Elastic waves for Pedestrians

B. Arntsen

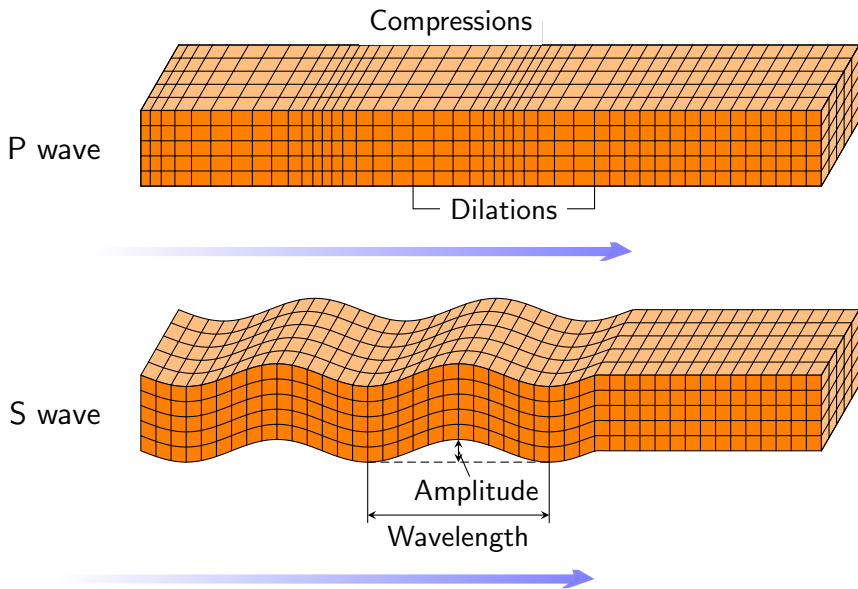NTNU
Department of Geoscience
`borge.arntsen@ntnu.no`
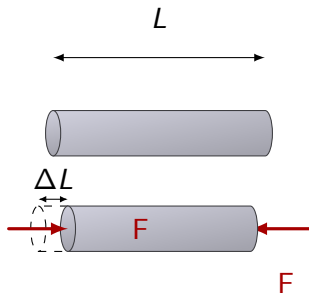
Svalbard April 2024

Content

Compressions

P wave

Dilations

S wave

Amplitude

Wavelength

Hooks Law

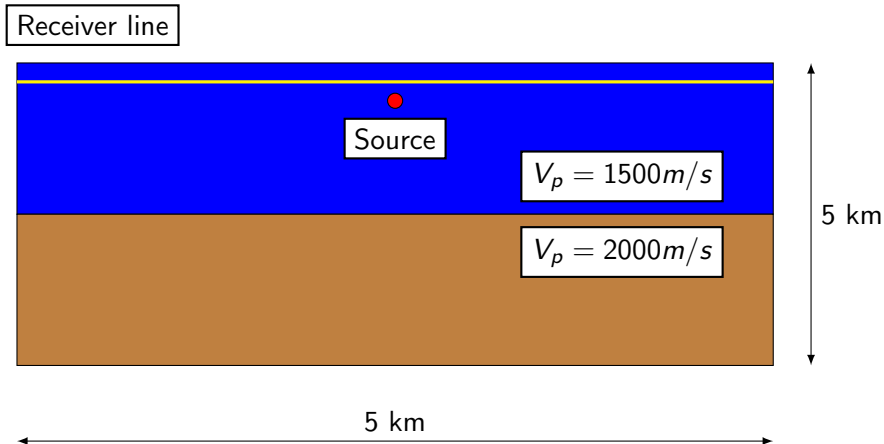$$F = \kappa \Delta L \tag{1}$$

STRESS - STRAIN
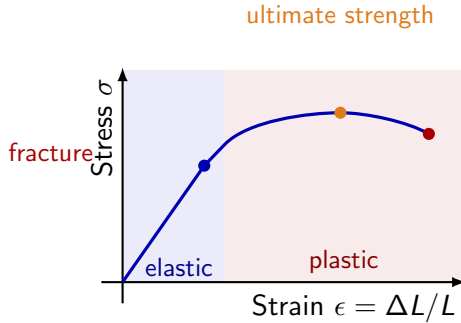
Newton and Hook's laws

$$
\begin{aligned}
\text{Force} &= \text{mass} \times \text{acceleration} \\
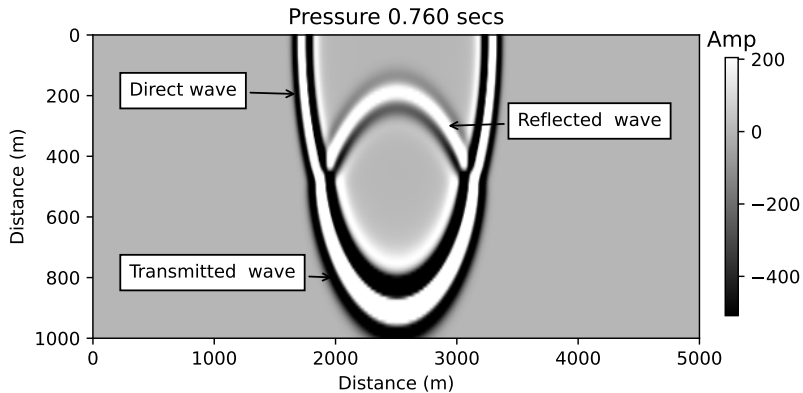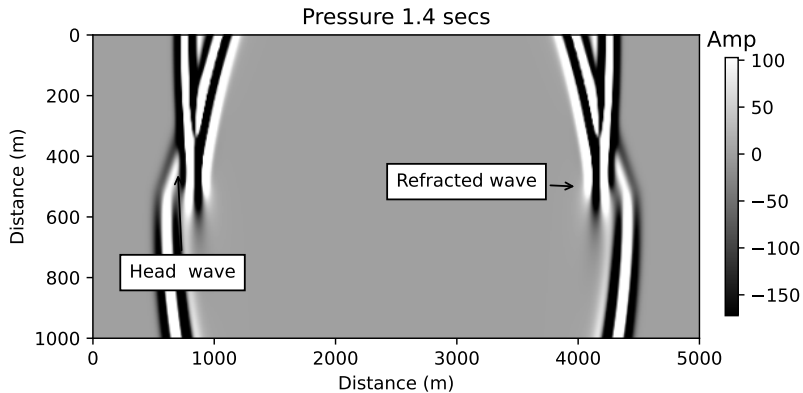\text{Stress} &= \text{Stiffness} \times \text{Strain}
\end{aligned}
$$

Simple model

P-waves

Movie-1

P-waves

Pressure 0.760 secs
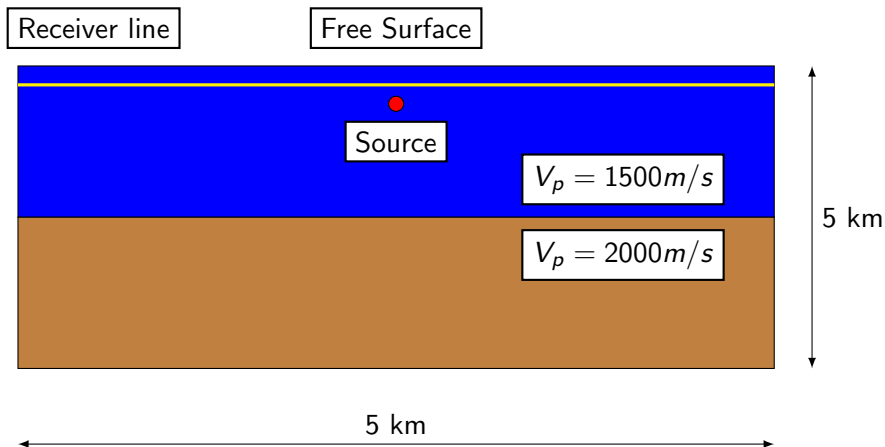
P-waves

Pressure 1.4 secs
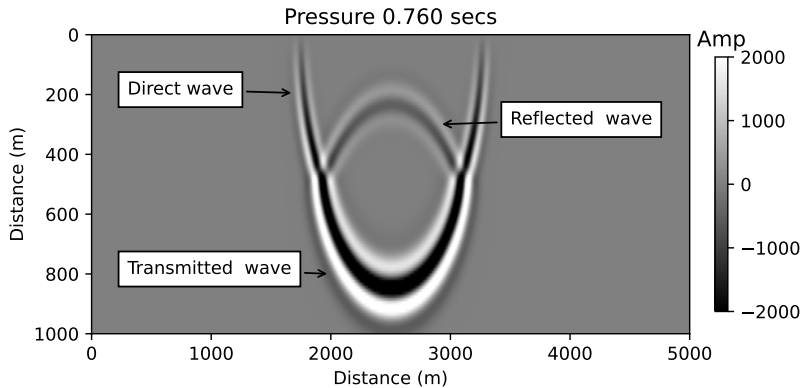
P-waves

Recorded pressure
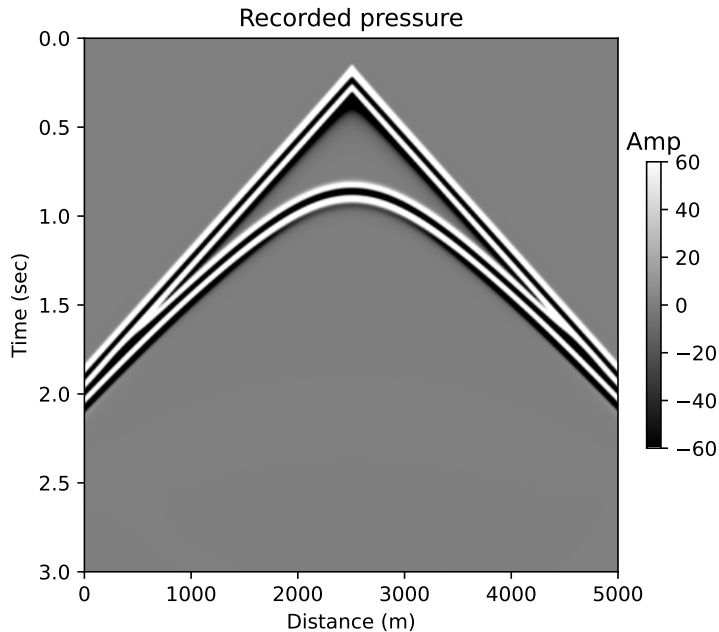
Model with free surface

P-waves free surface

Movie-2

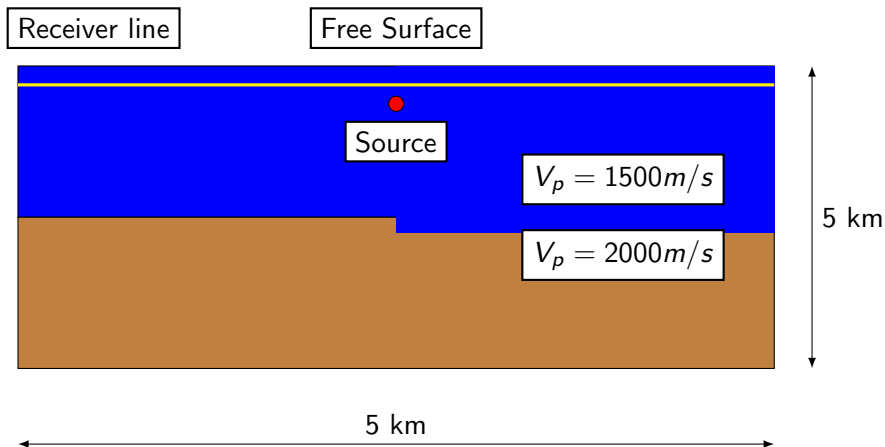# P-waves free surface

Pressure 0.760 secs

P-waves

Pressure 1.4 secs
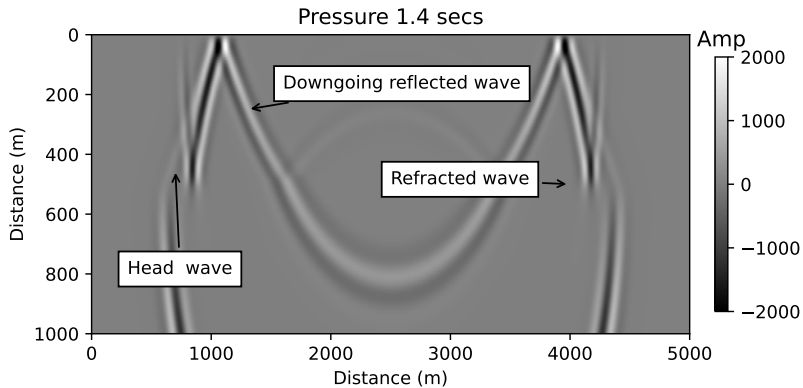
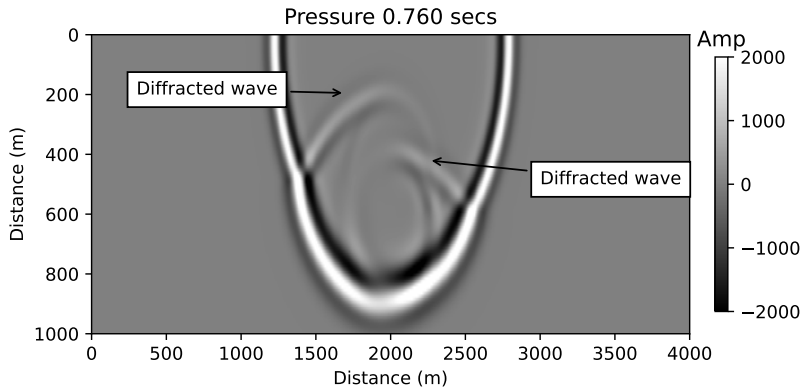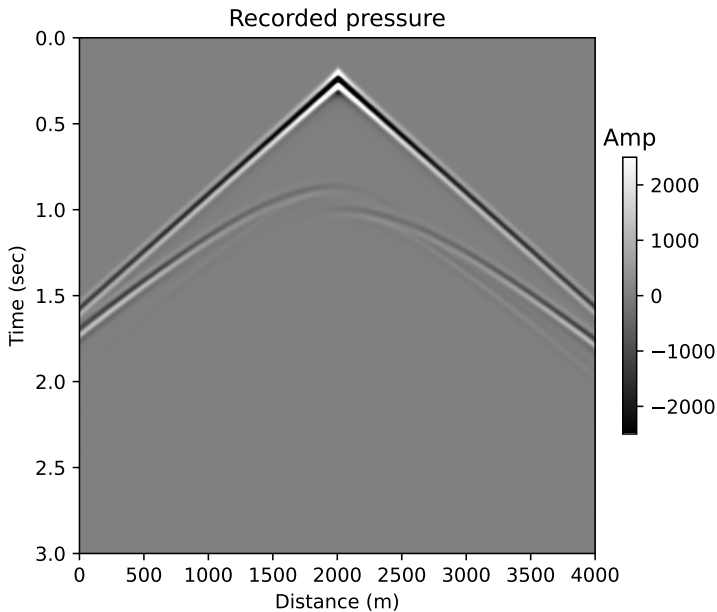# P-waves free surface

Recorded pressure
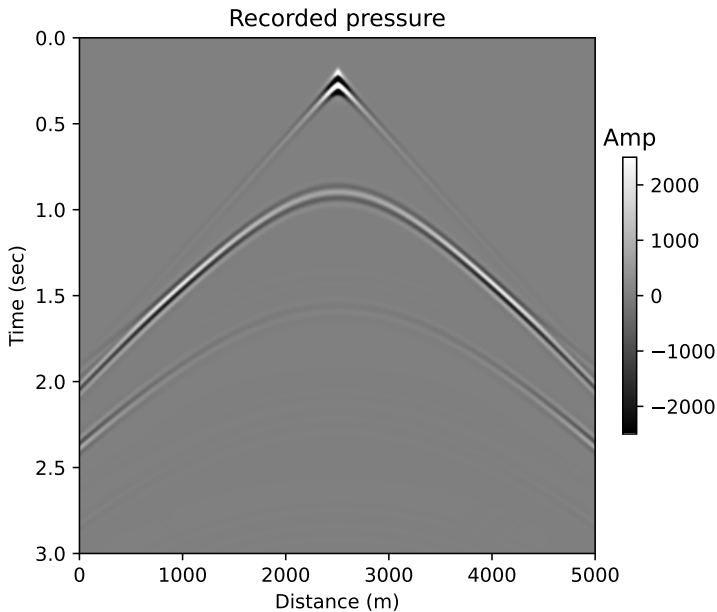
Diffracted waves

Diffracted waves

Movie-3

Diffracted waves
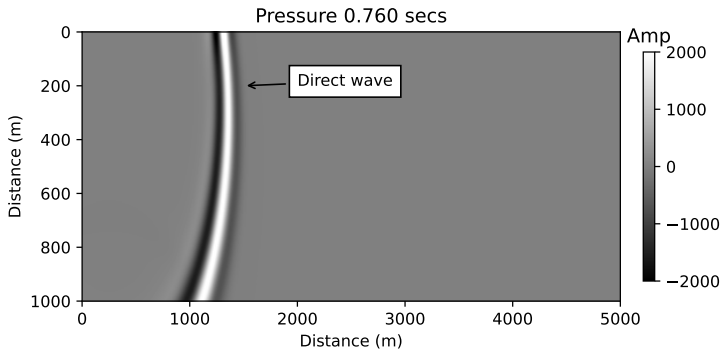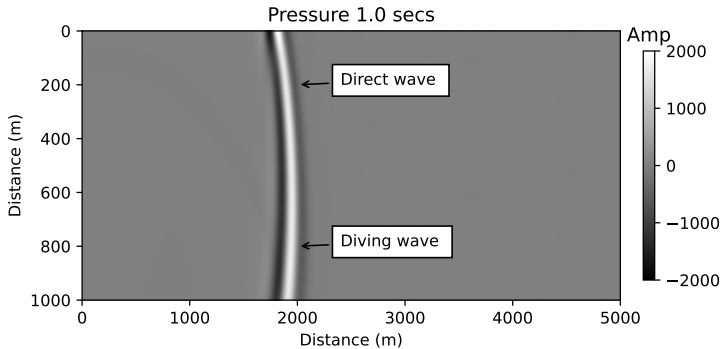
Diffracted waves

Recorded pressure

Diving waves

Model with velocity gradient

$V_p = 2000 + z$
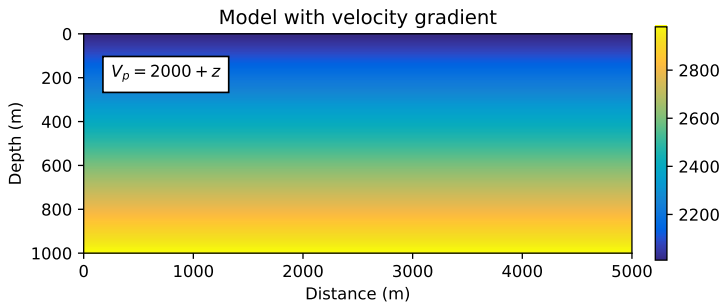
Diving waves

Movie-4

Diving waves

Pressure 0.760 secs

Diving waves

Pressure 1.0 secs

Diving waves

Pressure 2.0 secs

Diving waves

PS-waves

Receiver line

Source

$V_s = 1850 m/s$ $V_p = 3880 m/s$

$V_s = 1250 m/s$ $V_p = 2500 m/s$

2 km

5 km
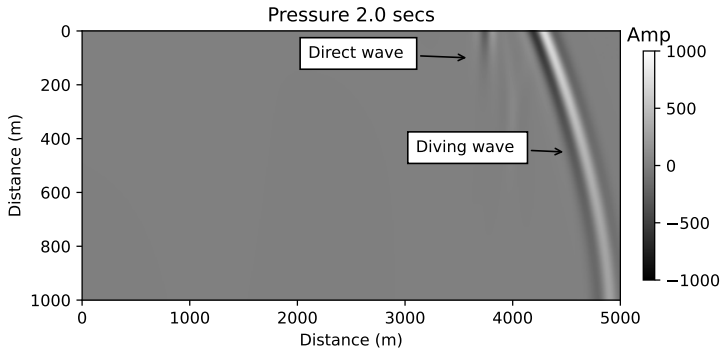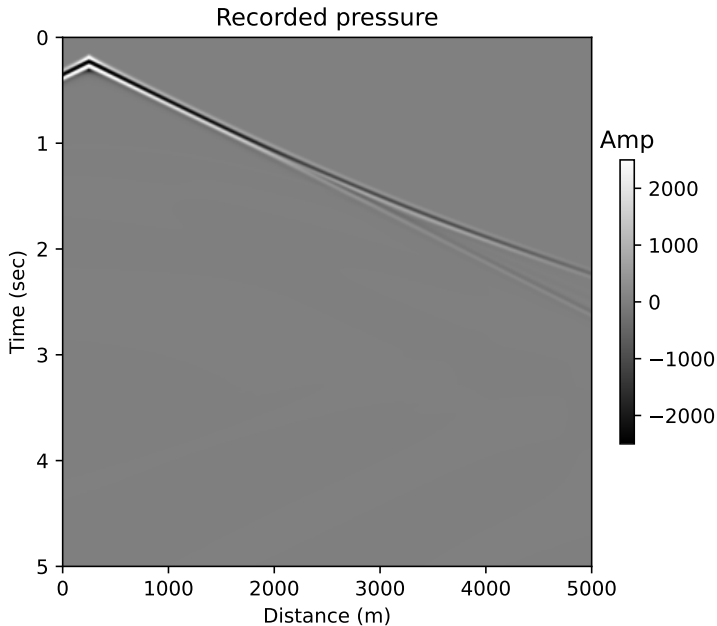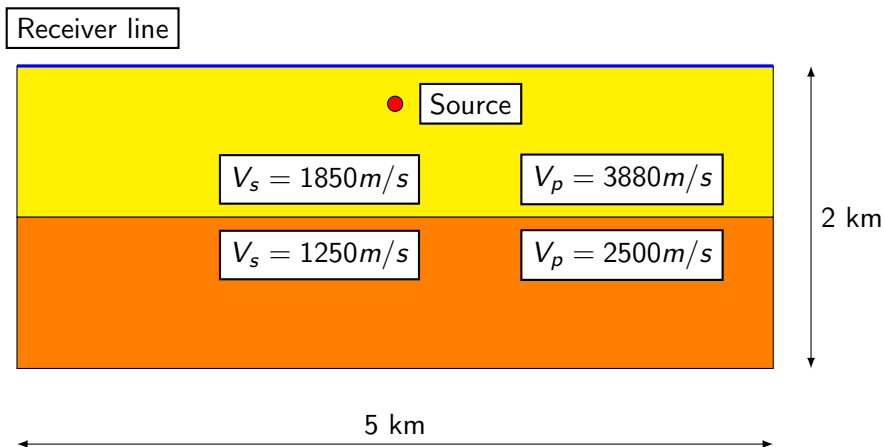
PS-waves v_x

Movie-5

PS-waves v_x

Vx 0.7 secs
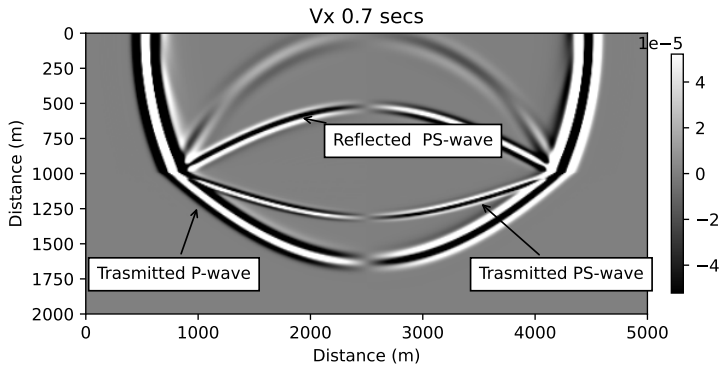
PS-waves v_x

Recorded Vx
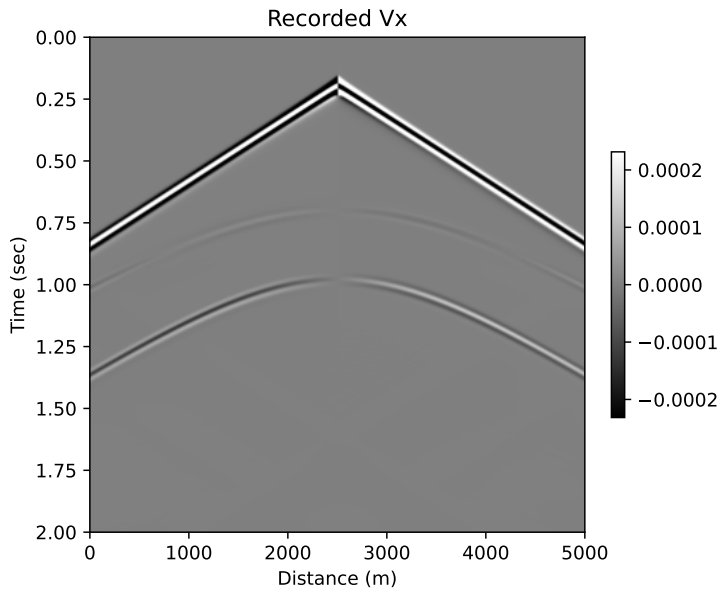
PS-waves v_y

Movie-6

PS-waves v_y

Vy 0.7 secs

PS-waves v_y

Recorded Vy
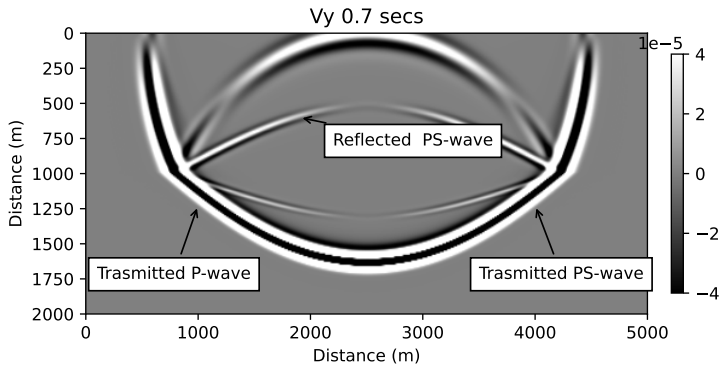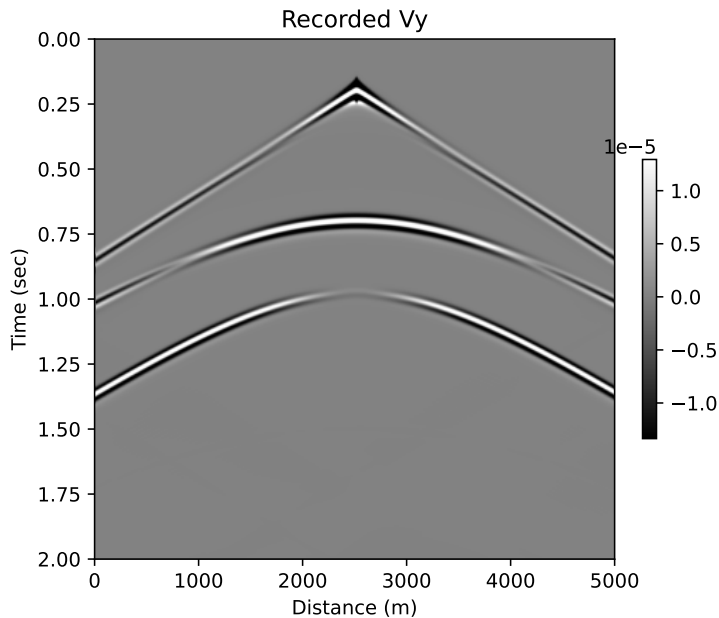
PS-waves Free surface
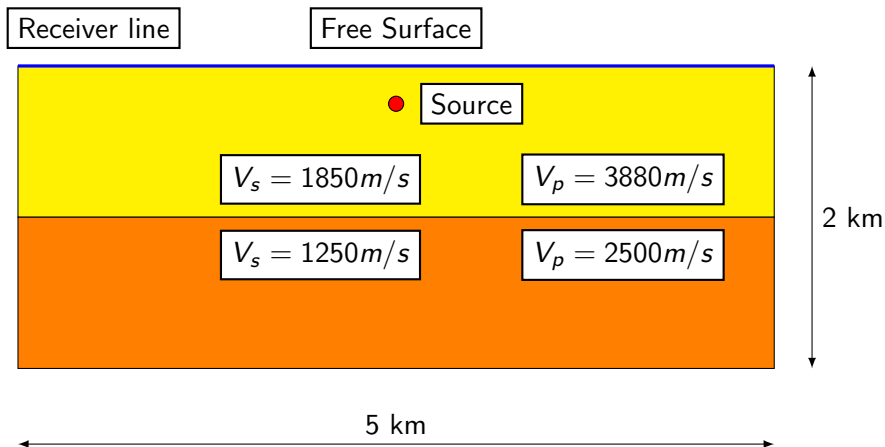
PS-waves Free surface v_x

Movie-7

PS-waves Free surface v_x

PS-waves Free surface v_x

Vx 0.95 secs

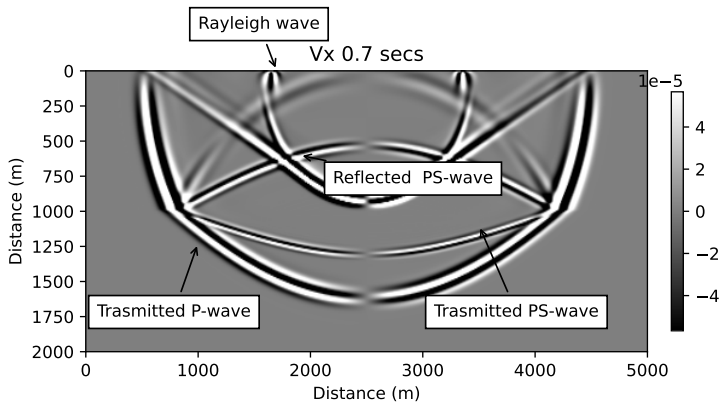# PS-waves Free surface v_x
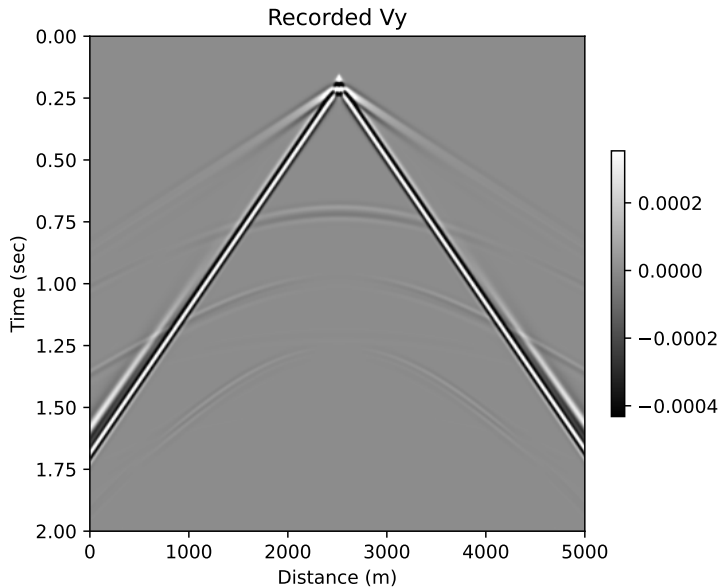

Recorded Vx
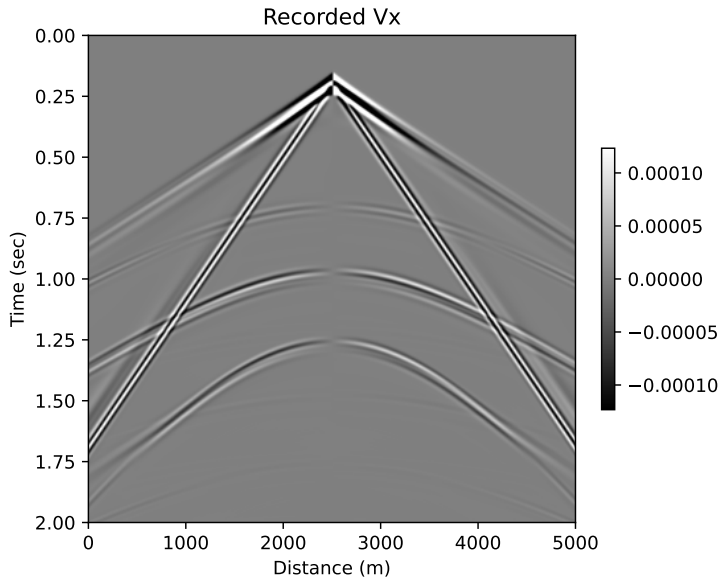
PS-waves Free surface v_y

Movie-8

PS-waves Free surface v_y
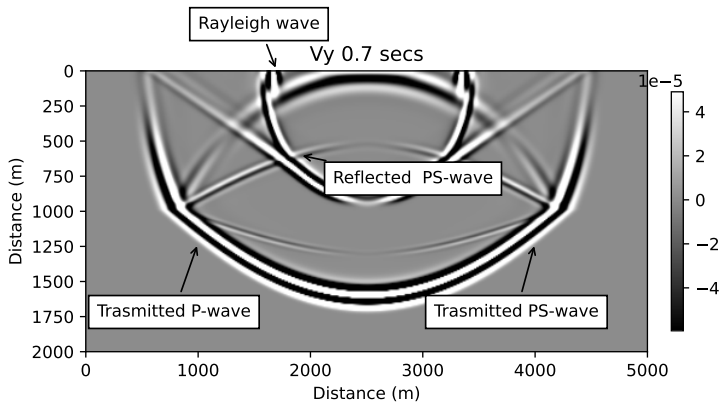
PS-waves Free surface v_y

Recorded Vy

Summary

- P-waves
- Reflected and Transmitted waves
- Refracted waves
- Head waves
- Diffractions
- Diving waves
- PS-waves
- Rayleigh waves (surface waves)