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Sedimentary successions on Baltoscandia support an early start of the Ordovician-Silurian Icehouse period

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The timing and controls for a shift from Greenhouse to Icehouse conditions in the Late Ordovician has been debated for many years. The terminal Ordovician (Hirnantian) glaciation was early recognised as a short-lived cooling of global climate in a longer-term Greenhouse cycle (FISHER 1981). The same view has later been supported by e.g. BRENCHLEY *et al.* (1994, 2003). A growing body of sedimentary and stable isotopic evidence suggests that cooling started several millions of year's earlier, in the early-middle Katian (FRAKES *et al*. 1992, SALTZMAN & YOUNG 2005, CALNER *et al*. 2009).

We provide sedimentary evidence from Baltoscandia for a major, and inferably climatically driven, sea-level fall and subsequent transgression close to the *Amorphognathus superbus* and *A. ordovicicus* zonal boundary in the middle Katian. Based on our high-resolution stable isotopic data (LEHNERT *et al*. 2008) this sea-level cycle overlaps with the Waynesville carbon isotope excursion, starting near the boundary between the Ka2 and Ka3 stage slices (see BERGSTRÖM *et al*. 2009). The combined evidence for sea-level change includes substantial, regional facies changes, preservation of erosional channels, and an associated palaeokarst horizon that can be traced several 100's of kilometres and across different depth-related facies belts of the basin. Contemporaneous sedimentary changes in the tropics (Laurentia), as well as in high latitude peri-Gondwana basins (Prague Basin), together with marked isotopic and faunal changes during this time interval suggest that this is an environmental perturbation that deserves global recognition.

In this presentation we focus on the recently documented palaeokarst in Baltoscandia. The palaeokarst horizon has an unusually wide spatial extent and can be followed more or less from the Caledonian foreland in the west, across Sweden and into the East Baltic area in the east. The horizon is several metres thick and related to an unconformity cut into fine-grained and sparsely fossiliferous carbonates formed at temperate latitudes: the Slandrom Limestone in Sweden and the time-equivalent Saunja Formation in the East Baltic area. The lithology of these formations and the morphology of solution cavities in them look unexpectedly similar in remote sections, such as in southern and central Sweden and in Estonia and Latvia. The combined evidence for a karst origin includes 1) frequent karren-like morphologies interpreted as 'Swiss-cheese' karst [*sensu* BACETA *et al*. 2001], 2) local occurrences of solution/collapse breccia, 3) presence of bladed pseudospar crystals in solution cavities (comparable to pseudospar illustrated by SCHOLLE & ULMER-SCHOLLE (2003), and interpreted as formed through early meteoric flushing), and 4) carbon isotope values indicating meteoric influence to the succession. These findings are put in context with previously reported, large-scale erosional channels that cut down several tens of metres below the Fjäcka Shale in the subsurface Baltic Sea area (TUULING & FLODÉN 2000), and with regional, anomalous thickness variations in the Slandrom Limestone and Saunja Formation, all together forming strong support for regional exposure of the Baltoscandian continent in the middle Katian. The surface of the palaeokarst horizon is overlain by the Fjäcka Shale (or lateral coeval shale formations) throughout large parts of Baltoscandia. This excellent marker bed constitutes dark brown to black, organic-rich shale and marks a swift transgression across the area in the early *A. ordovicicus* Zone. Based on chitinozoan biostratigraphy, there is a notable hiatus between the time interval of palaeokarst formation and the flooding of the basin during the deposition of the Fjäcka Shale.

The results from Baltoscandia presented here and in a recent, related paper of our research group (CALNER *et al*. 2009) add to the series of publications that more recently have provided new evidence for an early start of the Ordovician-Silurian Icehouse period.

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