Supplementary Information to:

Southern high latitude warmth during Jurassic - Cretaceous: new evidence from clumped isotope thermometry
Madeleine Vickers; David Bajnai; Gregory D. Price; Jolien Linckens; Jens Fiebig

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Supplementary Data
(in a separate Excel file)

Data S1.xlsx ................................................................. Results of the clumped isotope measurements. This file contains all replicate analyses for the samples, standards and equilibrated gases, including the dates of the measurements as well as the ETFs.
Age Model Construction

The Jurassic-Early Cretaceous sediments recovered at DSDP Site 511 have yielded an extensive range of age diagnostic fossils, including benthic (Basov and Krasheninnikov, 1983) and planktonic foraminifera (Krasheninnikov and Basov, 1983), calcareous nannofossils and mollusks as well as palynomorphs (Jeletzky, 1983). The lowermost sediments contain both nannofossil and dinoflagellates, and a molluscan fauna, which suggests Callovian to Early Kimmeridgian ages (Jeletzky, 1983). The overlying sediments (from 626 m to 600 m) yielded of a considerable number of the bivalve *Jeletzkiella falklandensis* and the presence of the belemnite *Belemnopsis cf. keari* are indicative of an Oxfordian to Early Kimmeridgian age (Jeletzky, 1983). From 599 m to 554 m the presence of the nannofossils *Vekshinella stradneri* and *Stephanolithion bigoti* are indicative of a Middle Oxfordian to Early Tithonian age (Jeletzky, 1983). The age diagnostic ammonite *Virgatosphinctes* sp. and the bivalve *Malayomaorica* sp. and palynological data attest to a Kimmeridgian to an Early–Late Tithonian age (Jeletzky, 1983). The interval from 554 m to 534 m contains age-diagnostic palynomorphs and hedbergellid foraminifera indicative of a Barremian age (Jeletzky, 1983; Krasheninnikov and Basov, 1983). Within the interval from 533 m up to 513 m the common presence of *Aucellina* sp. (Jeletzky, 1983), in addition to age diagnostic nannofossils and planktonic foraminifera (Krasheninnikov and Basov, 1983) makes it possible to attribute the sediments to the Barremian–Early Albian. The published strontium isotopic data (Price and Gröcke, 2002) was not used in the creation of the age model described above. These data can, therefore, be used to assess the validity of the age model constructed based on biostratigraphy. Measured $^{87}\text{Sr}/^{86}\text{Sr}$ values (Price and Gröcke, 2002) and calculated ages using the most recent seawater strontium isotope curve (McArthur et al., 2012) shows a good agreement between the biostratigraphic data and the Sr-isotope data, lending strong credence to the age model.
Electron Microscopy

EBSD (electron backscatter diffraction) analyses and SEM-BSE (secondary electron microscopy – backscattered electrons) images of selected rostra were made at the Goethe University, Frankfurt, Germany. on a JEOL JSM-6490 scanning electron microscope equipped with an Oxford Instruments Nordlys EBSD detector, using a 15 kV acceleration voltage and a beam current of ca. 8 nA. The mapping stepsize was set either 2 μm, 6 μm or 7 μm. During EBSD data processing misindexed points were removed (wild spikes) followed by the removal of some zero solutions based on four indexed neighbors.
Figure S1 | Microphotos of three polished belemnite thick sections from DSDP Site 511. These rostra are representative of all the samples investigated in this study. Most of the rostra are made of translucent light brown calcite. Calcite adjacent to the apical line is cloudy in appearance. For the clumped isotope analyses only the translucent parts were sampled.
Figure S2 | Preservation of sample 60-2-21. (A) Approximate positions of the SEM images and EBSD maps. The pink arrow marks the orientation of the sample during the EBSD analyses. (B,C) EBSD Y maps of the calcite rostra with grain boundaries (yellow lines, misorientation > 10°). Black indicates pixels where the orientation of the crystal could not be determined. On both maps X direction is horizontal, Y direction is vertical. (B PF, C PF) Pole figures of calcite c- and a-axes corresponding to the EBSD maps with analogous coloring. (D,E) SEM-BSE images of the rostra.
Figure S3 | Preservation of sample 67-4-LTH. (A) Approximate positions of the SEM images and EBSD maps. The pink arrow marks the orientation of the sample during the EBSD analyses. (B,C) EBSD X maps of the calcite rostra with grain boundaries (yellow lines, misorientation > 10°). Black indicates pixels where the orientation of the crystal could not be determined. On both maps X direction is horizontal, Y direction is vertical. (B PF, C PF) Pole figures of calcite c- and a-axes corresponding to the EBSD maps with analogous colouring. (D,E) SEM-BSE images of the rostra.
Figure S4 | Preservation of sample 60-3-38. (A) Approximate positions of the SEM images and EBSD maps. The pink arrow marks the orientation of the sample during the EBSD analyses. (B,C) EBSD Y maps of the calcite rostra with grain boundaries (yellow lines, misorientation > 10°). Black indicates pixels where the orientation of the crystal could not be determined. On both maps X direction is horizontal, Y direction is vertical. (B PF, C PF) Pole figures of calcite c- and a-axes corresponding to the EBSD maps with analogous coloring. (D,E) SEM-BSE images of the rostra.
References cited


