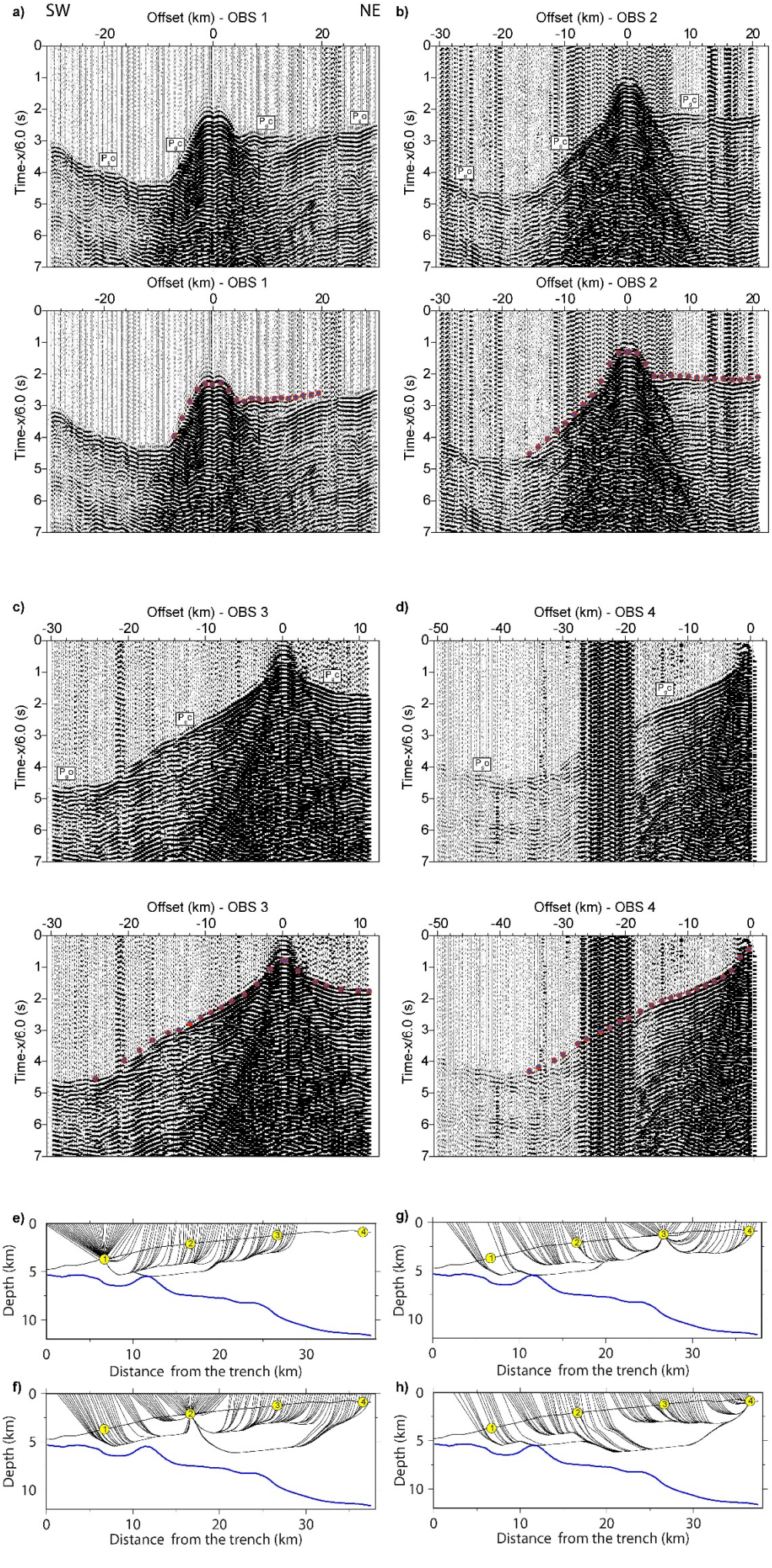
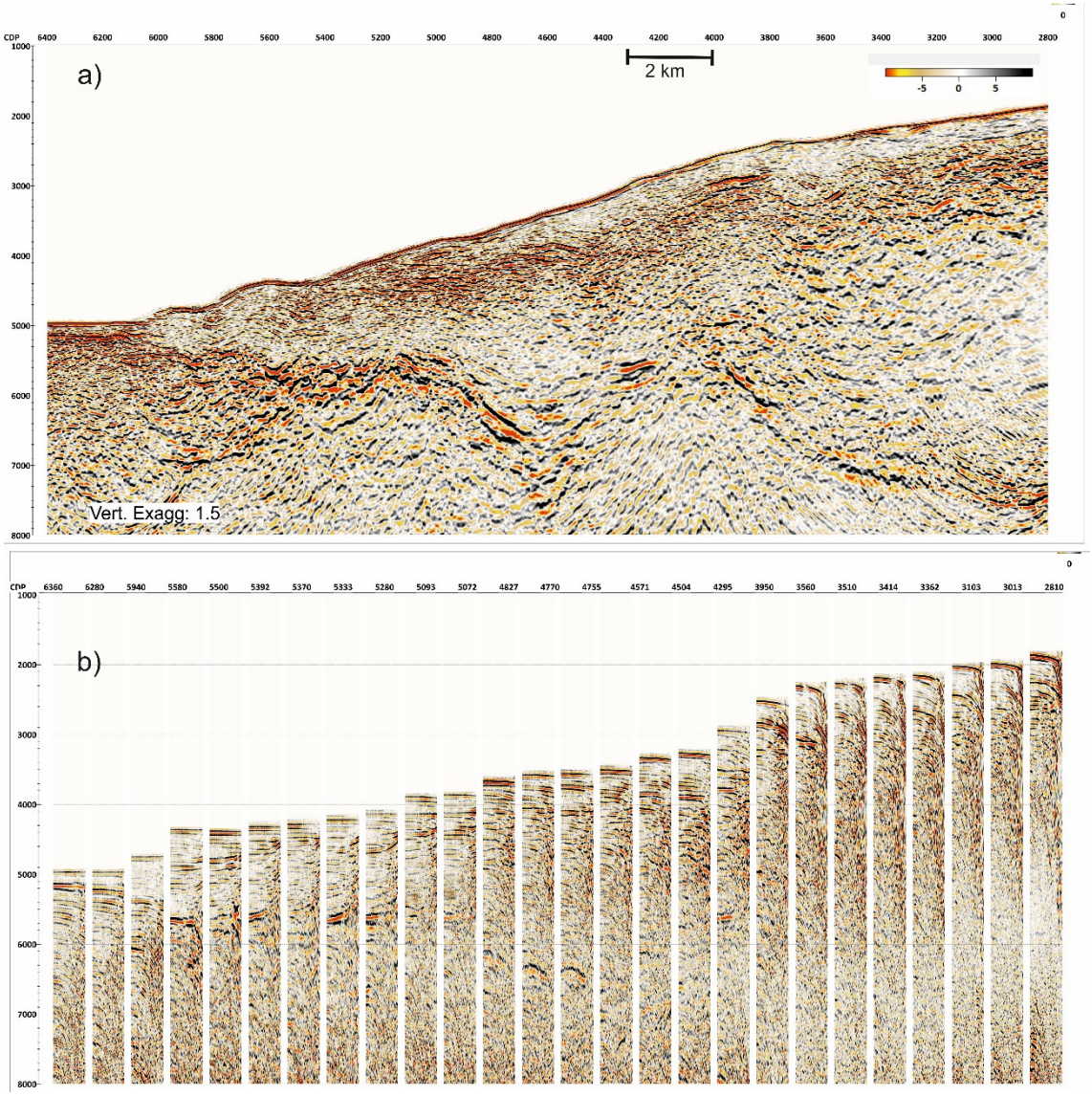
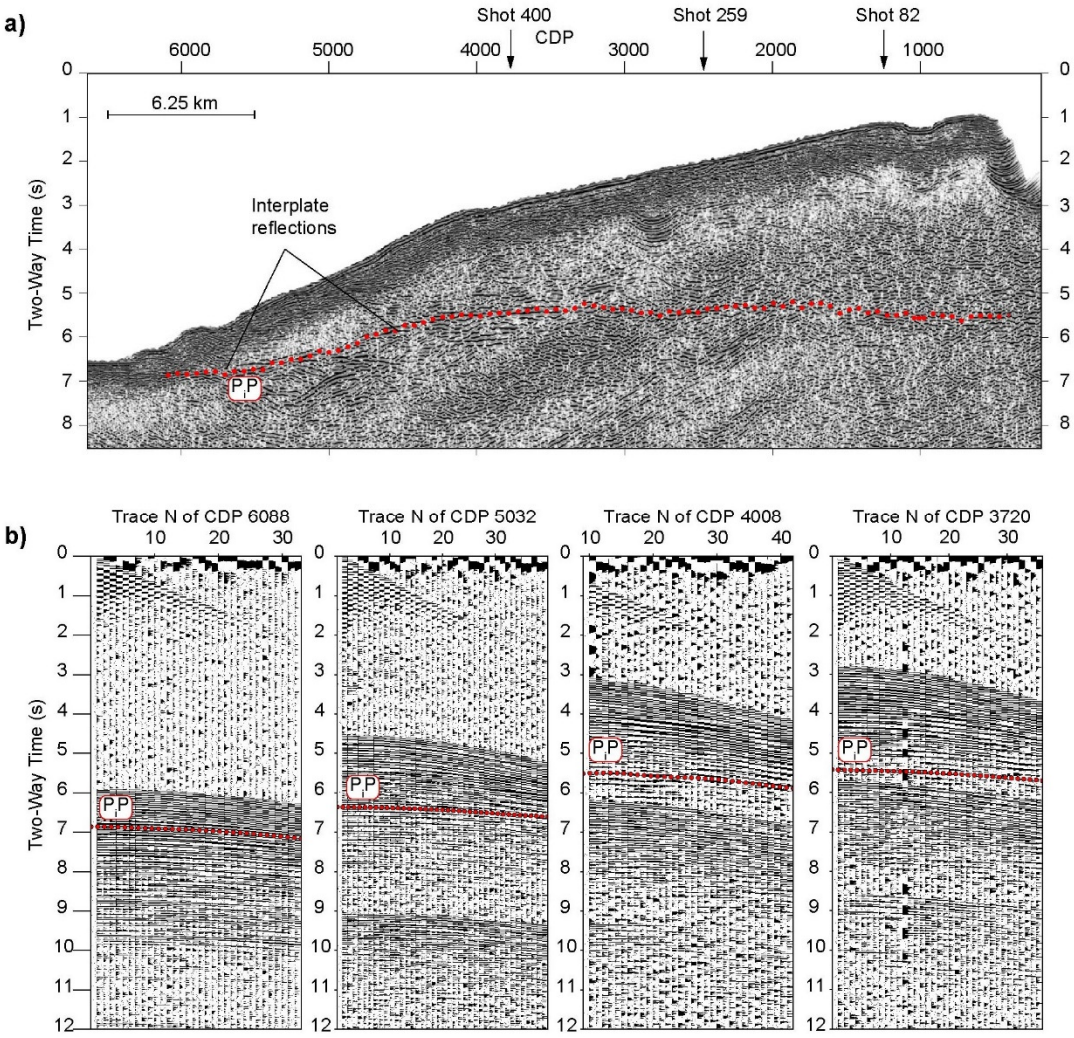

a)
SW
NE
Offset (km) - OBS 1
Time-x/6.0 (s)
b)
Offset (km) - OBS 2
c)
Offset (km) - OBS 3
d)
Offset (km) - OBS 4
e)
g)
f)
h)
Depth (km)
Distance from the trench (km)

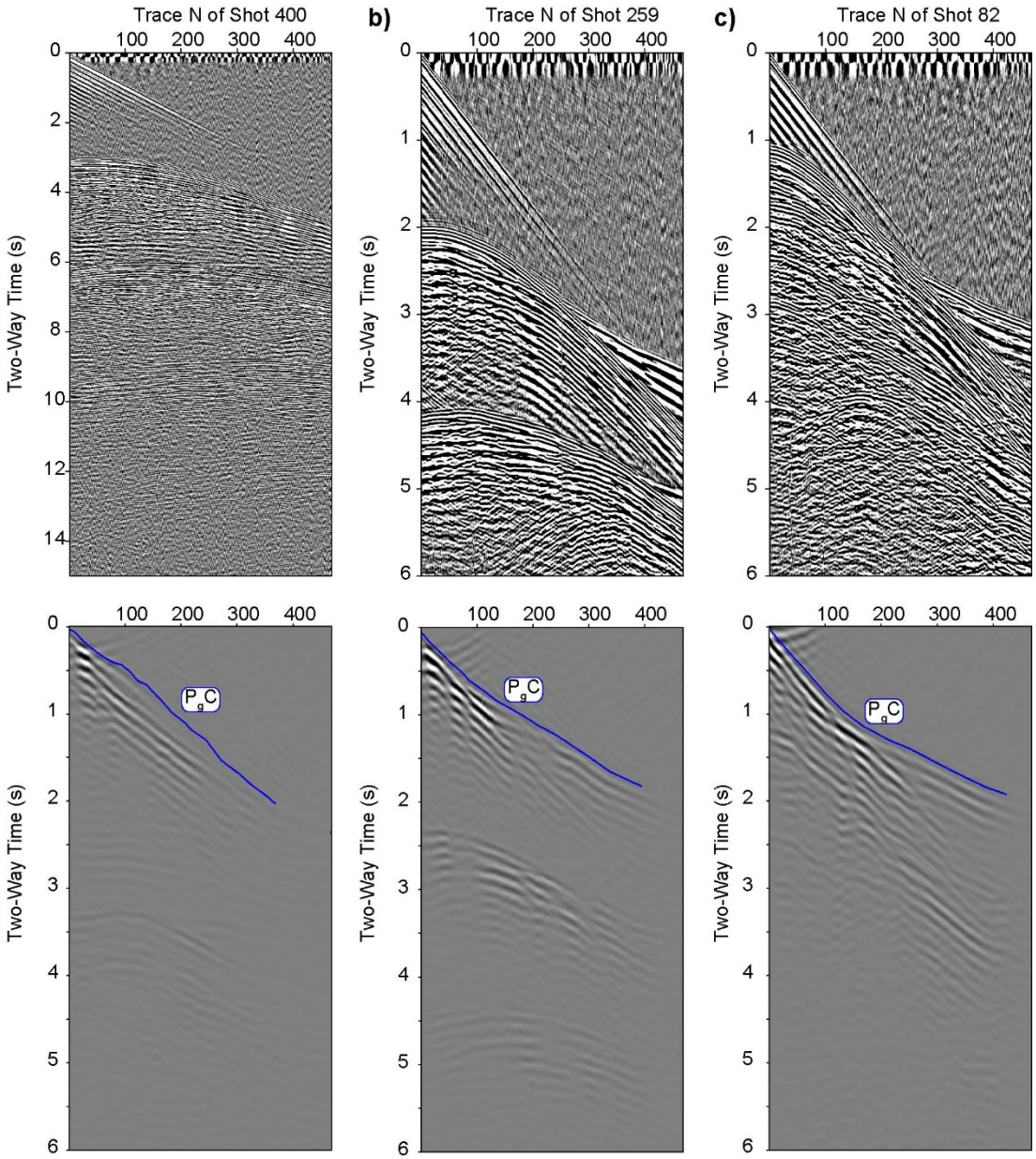
Supplementary Figure 1. – Wide-angle seismic records of ocean bottom seismometers 1 (a), 2(b), 3 (c), and 4(d). Upper panel show record sections with highlighted seismic phases of interest and no picks, while lower panels show the selected (red dots) and synthetic (blue dots) travel-times of each seismic phase. Ray tracing of OBS 1 (e), 2(f), 3(g) and 4(h) through the average final velocity model (Fig. 2a).



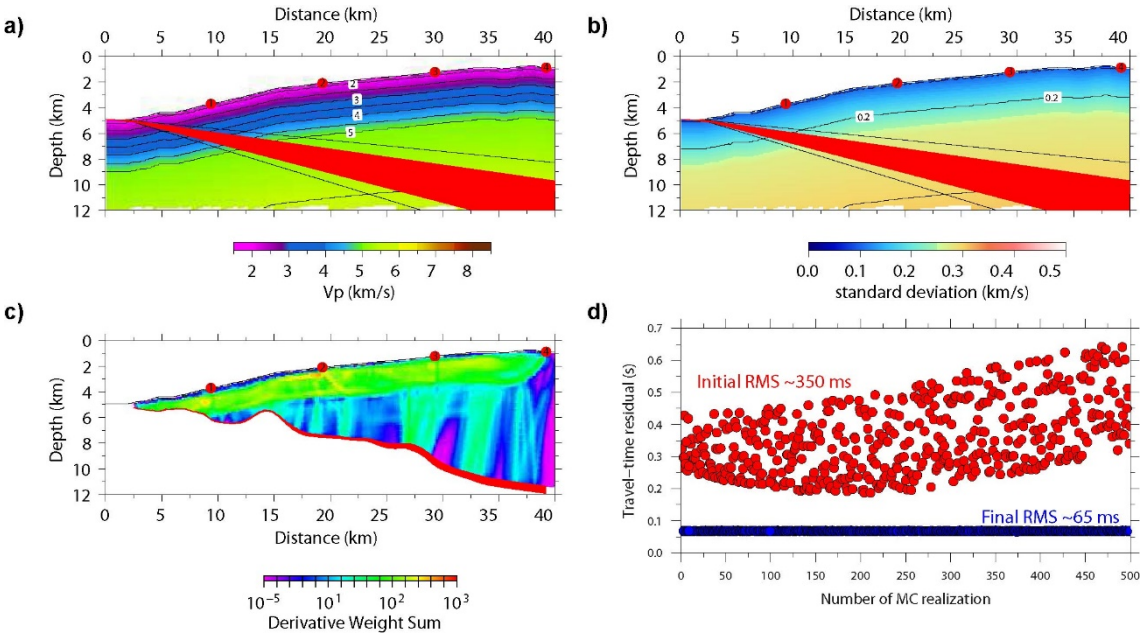
Supplementary Figure 2 – a) PSDM section and (b) Common Image Gathers.



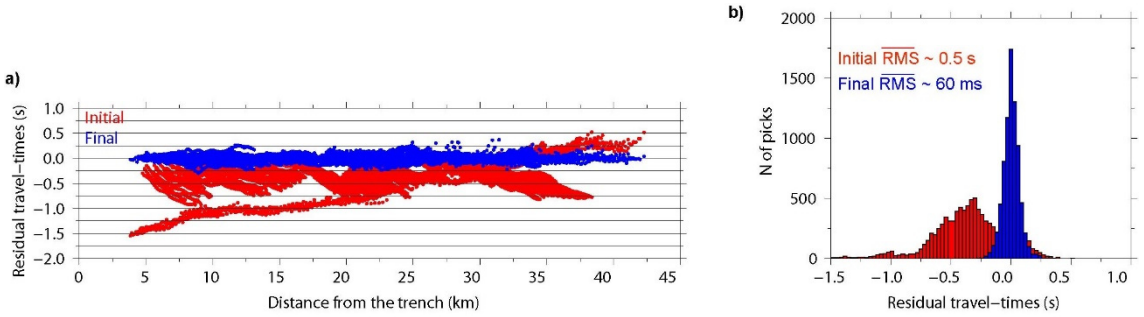
Supplementary Figure 3.- (a) Time migrated section TS02 showing near-offset *PiP* travel-times picked in each CDP gather. (b) Examples of CDP gathers showing *PiP* travel-times picked for the inversion.



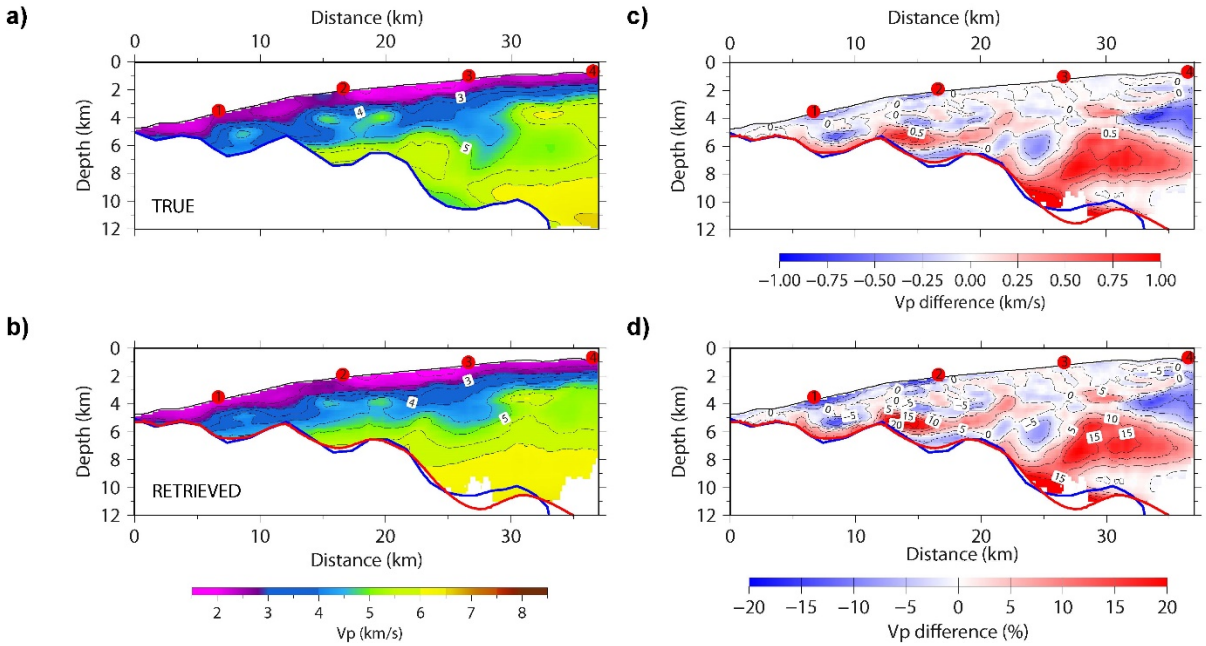
Supplementary Figure 4.- Shot gathers 400 (a), 259 (b), and 82 (c), before (upper panels) and after (lower panels) the downward continuation. The blue line in each lower panel depicts *PgC* travel-times picked for the inversion.



Supplementary Figure 5.- a) Average initial velocity model of the 500 models tested in the Monte Carlo analysis, and the corresponding initial standard deviation (b). The red band shows the standard deviation of the initial interplate reflector, and the upper and lower black lines the maximum and minimum depth-range tested during the analysis. c) Average derivative weight sum of the 500 final velocity models depicting the overall ray coverage. Red dots in (a)(b)(c) are ocean bottom seismometers. (d) Initial (red dots) and final (blue dots) root mean square values of each Monte Carlo inversion.



Supplementary Figure 6.- Initial (red) and final (blue) MCS travel-time residuals as a function of distance from the trench. b) Histogram showing the initial (red) and final (blue) distribution of MCS travel-time residuals.



Supplementary Figure 7.- Resolution test. a) True velocity model and true geometry of the interplate (blue line). b) Retrieved velocity model and geometry of the interplate (red line) compared with the true geometry (blue). c) Velocity difference between the true and retrieved model in absolute values (c) and percentage (d).