Climate stratigraphy as a new approach in near-synchronous correlation and estimation of geological time – insights from the subsurface and its application to outcrops

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Climate stratigraphy is basically the stratigraphy of climate changes and it employs principles first established by the global cyclostratigraphy model of Perlmutter and Matthews (1990). Global cyclostratigraphy uses the climate-lithofacies relationship as the driving mechanism in a forward-modelling approach to understanding lithofacies development at the basin scale. Having this in mind, it should be possible to retrieve the oscillatory climate change signals from the sedimentary rock succession and to use this information as a tool for predicting climate changes for the geological past and make it an approach for making near-synchronous stratigraphic correlations. To retrieve the oscillatory climate change signals from the sedimentary rock record, we will need the following conditions:

- A continuous and long stratigraphic profile, which includes long geological time spans.
- A continuous and, more importantly, a regular sampling of data.

Because of these conditions, we started to go to the subsurface and decided to use facies-sensitive wireline logs as the dataset. So initially, our climate stratigraphic understandings started from a deterministic analysis and modelling of wireline logs and, subsequently, applied these results to stratigraphy and sedimentology of the subsurface and outcrop.

A specially designed software with specific algorithms for analyzing waveform properties of the logs has been developed (CycloLog®). In summary, the software performs a machine-objective numerical analysis and modelling of the wireline logs in such a way that the hidden information derived from climate change signals is displayed in two log transforms, the Spectral Change Attribute (PEFA) and Spectral Trend Attribute (INPEFA) curves. We will in this presentation restrict our self to the INPEFA curve. The INPEFA curve is basically related to climatic and lithological changes, and in mathematically generated. Two main and remarkable features can be recognized in the INPEFA curve (Figure 1):

- The trends – a negative trend (up-to-the-left), and a positive trend (up-to-the right), representing trends of climatic development.
- The turning points – separating the two trends, representing geological events related dominantly to climate change and in some cases to tectonics.

The example in Figure 1 shows a climate stratigraphic correlation of two wells in a continental basin setting using the INPEFA curves. Well separation is approximately 10 km. The correlated section is mostly barren and a biochronostratigraphic correlation is not possible. The interval consists predominantly of fluvial sands (channels) with a subordinate amount of floodbasin silts and fines. The pattern of the INPEFA curve overlying the prominent turning point shows remarkable similarities between the tow wells, and equivalent higher-order positive and negative turning points are easily identified.

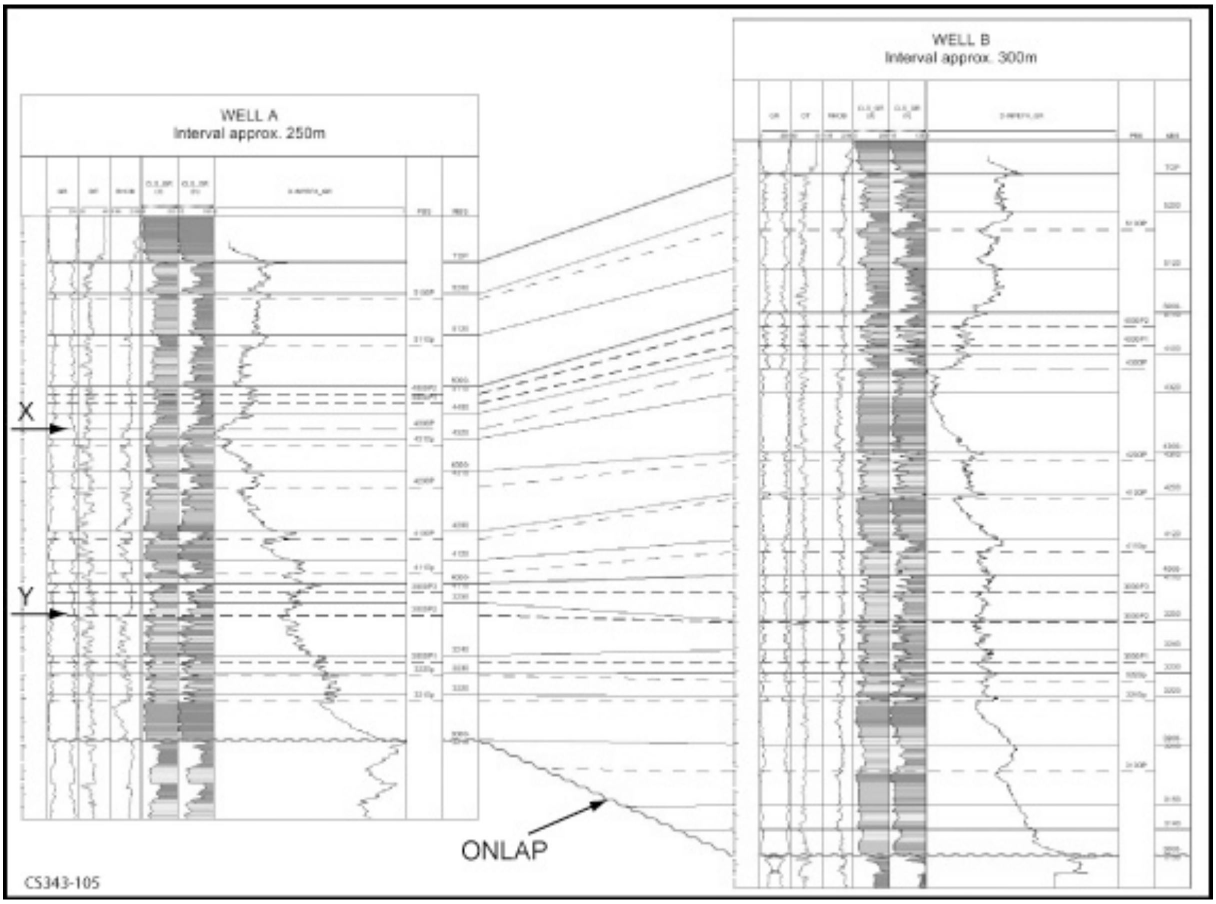

Figure 1. Near-synchronous climate stratigraphic correlation of two wells from a continental basin, using INPEFA curves.

Climate stratigraphic correlations using INPEFA curves from late Miocene turbidite sequences from the Mars-Ursa basin in the Gulf of Mexico are compared with biostratigraphic correlations based on biomarkers from the condensed shales. Finally, a discussion will be presented on the consequences of climate stratigraphic correlations in the subsurface and the estimation of geologic time in outcrops.

REFERENCES

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