

Seismic Sequence Stratigraphy and Sedimentology

Providing integrated and comprehensive study of stratigraphy and depositional facies as interpreted from seismic data, outcrops, core and well logs to generate model driven prediction scenarios for petroleum and mining exploration

Workflow of Sequence Stratigraphic Analysis

1. Tectonic setting study
2. Reconstruction of the paleo-depositional environments
3. Sequence stratigraphic framework

OpendTect SSIS plug-in is used to develop sequence stratigraphy model

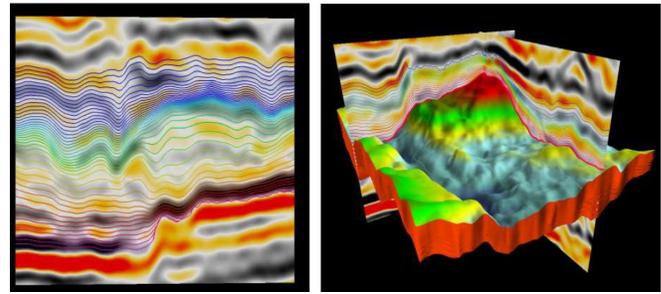
Horizon Cube

SSIS plug-in enables sequence sequence stratigraphic interpretation of HorizonCubes. This is a set of densely sampled 2D or 3D horizons that follow seismic events. Each chrono-stratigraphic horizon is a geologic time line.

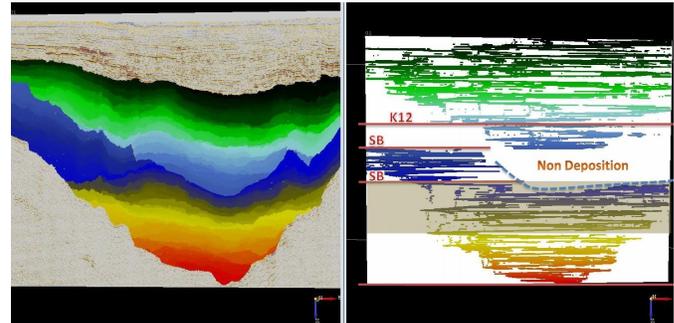
Creating a steering cube The dip of seismic events is calculated, optimized as input for the Horizon Cube algorithm that is used to conduct the Sequence Stratigraphic Analysis.

Fault Interpretation Fault interpretation is very crucial before applying sequence stratigraphic analysis as the algorithm will deal with independent compartments. Any fault with a dip-slip of more than ¼ seismic wavelength need to be interpreted. The initial horizon interpretation will be defined by the seismic sequence stratigraphic analysis. Faults will be interpreted based on Similarity, Volume Curvature and Fault Cube and Thinned Fault Likelihood (TFL) volumetric attributes. Creating chrono-stratigraphy and system tract information Dense set of chrono-stratigraphic horizons is auto-

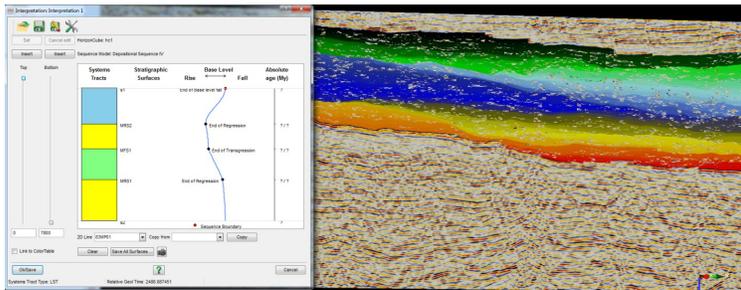
The trends visible in the chrono-stratigraphy will be used to make a sequence stratigraphic interpretation. A sample sequence stratigraphic interpretation without the application of dip-steered median filter showing the quality of data and the variations in stratigraphic fill. The stratal terminations define the sea level changes.



Example of sequence stratigraphy applied for 3D Seismic data, incised valley Fort McMurray (Statoil permission)



Example of sequence stratigraphy (left) and Wheeler diagram (right) applied for 3D seismic data in the Rift Valley basin, East Africa.



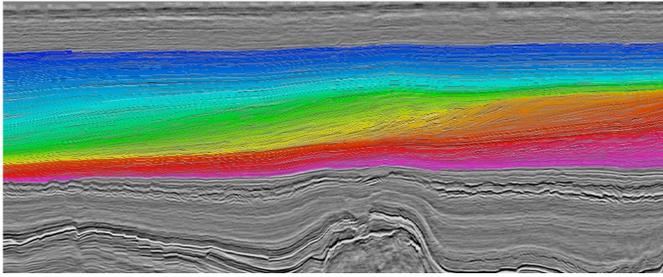
tracted on 3D seismic lines. Providing proper pre-processing this set will closely resemble actual chrono-stratigraphy as far as it can be deduced from the seismic data.

Processing of Chronostratigraphy

If necessary, seismic data is first pre-processed, for example, by applying Structurally Oriented Filtering to create seismic data with low signal-to-noise ratio. Then a steering cube is created, which serves as input to the chrono-stratigraphic calculation. Within a steering cube, every sample position contains dip and azimuth attributes of that particular seismic trace. For chronostratigraphy, dip steering allows tracking along seismic events.

SEISMIC SEQUENCE STRATIGRAPHY AND SEDIMONTOLOGY

Principle of the chronostratigraphic calculation



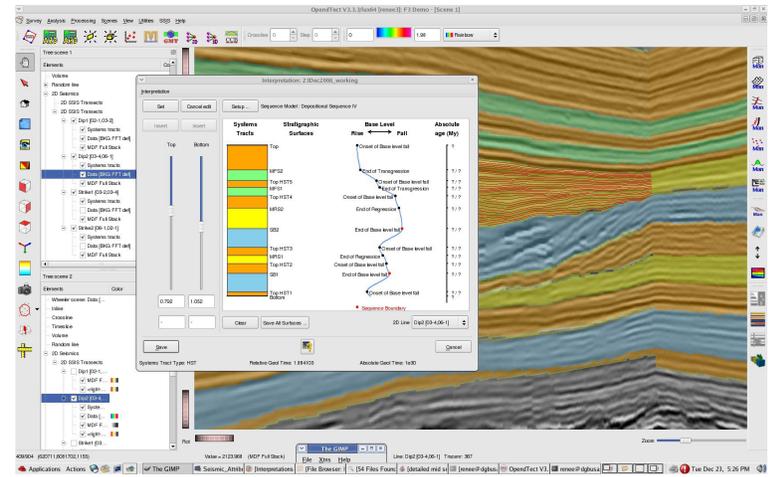
Example of a chrono-stratigraphy displayed on top of regular seismic data. All chronostratigraphic horizons shown here are computed (no manual tracking). The color scale depicts a relative geological index, ordering events to their relative age. Note that the unconformities are already readily visible.

Sequence Stratigraphic Interpretation of Seismic Data

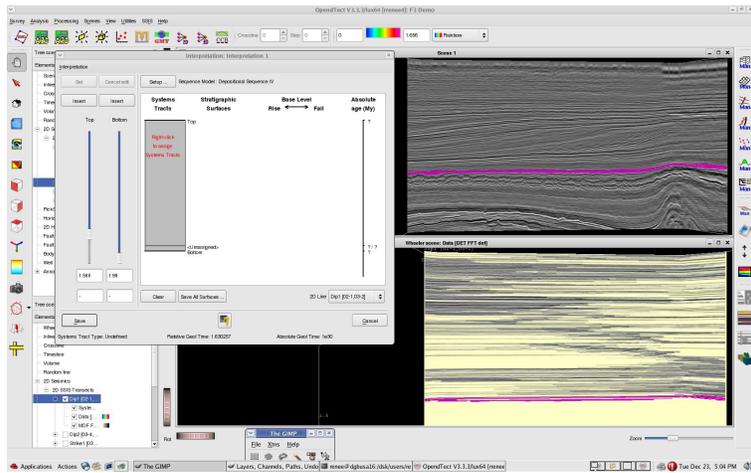
Once the chrono-stratigraphy is calculated it can be used to create a sequence stratigraphic interpretation. First, interpretation model is chosen or created. Then, system tracts are interpreted and interactively overlain on the seismic. The interpretation is based on the fact that the chrono-stratigraphy includes stratal terminations. Using the trends observed in the stratal stacking patterns and terminations, correct system tract for a certain interval is determined. In addition, to aid the interpretation a seismic Wheeler diagram can be created.

A seismic Wheeler diagram shows all chrono-stratigraphic horizons flattened, the vertical axis now being relative geological time and the horizontal axis showing the extent of sedimentation at any given time. It is easy to recognize transgressive and regressive trends in this display.

The top and bottom of the interpreted system tracts are defined by a relative geological index. This allows for a quick updates in the interpretation, facilitating quality control and collaboration on the interpretation. If the interpretation can be linked to true geological times, the system also allows us to replace the relative geological indices with true geological times.



This figure shows the final results for interpretation of seismic sequence stratigraphy. The interpretation is manipulated interactively and draped instantaneously on top of the seismic display as a semi-transparent layer.



Tools for system tract interpretation: chrono-slider, seismic Wheeler diagram and system tract interpretation window. This figure shows the starting point of the interpretation.

Interpretation of Sequence Boundaries

The interpretation based on seismic stratigraphy and stacking patterns allows a more complete comprehensive understanding of sub-surface. The boundaries are started with unconformities and then followed by their correlative conformities. The section between each sequence boundary is observed for stacking patterns and environment of deposition is established.



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