Carbon and Oxygen Isotope Composition of Upper Callovian-Lower Kimmeridgian (Middle-Upper Jurassic) Cephalopod Shells from the Russian Platform: A Proxy for A Global Climate Change?

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We present the carbon and oxygen isotope data derived from well-stratigraphically dated belemnite rostra and ammonite shells from two sections (Dubki near Saratov and Mikhalenino in the Kostroma district) in the Russian Platform. Studied samples were screened for diagenetic alteration using cathodoluminescence, trace element analysis, X-ray analysis and scanning electron microscopy (SEM) and were found to be well preserved. Belemnite rostra and ammonite shells were carefully separated from surrounding sediment with a microdrill and ground. Samples were analysed for carbon and oxygen isotopes using an automated carbonate reaction device (Kiel IV) connected to a Finnigan Mat Delta Plus mass spectrometer at the Institute of Geological Sciences and the Institute of Palaeobiology, Polish Academy of Sciences in Warsaw.

The belemnite $\delta^{13}C$ values are high and scattered (from 1.5‰ to 3.8‰ VPDB) in the uppermost Callovian and the lowermost Oxfordian and decrease slightly in the uppermost Middle Oxfordian-lowermost Kimmeridgian part of the studied interval, where they range from 1.0‰ to 3.2‰ VPDB. The new carbon isotope record is consistent with previously presented data from the Russian Platform (see Price and Rogov, 2009). The carbon isotope record of the Russian Platform with high belemnite $\delta^{13}C$ values differs significantly from the record of the Submediterranean ammonite province of Poland and Germany (cf. Wierzbowski 2002, 2004; Wierzbowski et al., 2009) being similar to the record of the Isle of Skye in Scotland (Nunn et al., 2009). Higher (than Submediterranean) $\delta^{13}C$ values of Russian belemnite rostra are likely related to high biologic productivity and/or high organic matter burial in semi-isolated Boreal marine basins. Further studies are, however, necessary to precisely document carbon isotope variations in the uppermost Lower and the lowermost Middle Oxfordian of the Russian Platform.

The temperatures calculated from the oxygen isotope compositions of belemnite rostra are low in the uppermost Callovian and the lowermost Oxfordian (averages of 5 ºC and 8 ºC for cylindroteuthids and belemnopseids, respectively; Fig.1). The trend to lower belemnite $\delta^{18}O$ values and higher temperatures is seen in the new dataset through the Middle-Upper Oxfordian and the Lower Kimmeridgian. The temperatures calculated for cylindoroteuthid belemnites are highest in the Kitchini Zone of the Lower Kimmeridgian ranging from 14 ºC to 18 ºC (Fig.1). The decrease in belemnite $\delta^{18}O$ values was already reported from the Russian Platform (cf. Price and Rogov, 2009) and interpreted as a result of global warming (Dromart et al., 2003). It is, however, not clear whether the observed decrease should be related to changing water temperature or chemistry as an apparent increase in calculated temperatures may be caused by a decline in seawater $\delta^{18}O$ value owing to the enhanced freshwater influx (Wierzbowski et al., 2009). Some observed facts like moderate temperatures calculated from well-preserved uppermost Callovian and lowermost Oxfordian ammonite shells (average 13 ºC) and the retreat of Mediterranean-Submediterranean ammonite fauna in the Upper Oxfordian of the Mikhalenino section seem to be not compatible with the inferred warming. On the other hand, the discordance between ammonite spectra oscillations and stable isotope data of belemnite rostra has recently been shown for the Late Kimmeridgian-Volgian of a central part of the Russian Platform (Price and Rogov, 2009). Ammonite associations were thought, in this case, to be influenced not only by changes in palaeotemperatures but also by palaeogeography changes in connections between the Volga Basin and the Tethys (Price and Rogov, 2009). It is also worth noting that belemnites are considered to be nectobenthic, while ammonites are thought to have inhabited an upper part of the water column (Wierzbowski and Joachimski, 2007; Price and Page, 2008), therefore, differences between belemnite and ammonite isotope records may be linked to different palaeotemperatures of bottom and surface waters.

Further studies are planned in order to present more detailed oxygen and carbon isotope record of the Russian Platform. We hope that the collected data will contribute to the better understanding of perturbations in the Middle-Late Jurassic climate and the global carbon cycle.

Key words: Stable isotopes; Belemnites; Ammonites; Palaeoclimate

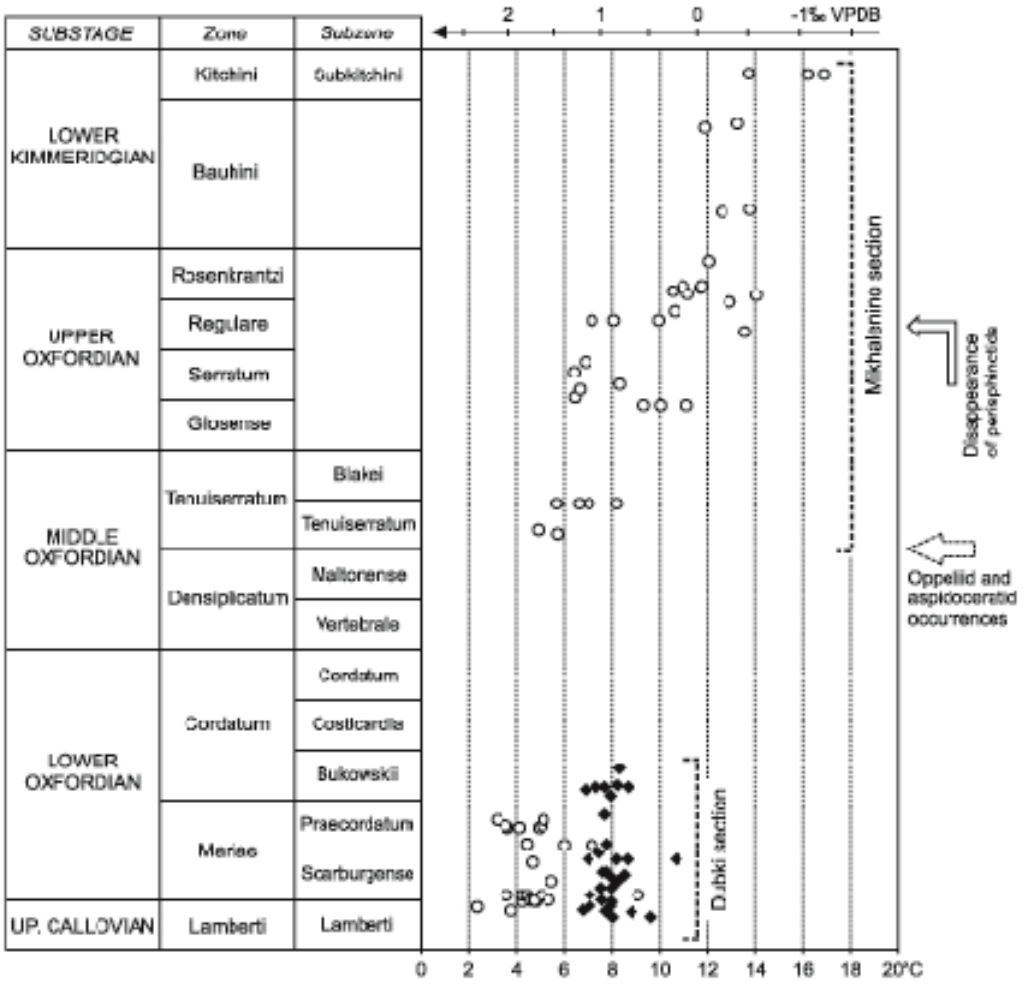

Fig.1 Stratigraphy, $\delta^{18}O$ values and palaeotemperatures calculated from $\delta^{18}O$ values of well-preserved belemnite rostra from the Russian Platform using equation given by O'Neil et al. (1969) and modified by Friedman and O'Neil (1977)
Open circles=cylindoroteuthid belemnites. Filled diamonds - belemnopseid belemnites.

References:

Dromart G., Garcia J-P., Gaumet F., et al. Perturbation of the carbon cycle at the Middle/Late Jurassic transition: geological and geochemical evidence. American Journal of Science, 2003, 303: 667-707.

Nunn E., Price G.D., Hart M.B., et al. Isotopic signals from Callovian-Kimmeridgian (Middle-Upper Jurassic) belemnites and bulk organic carbon, Staffin Bay, Isle of Skye. Scotland. Journal of the Geological Society, London, 2009,166: 633-641.

Price G.D., Page K.N. A carbon and oxygen isotopic analysis of molluscan faunas from the Callovian–Oxfordian boundary at Point, Weymouth, Dorset: implications for belemnite behaviour. Proceedings of the Geologists' Association, 2008, 119: 153-160.

Price G.D., Rogov M.A. An isotopic appraisal of the Late Jurassic greenhouse phase in the Russian Platform. Palaeogeography, Palaeoclimatology, Palaeoecology, 2009, 273: 41-49.

Wierzbowski H. Detailed oxygen and carbon isotope stratigraphy of the Oxfordian in Central Poland. International Journal of Earth Sciences (Geologische Rundschau). 2002, 91: 304-314.

Wierzbowski H. Carbon and oxygen isotope composition of Oxfordian-Early Kimmeridgian belemnite rostra: palaeoenvironmental implica- tions for Late Jurassic seas. Palaeogeography, Palaeoclimatology, Palaeoecology, 2004, 203: 153-168.

Wierzbowski H, Joachimski, M. Reconstruction of late Bajocian–Bathonian marine palaeoenvironments using carbon and oxygen isotope ratios of calcareous fossils from the Polish Jura Chain (central Poland). Palaeogeography, Palaeoclimatology, Palaeoecology, 2007, 254: 523-540.

Wierzbowski H., Dembicz K., Praszkier T. Oxygen and carbon isotope composition of Callovian–Lower Oxfordian (Middle–Upper Jurassic) belemnite rostra from central Poland: A record of a Late Callovian global sea-level rise? Palaeogeography, Palaeoclimatology, Palaeoecology, 2009, 283: 182-194.