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Paleoenvironment of the Western Interior Seaway inferred from $\delta^{18}O$ and $\delta^{13}C$ values of molluscs from the Cretaceous Bearpaw marine cyclothem

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Abstract

$\delta^{18}O$ and $\delta^{13}C$ values of ammonites and inoceramids provide information on the paleoenvironmental conditions in the Western Interior Seaway (WIS) during the Campanian–Maastrichtian Bearpaw marine cycle, the last major Transgression–Regression (T–R) cycle to affect the seaway during the Cretaceous Period. Ammonites and inoceramids exhibit distinct stable-isotope values: inoceramids have higher $\delta^{13}C$ values (0.6‰ to 5.0‰) and lower $\delta^{18}O$ values (−4.0‰ to −2.8‰), whereas coeval baculitid ammonites have lower $\delta^{13}C$ values (−4.8‰ to −0.3‰) and higher $\delta^{18}O$ values (−2.3‰ to 0.0‰), with other ammonites having stable-isotope values ranging between the baculitids and inoceramids. The isotopic composition of the inoceramids and ammonites are unlikely due to kinetic or vital effects because species from open ocean environments have values expected from marine water and there is no correlation between the $\delta^{13}C$ and $\delta^{18}O$ values of the inceramids as has been reported for modern foraminifers and calcareous algae suspected of exerting vital effects. The heterogeneity in stable-isotope values of coeval molluscs implies that the Bearpaw Sea was isotopically stratified. Isotopic exchange between the water and sediments, and the formation of ^{18}O-depleted deepwater mass by mixing of Tethyan and Boreal waters in the WIS, may have caused such isotopic stratification.

A clear relationship exists between the $\delta^{18}O$ values of Bearpaw zonal baculitids and their biostratigraphic sequence. Baculitids from zones during peak transgression have the lowest average $\delta^{18}O$ values (−2.3‰ to −0.7‰), whereas those from the underlying and overlying zones have higher $\delta^{18}O$ values (−0.8‰ to 0.2‰). This pattern of $\delta^{18}O$ values can be explained by fluctuations in temperature rather than variations in freshwater influx, this influx probably having been reduced by lower precipitation and run-off under drier, warmer, climatic conditions. The Bearpaw Sea was not brackish and

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other paleoenvironmental factors likely account for the character of the Bearpaw fauna that is dominated by ammonites and inoceramids and lacks many of the taxa prevalent in the contemporaneous open oceans and seas.

Keywords: Stable isotopes; Molluscs; Paleoenvironment; Western Interior Seaway

1. Introduction

During the Cretaceous Period, the Western Interior of North America was the site of a vast foreland basin, extending from the Gulf of Mexico to the Arctic Ocean and from eastern British Columbia to western Ontario (Fig. 1). Both Tethyan waters from the Gulf of Mexico and Boreal waters from the Arctic Ocean

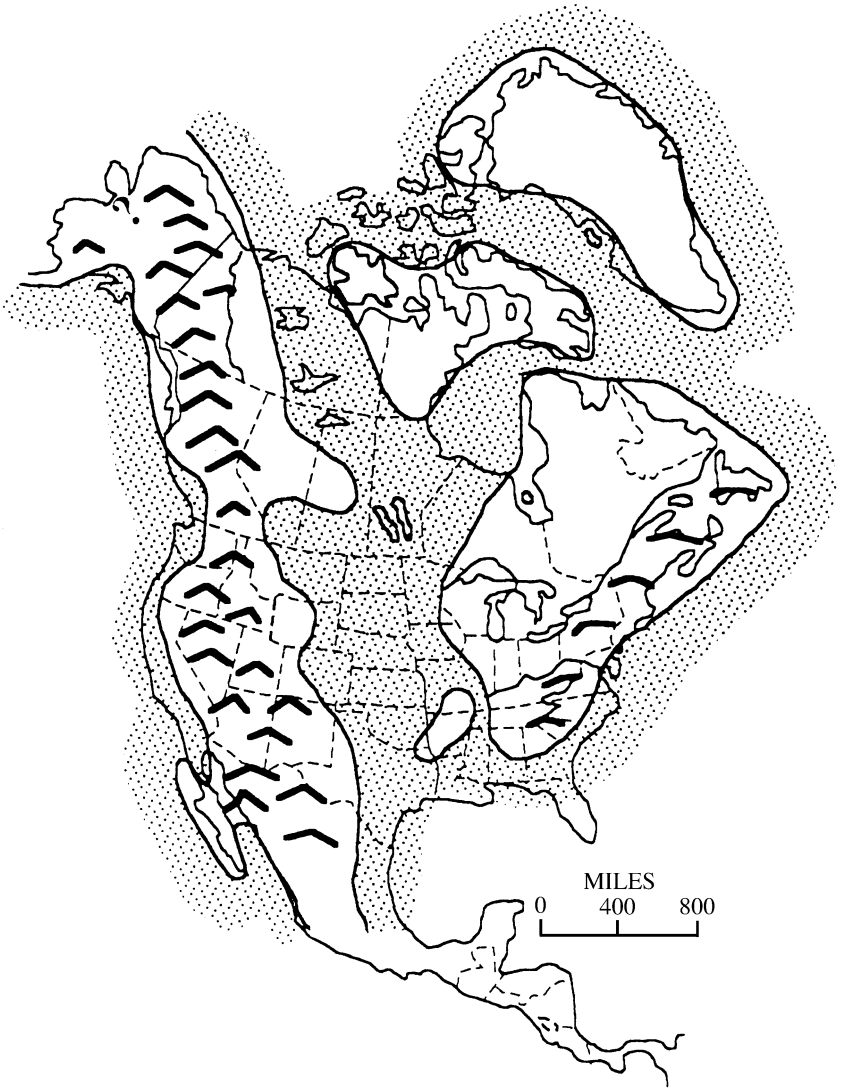

Fig. 1. Map showing the extent of the Cretaceous Western Interior Seaway of North America during the Bearpaw cyclothem at *Baculites baculus* time (after Williams and Stelck, 1975).