Dynamics and evolution of continental margin clinoform systems

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Clinoforms are aquatic sedimentary features commonly associated with strata prograding from a shallower water depth into a deeper water depth. They are very sensitive to changes in water depth, rapidly moving along the shelf in response to sea level changes. By reconstructing the initial clinoform geometry of buried clinoforms, an estimate of the paleo water depth (PWD) can be made. When this is done for several subsequent clinoform sets the amounts and rates of bathymetric changes can be calculated.

Here we present a novel approach to estimate clinoform parameters and depositional depths for continental margin clinoforms using seismic reflections, wellbore and biostratigraphy data. Seismic interpretation of three relatively east-west regional full-stack seismic reflection data from the continental margin of the western Barents Sea revealed twelve Late Cenozoic horizons. The clinoform shapes have been restored by removing the effects of compaction and flexural isostasy (backstripping). This includes the effects of glacial/interglacial scenarios on horizons with strong glaciomarine seismic indications.

Based on the reconstructed clinoform geometries we use empirical relationships from literature between clinoform geometry and depositional depth to estimate PWD values. In these analyses it is possible to estimate the PWD of the upper rollover point and the toe point by measuring the bottomset height, foreset height and topset height. A sensitivity analysis study has also been done on several different scenarios, varying elastic thickness, decompaction and net to gross ratio. Comparison with biostratigraphic water depth estimates indicate that PWD estimates revealed from clinoform parameters give reliable results.

Any mismatch between the backstripped PWD values and the PWD values derived from the clinoform geometry can then be attributed to geological processes not included in the backstripping process. Among others, these could be explained by rifting, thermal effects in the lithosphere, faulting or eustatic sea level changes. This allows the quantification of the magnitude of these large-scale crustal processes through time.

We will demonstrate that this method can further constrain the PWD on the continental margin clinoform system and thus can help to improve the understanding of the interplay between sedimentary processes and large-scale crustal processes. Furthermore, the PWD estimates will be a reliable input for further analysis of source-to-sink and stratigraphic forward modeling studies as
well as reservoir and source rocks prediction on the petroleum development and exploration.