# Sequence Stratigraphy of the Taebaek Group (Cambrian-Ordovician), Mideast Korea


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Long-term (second- or third-order) transgressive-regressive sequences commonly formed in carbonate platforms during greenhouse periods, i.e., Lower Paleozoic and Mesozoic (Read and Goldhammer, 1988; Lehrmann and Goldhammer, 1999; Sarg et al., 1999). Because high-order sea-level fluctuations during greenhouse periods are small and short in magnitude and duration, respectively, the development of the greenhouse sequences is primarily controlled by basin geometry, subsidence pattern, sediment supply, and long-term sea-level changes (Read and Goldhammer, 1988; Schlager, 1992; Montanez and Osleger, 1993; Lehrmann and Goldhammer, 1999; Sarg et al., 1999). The greenhouse transgressive-regressive sequences are devoid of distinct features for abrupt facies shift and prolonged subaerial exposure (Lehrmann and Goldhammer, 1999). Instead, the sequences are characterized by retrogradational to progradational stacking patterns and deepening to shallowing facies shifts (Read and Goldhammer, 1988; Koerschner and Read, 1989; Goldhammer et al., 1993; Montanez and Osleger, 1993; Lehrmann and Goldhammer, 1999).

The Taebaek Group (Cambrian-Ordovician) in mideast Korea comprises mixed carbonate-siliciclastic sequence of sandstone, shale, and carbonate successions (Chough et al., 2000; Choi et al., 2004). It can be partitioned into four packages that are characterized by upward deepening to shallowing facies shifts. Each package represents greenhouse transgressive-regressive sequence in the Lower Paleozoic (Chough et al., 2000; Ryu, 2002), defined as second-order 'supersequence' formed during

10-50 m.y. (e.g., Sarg et al., 1999). This study outlines a sequence stratigraphic scheme for the Taebaek Group, delineating changes in relative sea level and eustasy, regional tectonism, and interplay between siliciclastic sediment input and carbonate productivity. According to the tectonic reconstruction of the Paleozoic basins in the Korean peninsula (Chough et al., 2000), the Taebaeksan Basin was in close proximity to the Pyeongnam Basin (North Korea) during the Lower Paleozoic, forming part of the northeastern margin of the North China platform. This study will provide basis for sequence stratigraphic comparison with the coeval sequences in the North China platform (Meyerhoff et al., 1991; Meng et al., 1997).

A detailed sedimentological measurement of three outcrop sections (Seokgaegae, Dongjeom, and Sangdong sections) suggests that the Taebaek Group consists of 15 siliciclastic and 20 carbonate facies, which can be organized into 14 facies associations. The siliciclastic facies associations represent clastic wedge and shoreface (FA 1), restricted shoreface (FA 2), inner shelf (FA 8), outer shelf (FA 3), outer shelf and slope (FA 6), and basin and slope (FA 13) environments in deepening order, whereas the carbonate associations represent carbonate sabkha-type peritidal (FA 12), subtidal to peritidal (FA 14), shallow subtidal and intertidal (FA 5), shallow subtidal (FA 11), subtidal shoal and back shoal (FA 4), inner ramp (FA 10), deep ramp (FA 7), and outer ramp (FA 9) environments in deepening order.

According to the vertical arrangement of the facies associations, the mixed carbonate-siliciclastic sequence of the Taebaek Group can be grouped into four formation packages: package P1 (Jangsan/Myeonsan, Myobong, and Daegi fms), package P2 (Sesong and Hwajeol fms), package P3 (Dongjeom, Dumugol and Makgol fms), and package P4 (Jigunsan and Duwibong fms). Each package comprises an upward-deepening to -shallowing arrangement of facies association, which is common in second-order greenhouse transgressive-regressive sequences formed during 10-50 m.y. (Read and Goldhammer, 1988; Lehrmann and Goldhammer, 1999; Sarg et al., 1999). The sequence boundaries are characterized by abrupt facies shift with subaerial or submarine exposure surface.

Each sequence formed by siliciclastic deposition during lowstand and early transgression and by progradation of carbonate strata during late transgression and highstand. Supersequence I (Jangsan/Myeonsan, Myobong, and Daegi fms) represents initial inundation and subsequent drowning during the late Early to middle Middle Cambrian. In the late Middle and Late Cambrian, supersequence II (Sesong and Hwajeol fms) formed by prolonged marine flooding and terminated by large supply of siliciclastics and shallowing due to regional uplift in the earliest Ordovician. Supersequence III (Dongjeom, Dumugol, and Makgol fms) is characterized by lowstand siliciclastics generated by rejuvenation of the drainage area, transgressive marine flooding, and progressive highstand shallowing in the Early Ordovician. Following the large-scale fall of sea level in the earliest Middle Ordovician, supersequence IV (Jigunsan and Duwibong fms) formed by resumed marine flooding in the Middle Ordovician on subaerial exposure surface (type-1 sequence boundary). The four supersequences are bounded by drowning events between the Middle and Late Cambrian, relative sea-level fall due to regional uplift in the earliest Ordovician, and large-scale eustatic fall in the earliest Middle Ordovician, in ascending order.

The Taebaek Group in the Taebaeksan Basin represents part of the North China Block in the Lower Paleozoic (e.g., Chough et al., 2000). Recent analyses on trilobite assemblages (Choi et al., 2001) and Archaeoscyphia and Calathium association (Kwon et al., 2003) clearly demonstrate that the Taebaeksan Basin was connected to the carbonate platform of North China during the Cambrian to Ordovician. According to Meng et al. (1997), the strata in North China platform are divided into two megasequences. In the Taebaek Group, four second-order supersequences are recognized. The lower three of the Taebaek Group correspond to the first megasequence from the Cambrian to Lower Ordovician in North China (Meng et al., 1997). On the other hand, the uppermost one is stratigraphically equivalent to the second megasequence in North China.

In North China, two sequences of megasequence-scale are discriminated by global eustatic fall in the earliest Middle Ordovician (Meng et al., 1997). The global fall also caused to form type-1 sequence boundary between the supersequences III and IV in the Taebaek Group. In the group, however, two other second-order sequence boundaries are recognized. These two sequence boundaries most likely resulted from significant changes in relative sea level, not of global eustatic fluctuations. One is the boundary due to rapid rise of relative sea level, probably enhanced by tectonic tilting of North China between supersequences I and II, whereas the other is the boundary due to relative sea-level fall by local uplift between supersequences II and III.