# Paleoenvironmental changes at the Middle–Late Jurassic transition: deciphering T and $\delta^{18}O_{water}$ variations from the clumped isotope signal

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Prominent oceanographic and environmental changes are observed at the Middle–Late Jurassic transition. Boreal seas were characterized by continuous siliciclastic sedimentation allowing us to reconstruct climatic variations in this time period.

A prolonged (Late Callovian–Middle Oxfordian) period of the presence of cold (5– 8.5 ºC) bottom waters is suggested for the epicontinental Middle Russian Sea, belonging to the Boreal province, as based on $\delta^{18}O$ values of belemnite rostra [Wierzbowski et al., 2013]. The occurrence of the cold bottom waters is interpreted as a result of the establishing of wide marine connections with the Arctic Sea during a sea-level highstand. The cooling is sometimes correlated with similar but shorter cooling events known from the Western Europe. The cool period is followed by a pronounced Late Oxfordian–earliest Kimmeridgian warming, which is estimated to 6.5–9.5 ºC based on $\delta^{18}O$ values and elemental ratios of belemnite rostra [Wierzbowski et al., 2013]. As the $\delta^{18}O$ record studied may be affected by salinity variations real palaeotemperatures may by deciphered from the clumped isotope composition of well-preserved carbonate fossils.

Well-preservation state of studied fossils from the Russian Platform is confirmed by the preservation of metastable aragonite and low thermal maturity of the organic matter [Wierzbowski et al. 2013; Bushnev et al., 2006]. Clumped isotope analyses were performed on homogenized powder of 4 belemnite rostra (low-magnesium calcite) and 1 ammonite shell (aragonite) derived from distinct stratigraphic levels of the Russian Platform. At least 5 replicates (each ca. 4 mg) were run for all samples. Material was digested at 90 °C in a common acid bath connected to a fully-automated device for cryogenic purification and GC cleaning of $CO_2$ gas. Analyte gas was measured on a Thermo Scientific MAT 253. $\Delta_{47,raw}$ data correction comprised the application of a background correction scheme [Fiebig et al., 2015] and the direct projection to the absolute scale [Dennis et al., 2011]. The calcite calibration line of Wacker et al. [2014] was used for $T(\Delta_{47})$ estimations.

Preliminary clumped isotope data show a higher temperature (ca. 10 ºC) of bottom waters of the Middle Russian Sea during the Middle Oxfordian, and probable salinity stratification of the water column. It raises doubts about the theory of the pronounced cooling at the Middle–Late Jurassic transition. The clumped isotope data also show that the Late Oxfordian–earliest Kimmeridgian warming of the bottom water was lower than previously assumed and may have amounted to ca. 5 ºC; the rest of the observed $\delta^{18}O$ variations may have been related to a decrease in salinity of the local seawater.

Bushnev et al. (2006) *Lithology and Mineral Resources*, 41, 423–434.
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Fiebig et al. (2015) *Isotopes in Environmental and Health Studies* 1-17.
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Wierzbowski et al. (2013) *Global and Planetary Change*, 107, 196–212.