EGU21-4555
https://doi.org/10.5194/egusphere-egu21-4555
EGU General Assembly 2021

Long-term sedimentary cycles of the Phanerozoic; insights from the integration of global stratigraphic datasets and tectonic modelling

Jean-Christophe Wrobel-Daveau, David Ray, Gareth Carroll, Michael G. Tetley, Graham Baines, Mike Simmons, and Frans van Buchem
Halliburton Ltd, United Kingdom of Great Britain – England, Scotland, Wales (jean-christophe.wrobel-daveau@halliburton.com)

The Phanerozoic sedimentary record documents a diverse series of cyclic patterns of sedimentation that reflect multiple drivers of change (e.g. climate, eustasy, tectonics, biotic evolution) operating over a range of time scales (days to hundreds of million years). While short-term cycles can be easily identified within the rock record and have frequently been related to the Milankovitch cycles, medium-term (a few tens of million years) and long-term (hundreds of million years) cycles are less-well-resolved. Notably the identification of medium- and long-term cycles are reliant upon global scale studies, which are typically hampered by low stratigraphic resolution or address sedimentary changes indirectly through proxies (e.g. sea-level models, geochemical trends). Moreover, such difficulties have resulted in uncertainties as to the drivers and durations of medium- and long-term cycles.

To adequately address this challenge, an integrated approach is required, combining 1) large sedimentary and global events datasets, 2) a high-resolution sequence stratigraphic model, and 3) plate tectonic and digital palaeo-elevation modelling.

We present the preliminary results of an industry-led study of medium- to long-term Phanerozoic cycles in global sedimentation and an assessment of the drivers of these cycles. Our study is based upon a spatially- and temporally-enabled global dataset of sedimentary records, obtained from over 8,500 wells. The sedimentary data contained within the wells have been standardised using a hierarchical classification of sediment types and divided into time slices based upon sequence stratigraphic interpretations, and the identification of age calibrated maximum flooding surfaces derived from the Neftex Global Sequence Stratigraphic Model. This approach allows the Phanerozoic sedimentary record to be subdivided into 132 time slices and the proportion of different sedimentary compositions preserved for each time slice can be reported as a percentage. The resultant analysis identifies medium- to long-term cycles in the proportions of siliciclastics, carbonates and evaporites.

There are two long-terms trends apparent from our data, and these have been analysed by a palinspastic reconstruction of each time slice using our digital palaeo-elevation and tectonic models. The first trend is a progressive decrease in the proportion of carbonates relative to siliciclastics, such that carbonates represent ~50% of Cambrian sediments and ~30% of Neogene

sediments. This appears linked to early Palaeozoic low latitude continental configurations favouring carbonate sedimentation. The second trend is a notable increase in evaporites from the Late Permian to Late Jurassic (5% to 10%, from a Phanerozoic average of <2%) this appears linked to the Pangea super-continent configuration and persists until its breakup. In addition, other lesser breakup events appear linked to increases in evaporites.

Medium-term cycles are identifiable as significant shifts in the global proportions of siliciclastics relative to carbonates. There is a hierarchical arrangement to these cycles, both in terms of duration and severity of change, suggestive of multiple drivers. An initial comparison with known glaciations, major biotic events impacting carbonate producers and orogenies appears to explain many of these cycles.