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Early Cambrian sea-level changes: A Scandinavian perspective

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The Scandinavian area (present-day western Baltica) is ideal for reconstructing Early Cambrian eustatic changes as deposition was condensed and the area essentially tectonically quiescent. A semi-quantitative approach has been developed for reconstructing sea level changes by combining sedimentary facies changes, coastal onlap/offlap and thickness of strata where the accommodation space was filled. The model assumes that accommodation space was controlled exclusively by eustasy as well as isostasy caused by sedimentary load, but without active basin subsidence.

Baltica became intensively peneplained following an orogeny at around 1 Ga, and the craton had an extremely low relief at the dawn of the Cambrian. The Scandinavian area became stepwise transgressed during the Early Cambrian (Terreneuvian and Cambrian provisional Series 2) and was eventually completely inundated in the Mid Cambrian (Cambrian provisional Series 3, Drumian Stage)[1,2]. During the Early Cambrian, Baltica was surrounded by passive margins except to the north, where the last phase of the Timanide collision was ongoing[1]. Due to the peneplained state of the hinterland the sedimentary supply to the epicontinental sea was limited and further declined as the transgression progressed and reduced the sediment-producing land areas.

The transgressional pattern reveals a gradually rising 1st order sea-level throughout the Early and Mid Cambrian. However, the rising trend was punctuated by several temporary falls. Major 2nd order regressive events occurred in the mid Early Cambrian (Rispebjerg Lowstand, see ref. 1), at the Early/Mid Cambrian transition (Hawke Bay Event, see ref. 2) and in the medial Mid Cambrian (unnamed); the resulting unconformities are defined as super-sequence boundaries.

Overall, the Early Cambrian sea-level rose significantly to reach a temporary maximum in the early part of Cambrian global series 2 at which stage trilobites appeared. This 2nd order highstand was terminated by the Rispebjerg Lowstand. Afterwards, the sea-level rose again to reach an even higher level in the late part of the Early Cambrian, forming another 2nd order highstand that was terminated by the Hawke Bay Lowstand. The sea-level remained comparatively low in the early part of the Mid Cambrian and then rose again to reach a Cambrian maximum in the latest Mid Cambrian after a transient major lowstand in the medial Mid Cambrian (unnamed). The sea-level in the Furongian was high although not as high as the late Mid Cambrian sea-level. The presentation focusses on the Early Cambrian and post-Early Cambrian sea-level changes will be analysed in greater detail at a later stage.

The rising Cambrian sea-level probably relates to plate tectonic dispersal, but the short-term changes such as the Rispebjerg Lowstand are reminiscent of glacioeustasy. Also the terminal Early Cambrian Hawke Bay Lowstand may in part reflect a glaciation that continued into the early part of the Mid Cambrian, which is characterized by overall low sea-level and frequent sea-level changes[2]. However, the Hawke Bay Lowstand was complex and may at least partly be overprinted by plate tectonic changes[2].

The Hawke Bay regression thus seemingly coincides with the onset of subduction in the Iapetus Ocean and widespread isostatic uplift in Scandinavia[2]. The medial Mid Cambrian lowstand may also reflect glacioeustasy, but the overall high Mid Cambrian-Furongian sea level may be due to general absence of extensive ice-sheet. Concomitant widespread dysoxic conditions may relate to sluggish global circulation in a generally non-glaciated world.

References:

[1] Nielsen A T and Schovsbo N H (2011) Earth-Science Reviews 107, 207-310.

[2] Nielsen A T and Schovsbo N H (2015) Earth-Science Reviews 151, 288-350.