Born and ray-theory seismograms in 2D heterogeneous isotropic models

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Differences in the methodology
Corrections of the direct waves
Waves diffracted from the edges

Structure of the speach

1. Differences in the methodology

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Current section

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Differences in the methodology

- We compare: Born seismograms & differences between the ray-theory seismograms in partially perturbed models and the background model. (corrections of the direct waves)
- Abscissae in the seismograms:
  - travel times (computed in the background model) of the diffracted waves
  - the waves are diffracted from the edges of the block containing the perturbation
  - colours of the abscissae (block has 4 edges):

Edge	left upper	left lower	right upper	right lower
Colour	green	pink	yellow	blue

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Exceptional blocks

- most blocks: 4 edges
- exceptional blocks:
  - Block 3, Block 16: 3 edges (no problem, the same color palette)
  - Block 10: 5 edges (no diffracted waves from 2 edges located at the upper model boundary)
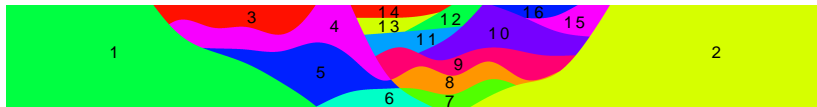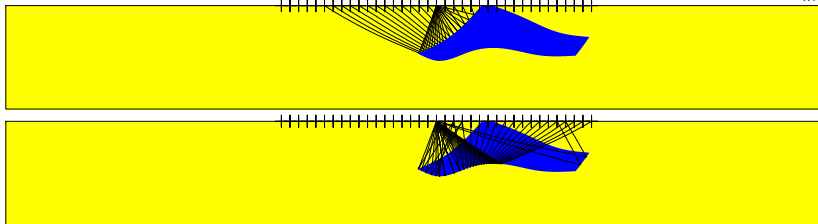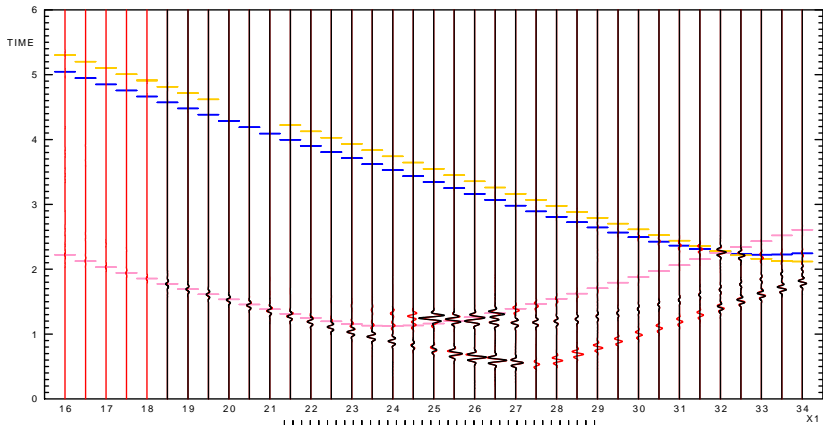

Figure: Blocks in model P1I.

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Current section

1. Differences in the methodology

2. Corrections of the direct waves

3. Waves diffracted from the edges
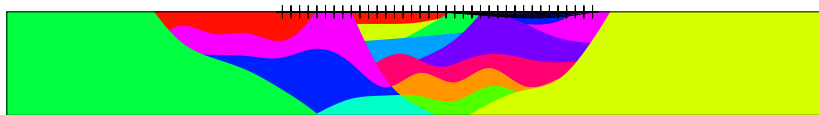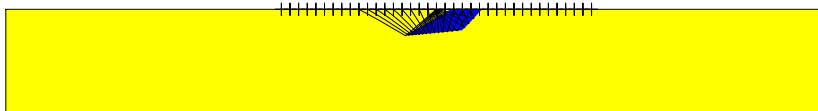
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-10-10% scaled by 1×10^4.

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Origin of these waves

Figure: The ray diagram of the direct wave computed in the background model, depicted together with the blocks in model P1I.

rays travel through Blocks 10, 12, 14, 15, 16

⇓

corrections of the direct waves in models P1-10-10%, P1-12-10%, P1-14-10%, P1-15-10%, P1-16-10%
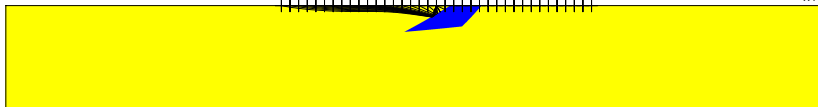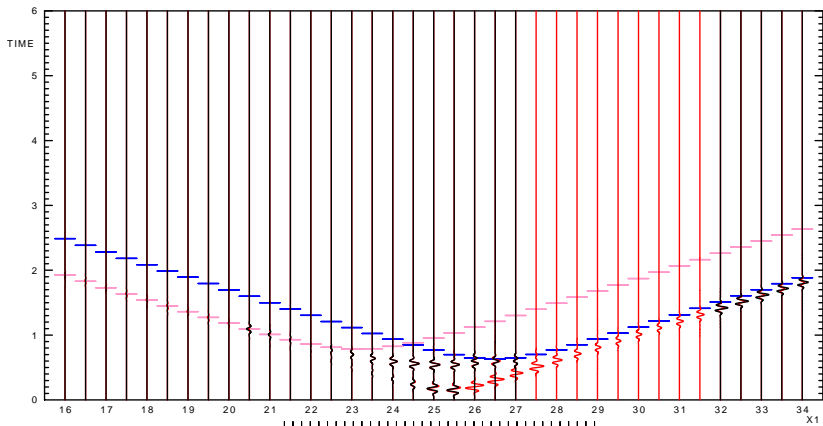
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-12-10% scaled by 1×10^3.
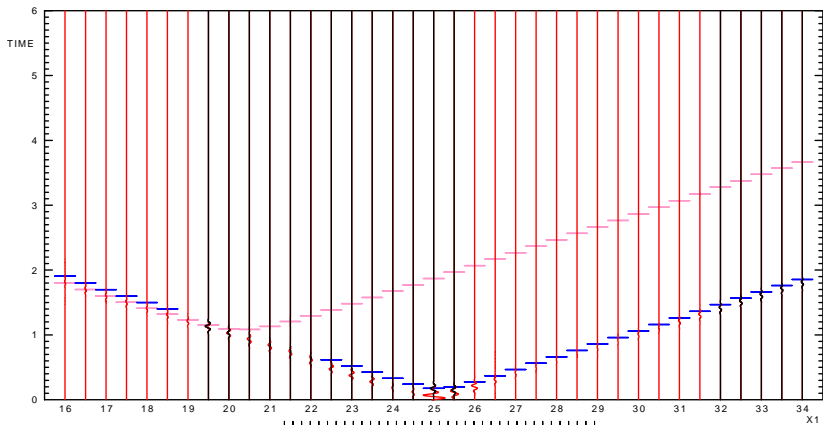
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-14-10% scaled by 1×10^3.
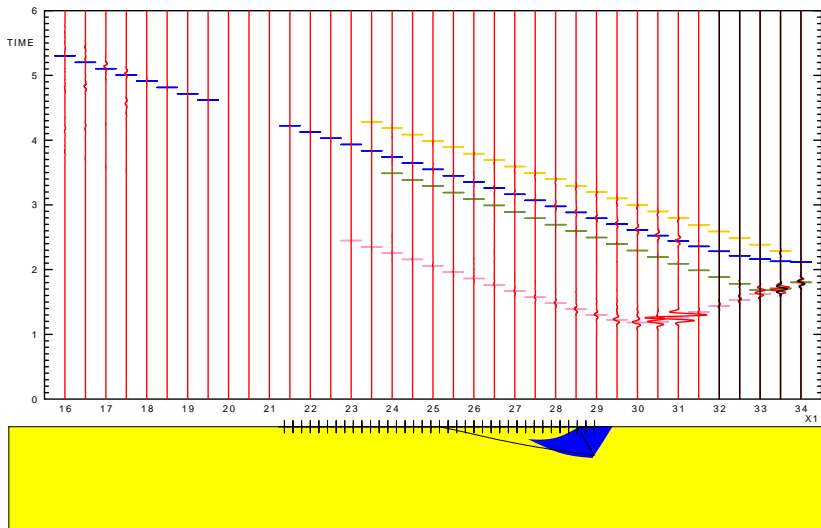
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-15-10% scaled by 2×10^5, between $x_1 = 31.5$ km and $x_1 = 34$ km scaled by 2×10^3 km.

Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-16-10% scaled by 1×10^6, at $x_1 = 28.5$ km scaled by 1×10^5, at $x_1 = 29$ km scaled by 1×10^4, between $x_1 = 29.5$ km and $x_1 = 34$ km scaled by 1×10^3.
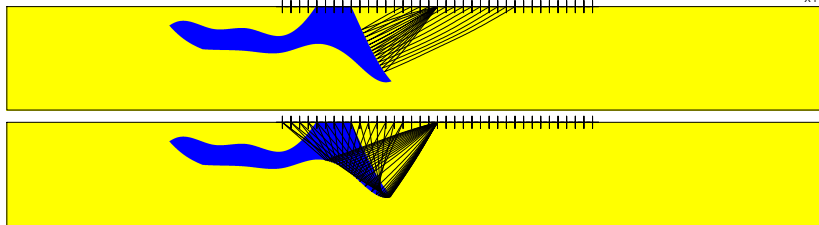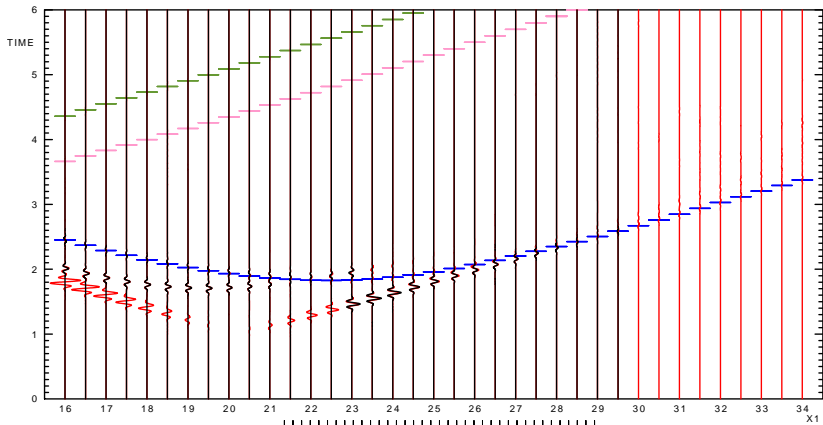
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-3-10% scaled by 1×10^6.

Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-4-10% scaled by 4×10^4.

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Corrections also in P1-3-10% and P1-4-10%?

- no rays crossing Block 3 or Block 4, see figure with direct rays

- rays incident at the receivers situated on the left-hand side of the model ????, extended model $\Rightarrow$ OK

- amplitudes of the wavegroups grow from $x_1 = 19.5$ km to $x_1 = 16$ km (length of the affected ray grows)

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P1-7-10%

- triplication: receivers between $x_1 = 24$ km and $x_1 = 27$ km; no abscissae

- diffractions from the edges:
  - green abscissae (left upper edge) $x_1 \leq 20.5$ km - 1st elementary wave
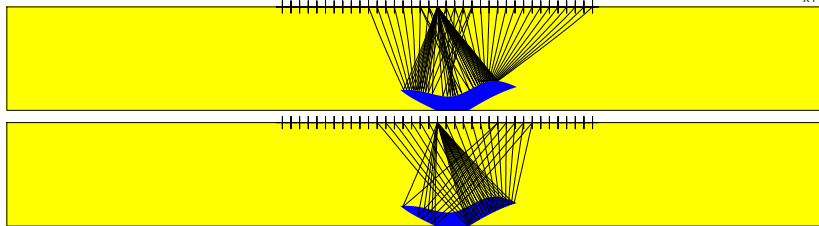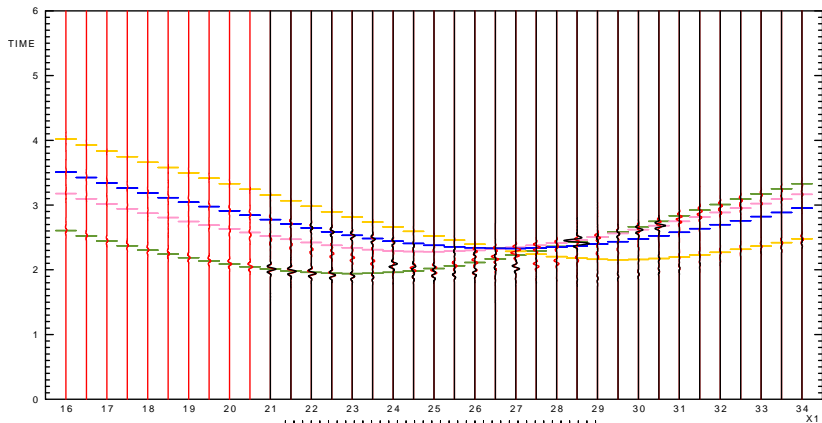 - blue abscissae (right lower edge) $x_1 \leq 21$ km - 2nd elementary wave

Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-7-10% scaled by 1×10^5.

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P1-9-10%

- diffractions from the edges:
  - from all edges? Not clearly visible.
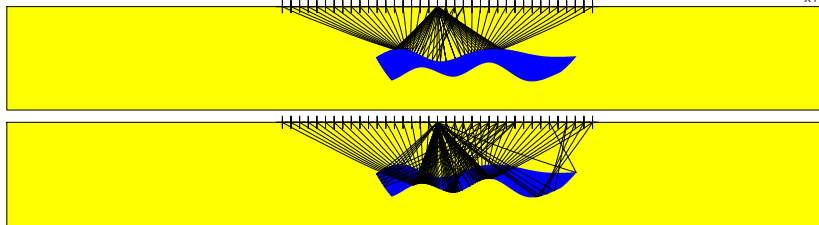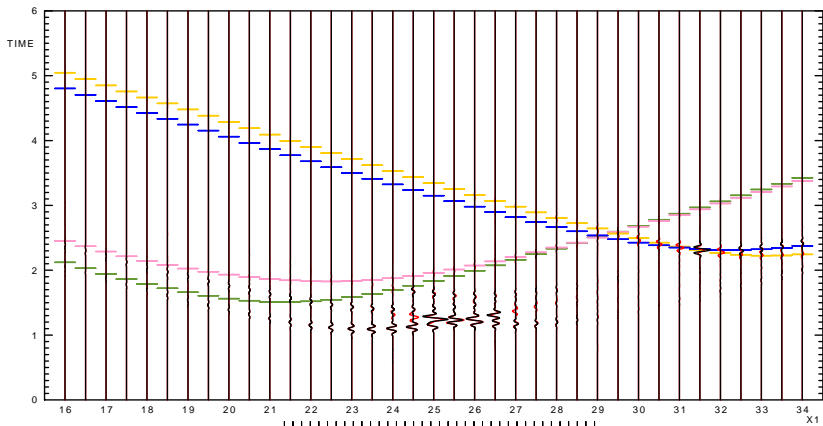 - yellow abscissae (right upper edge) between $x_1 = 29.5$ km and $x_1 = 31$ km - 2nd elementary wave

Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-9-10% scaled by 1×10^4.

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P1-11-10%

- yellow abscissae (right upper edge) $x_1 \geq 27.5$ km - 1st elementary wave (receivers between $x_1 = 16$ km and $x_1 = 27$ km, arrive first)

- green abscissae (left upper edge) between $x_1 = 22$ km and $x_1 = 23.5$ km - 2nd elementary wave, reflected from the left interface (receivers between $x_1 = 24$ km and $x_1 = 27.5$ km)
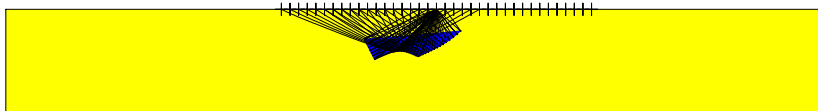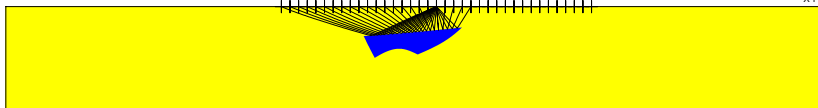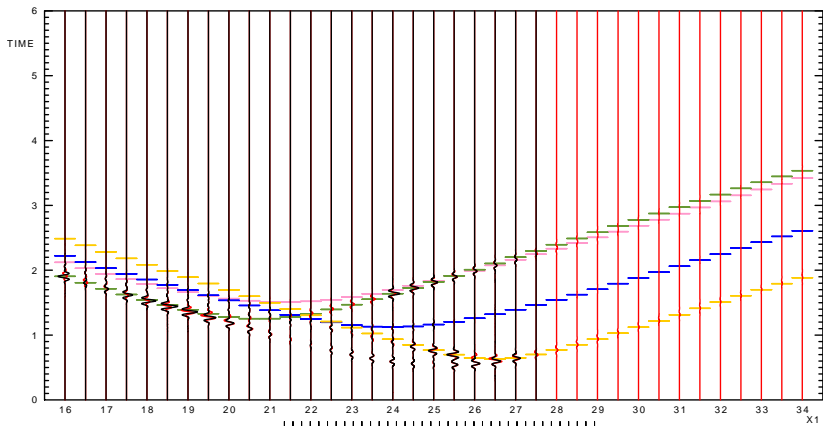
Figure: Vertical components of the Born (red) and ray-theory (black) seismograms computed in model P1-11-10% scaled by 1×10^4.

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P1-15-10%

- very simple ray diagram: one arrival (2nd elementary wave)

- diffractions from each of the four edges of Block 15
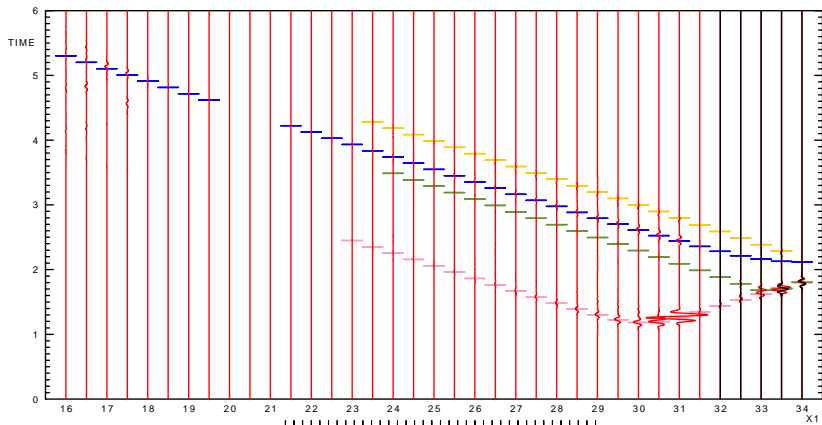
Figure: Horizontal components of the Born (red) and ray-theory (black) seismograms computed in model P1-15-10% scaled by 2×10^5, the seismograms between $x_1 = 31.5$ km and $x_1 = 34$ km scaled by 2×10^3 km.

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Concluding remarks

Born seismograms contain

- reflected waves

- diffracted waves (caustics, edges of the block - continue to the shadow zone)

- corrections of the direct waves

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Acknowledgements

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