Stratigraphical Consistent Seismic Profile for Geologically Informed Machine Learning Interpretation
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ABSTRACT

Machine Learning solutions have become increasingly popular and should be a natural tool for seismic stratigraphic and seismic facies analysis. As a detailed stratigraphic analysis is time-consuming, it tends to be done post-structural interpretation. These methods are based on pattern recognition, meaning an experienced interpreter could use these machine-learning observations to prioritize their initial structural interpretation. Moving this time-consuming and multi-dimensional analysis earlier in a workflow and flagging potential explanations without personal bias should significantly improve sub-surface analysis.

Stratigraphic interpretation (Mitchum, 1977; Vail, 1977, 1984 & 1987; Posamentier, 2022) is a well-established principle of seismic interpretation and involves analyzing of reflector waveforms and termination geometries (figure 1). The application of machine learning should provide moving stratigraphic and facies analysis early in an evaluation to prevent preconceived geological notions from contaminating a study and causing subtle items from being missed or misinterpreted.
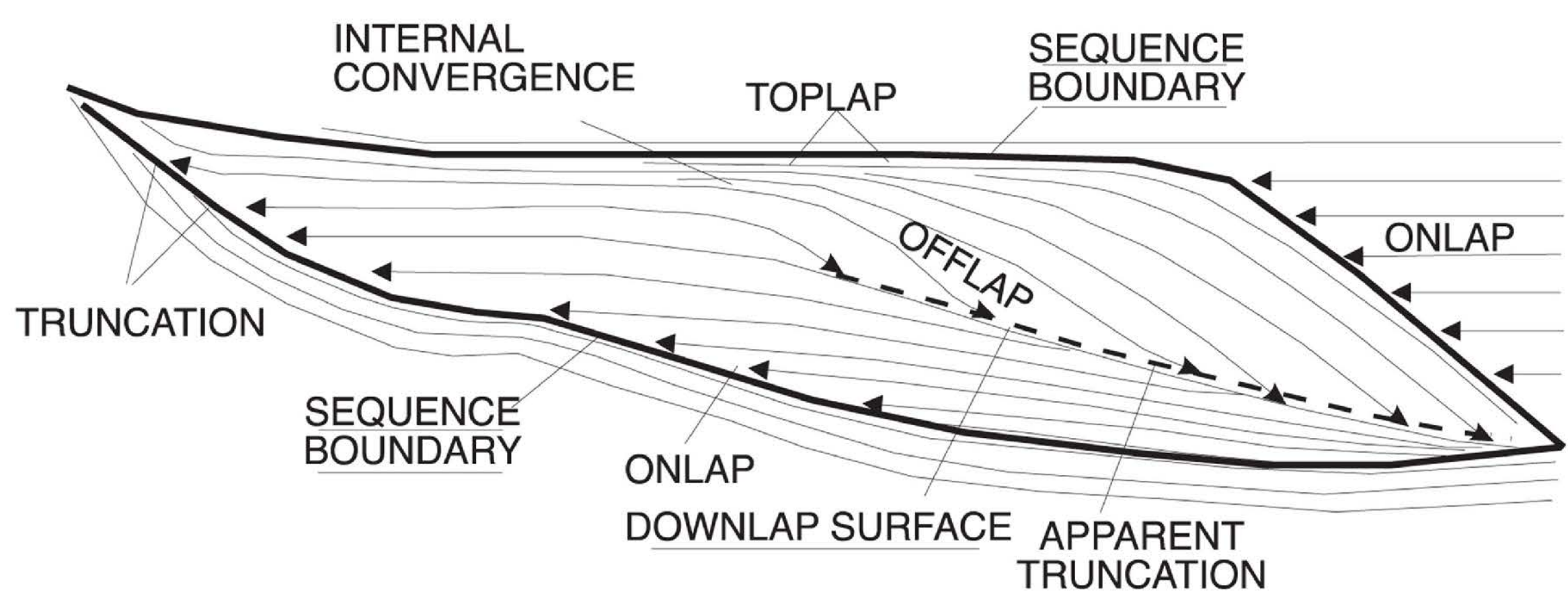

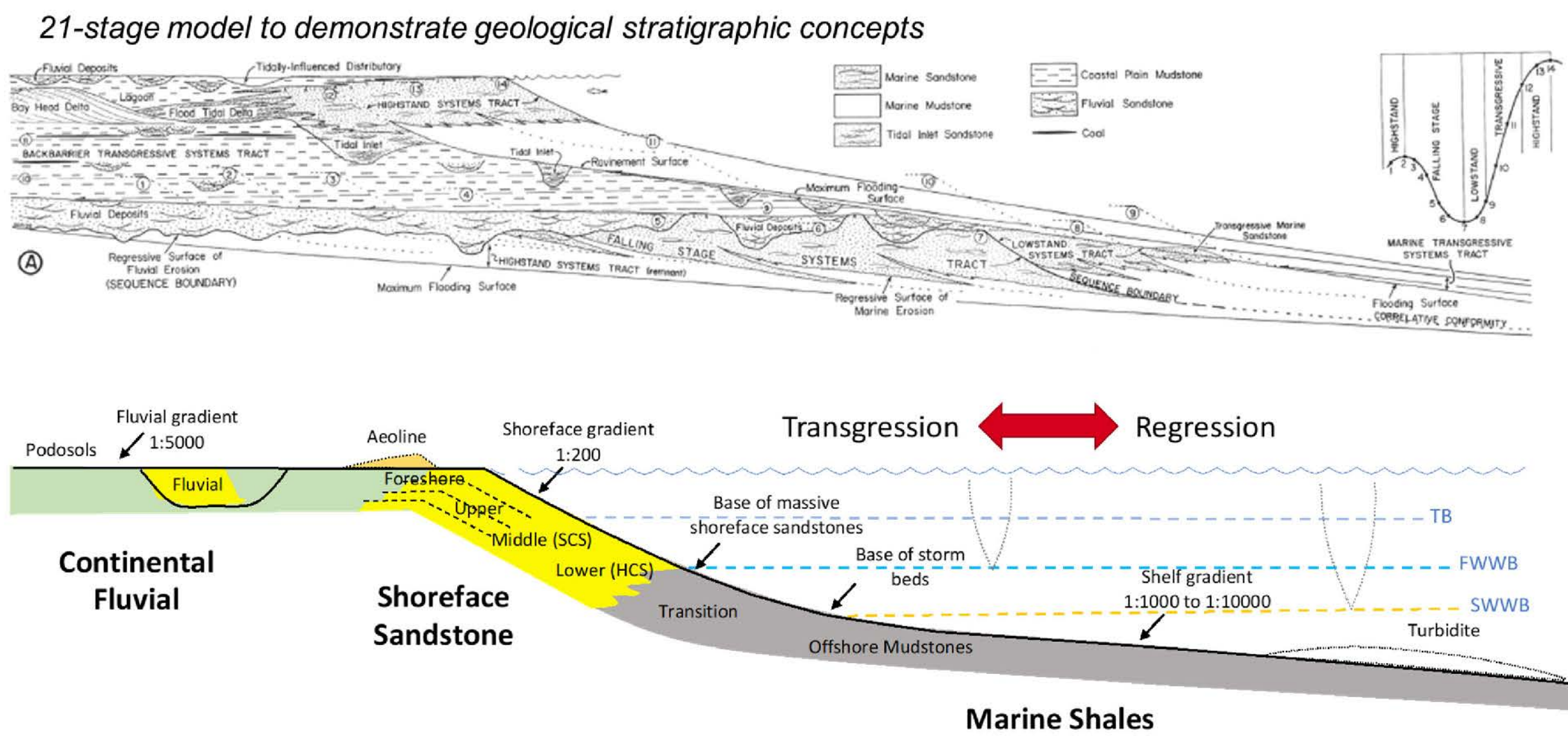Figure 1: Reflection Termination Patterns, from wiki.aapg.org adapted from Vail 1987

Figure 2: Depositional Model by Plint & Nummedal 2000

FUTURE WORK

Extending the 2D modelling into 3D and instigating the AVO and spectral decomposition response to create a multi-volume machine learning solution. The ultimate aim is to improve the detection of the more subtle geological features.
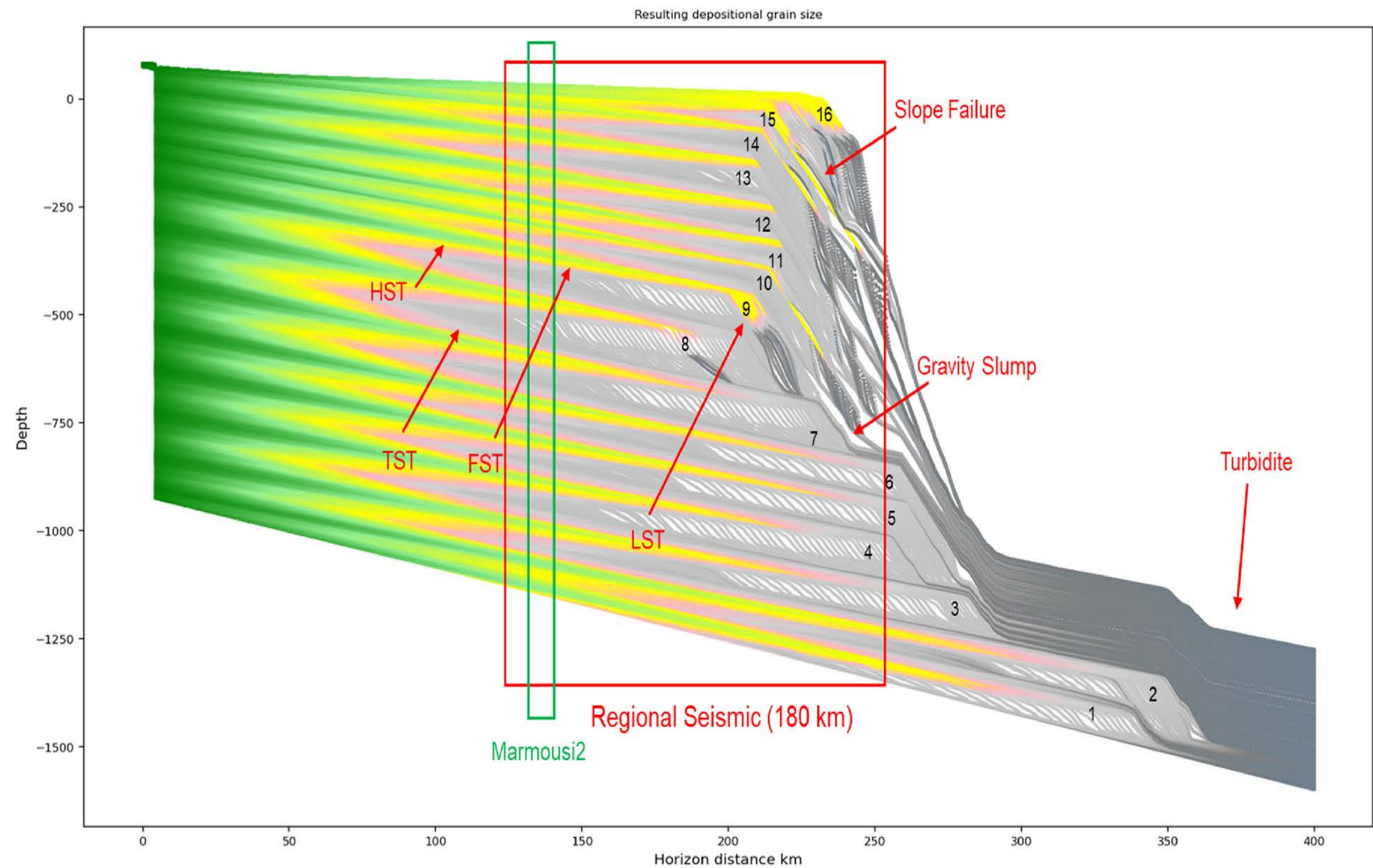
ACKNOWLEDGEMENT

Figure 3: Sediment input fraction for a model with 15 third-order cycles of 37.5 m, 5 four-order cycles of 8 m, subsidence of the model's left side by 33.3 m per third-order cycle, and 25 m on the model's right side.
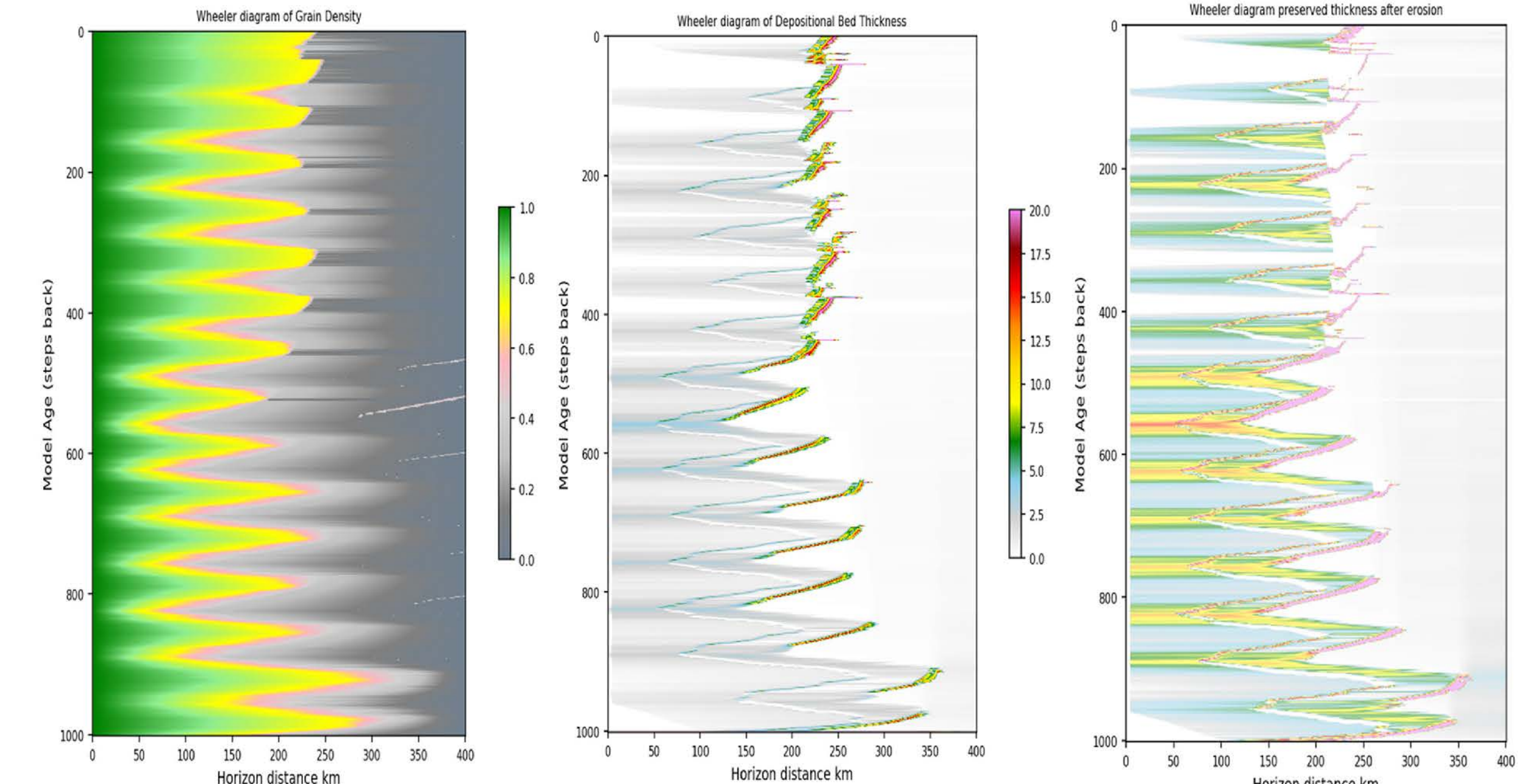

Figure 4: Wheeler display of sediment input fraction (left), thickness deposited (center) and net thickness after erosion and compaction (right)
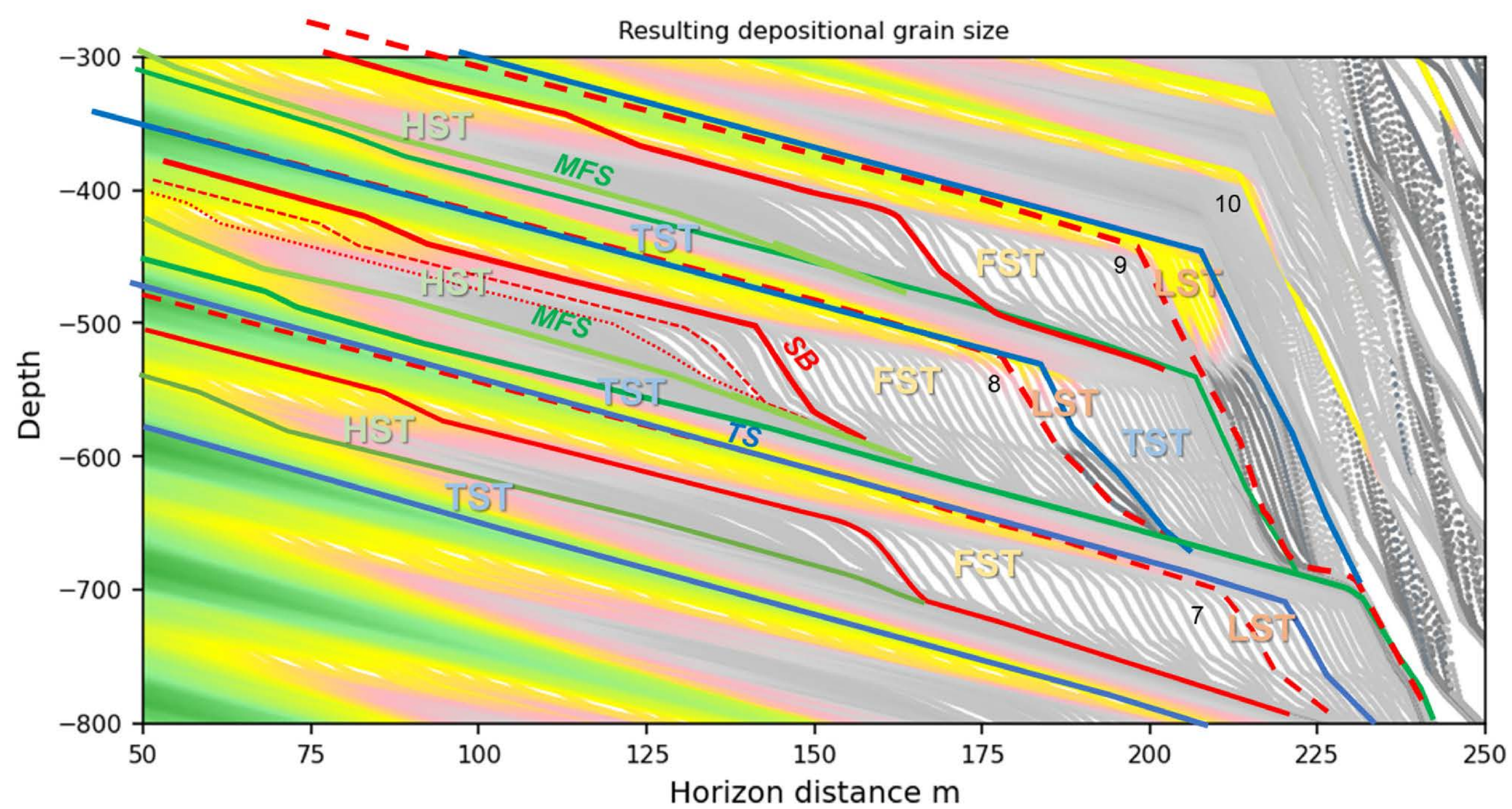

Figure 5: Wheeler display of sediment input fraction (left), thickness deposited (center) and net thickness after erosion and compaction (right)
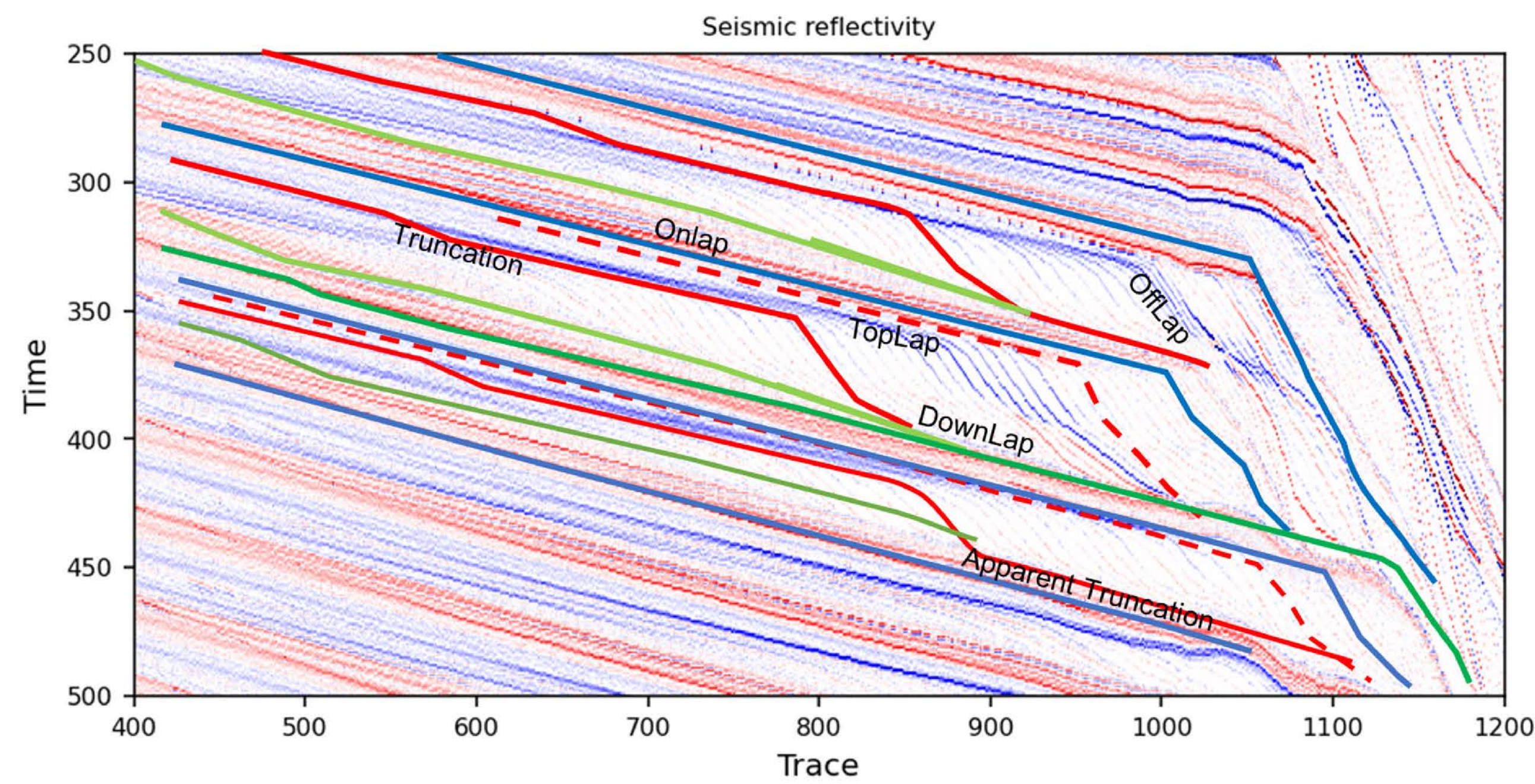

Figure 6: Seismic reflection surface in time with Sequence stratigraphy interpretation and conceptional geological geometries.
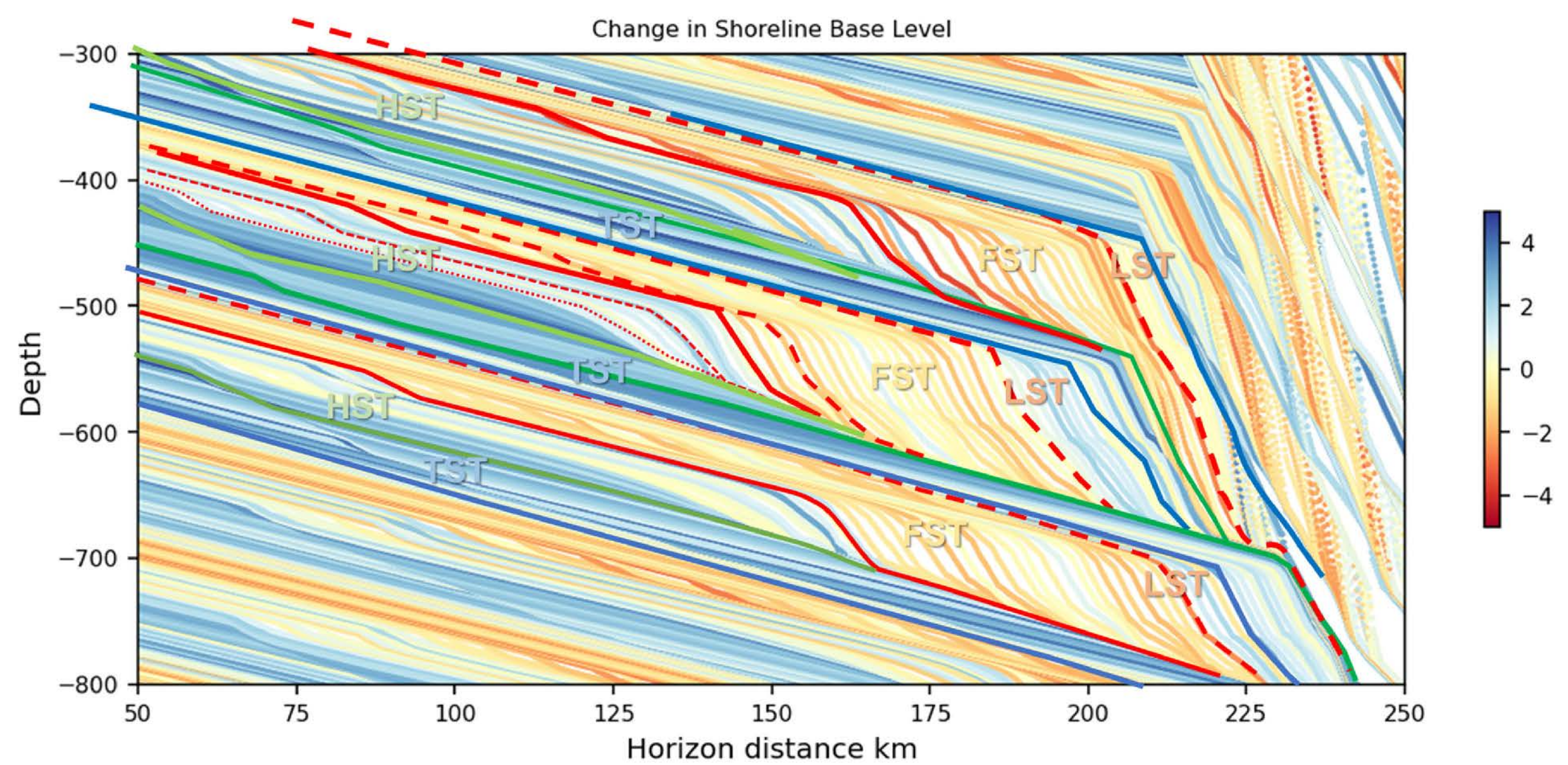

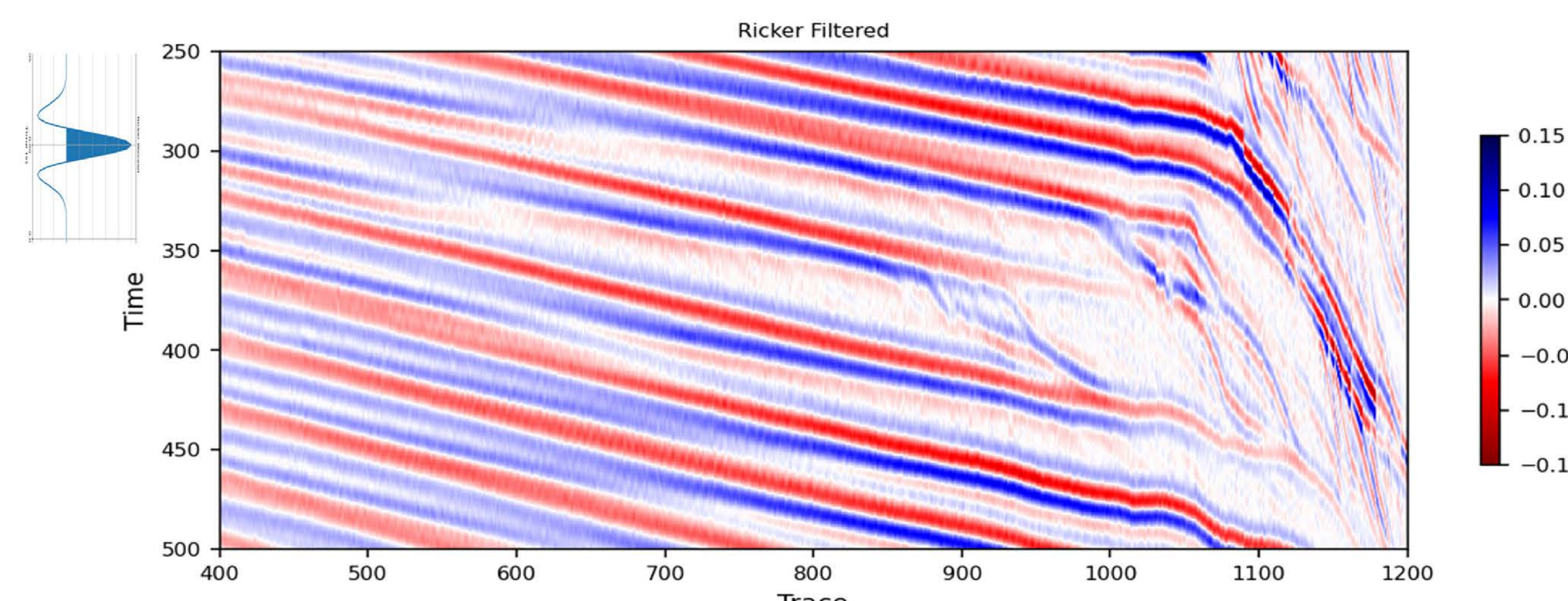Figure 7 Net change in base level between each step of the model

Figure 8: Seismic profile using a 25 Hz ricker (top) and broadband Ormsby (bottom). Significantly reduced resolution, resulting in the merging of surfaces in single reflections.
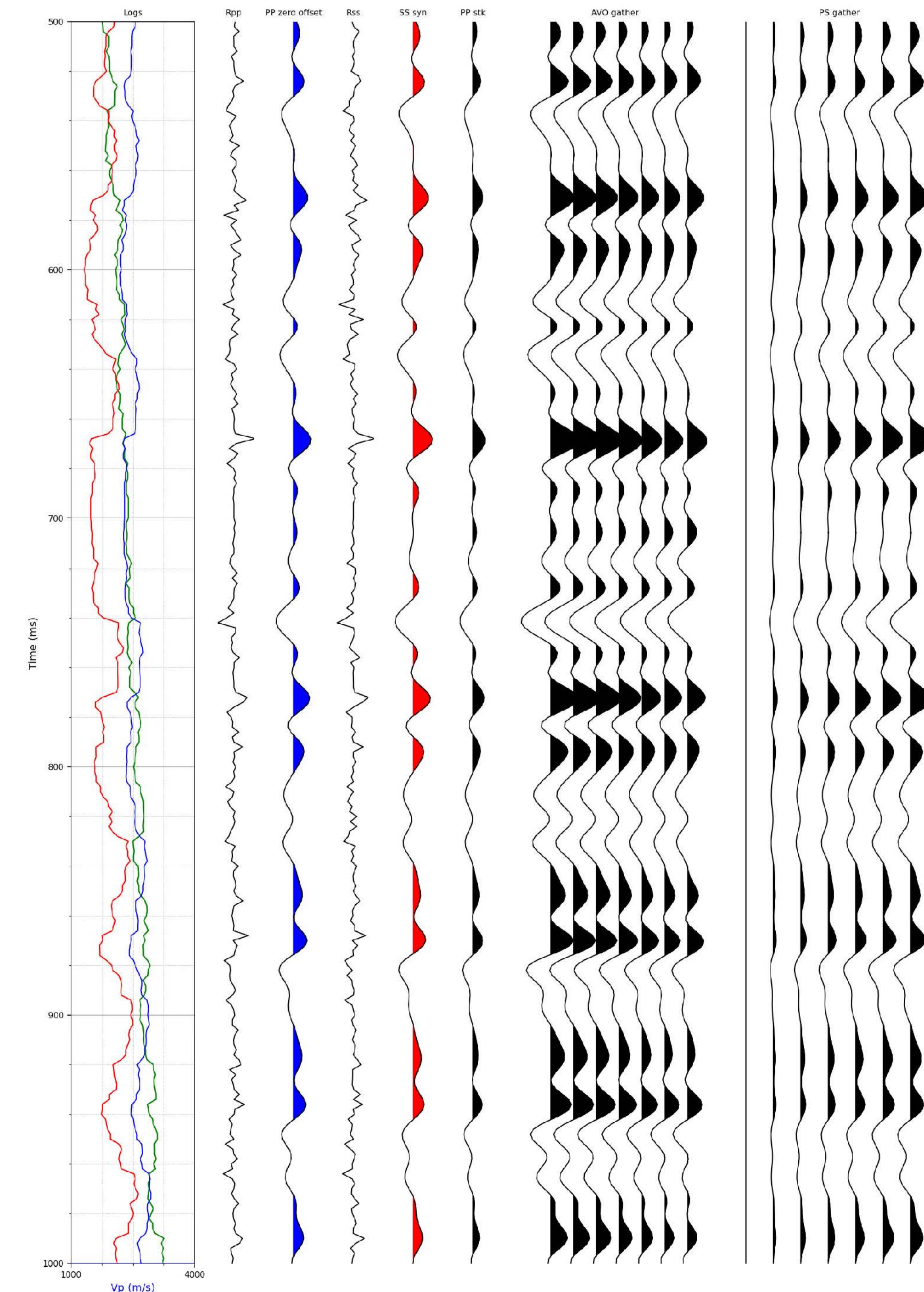

Figure 9: Synthetic traces and gathers from the model at station 750

1