# matters arising

## Injection events in ocean history

THE hypothesis that sudden intermittent injections of brackish or hypersaline water from large, temporarily isolated basins into the world ocean may have so altered the existing density stratification that mass extinctions (particularly of the open ocean plankton) resulted[1,2], is fraught with possibilities. The mid-Cretaceous anoxic event and the Messinian evaporite event may have workable models, but we are concerned that the models for the Cretaceous–Tertiary boundary and Eocene–Oligocene event have major flaws in that both models require an isolated, fresh to brackish water Arctic Ocean. The best (and perhaps only) available evidence for Maastrichtian time indicates that the open ocean plankton of the Arctic Ocean were neither endemic nor brackish or fresh water. Deep-sea sediment core FL-437 recovered in 1969 from the Alpha Cordillera of the central Arctic Ocean[3], contains a rich phytoplankton biota described originally to show specific affinities with late Cretaceous marine silicoflagellates of Russia and California[4], and subsequently of the south Pacific and Indian Oceans[5-7]. A study of the abundant diatom flora substantiates these affinities with known normal marine species (J. A. Kitchell and D. L. Clark in preparation). The complex is similar to the middle–late Maastrichtian complexes of California and the Koryak Range of Siberia[8]. Consequently, if a brackish water injection event occurred in the latest Cretaceous, it certainly did not originate from an Arctic basin encompassing the Alpha Cordillera.

The Eocene termination similarly requires an isolated Arctic basin. Unfortunately, neither Eocene nor Oligocene deep-sea sediment has been recovered from the central Arctic, and this model cannot be tested.

However, recent tectonic interpretations suggest that the time of rotation of the Amerasia Basin was pre-late Cretaceous[9,10]. Detailed tectonic studies in the Bering Strait region support a late Cretaceous compressional event related to opening of the North Atlantic[11,12]. The post-Miocene benthic foraminifera and ostracode fauna of the Alpha Cordillera exhibit both endemism and Atlantic affinities[13]. Hence, the palaeontologic data derived from the central Arctic to date, support a transition from Pacific circulation patterns to Atlantic circulation, in conjunction with the time of opening of the North Atlantic. The observed extinctions of plankton species in the North Atlantic during this time interval may consequently represent the results of competitive interactions.

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THIERSTEIN REPLIES—There is little doubt that the Arctic Ocean was filled with marine waters at times during the late Cretaceous. In addition to the evidence cited by Clark and Kitchell of reworked late Cretaceous phytoplankton found in Plio–Pleistocene piston-cores[1,2], records of Maastrichtian marine microplankton succeeded by dominantly terrestrial palynomorphs are known from several basins in northern Alaska and the Canadian Arctic[3,4]. The transition from marine to terestrial deposition in these marginal basins, however, may be time-transgressive and could be due to local tectonic effects[4,5]. Tectonic activity in conjunction with a worldwide regression would provide the ideal setting for a temporary isolation and subsequent flushing of the Arctic Ocean through, for instance, the M'Clure graben near the end of the Mesozoic (refs 6, 7 and H. R. Balkwill, personal communication). Considering the short time estimated necessary for a freshening of the Arctic Ocean[8] and the comparatively long duration of several million years of phytoplankton zones in the late Cretaceous[9,10], the evidence presently available from the Arctic does not preclude a temporary freshening and subsequent flushing of that basin at the very end of the Maastrichtian and Eocene.

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## Shelf temperatures and reef growth on the south-east Florida coast

LIGHTY *ET AL.*[1] describe a drowned Holocene *Acropora palmata* reef off the south-east Florida coast. In attempting to explain the lack of growth of this structure over the past ~7,000 yr, the authors list papers which they claim support low temperature as the principal limiting factor ("..., pronounced temperature fluctuations and unusually cold bottom waters in the shallow waters off south-east Florida are effectively preventing active reef growth north of Miami."). However, none of their references apply to this point. The paper by Taylor and Stewart[2], for example, deals with upwelling off the north-east and central Florida coast—not

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