Geophysical Research Abstracts,
Vol. 11, EGU2009-14029, 2009
EGU General Assembly 2009

Limestones: the love of my life – sun, sea and cycles (Jean Baptiste Lamarck Medal Lecture)

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In studies of sedimentary rocks we are striving to understand the short and long-term controls on deposition that lead to the variety of facies we see in the geological record. With the development and application of sequence stratigraphy has come the realisation that in most cases the stratigraphic record is not random, but there are patterns and trends in the nature (composition, facies, diagenesis) and thickness of sedimentary units. In addition, sedimentary cycles are widely, if not ubiquitously, developed through stratigraphic successions, and do themselves vary in thickness and facies through a formation and through time. In many cases, orbital forcing is clearly a major control, in addition to longer term tectonic and tectono-eustatic processes.

Understanding the major controls on the stratigraphic record and the processes involved in deposition enables us to develop a degree of prediction for the occurrence of particular facies and rock-types. This is especially significant in terms of hydrocarbon potential in frontier basins, notably in the search for source and reservoir rocks.

In the case of carbonate and carbonate-evaporite successions, recent work is showing that even at the higher-frequency scale of individual beds and bed-sets, there are regular patterns and changes in thickness. These show that controls on deposition are not random but well organised. Studies of Carboniferous shelf/mid-ramp bioclastic limestones and Jurassic shallow-marine oolites from England reveal systematic variations in bed thickness, as well as oxygen isotopes, Sr and org C values. Permian lower slope carbonates from NE England show thinning-thickening-upward patterns in turbidite bed thickness on several orders of scale. Turbidity current frequency of 1 per $\sim$200 years can be deduced from thicknesses of interbedded laminated facies, which provide the timescale.

Beds in ancient shelf and slope carbonates of many geological periods are on a millennial-scale and their features and patterns clearly indicate that millennial-scale changes in climate, most likely driven by fluctuations in solar output, analogous to the D-O cycles of the Quaternary, were responsible, and that these were then modulated by orbital forcing.

Solar forcing rules in carbonates, even at the highest frequency.