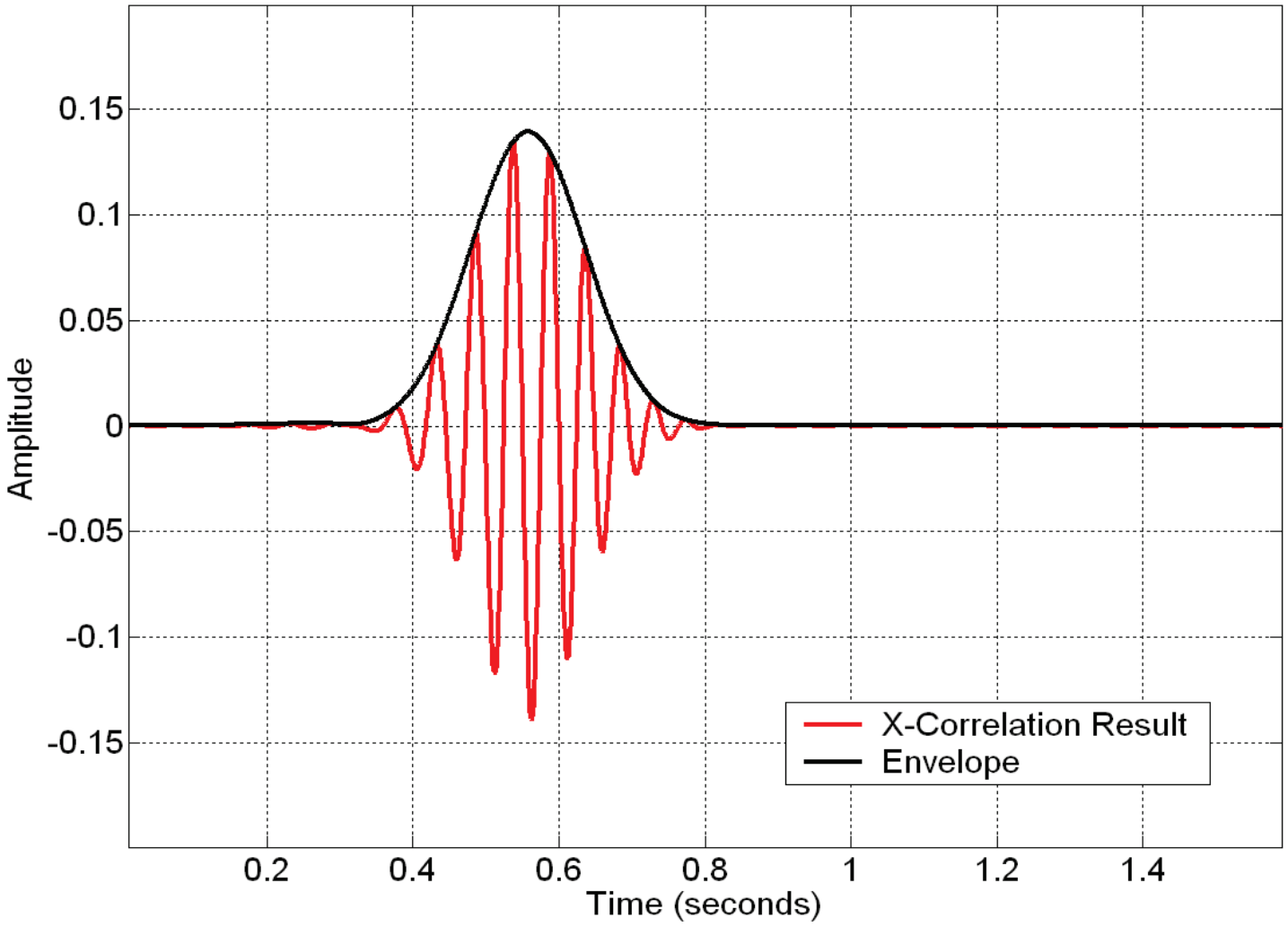
Plane Wave Components of a Spherical Wave



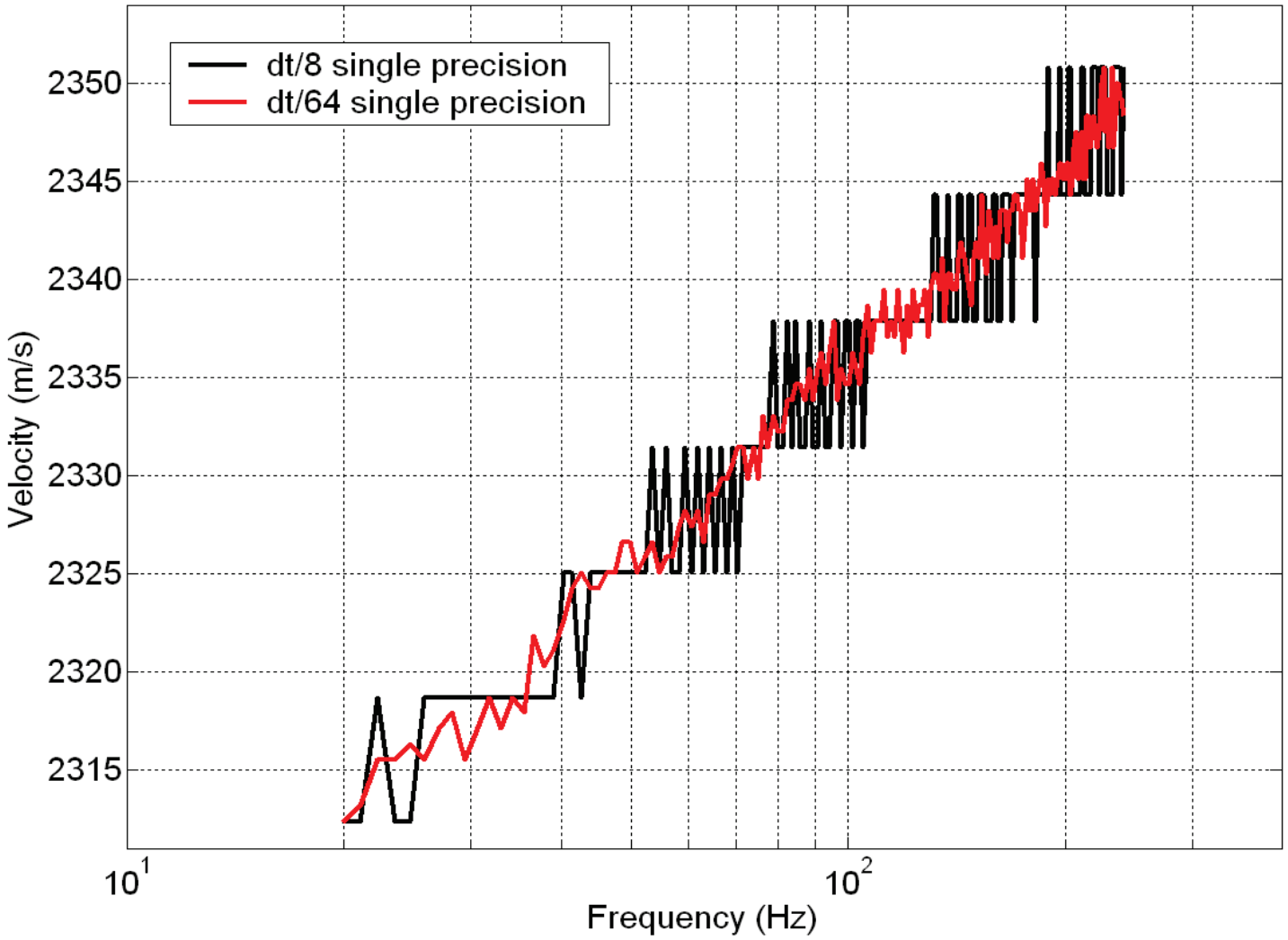
Frequency Components of a Waveform (Sheriff, 2002)



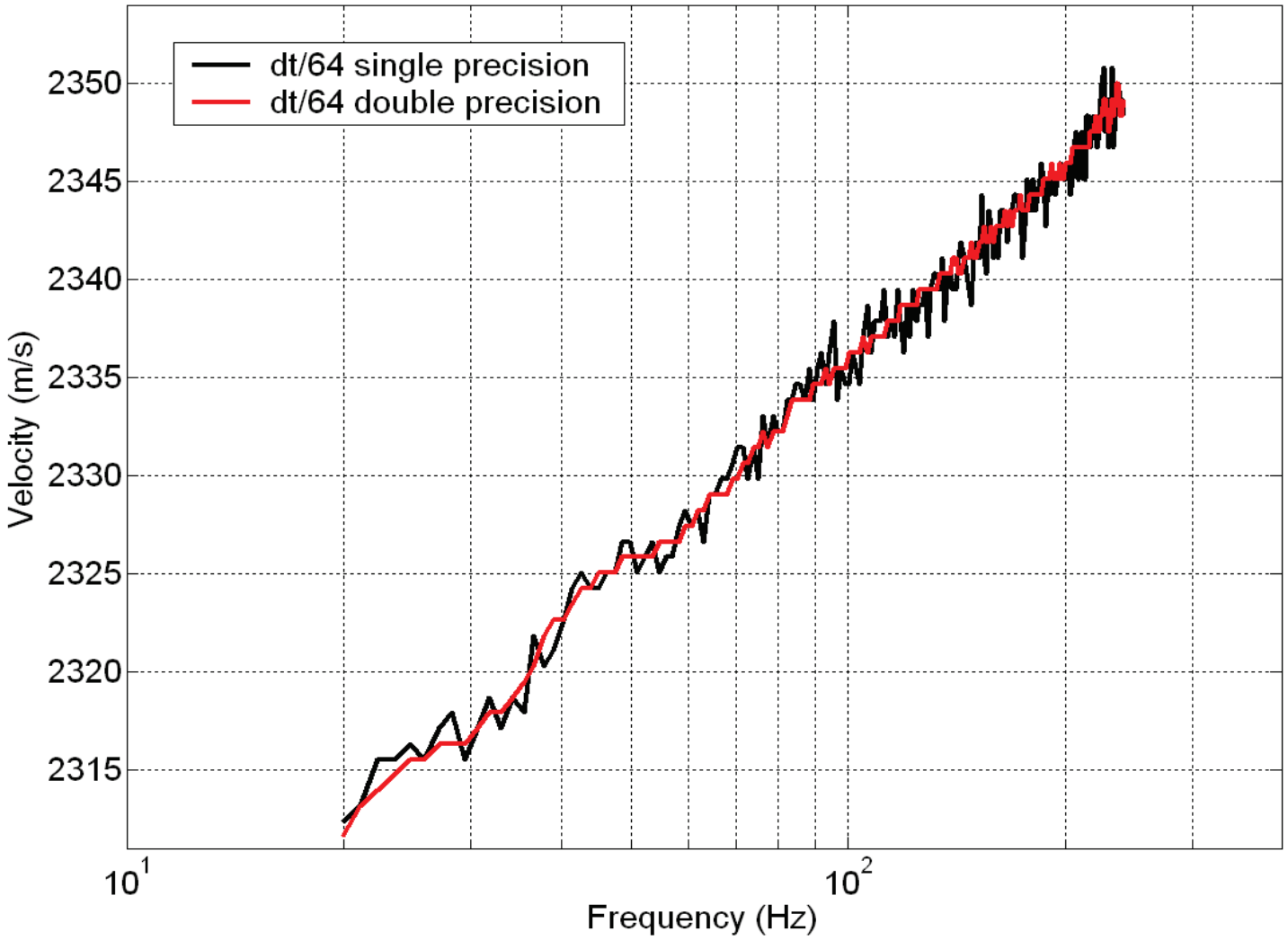
Uncorrelated VSP-trace as function of time



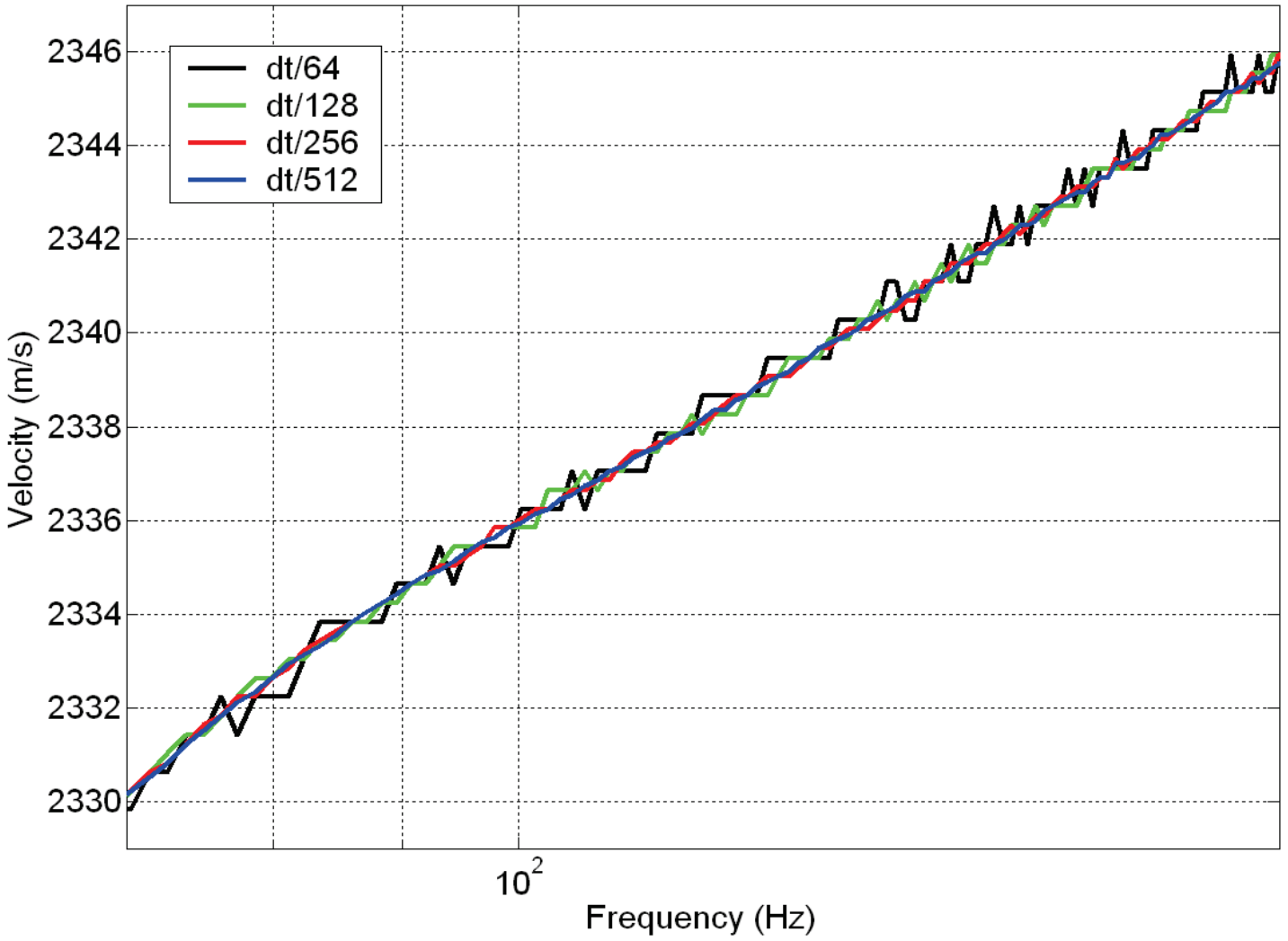
Cross-correlation of windowed sweep and VSP-trace



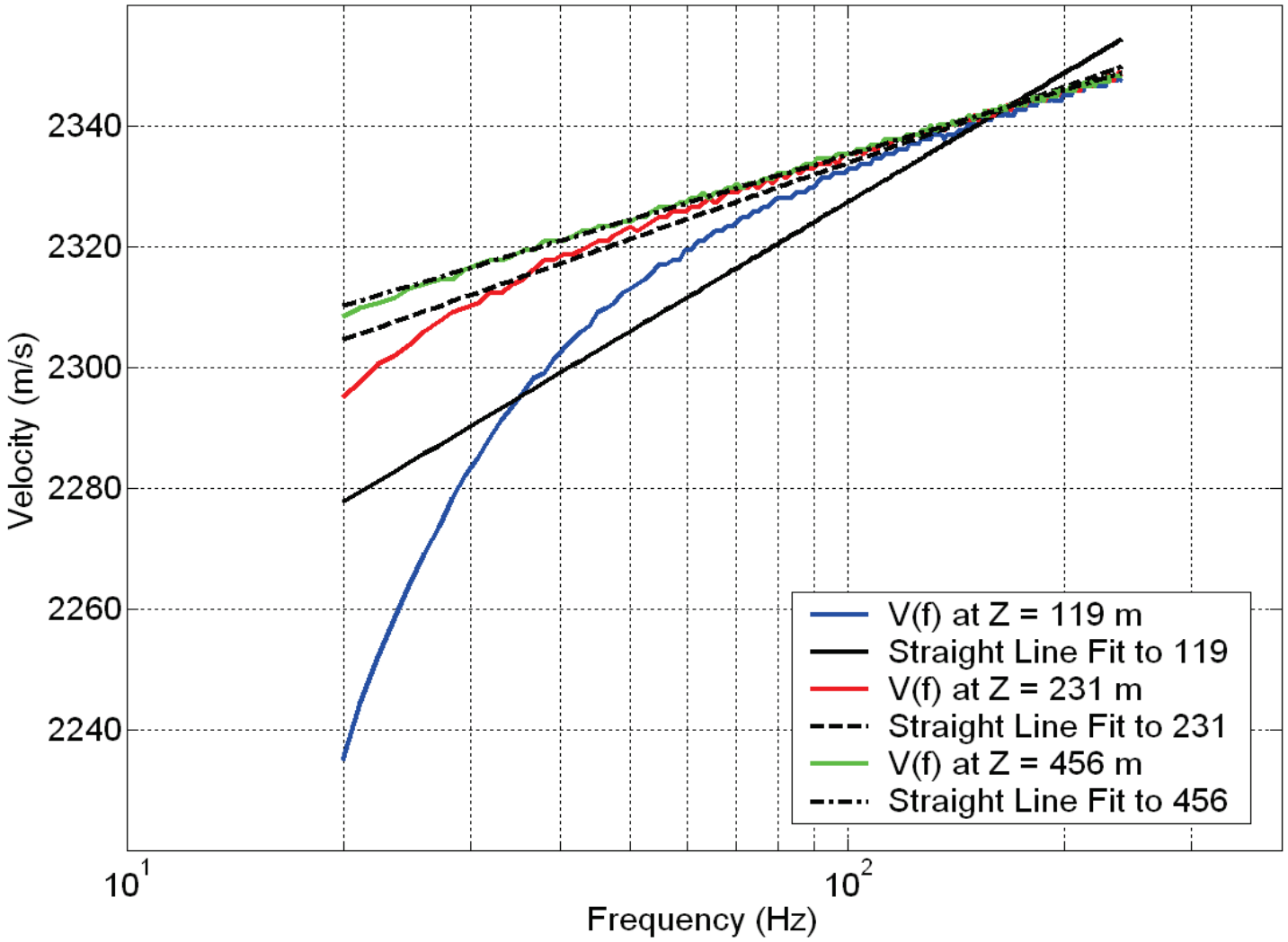
Velocity as function of frequency (sample interval test)



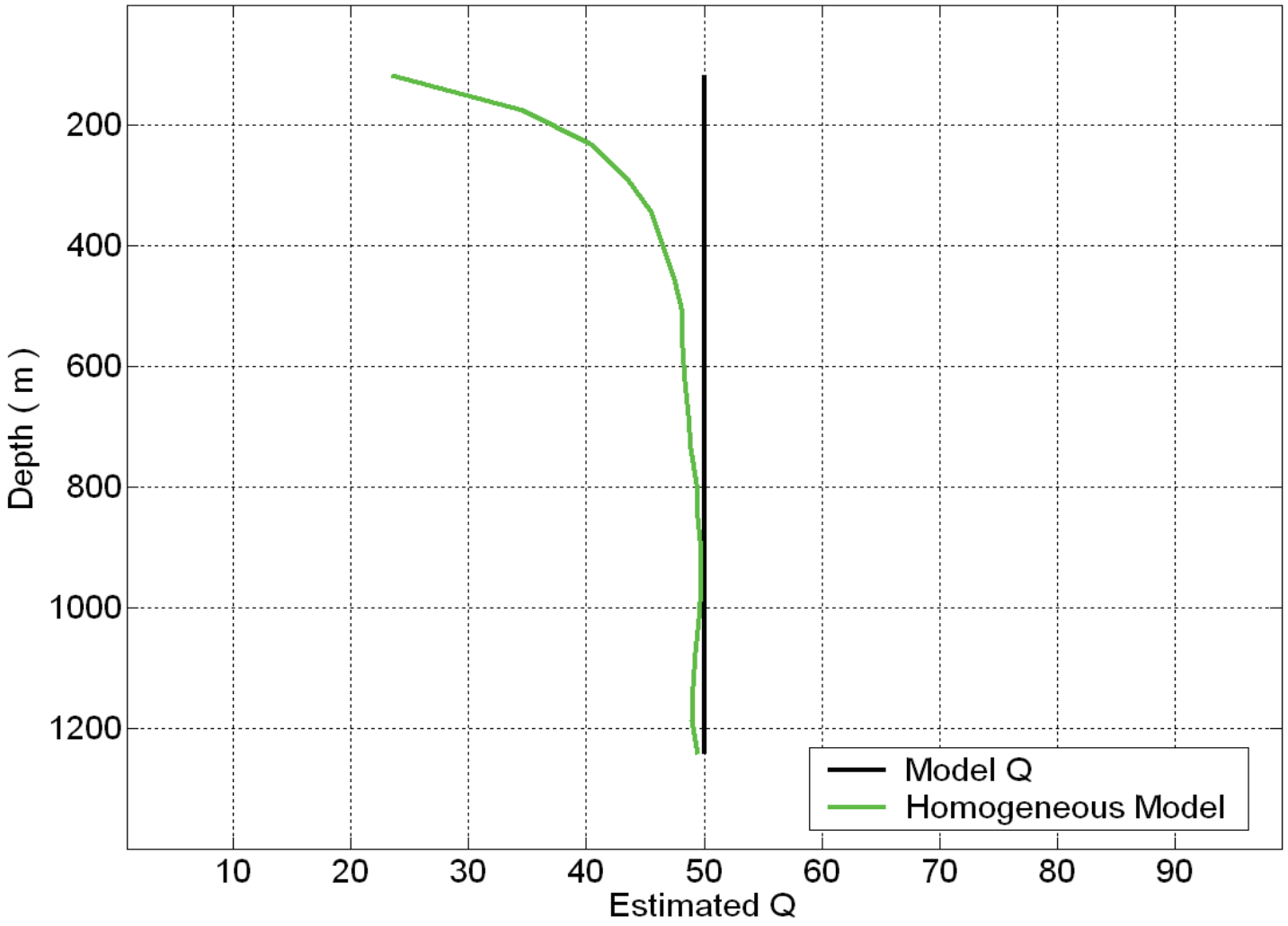
Velocity as function of frequ. (single/double precision)



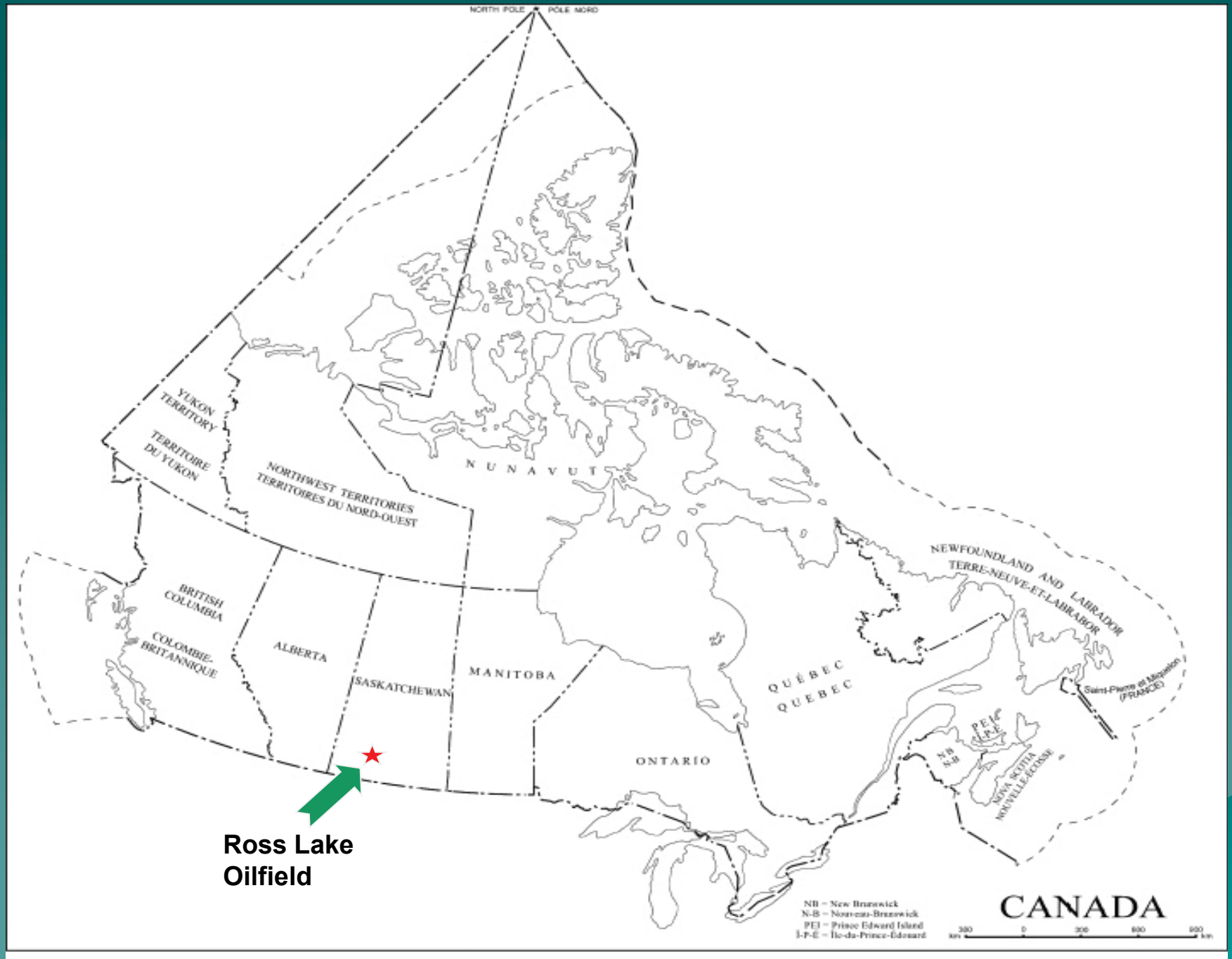
Velocity as function of frequency (sample interval test)

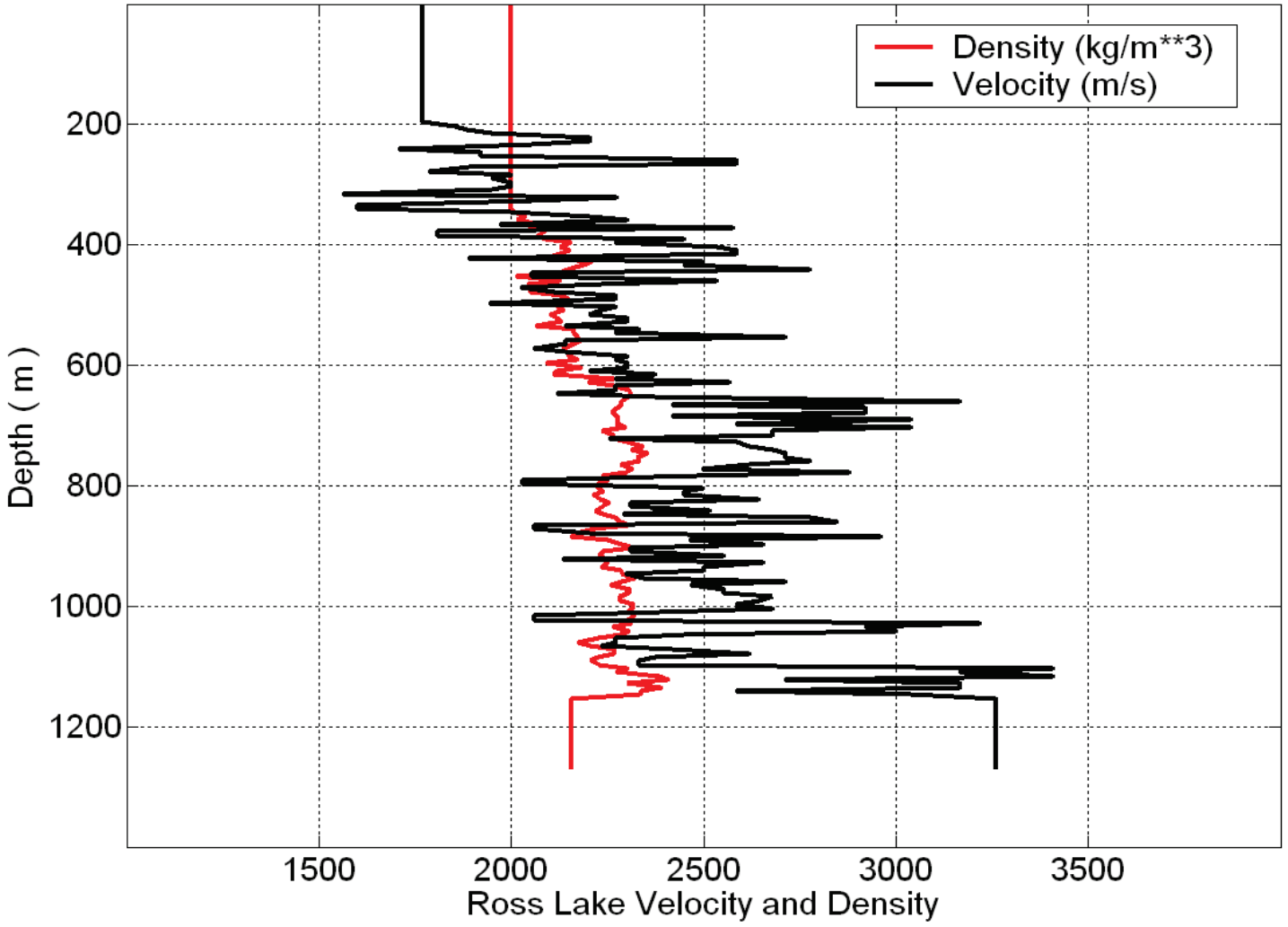


V(f) at different depths (homogeneous model)

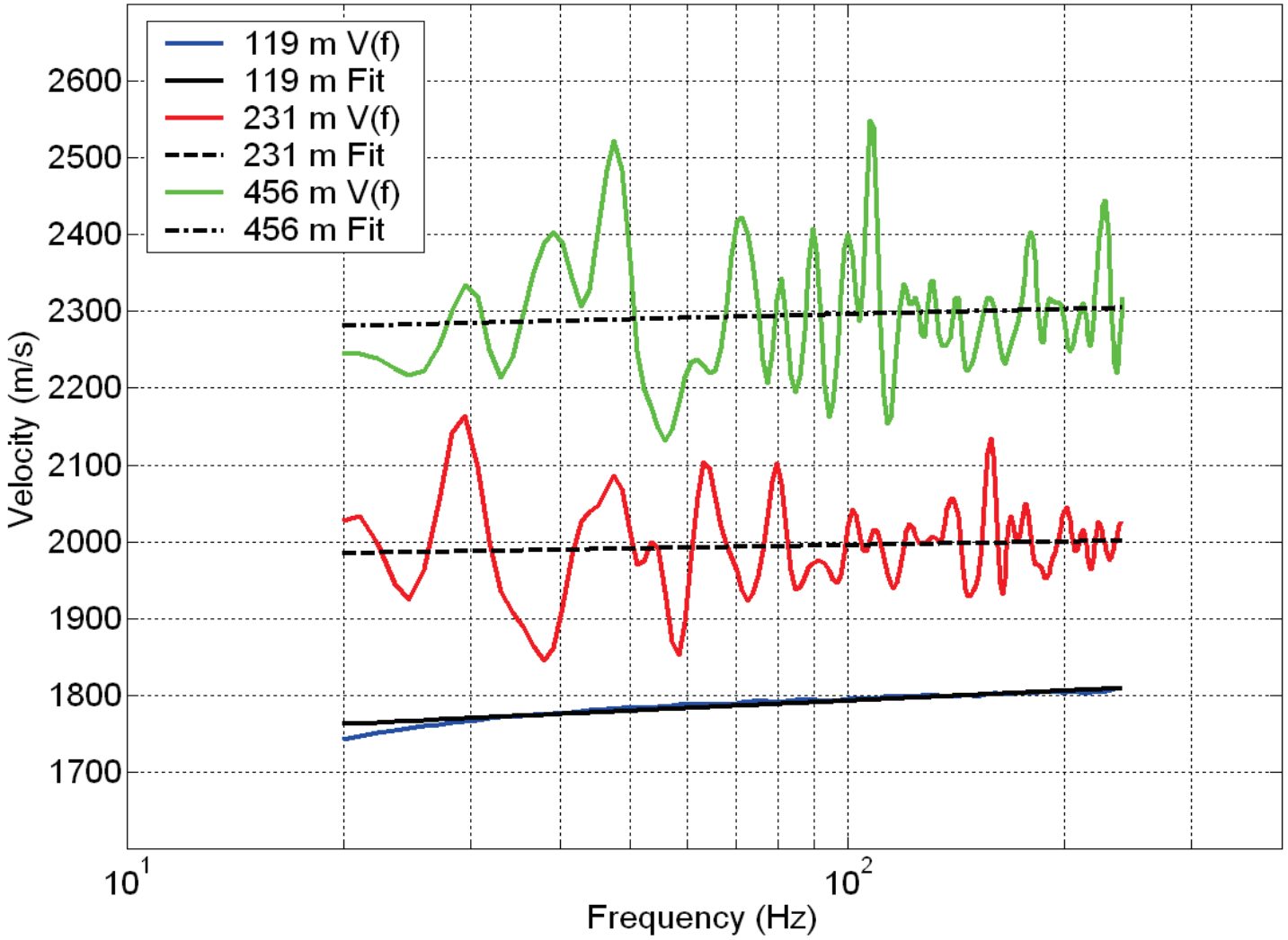


Q-estimate by velocity dispersion method

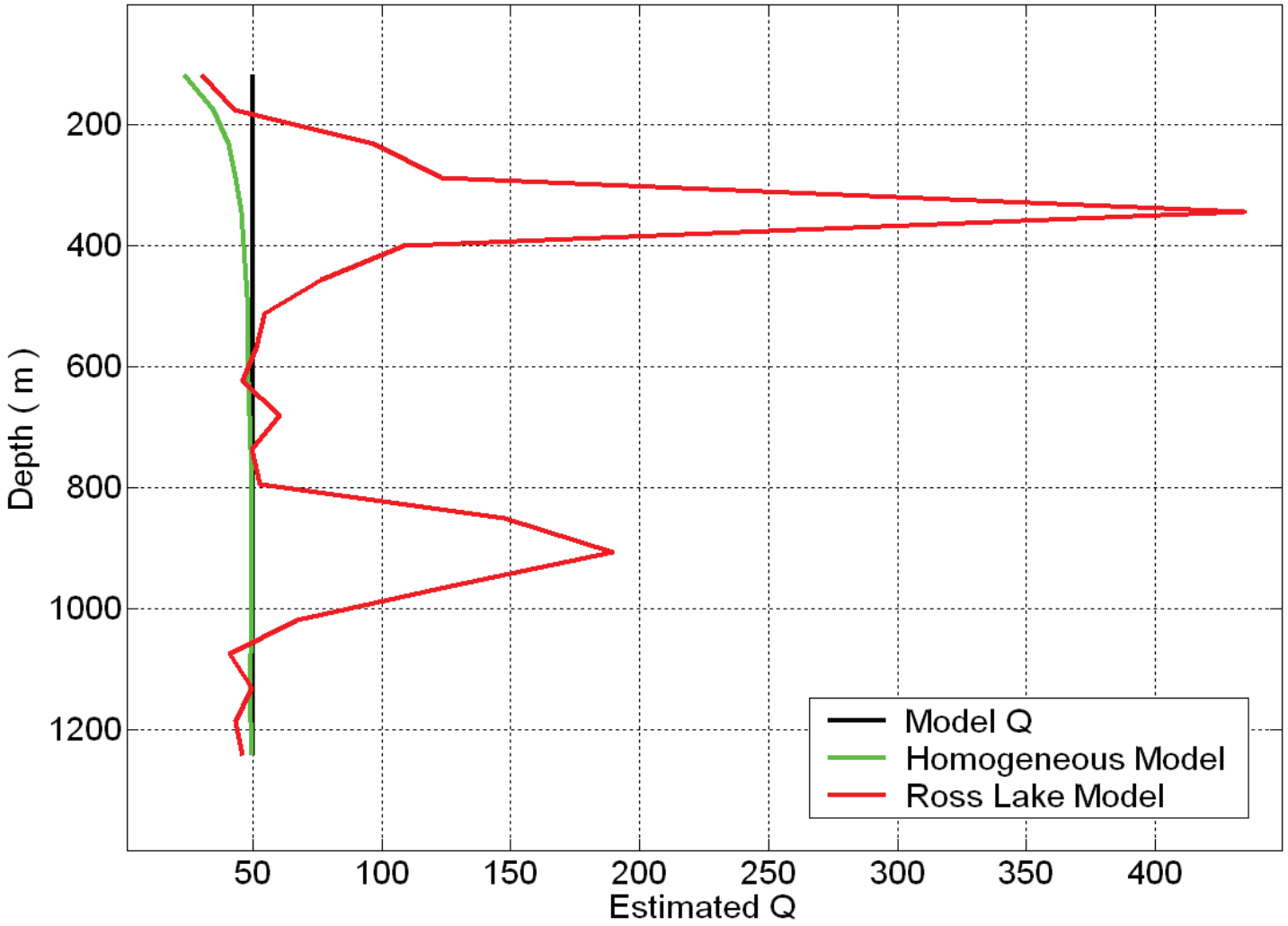

NORTH POLE
PÔLE NORD
YUKON TERRITORY
TERRITOIRE DU YUKON
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
NUNAVUT
BRITISH COLUMBIA
COLOMBIE-BRITANNIQUE
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUÉBEC
QUEBEC
NEWFOUNDLAND AND LABRADOR
TERRE-NEUVE-ET-LABRADOR
Saint-Pierre et Miquelon (FRANCE)
P.E.I. I.P.E.
N.B. N.-B.
NOVA SCOTIA
NOUVELLE-ÉCOSSE
Ross Lake Oilfield
NB = New Brunswick
N-B = Nouveau-Brunswick
PEI = Prince Edward Island
I-P-E = Île-du-Prince-Édouard
CANADA



Velocities and densities taken from Ross Lake well-log



V(f) at different depths (Ross Lake model)



Q-estimate by velocity dispersion method (both models)

Conclusions

- Sample interval size is critical for automated travel time picking.
- Computed velocity dispersion is quite sensitive to stratigraphic effects.
- Near-field effects can be observed.
- Stratigraphic compensation is required for more accurate Q-factor recovery.

Acknowledgements

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Thank you for your attention.