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High Resolution Sequence Stratigraphy of Carbonate Systems - the role of climate and sequence hierarchy

Carbonate systems are known for their organisation at different scales of sequences, from the large scale, 2nd order, to the small scale, 5th order. One of the reasons for this organisation is the sensitivity of the carbonate producers to changes in the sedimentary environment, and the high preservation potential of the platform deposits due to early cementation. However, depending on the dominant climatic conditions, the relative importance of the different sequences changes : ice-house periods are dominated by 4th order glacio-eustatic fluctuations, greenhouse by 3rd order eustatic/tectonic sequences, and intermediate-house by 2nd order tectonic/eustatic sequences. Three basin to platform transects are presented to illustrate these cases. The Upper Carboniferous of the Paradox Basin, USA, shows the overriding control of 4th order glacio-eustatic sea level changes on the stratigraphic organisation in a mixed carbonate-siliciclastic system. Third order sequences are difficult to recognise due to the strong overprint of the high frequency (400 ky/100ky), high amplitude (up to 40 meter) sea level fluctuations. The green-house example is a carbonate ramp system of Mid Cretaceous age in Oman (Natih Formation). The sedimentary system shows a typical evolution from intra-shelf basin formation to infill within a third order sequence. During intermediate-house times, intra-shelf basin creation and infill occurs at the 2nd order scale, and 3rd order sequences play a secondary role. The example demonstrating this is from the Upper Devonian (Frasnian) mixed carbonate-clay system in the western Canad (Leduc and Nisku Formations). In addition to the shallow water carbonates, also the source rocks deposited in the adjacent basins of the above examples have been integrated in the models, thus providing a complete insight in the architecture of these carbonate petroleum systems.