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The Penultimate Deglaciation in Western Europe: A Case-study from Amsterdam Basin, The Netherlands

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A rapid climate transition from a glacial lake to a fjord-like lagoonal marine system was found in the sedimentary sequence contained in the Amsterdam Basin. This Saalian (~136 ka) glacial basin, in which the parastratotype for the Eemian is defined, contains a continuous and, especially, highly resolved record of the late-Saalian to Eemian climate transition. The Saalian ice cap, which covered a large part of northwestern Europe, formed the ice-pushed ridges and the glacial basins in The Netherlands. The varved sediments in these glacial basins register, in the chemical and isotopic composition of the authigenic calcium carbonate matrix, the environmental changes caused by the disintegration of the remaining dead-ice field. The geometry and the character of the sedimentary infill of Amsterdam Basin is well described using a large amount of drill-cores over the entire basin. The size of the ephemeral lake was on the order of 5000km^2 with an average depth of 25m.

Based on varve counting, oxygen isotope and pollen analyses we could establish that in the ~2500 year preceding the Eemian, climate substantially fluctuated. A relatively warm period from 2500 to 1000 years before the onset of the Eemian suddenly changed into a severely cold one, which ended just prior to the Eemian. The oxygen-isotope record in conjunction with the strontium isotopes show that over this time interval an ephemeral lake developed, which received large volumes of melt- and river water. The variations in the oxygen isotopic composition seem to be caused by rapid changes in atmospheric circulation and temperature. The strontium isotopic record is indicative of the size (volume) and stability of the lake. Furthermore, the carbon isotopes covary with the oxygen isotopes over the varved interval indicating changing seasonality.

Permafrost development during the cold period just prior to the Eemian caused formation of methane-clathrates in the underlying sediments. This coincides with a substantial lake level drop, resulting in remaining shallow ponds. The permafrost not only caused the texture of the sediments to change, also the authigenic components of the sediments were altered. Siderite formed due to methanogenesis and associated partial decomposition of calcium carbonates.

Deepening of the lake at the onset of the Eemian and the development of a sapropelic layer and a diatomite, is rapidly followed by the marine transgression when sea level rises above the ~ 30 m sill depth of the lake. Before the marine transgression is completed we can already distinguish an exchange between lake- and groundwater on the one hand, and seawater on the other hand, based on the strontium isotopic composition. The benthic foram and mollusc fauna which is found in the early Eemian is still indicative of Arctic elements. However, Lusitanien and Mediterranean fauna are found intermingled with the cold water species indicating a very rapid climate amelioration which is substantiated in the oxygen isotope composition of the mollusc *Corbula gibba*. The water composition in the lagoonal system is marked by a full marine signature in pollen-zone E4b-E5, after the first climate maximum in E4a. Towards the top of the Eemian, climate must have become wetter since the strontium- and oxygen isotopic composition of Corbula gibba are indicative of lowering salinity, and hence more continental runoff. The top of the Eemian, pollen zone E6 (dated at 118.2 ka with TIMS U-Th isochron methods) is marked by the lowest salinity.