Estimation of carbonate stratal completeness via stratigraphic forward modeling

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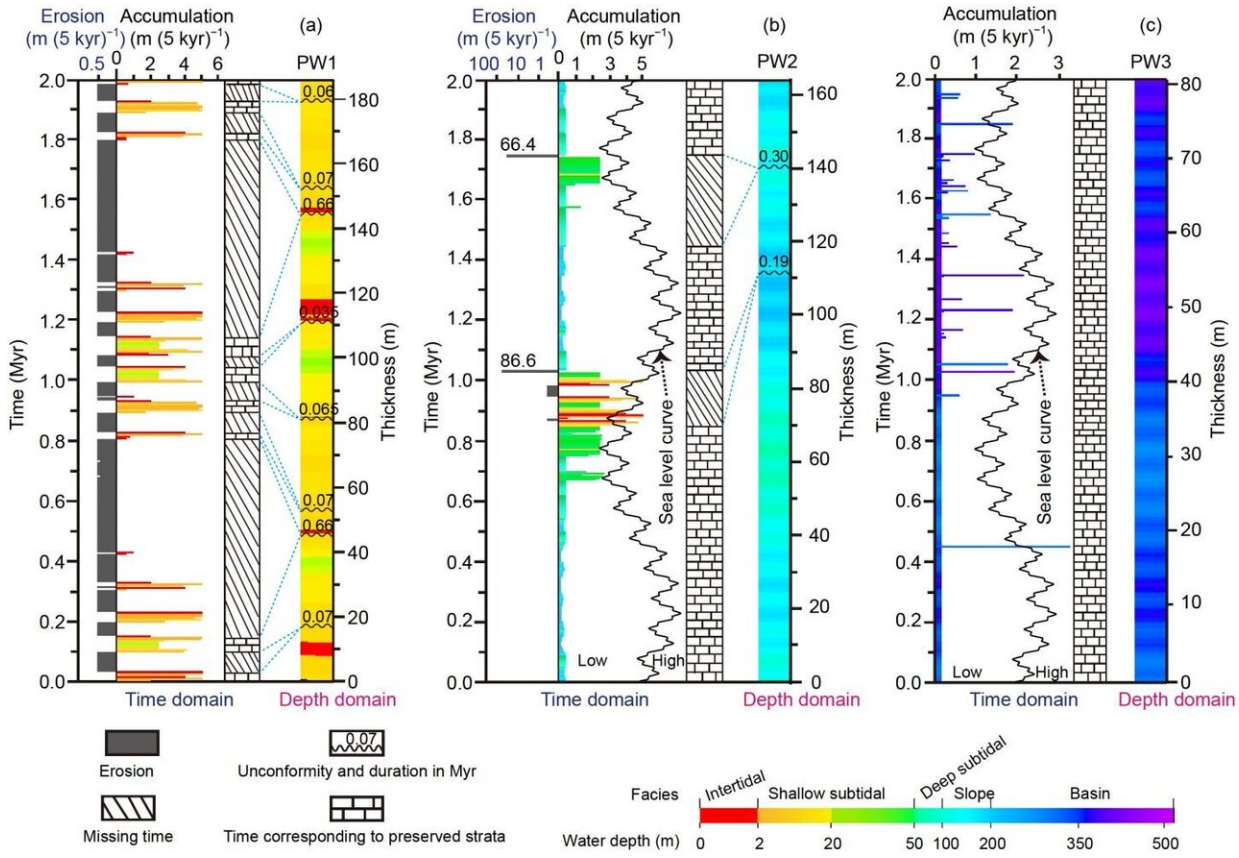

Columns of depth and time domains at the PW1 (a), PW2 (b) and PW3 (c) locations, corresponding to the platform margin, slope and basinal environments, showing the integrated accumulation and erosion (or slope failure) processes, and the preserved and missing time durations and the corresponding preserved strata. Credit: Science China Press

Strata completeness refers to "the fraction of time intervals of some specified length (t) that have been preserved." Since the 1780s, it has been widely accepted that most stratigraphic sections are riddled with gaps and are discontinuous over a range of temporal scales. Recognizing stratal disconformities or hiatal surfaces, and quantifying the stratal completeness of carbonate/clastics are essential for: (1) adequately constructing time series of palaeoclimatic and palaeobiologic changes, (2) understanding the impact of orbital forcing and sea-level changes on the geochemical signals within the strata, (3) enhancing interpretations of time series of depositional settings and sedimentary processes, and (4) hydrocarbon explorations. Although many researchers have attempted to delineate strata completeness using different approaches, such as statistical method, dating techniques, physical modeling, stochastic modeling and stratigraphic forward modeling, there are still some unresolved issues relating to the topics, and especially regarding quantitative determination of strata completeness and key factors affecting it.

Researchers from China University of Petroleum (East China) investigated carbonate deposition with different depositional environments. They firstly constructed a three-dimensional basin-fill model using sedimentary process-based stratigraphic forward modeling and then extracted crucial information of both "depth domain" and "time domain" from the 3-D model to probe sedimentary evolution process, delineate hiatus surfaces and quantitatively determine the completeness of strata in the platform margin, slope and basin facies.

Through sensitivities analysis, the researchers have also demonstrated that the stratal completeness appears to be controlled by sea level changes, depositional environments, carbonate growth rates and tectonic subsidence patterns in various ways.

This study concludes that the sedimentary process-based SFM approach

is quite effective in determining stratal completeness and its characters within a stratigraphic sequence by taking the full advantage of information from both the depth domain and corresponding time domain information in a 3-D SFM model. It enables the reconstruction of sedimentary evolution by considering various geological processes (e.g., deposition, erosion or hiatus) holistically and provides a novel approach for interpreting palaeo-depositional environments. Knowledge on the completeness of a stratigraphic sequence is also crucial for reservoir quality assessment and predicting hydrocarbon migration and entrapment.

More information: Jianliang Liu et al, Estimating stratal completeness of carbonate deposition via process-based stratigraphic forward modeling, *Science China Earth Sciences* (2020). DOI: 10.1007/s11430-020-9660-8

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