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# The early Barremian warm pulse and the late Barremian cooling: A high-resolution geochemical record of the Boreal Realm

Matthias Malkoč and Jörg Mutterlose*

*Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätsstrasse 150, 44801 Bochum, Germany*
*e-mail: Joerg.Mutterlose@ruhr-uni-bochum.de*
**Corresponding author.*

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## ABSTRACT

A total of 289 belemnite guards was analyzed from the Boreal Barremian (northeastern England and northwestern Germany) for their trace elements and isotopic composition. The oxygen-isotope signature shows similar paleotemperature variations for all seven sections investigated. Three different phases of climatic evolution can be recognized. An earliest Barremian cool phase (*Praeoxyteuthis pugio* belemnite Zone) is followed by a distinctive warming event in the late early Barremian (*Aulacoteuthis* spp. belemnite Zone). This *Aulacoteuthis* warm pulse has a relatively short-term peak (~500 kyr), which accompanies widespread anoxic bottom-water conditions and records the highest temperature throughout the Valanginian–Barremian in the Boreal Realm. The late Barremian (*Oxyteuthis brunsvicensis, O. germanica*, and *O. depressa* belemnite Zones) is characterized by relatively positive $\delta^{18}O$ values reflecting a cooling phase. This paleotemperature interpretation of the oxygen data is supported by the Mg/Ca trends. The carbon isotope curve of the Barremian shows an increase from 1‰ in the early to 3‰ in the late Barremian. This trend may reflect the global signal of the carbon budget of Barremian oceans and be related to the widespread deposition of TOC-rich sediments in the southern part of the Boreal Realm and the progradation of the Urgonian carbonate platforms in the Tethys. There is evidence, however, that paleobiological factors may have played a much more important role in the incorporation of stable carbon isotopes than hitherto thought. In a monospecific belemnite population collected from one 30-cm-thick interval, the $\delta^{13}C$ signal shows a variation of 1.5‰. Ontogenetic changes in the metabolic activity linked to temperature or food changes may explain changes in the fractionation rate, resulting in an ontogenetically controlled biofractionation.