Sediment Supply and its Impact on the Interpretation of Eustatic Sea-Level Changes

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Abstract

Changes in eustatic sea level and their potential impact on sediment distribution at basin scale have been an ongoing controversy in sequence stratigraphy and basin analysis, both in the industry and academia. This study shows that changes in sediment distribution are not necessarily controlled by eustatic sea-level changes and varied over a few millions to tens of million years. Eustatic sea-level curves are widely used in academia and the industry for sequence stratigraphic models, as proxies for climate change, for reservoir quality and stratigraphic trap prediction. The large majority of current eustatic sea-level curves is based on two assumptions: 1) rates of subsidence do not change significantly over 1-5 My (3^{rd} order) and, 2) sediment supply and distribution do not change significantly over 5 My to few tens of My (3^{rd}, 2^{nd} order). Both assumptions allow to interpret reflector/stratal terminations, sediment trajectories and stacked shallowing-/deepening upwards trends as direct indicators for eustatic sea-level changes. This study developed maps of sand distribution and sand front trajectories for the Jurassic to Cretaceous western Neotethys continental margin. Input data come from several thousand exploration wells for a total of 21 stratigraphic intervals. The sand front defines the basin-ward 10% sand contour line. We measured the average distance of the sand front from a reference line for each interval studied. This workflow is adapted to the fact that Jurassic to Cretaceous coastlines have not been preserved. The results reveal a discrepancy between the lateral migration of the sand front and eustatic sea level curves during specific time intervals. Existing eustatic sea-level curves propose a major eustatic sea level fall in the Early Cretaceous, however, no equivalent basinward migration of the sand front from its Jurassic landward position occurred. For the early Late Cretaceous curves propose a medium-amplitude fall, but the sand front experienced a major basinward shift. Current sequence stratigraphic approaches will lead to models that do not reflect changes in accommodation including eustatic sea level but changes in the regional reconfiguration of sediment delivery systems in continental hinterlands. Correlations based on sequence stratigraphy with other basins may be misleading. General conclusions from the novel workflow and its application to continental margin basins include: first, key indicators (trajectories, coastal onlap, stacked shallowing-/deepening upward trends) used for interpreting eustatic sea-level curves represent a mixed signal of changes in accommodation and sediment supply. Second, reservoir quality and stratigraphic trap prediction based on current eustatic sea-level curves bear major uncertainties. Third, quantitative analysis is essential to improve current eustatic sea level curves for the Mesozoic.