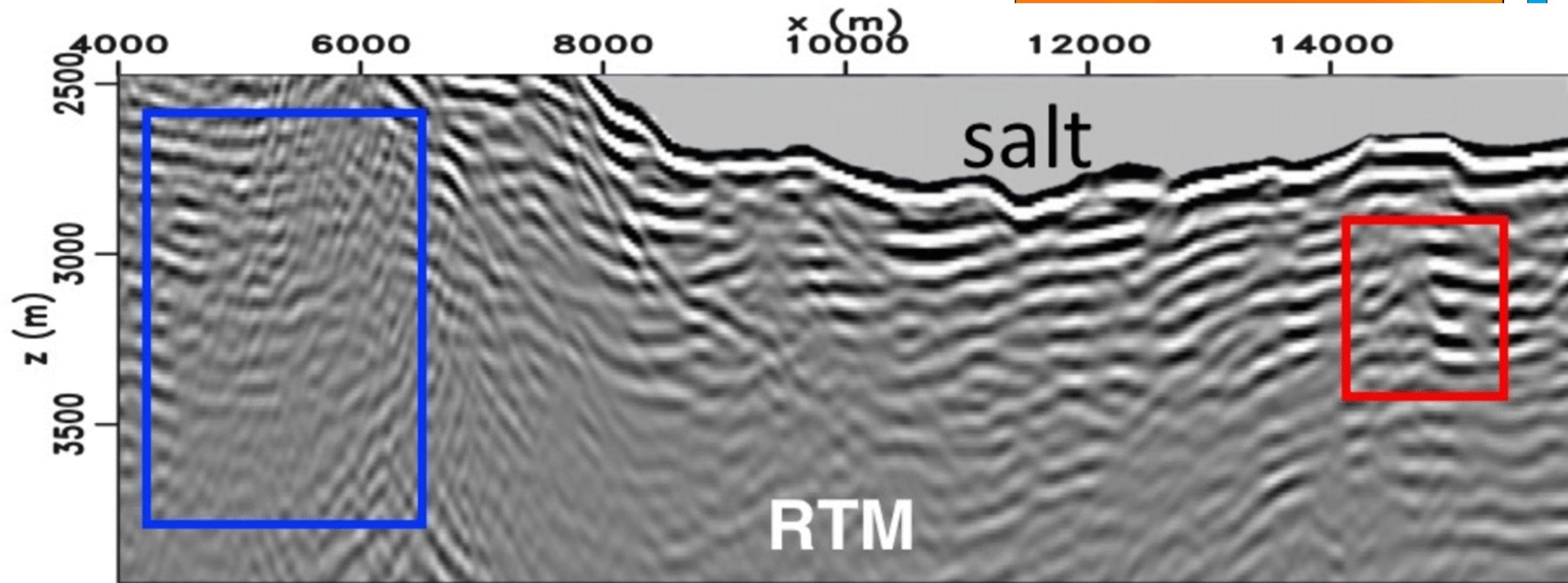
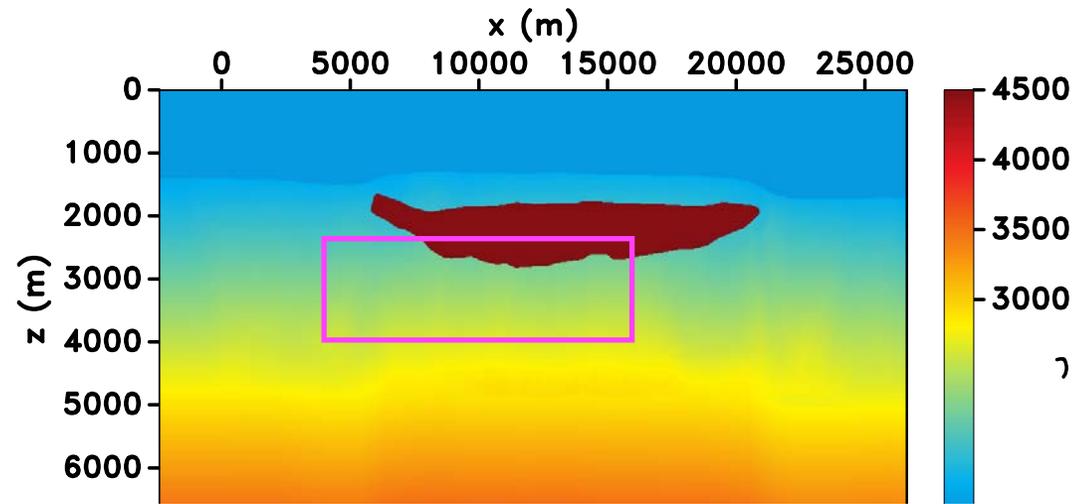


# Making Marchenko imaging work with field data and the bumpy road to 3D

Alex Jia\*, Antoine Guitton, and Roel Snieder

Center for Wave Phenomena, Colorado School of Mines





	RTM	Marchenko Imaging
pros	<ul style="list-style-type: none"> <li>➤ whole model</li> <li>➤ easy implementation</li> </ul>	<ul style="list-style-type: none"> <li>➤ target orientated</li> <li>➤ remove artifacts by internal multiples</li> </ul>
cons	<ul style="list-style-type: none"> <li>➤ artifacts by internal multiples</li> </ul>	<ul style="list-style-type: none"> <li>➤ require wavelet</li> <li>➤ learning curve (e.g. acquisition geometry)</li> </ul>

# outline

- ▶ Marchenko imaging: how and why?
- ▶ Complications:
  - ▶ missing near offsets
  - ▶ data calibration
- ▶ Why is 3D Marchenko necessary and challenging?

background  
velocity model



first arrival

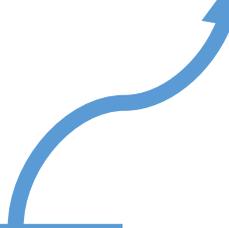


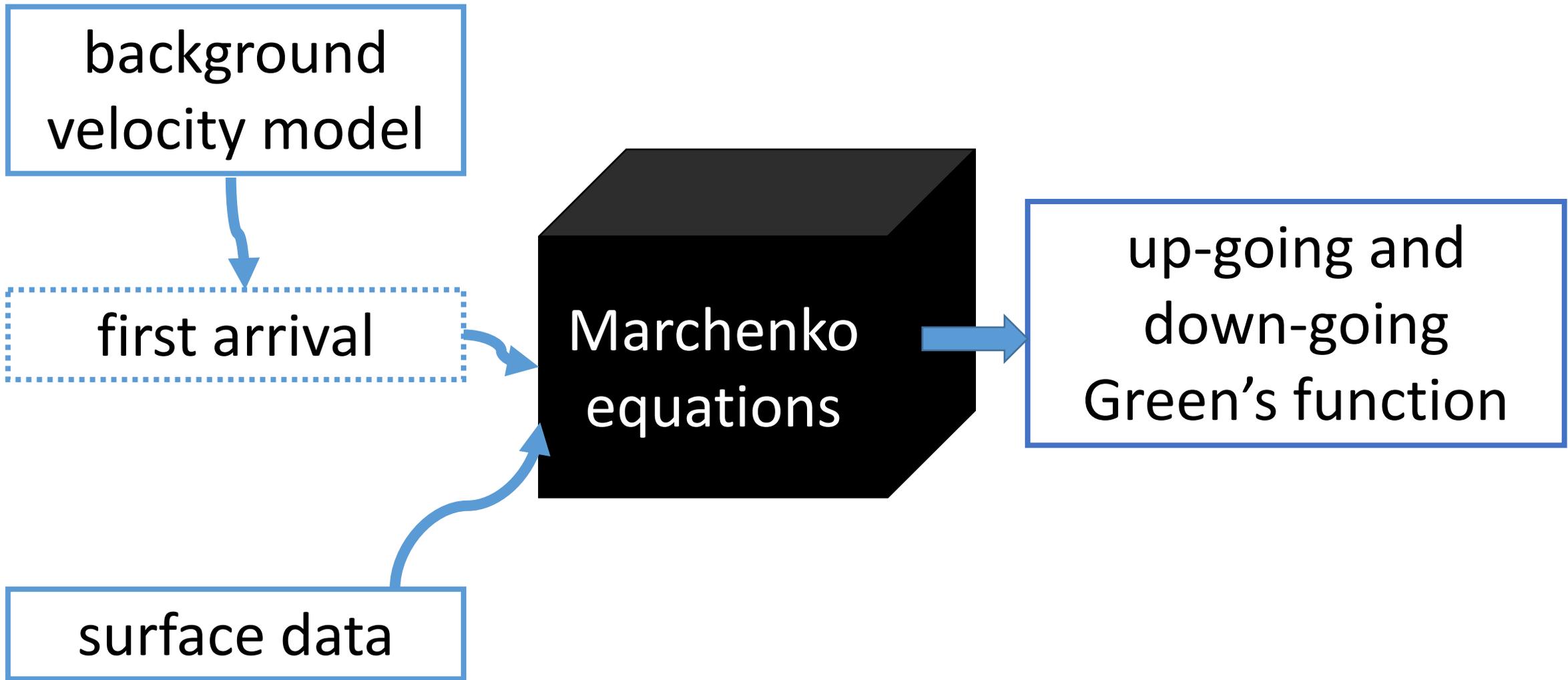
Marchenko  
equations

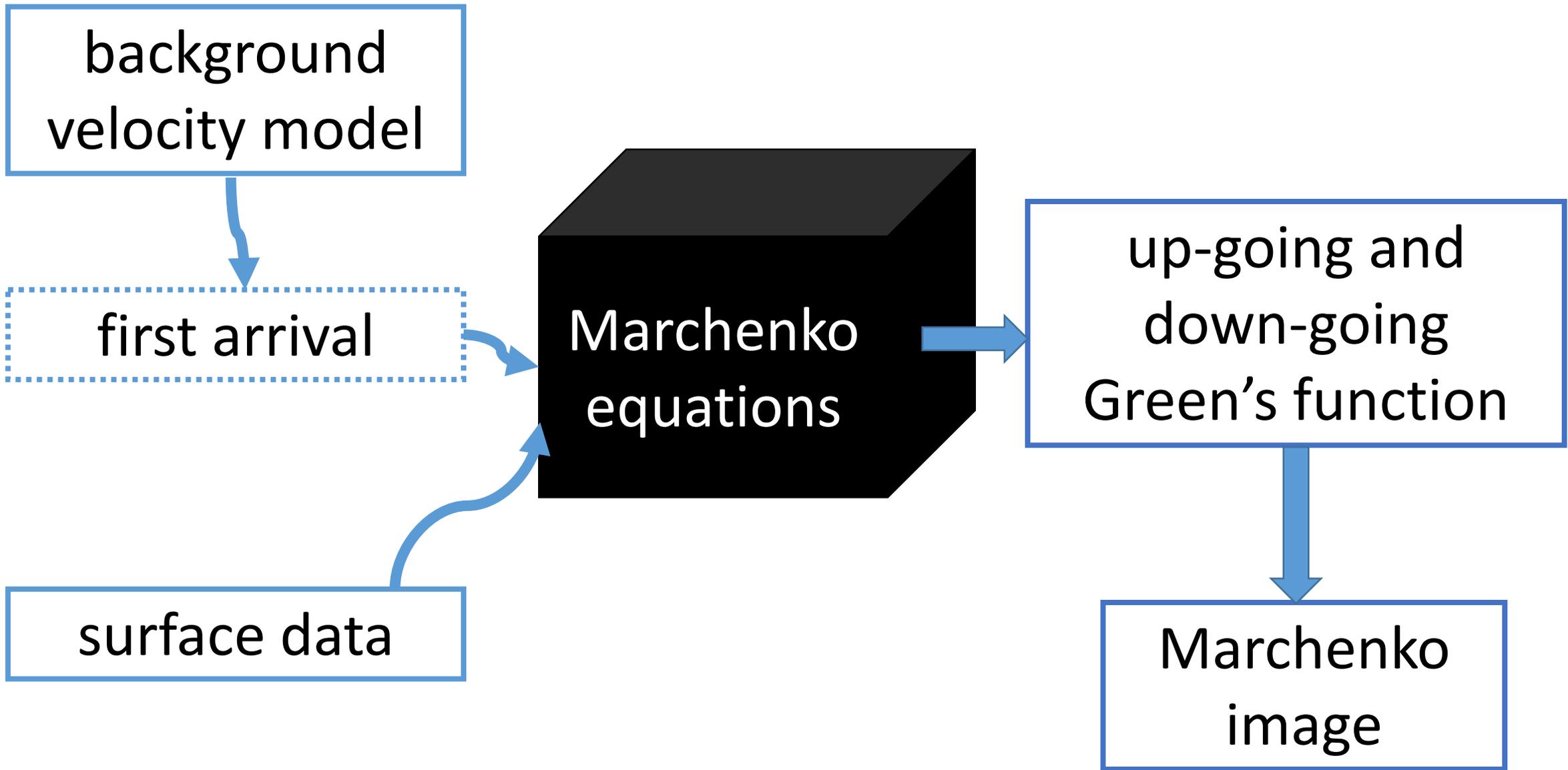


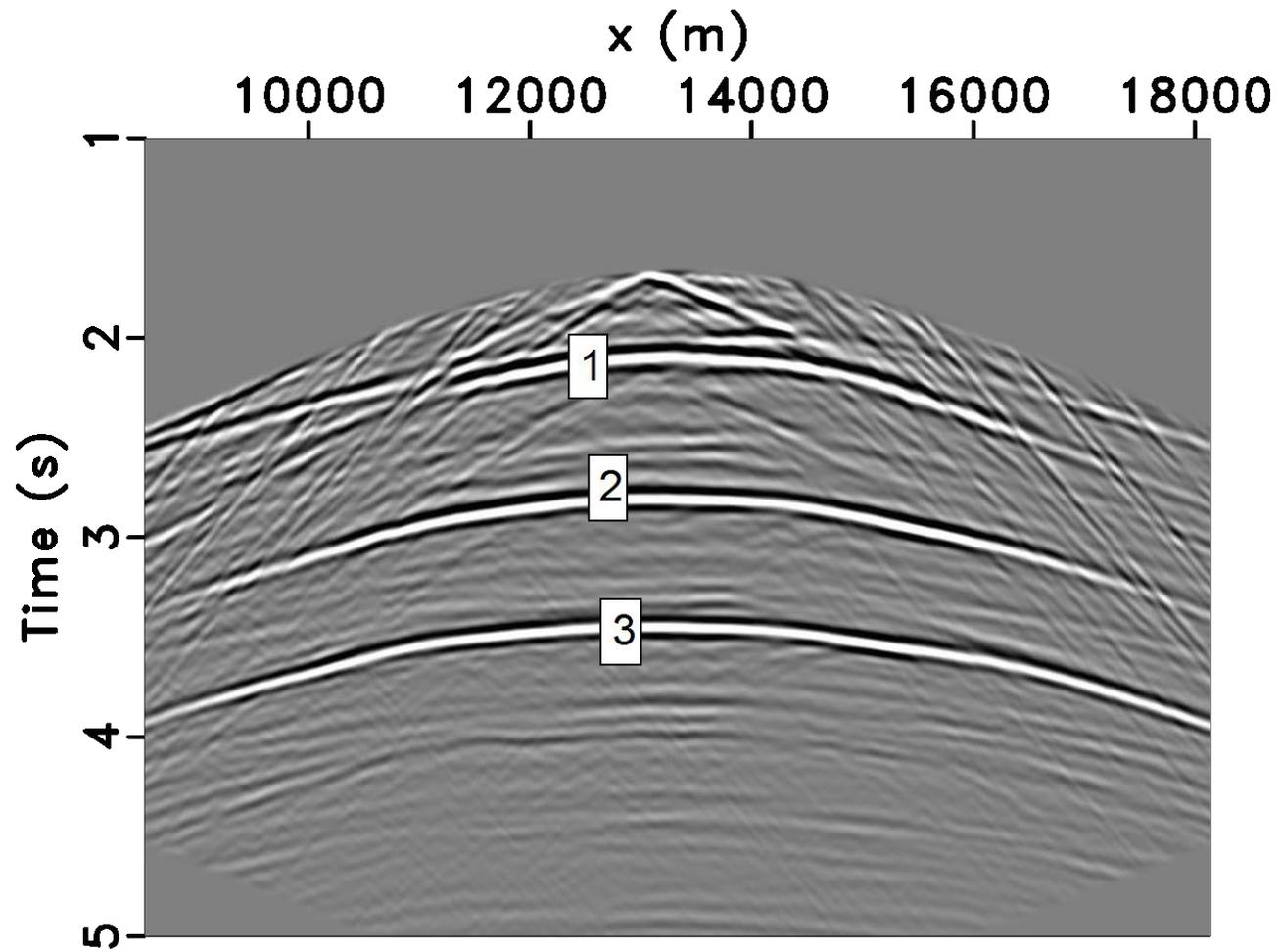
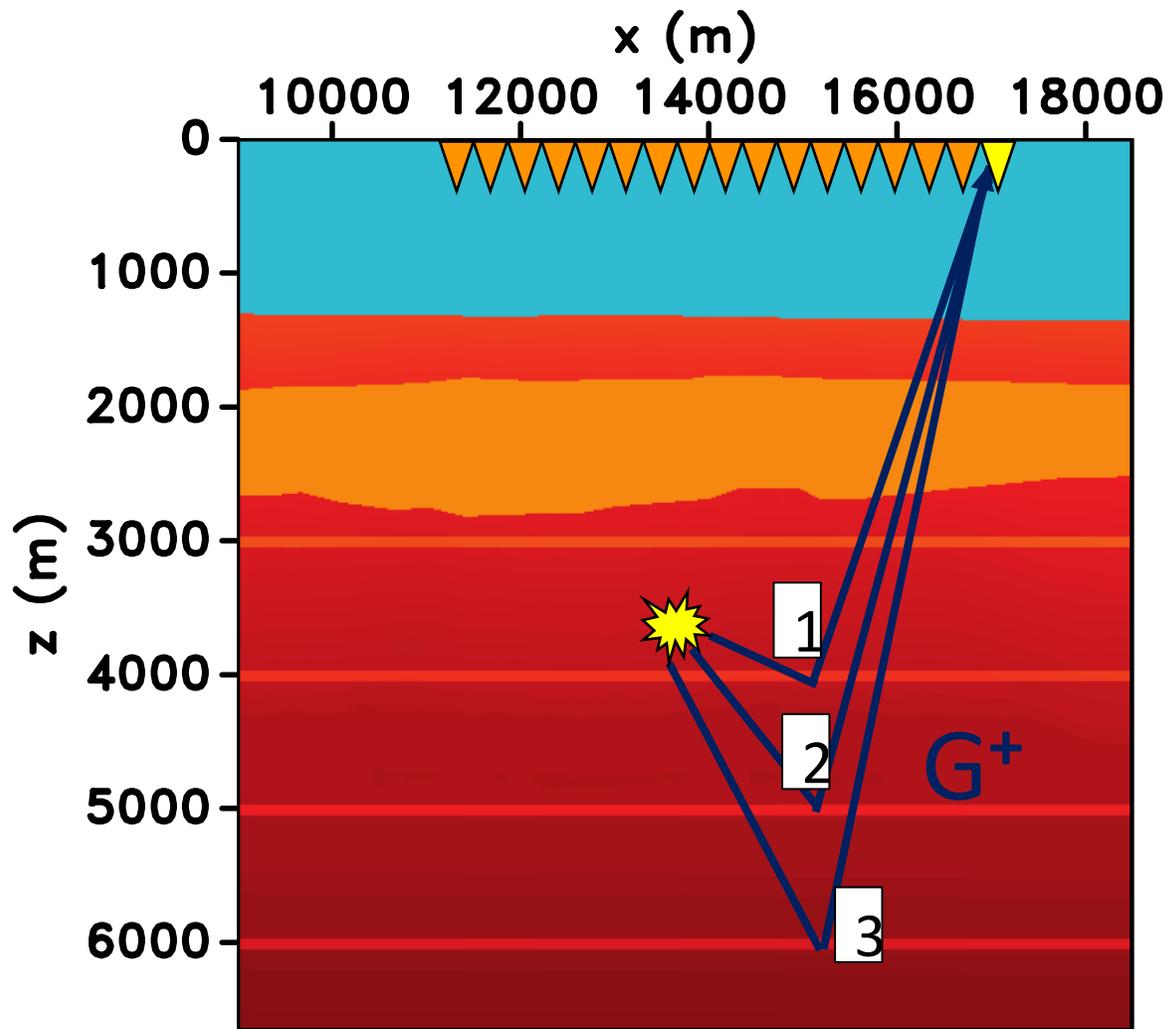
surface response to  
virtual source  
(reverse VSP data)

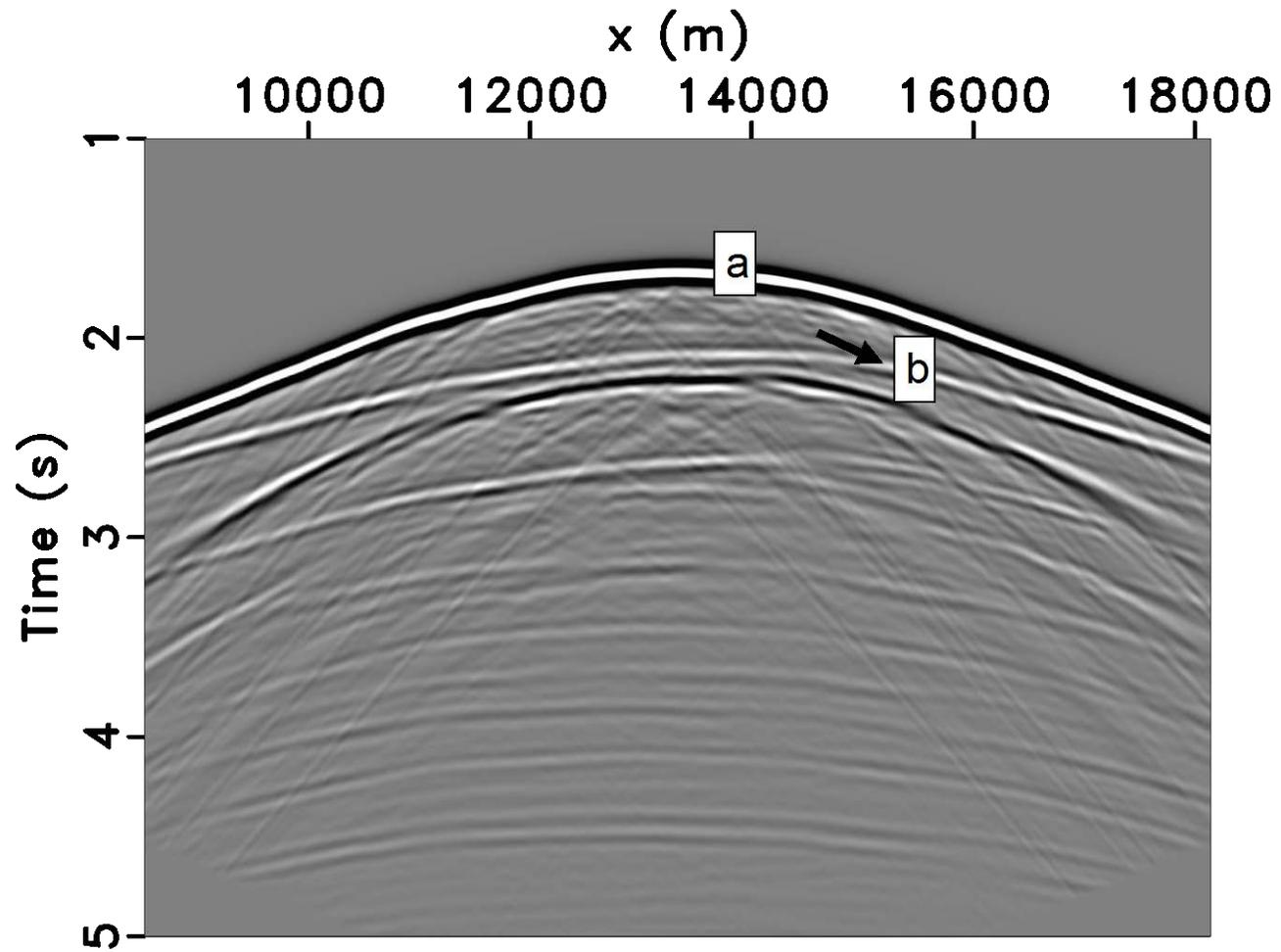
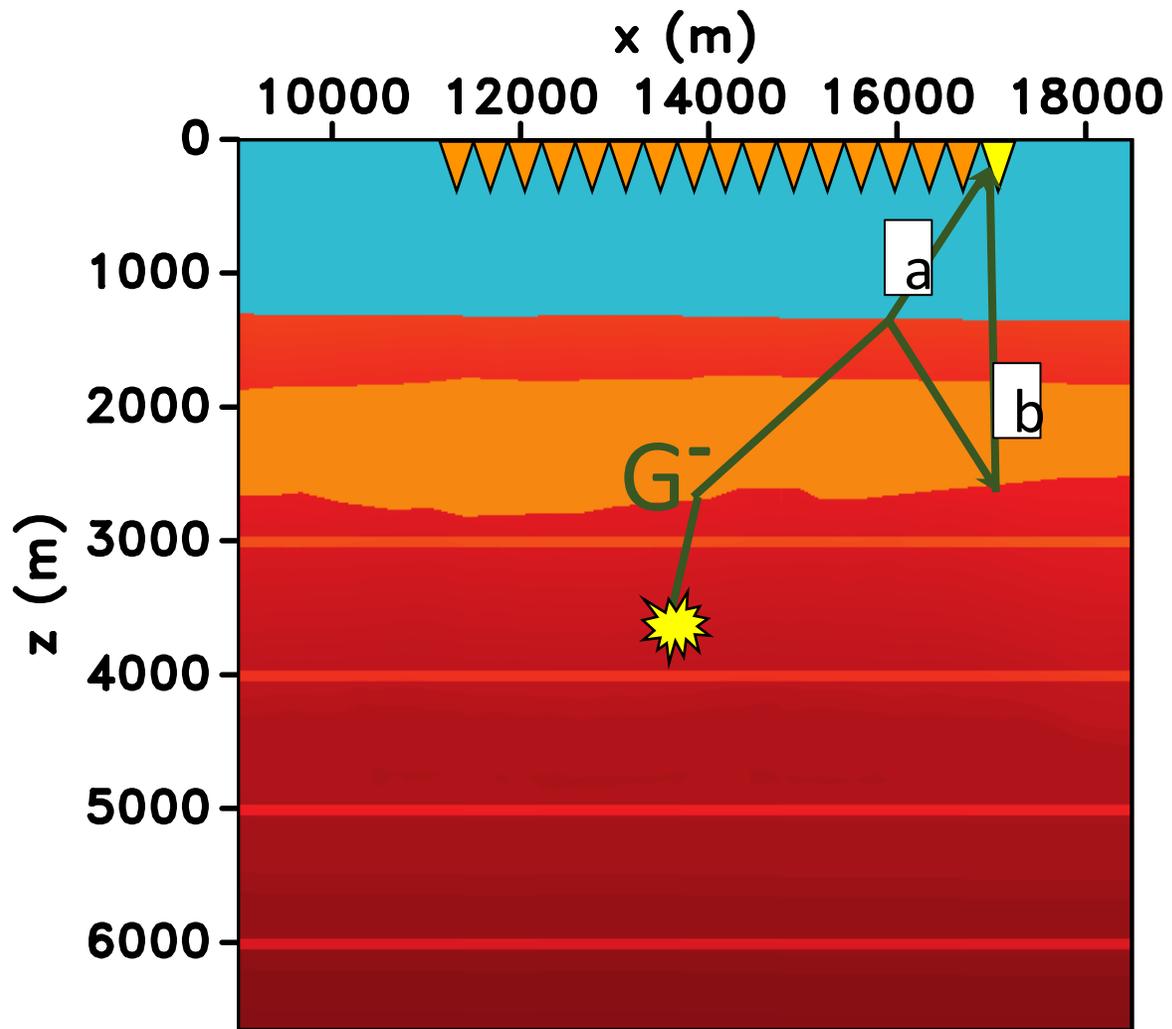
surface data



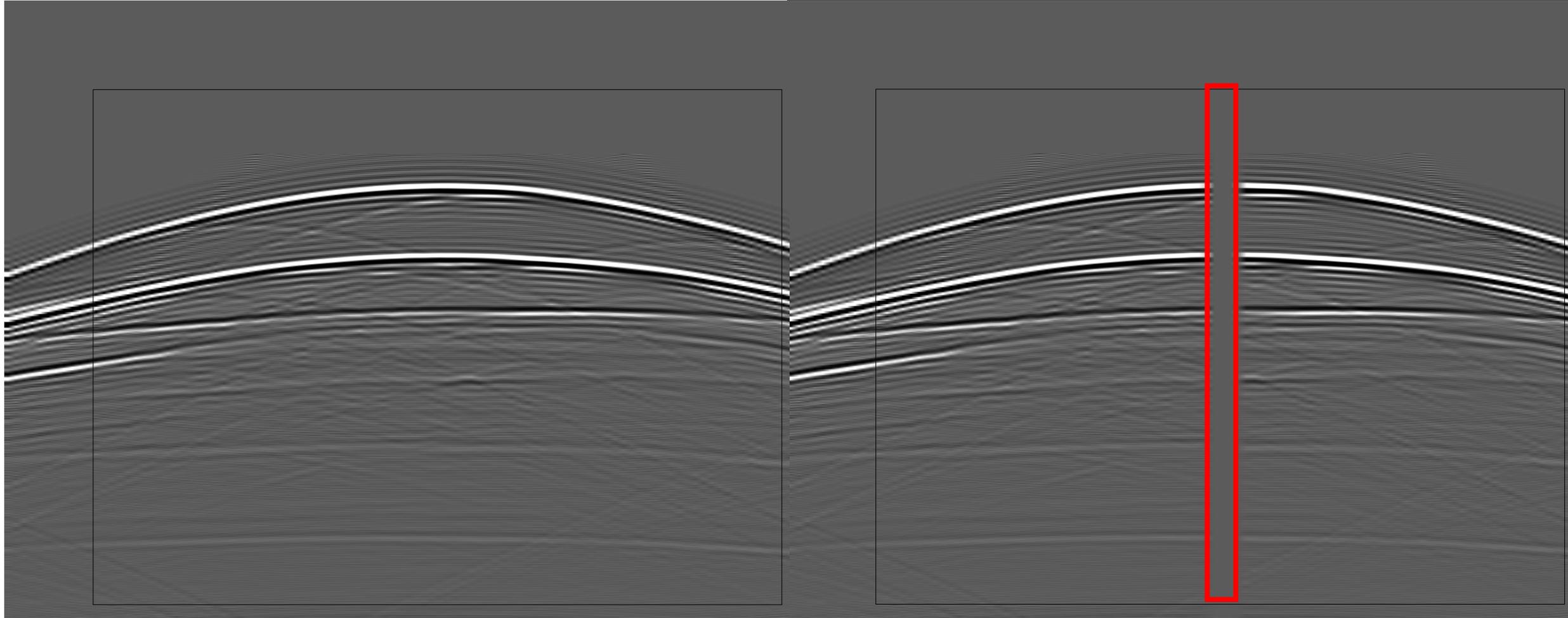






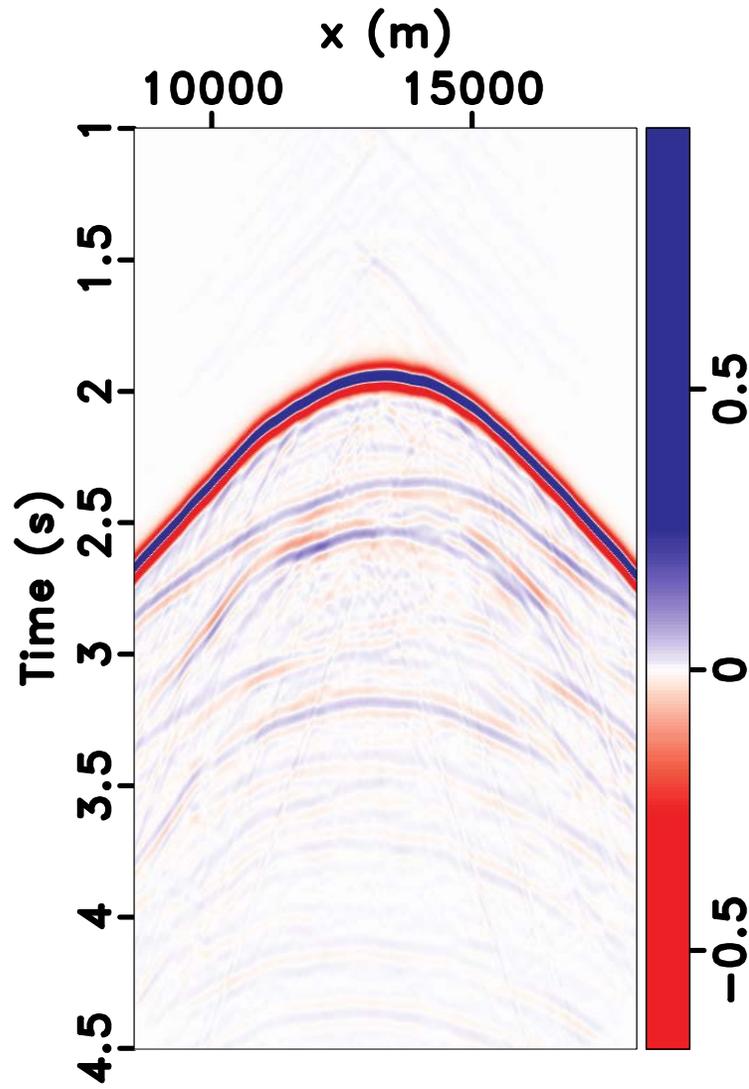


# missing near offsets

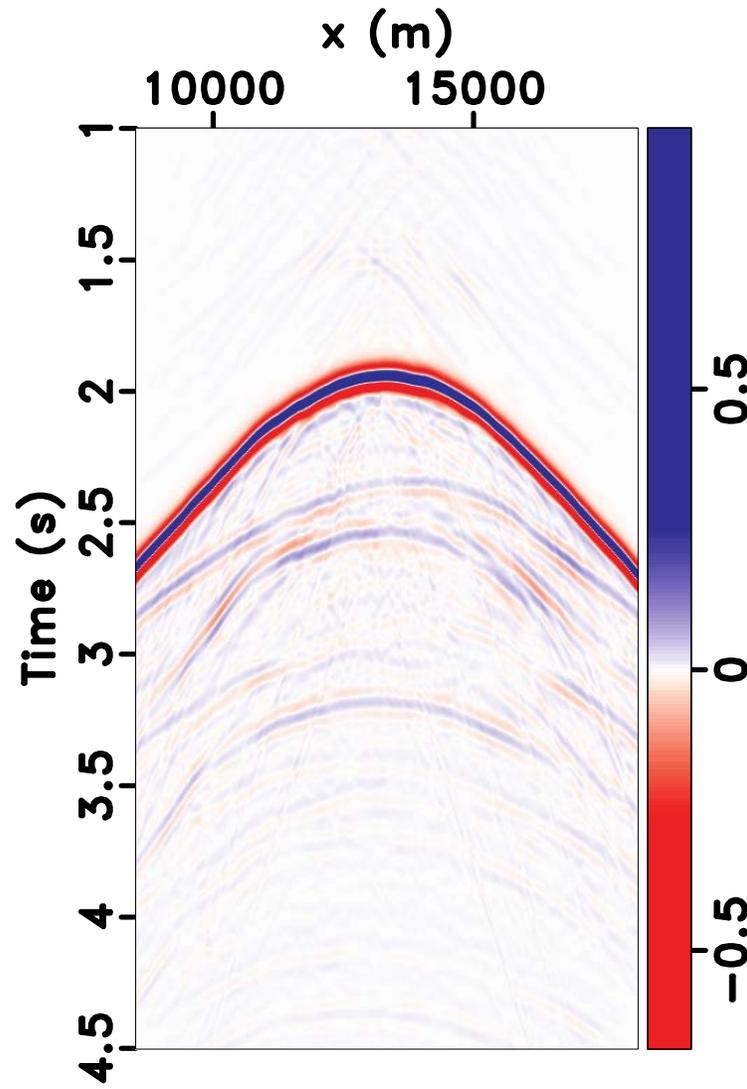


missing near offsets: 7 traces, 214 m

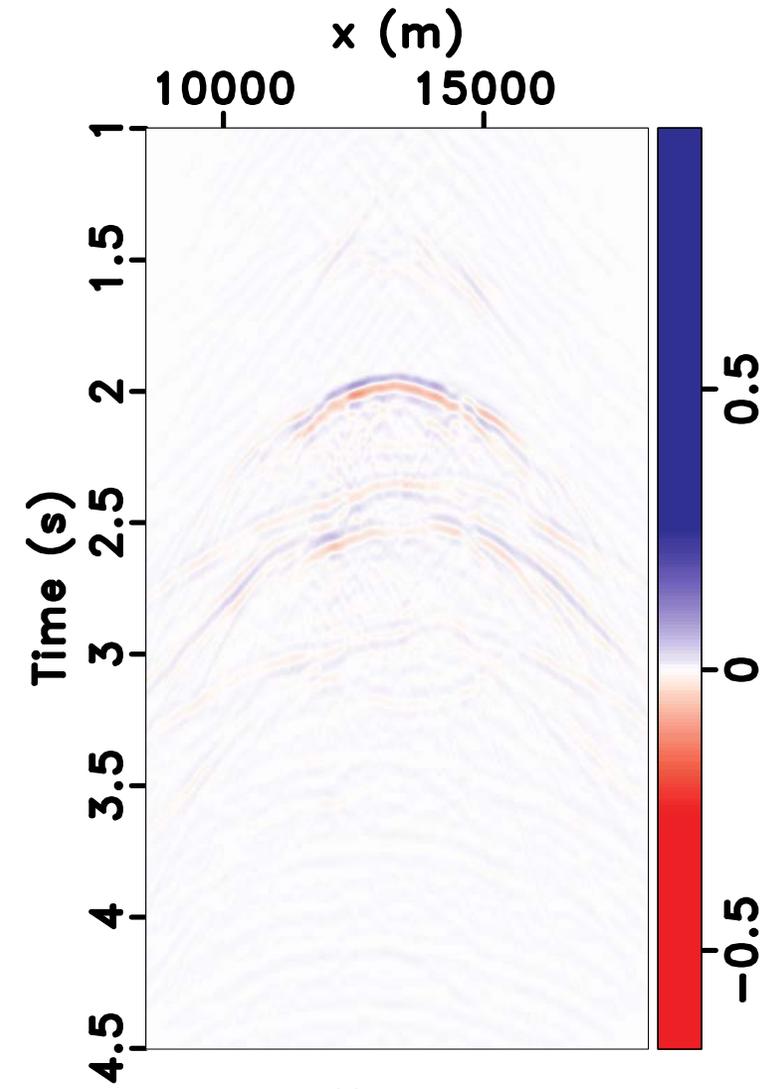
# retrieved Green's function



full offset



missing near offsets



difference

# missing near offset

- ▶ stronger for shallow events and near offset events
- ▶ maximum missing near offset

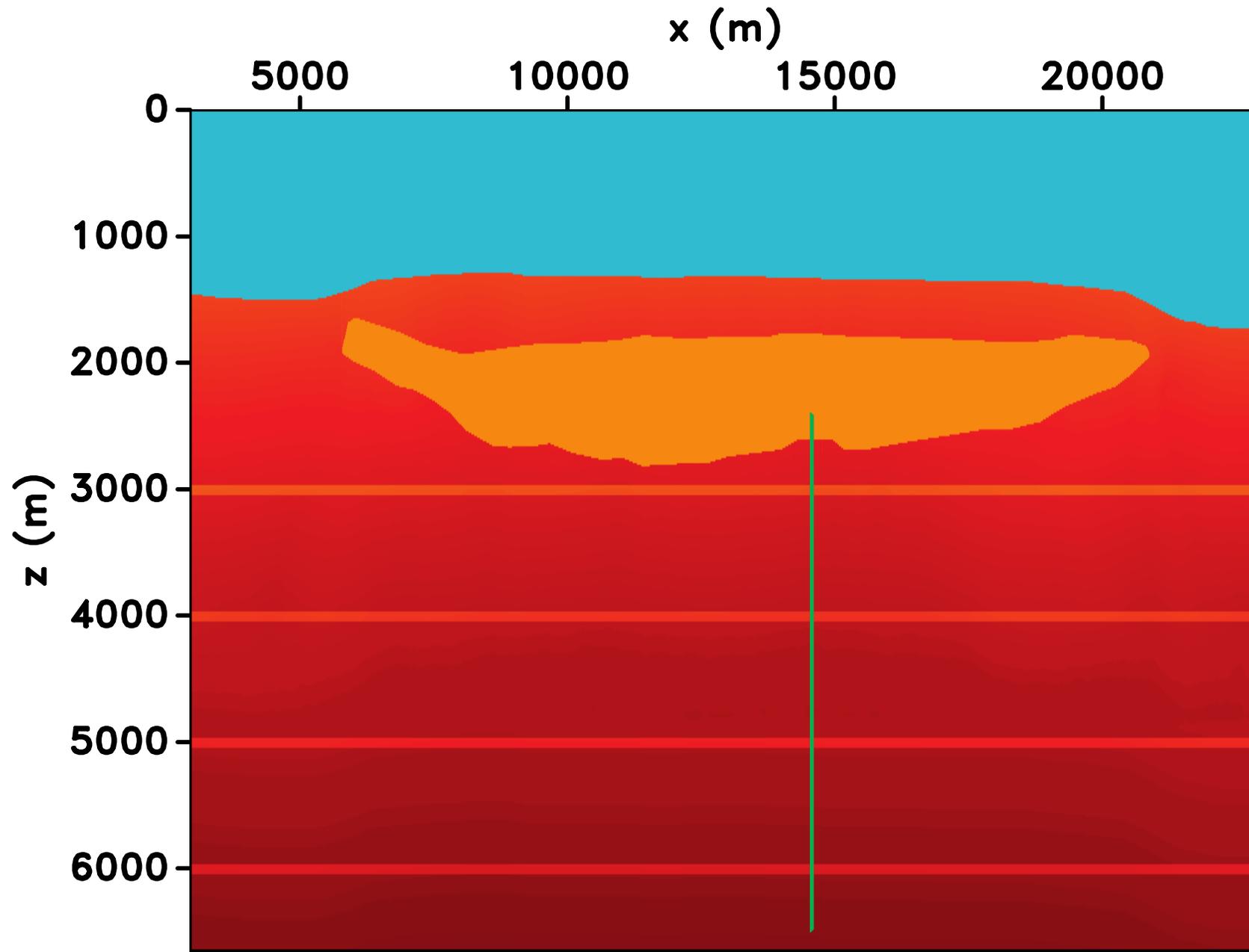
$$h \lesssim \sqrt{2DT}v_{nmo}$$

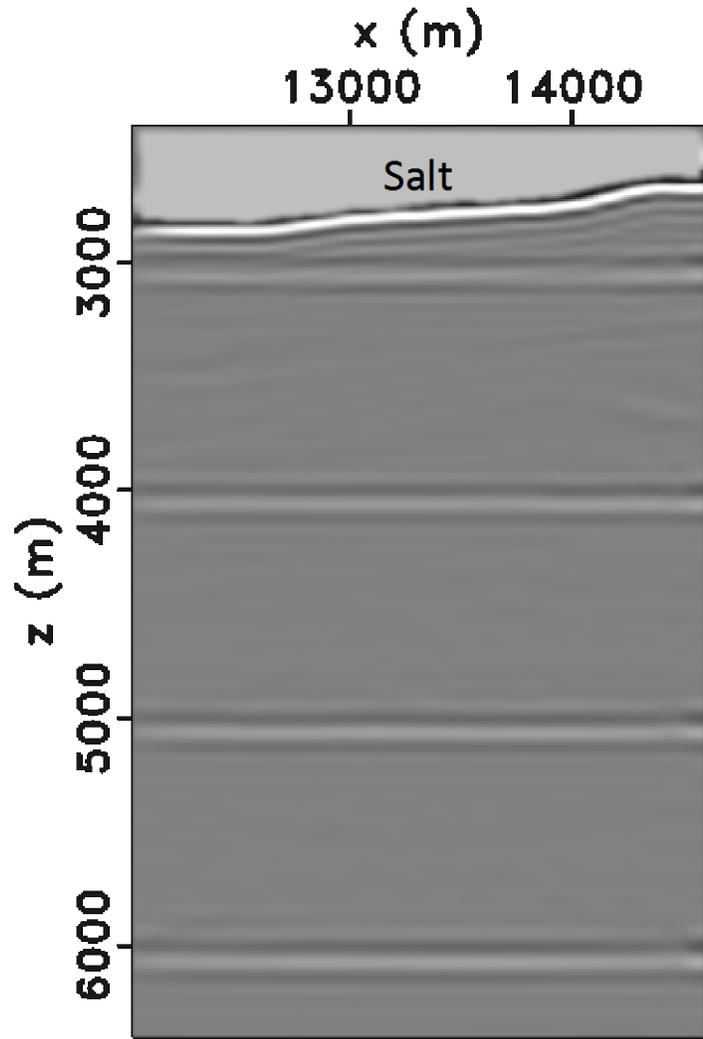
---

D: depth of reflector

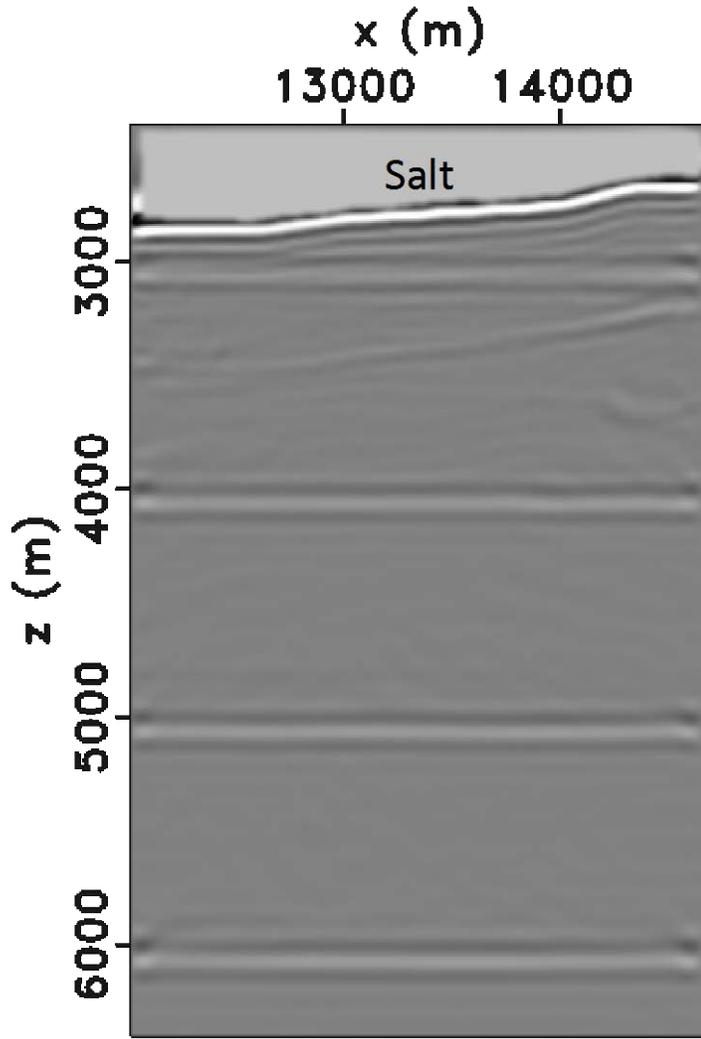
T: dominant wave period

assumption: hyperbolic assumption for flat multi-layered earth (details in CWP report)

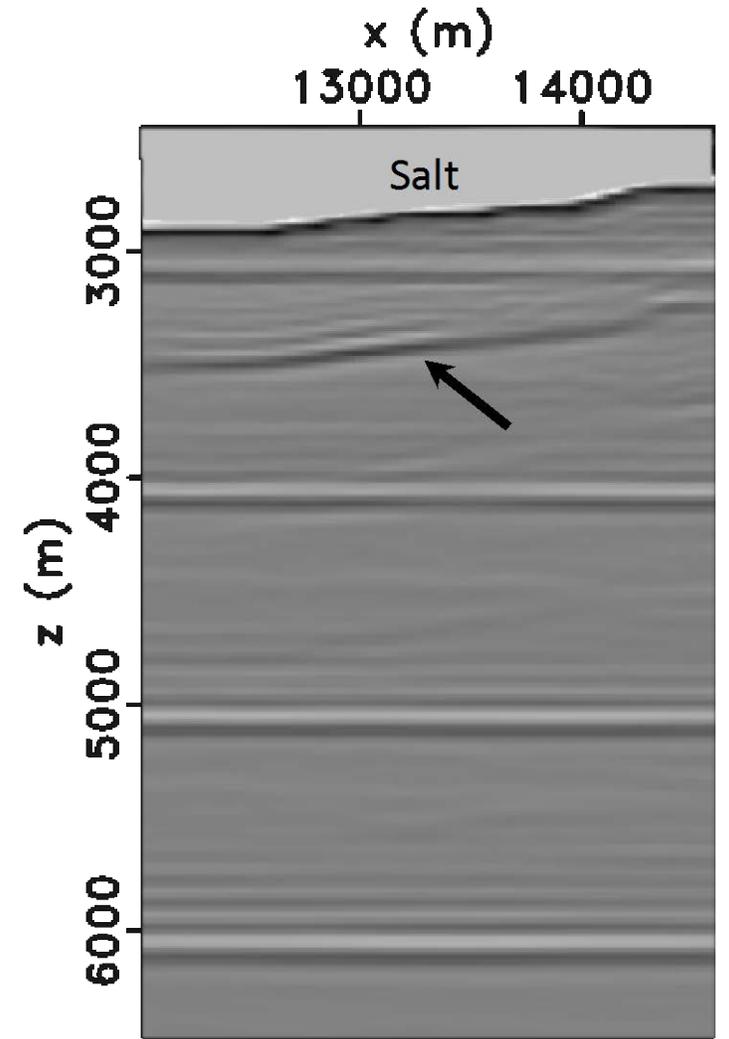




full offset



missing near offsets



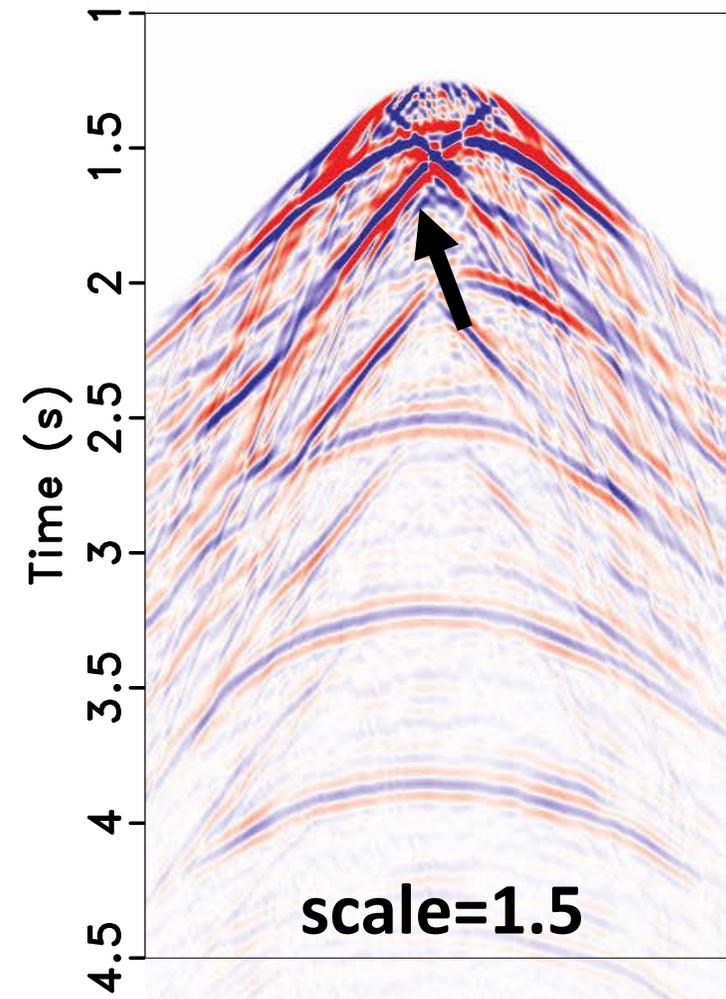
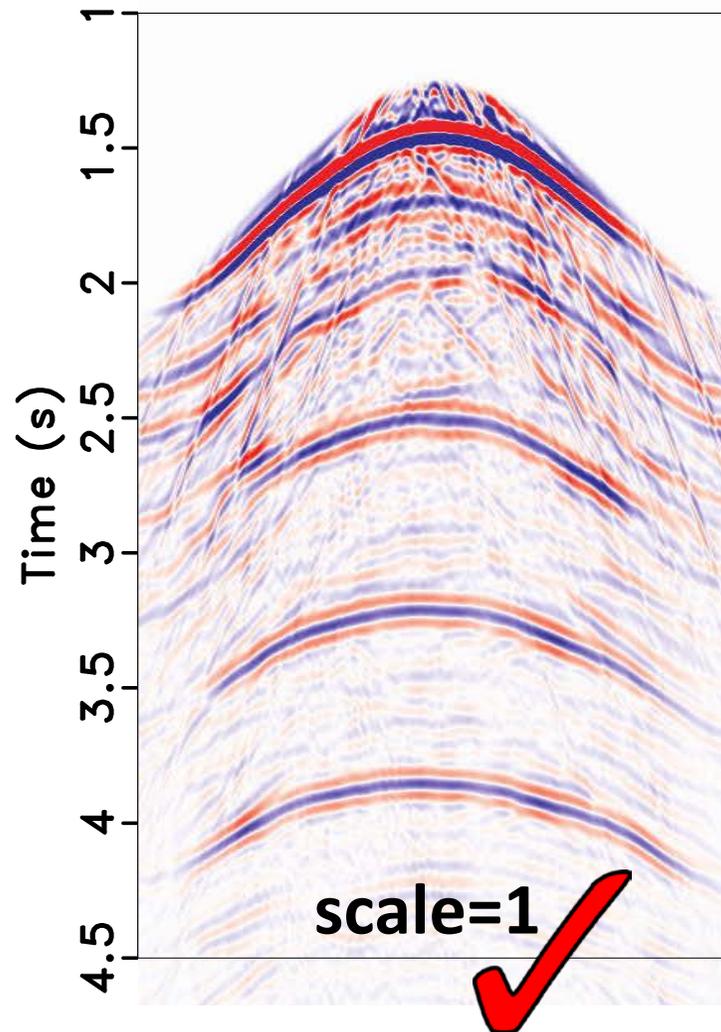
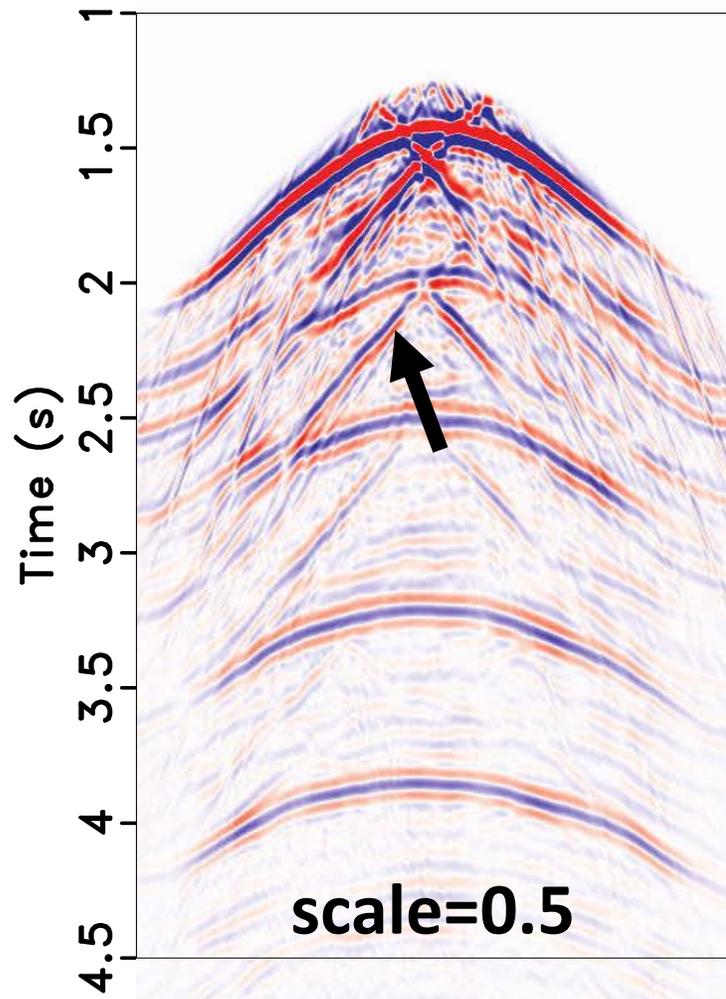
RTM

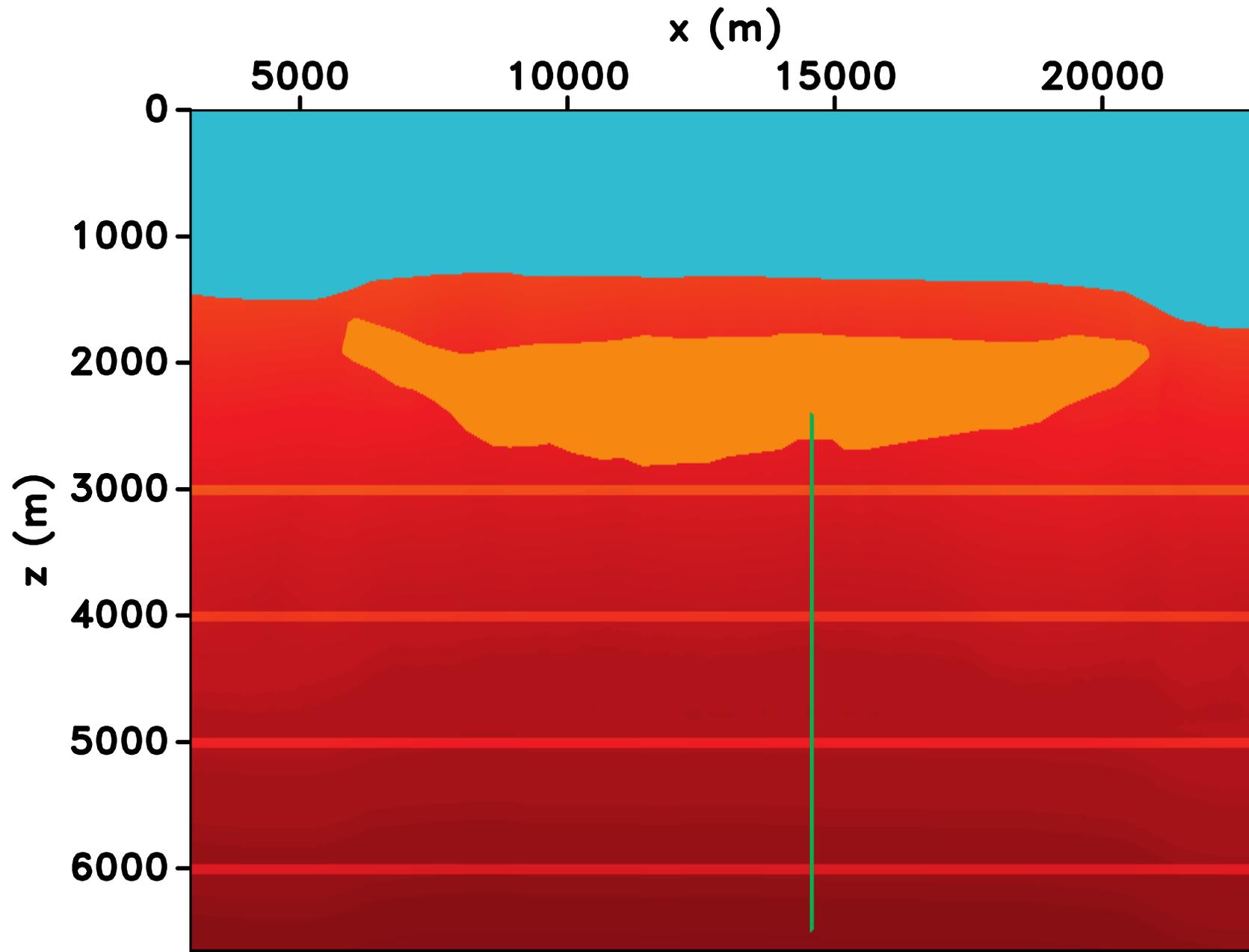
# data calibration

- ▶ input 1: surface reflection response
- ▶ input 2 : first arrival
- ▶ amplitude should match

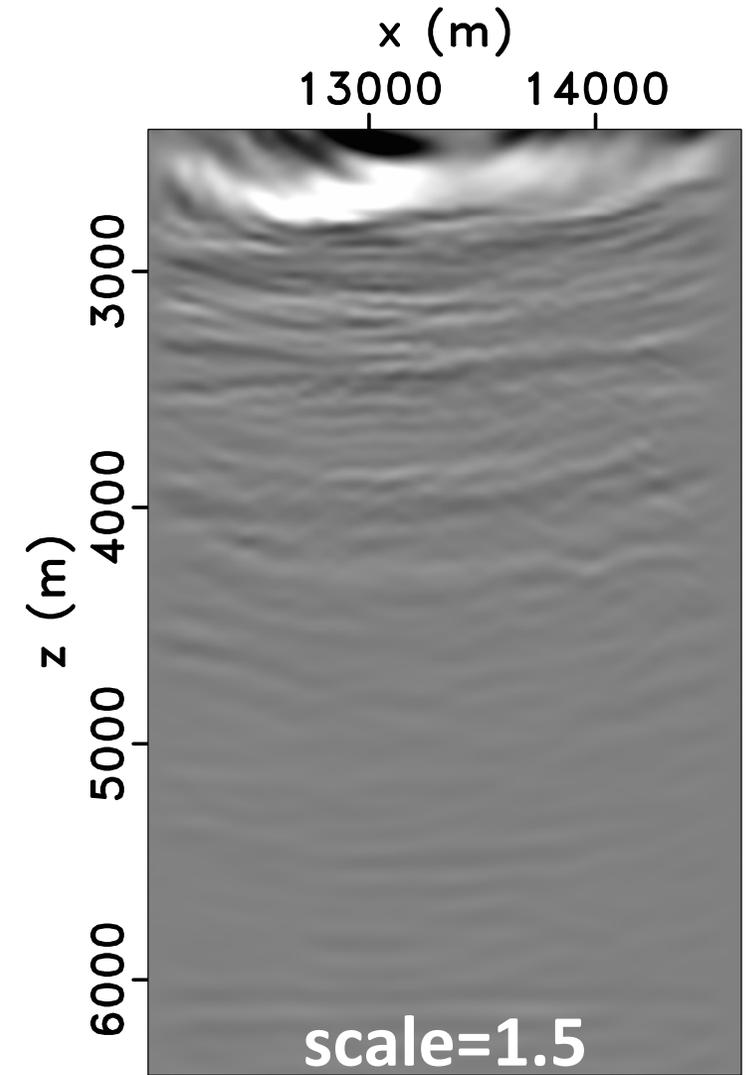
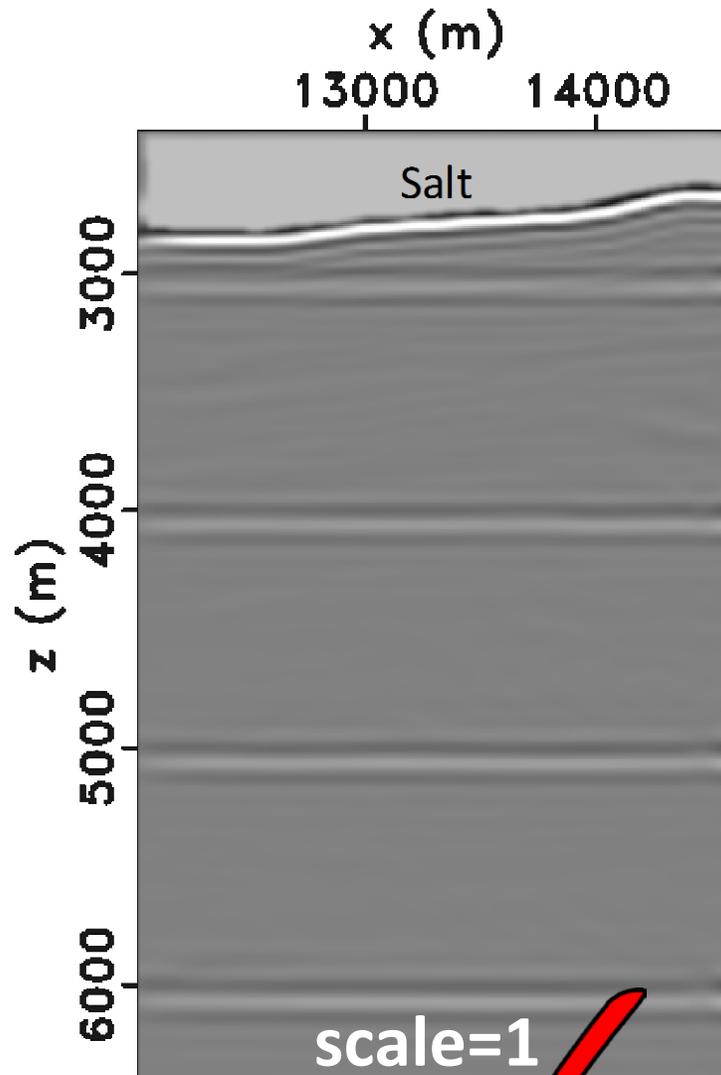
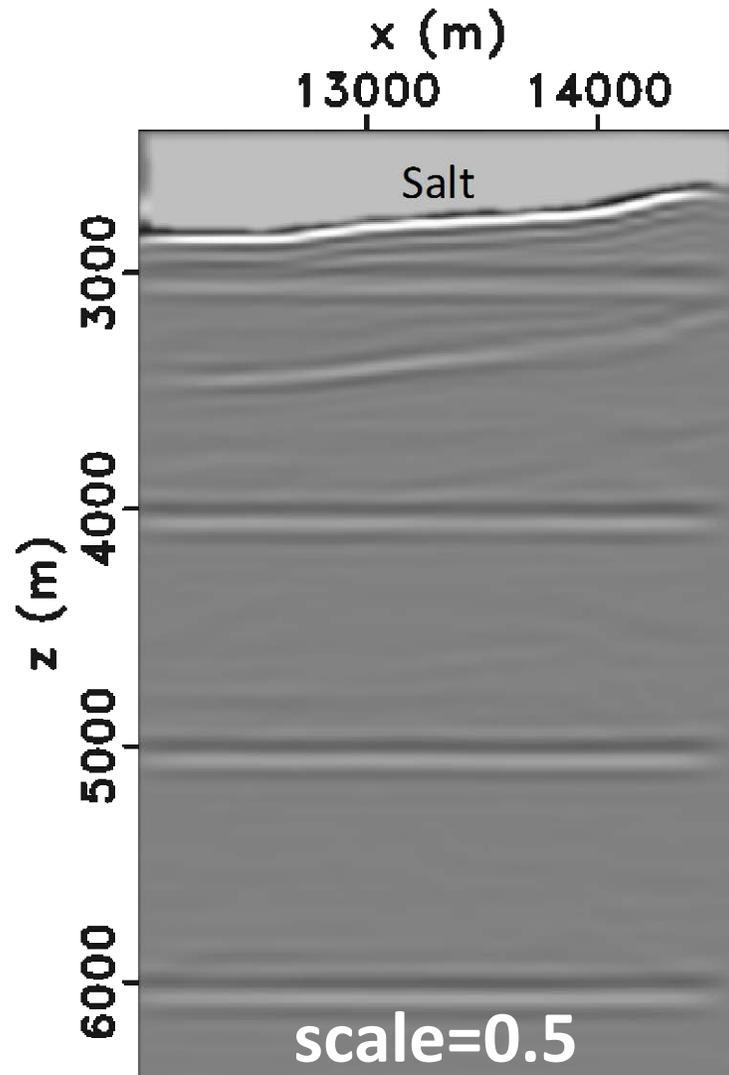


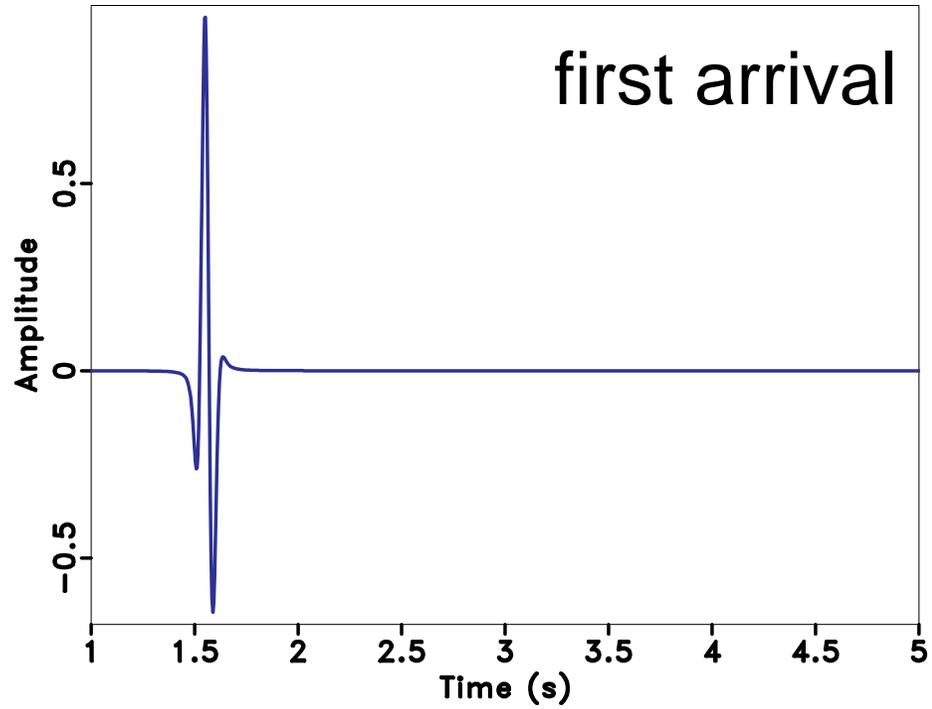
# retrieved Green's function



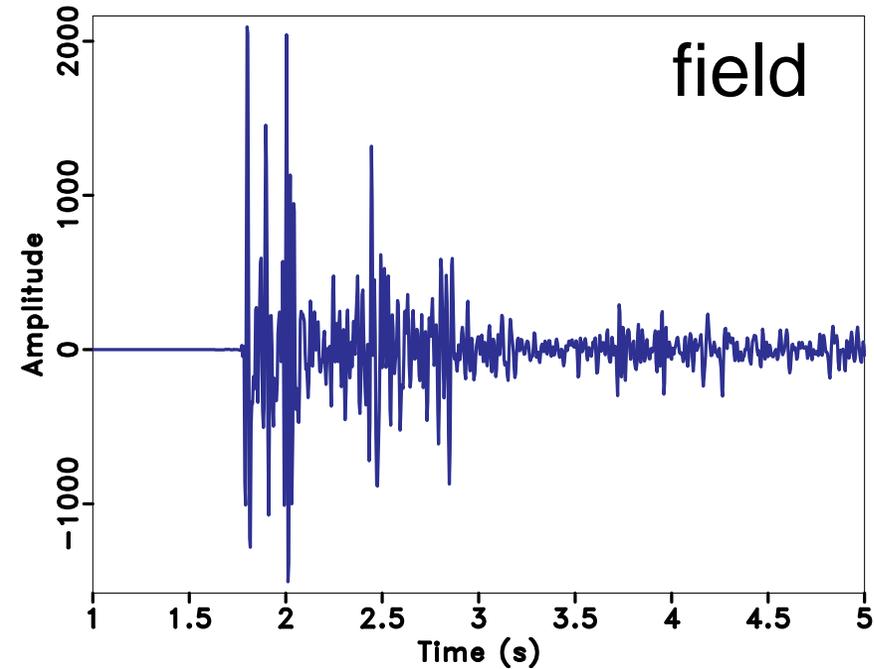
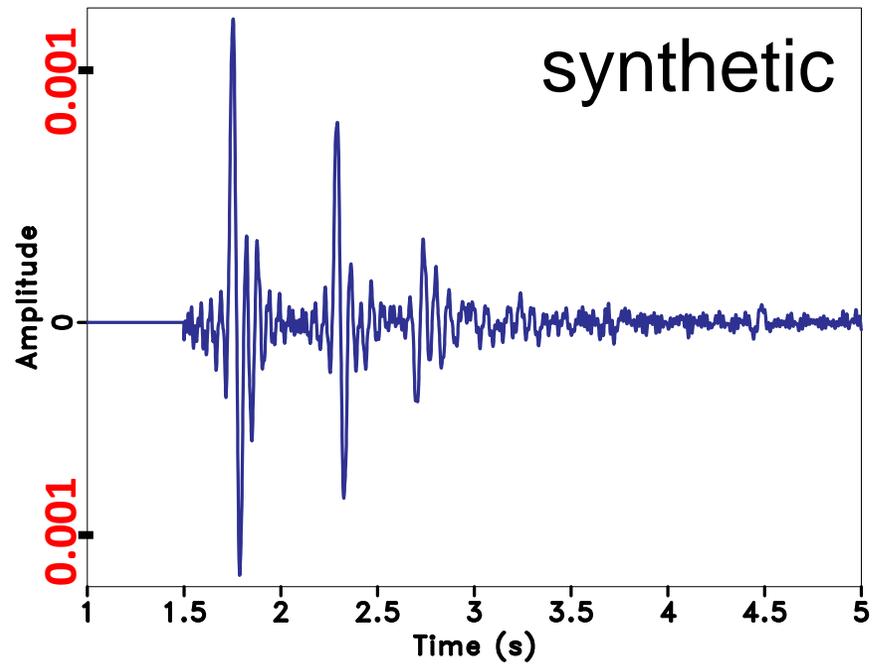


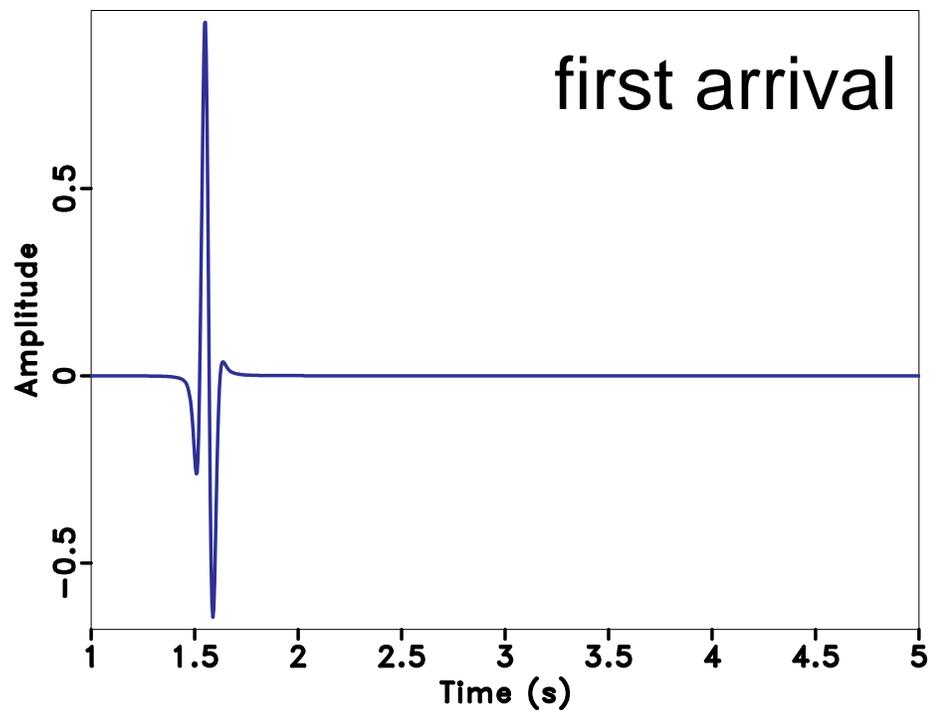
# data calibration



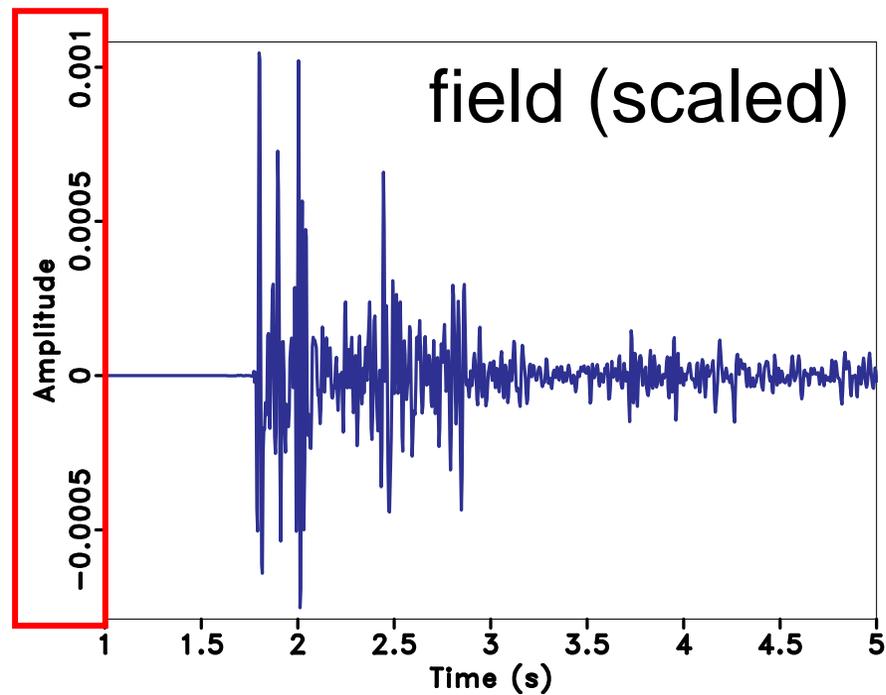
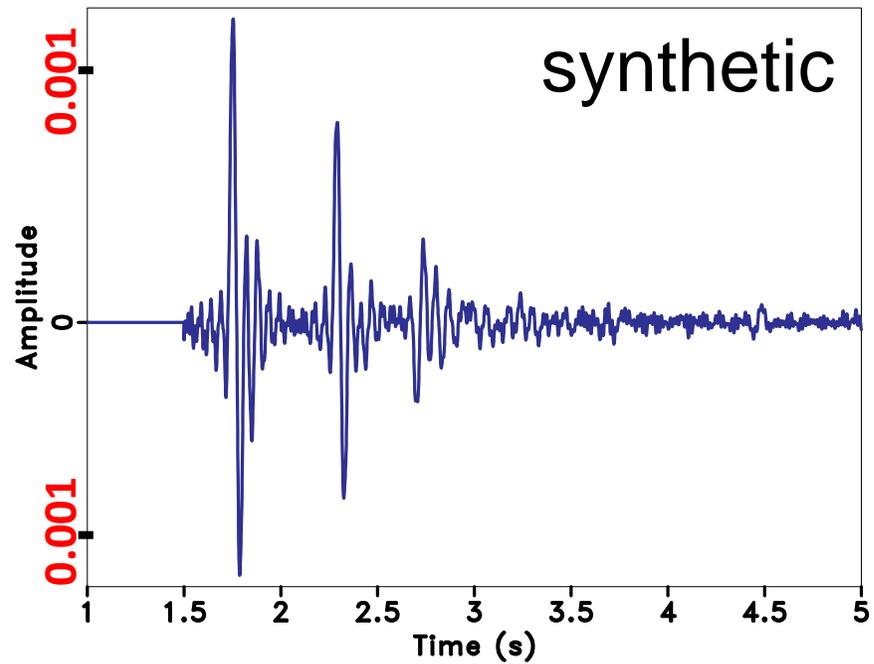


\*



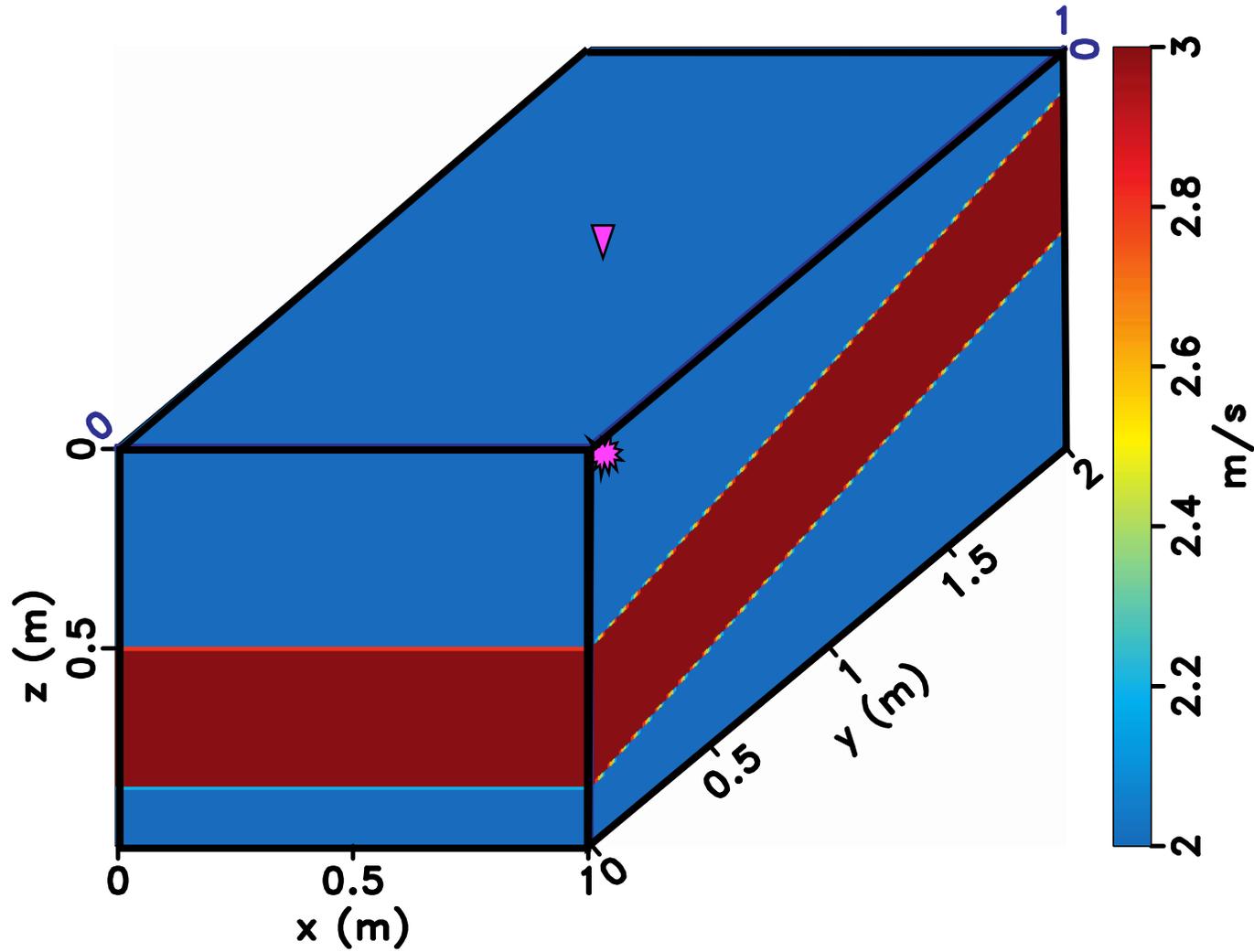


\*



# 2D can be deceptive

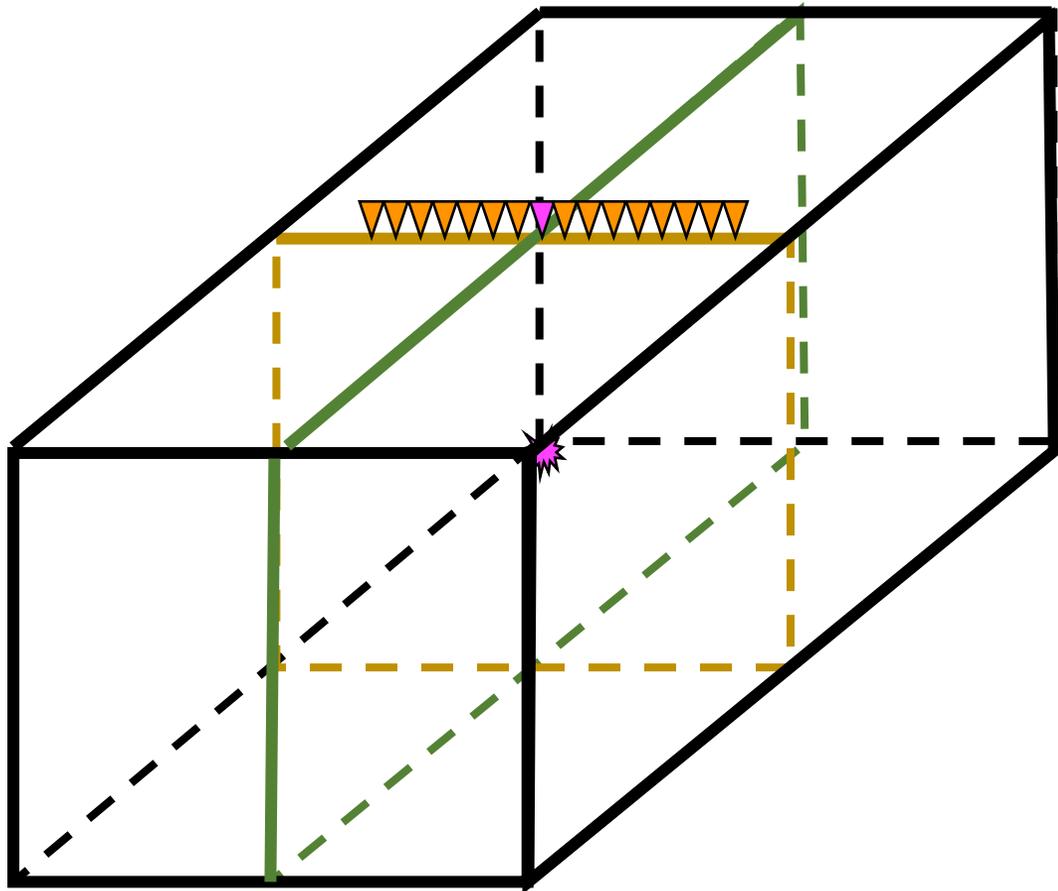




Green's function  
in 3D structure

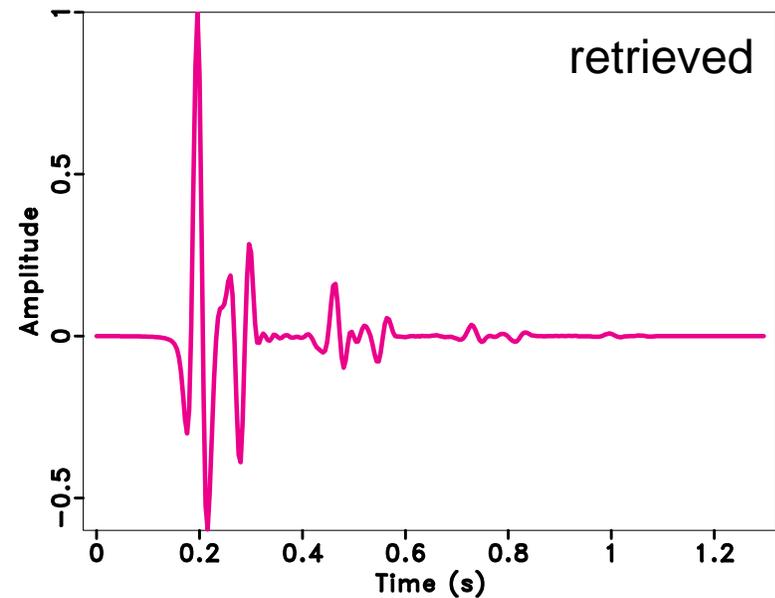
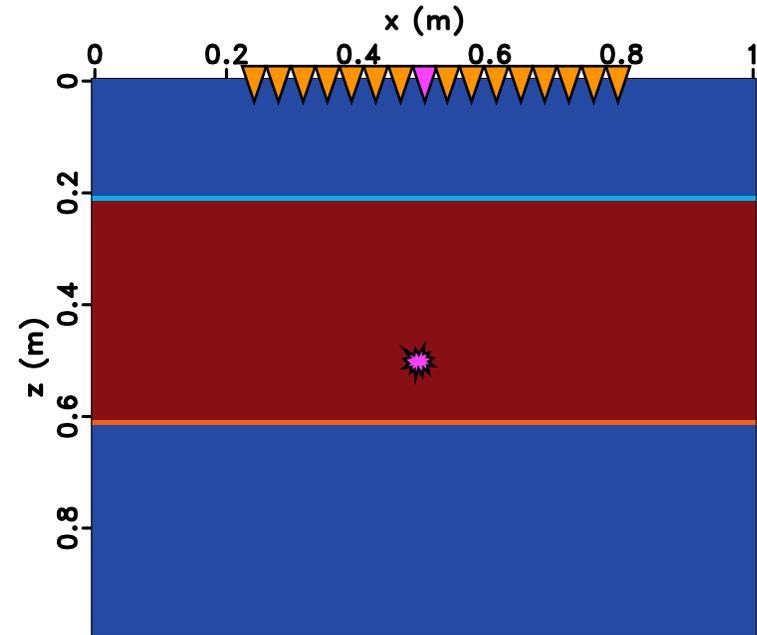
▽  $x=0.5, y=1, z=0$

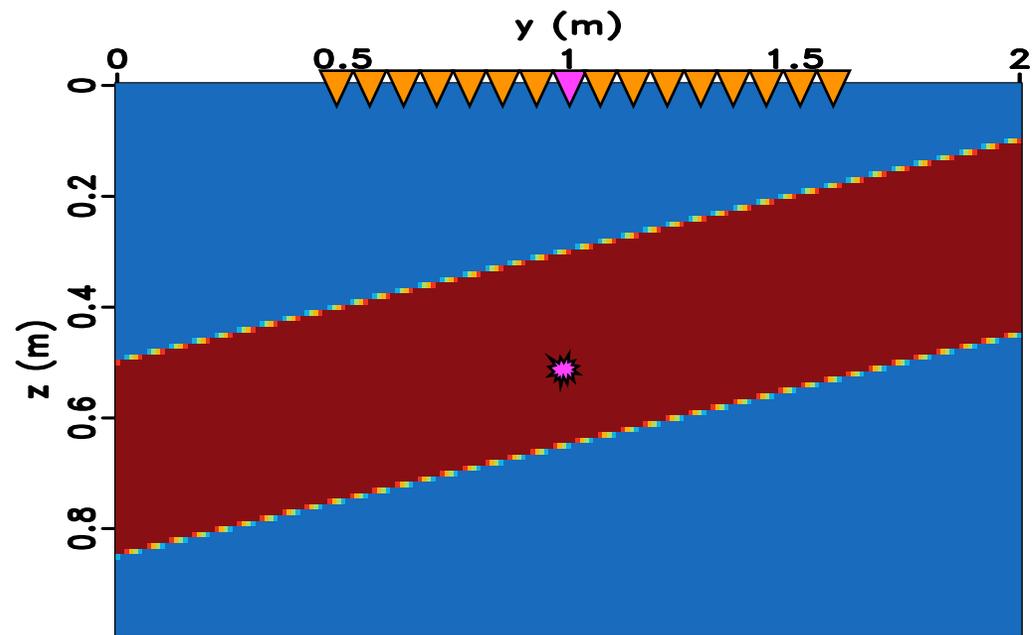
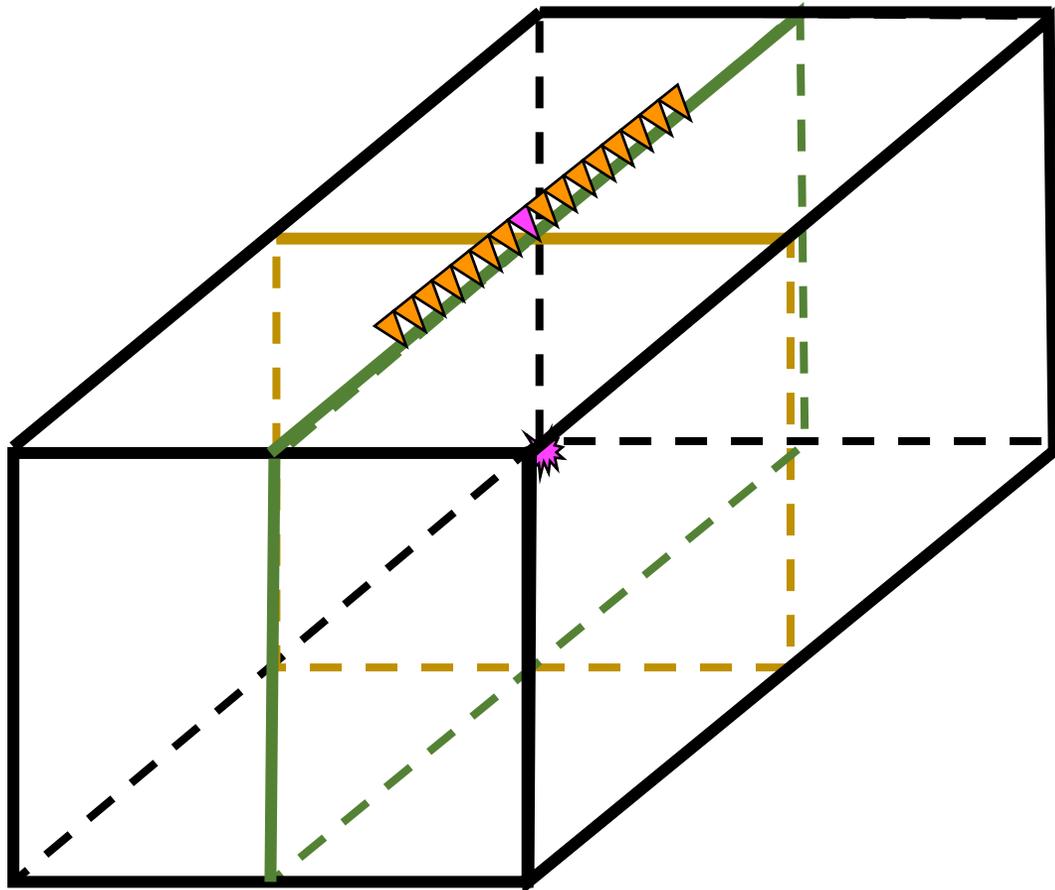
★  $x=0.5, y=1, z=0.5$



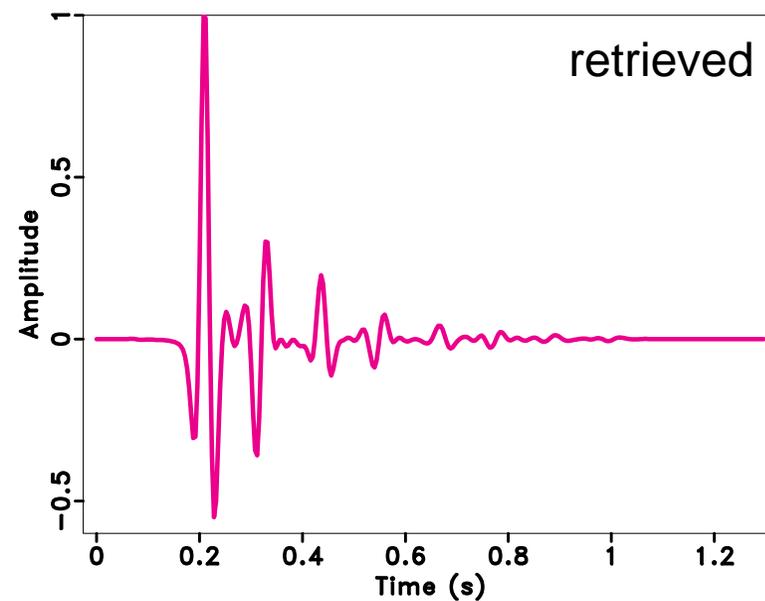
▽  $x=0.5, y=1, z=0$

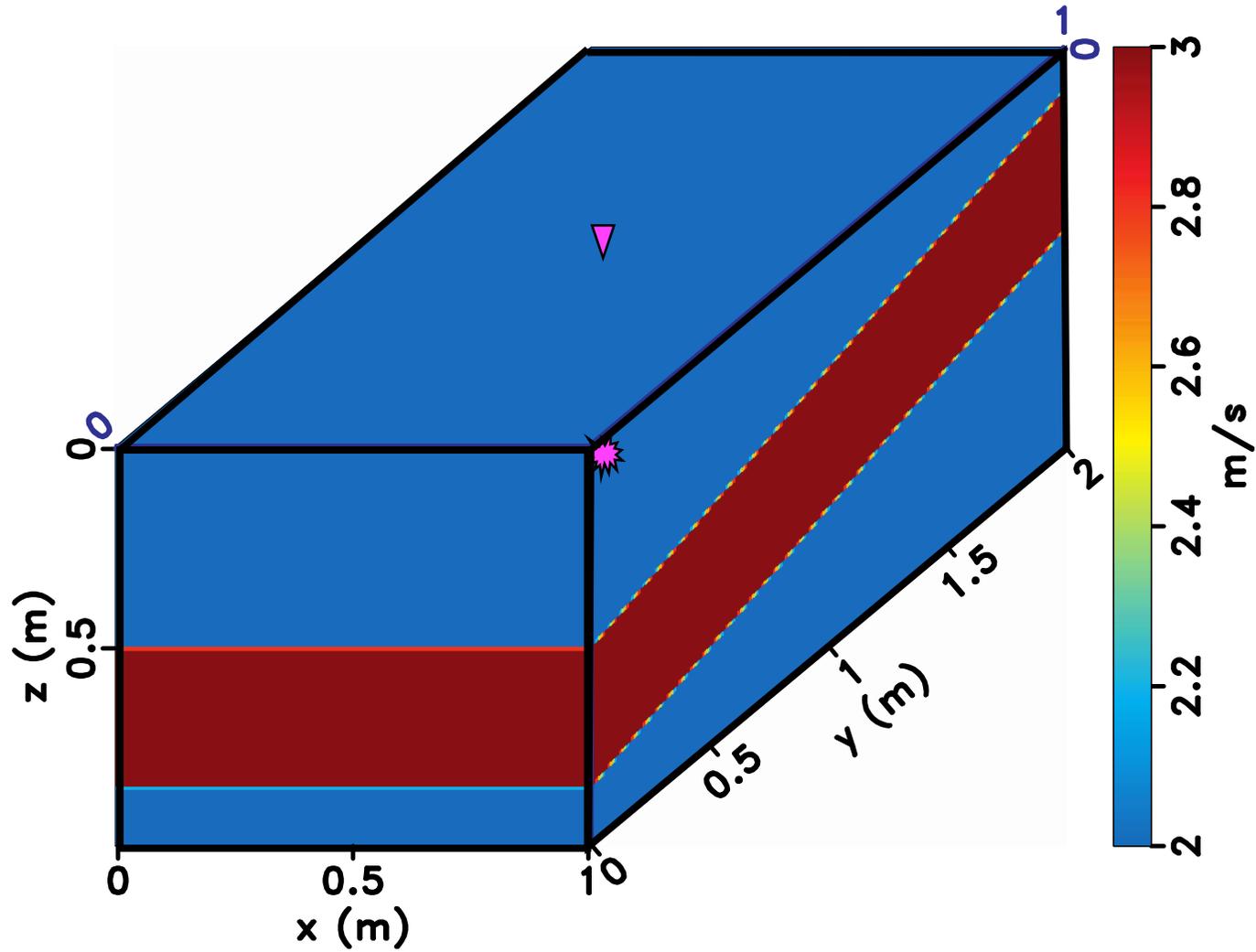
★  $x=0.5, y=1, z=0.5$





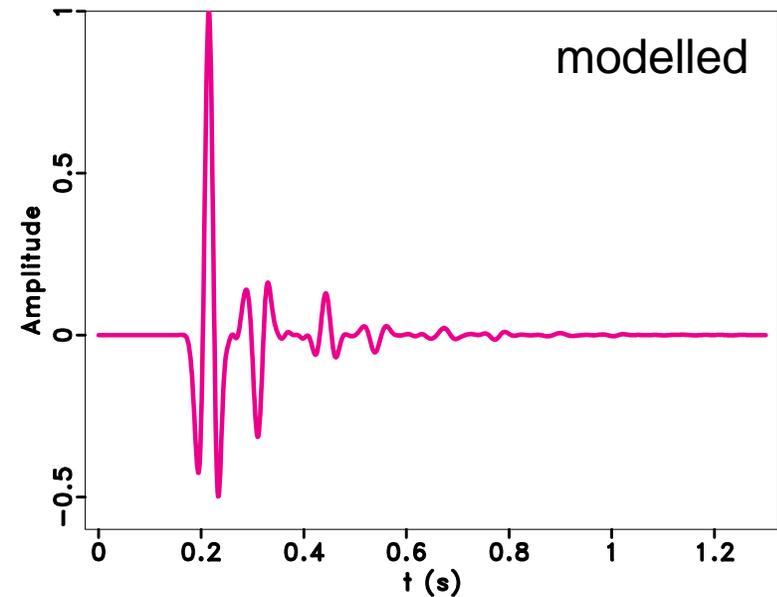
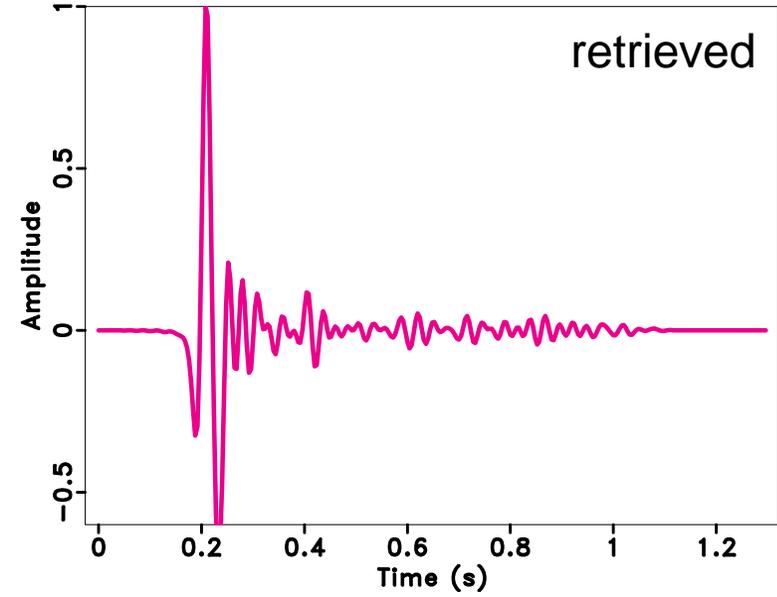
- ▼  $x=0.5, y=1, z=0$
- ★  $x=0.5, y=1, z=0.5$





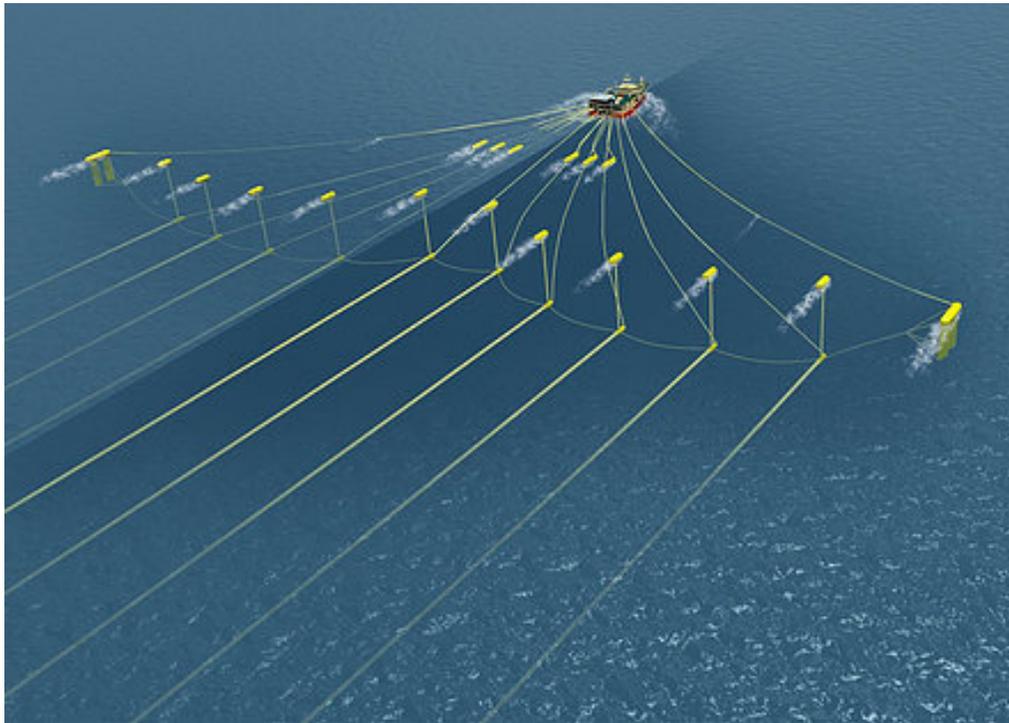
▽  $x=0.5, y=1, z=0$

★  $x=0.5, y=1, z=0.5$



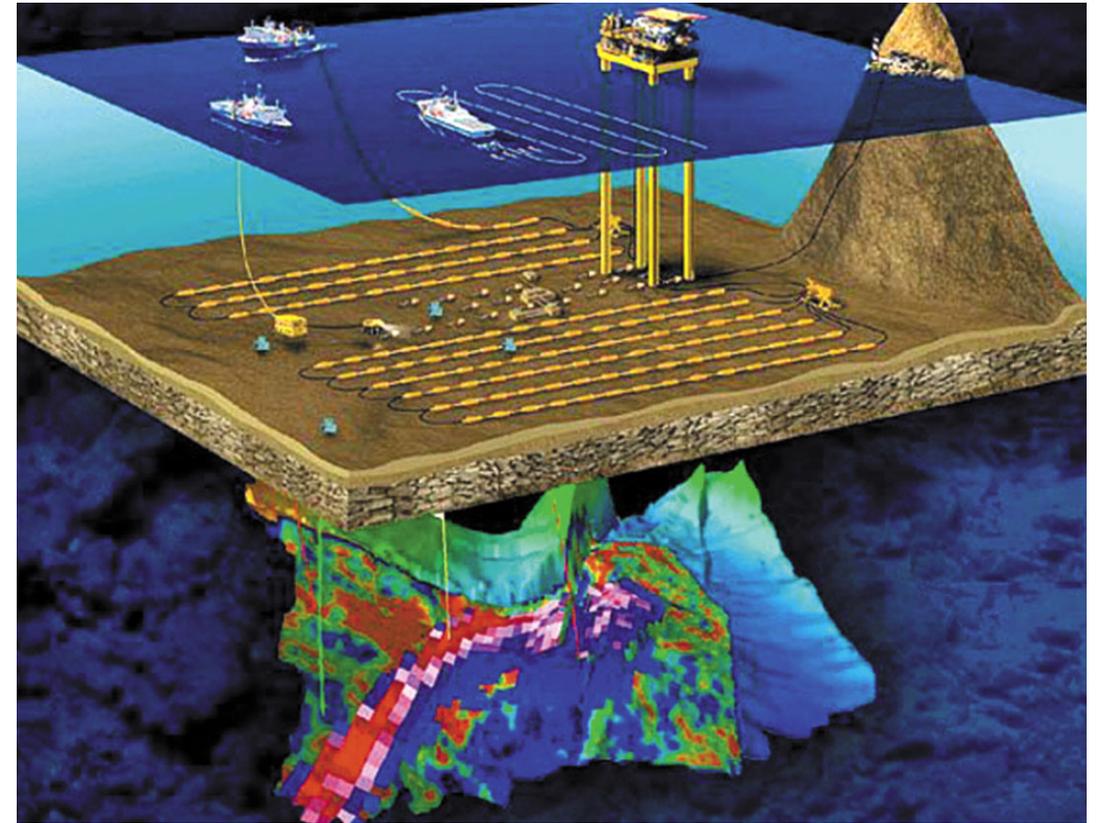
# 3D Marchenko

streamer data  
(dense in-line, sparse x-line)



(<http://www.prism-exploration.com/seismic-ops>)

ocean bottom data



(Wang et al. 2009)

