



Dynamics of Devonian carbonate platform development in South China: Insights from cycle and sequence stratigraphy

Daizhao Chen^{1,2}, M.E. Tucker³, Hairuo Qing⁴, Liyu Zhang¹

1. Institute of Geology and Geophysics, Chinese Academy of Sciences (CAS), Beijing 100029, China
2. University of CAS, Beijing 100049, China
3. Department of Earth Science, University of Bristol, BS8 1RJ, UK
4. Department of Geology, University of Regina, Regina, SK S4S0A2, Canada

ABSTRACT

During the early Middle Devonian, the South China Block was subject to strong extensional to transtensional rifting, laying the foundation to develop a complex pattern of platforms, and interplatform basins. In Givetian and Frasnian carbonate successions, five depositional facies, including peritidal, restricted shallow subtidal, semi-restricted subtidal, intermediate subtidal and deep subtidal facies, and 18 lithofacies units are recognized from measured sections on three isolated platforms. These deposits are arranged into metre-scale, upward-shallowing peritidal and subtidal cycles. Nine third-order sequences are identified from changes in cycle stacking patterns, vertical facies changes and the stratigraphic distribution of subaerial exposure indicators. These sequences mostly consist of a lower transgressive part and an upper regressive part. Transgressive packages are dominated by thicker-than-average subtidal cycles, and regressive packages by thinner-than-average peritidal cycles. Sequence boundaries are transitional zones composed of stacked, high-frequency, thinner-than-average cycles with upward-increasing intensity of subaerial exposure, rather than individual, laterally traceable surfaces. These sequences can be further grouped into catch-up and keep-up sequence sets from the long-term (second-order) changes in accommodation and vertical facies changes. Catch-up sequences are characterized by relatively thick cycle packages with a high percentage of intermediate to shallow subtidal facies, and even deep subtidal facies locally within some individual sequences, recording long-term accommodation gain. Keep-up sequences are characterized by relatively thin cycle packages with a high percentage of peritidal facies within sequences, recording long-term accommodation loss. Correlation of long-term accommodation changes expressed by Fischer plots reveals that during the late Givetian to early Frasnian increased accommodation loss on platforms coincided with increased accommodation gain in interplatform basins. This suggests that movement on faults resulted in the relative uplift of platforms and subsidence of interplatform basins. In the early Frasnian, extensive siliceous deposits in most interplatform basins and megabreccias at basin margins correspond to exposure disconformities on platforms.

In the Famennian succession, four main facies and fourteen lithofacies are identified in the three isolated platforms; these are vertically arranged into decimetre- to metre-scale, shallowing-upward peritidal and subtidal cycles (or parasequences), in which the peritidal cycles predominate over the lower-middle Famennian. Six thirdorder sequences (S1 to S6) are identified based on the cycle stacking patterns as illustrated by Fischer-plots and vertical facies changes; these sequences are temporally calibrated through correlation with basinal sequences constrained with conodont zonation, and match well the six main Famennian transgressive–regressive cycles (T1 to T6) in Euramerica and elsewhere, indicating a eustatic control. However, an opposite longer-



term trend in accommodation change (S3 to S4) between platform interior and deeper open shelf-to-basin settings during the middle Famennian suggests a differential subsidence across the platform–basin section, likely driven by block tilting. Thus, both eustatic fluctuations and local tectonism had played an important role in platform development and evolution. This scenario is similar to that case occurred in the Frasnian.

The high-resolution cyclostratigraphic approach further constrain the timing of Frasnian-Famennian (F-F) biotic crisis and subsequent biotic recovery. The F-F boundary is placed slightly below the sequence boundary so that the F-F crisis occurred in the context of sea-level fall. After the F–F biotic crisis, main marine benthos preferentially recovered in the normal marine niches on the nearshore open shelves, and radiated gradually into offshore restricted platforms. Brachiopods, notably rhychonellides, were the taxa recovering the earliest (S1) in the normal (or near normal) marine conditions, then echinoderms (S3), stromatoporoids (upper S3) and corals (S5) stepped in episodically. However, these benthos generally appeared later in the restricted platform interiors only as if the ecological conditions were improved well enough for their colonization. Therefore, the biotic recovery processes were diachronous: both taxonomically- and ecologically-specified.