North Atlantic glacial-interglacial ostracode faunal patterns through the Mid-Pleistocene Transition (MPT) at ODP Sites 980/982

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BACKGROUND AND INTRODUCTION

The glacial-interglacial (G-I) cycles through the Mid-Pleistocene Transition (MPT; 1.2-0.6 Ma) are characterized by a frequency decrease from 41 to 100 kyr and an amplitude increase via more extreme glacials. This MPT has been the focal point of many paleoceanographic and micropaleontological studies in the North Atlantic, but little is known about regional deep-ocean ostracode faunas through the MPT. Cyclic or secular variations in local benthic conditions through the MPT may be reflected in ostracode faunal patterns. However, ostracode faunal data through the MPT at ODP Site 982 (1,145 m) and Site 980 (2,168 m) reveal no clear or consistent interglacial-glacial variations.

This absence of pronounced G-I variations in ostracode assemblages through the MPT stands in stark contrast to documented G-I variations in North Atlantic ostracode assemblages during the Late Pliocene (Cronin et al.,1996) and latest Pleistocene (Didie and Bauch, 2000), which have been attributed to G-I variations in intermediate water ventilation and surface export production.

Within the MPT interval, Kawagata et al. (2005) documented a major decline and eventual extinction of 51 species of deep-sea infaunal benthic foraminifera at Sites 980 and 982 from ~800 to ~640 kya. This benthic foraminifera response contrasts with coeval ostracode assemblages that show no comparable taxonomic loss.

Although our sampling resolution is relatively low (i.e., 42 samples from two sites over 24 G-I cycles), our ostracode data show no clear cyclic or secular changes in accumulation rates, sample richness, or relative abundances through the MPT. This may be related to relatively stable North Atlantic thermohaline circulation relative to earlier and later time intervals as proposed by Raymo et al. (2004) based on oxygen and carbon stable-isotope variations.

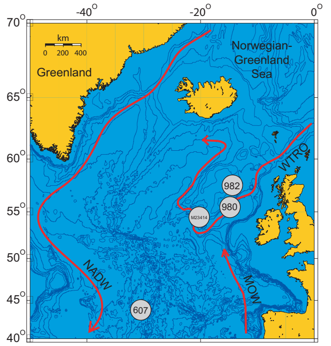


Figure 1. Location of ODP Sites 980 and 982 of present study and Sites 607 and Kasten Core M23414 of other Neogene North Atlantic ostracode studies discussed in poster. Arrows indicate modern intermediate and deep-water circulation patterns. NADW = North Atlantic Deep Water; WTRO = Wyville-Thomson Ridge Overflow; MOW = Mediterranean Overflow Water. Thermohaline circulation after Raymo et al. (2004).

MATERIALS AND METHODS

We picked all ostracodes from the >150 µm size-fraction for 42 samples spanning 24 G-I cycles from ODP Sites 980 (2,168 m, 55°N, 14° W) and 982 (1,145 m, 57° N, 15° W) (Figure 1). Site 980 is located on the Feni Drift on the northwest flank of the Rockall Trough and is influenced by the highly oxidized Wyville-Thomson Ridge Overflow (WTRO) that contributes to North Atlantic Deep Water (NADW). Site 982 is located on the Rockall Plateau and is bathed by warm Mediterranean Overflow Water (MOW) with lower oxygen concentrations.

Valves were identified to the generic level (Figure 2) and tallied as right/left and adult/juvenile. Total valve counts for each sample included whole valves (i.e., W = >50% complete) and valve fragments (i.e., F1 = 25%-50% complete; F2 = <25% complete). Total valve abundances were calculated by W + 1/2 (F1) + 1/4 (F2).

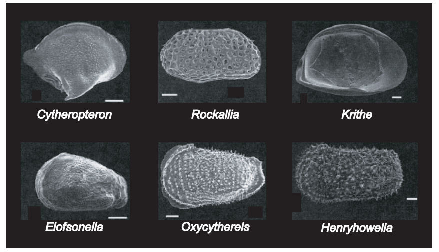


Figure 2. SEM images of common North Atlantic Quaternary ostracode taxa present at Sites 980 and 982. All images are external views except *Krithe*; white scale bars are 100 µm (images from Didie and Bauch, 2002).

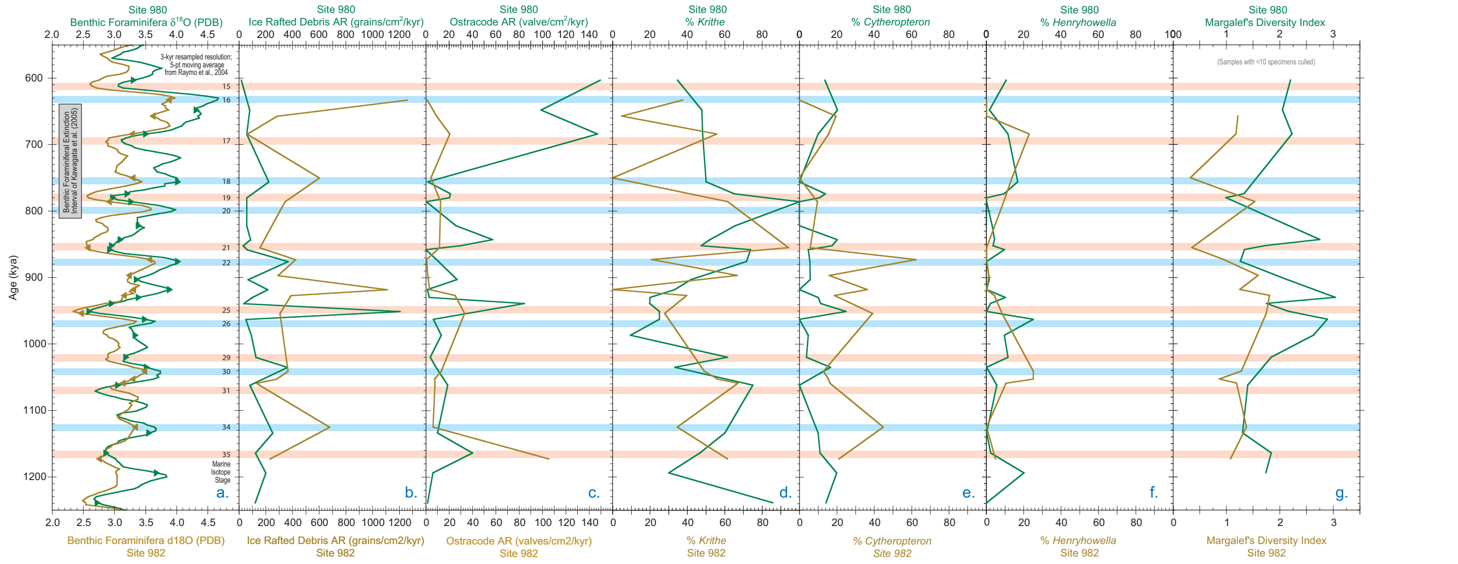


Figure 3. a) Sites 980 and 982 oxygen isotope stratigraphy showing distribution of ostracode faunal samples relative to glacial and interglacial Marine Isotope Stages in blue and red, respectively. Benthic foraminifer extinction interval (~810 to ~640 kya) for small infaunal taxa based on Kawagata et al. (2005) indicated by gray vertical band; b) ice rafted debris accumulation rate (AR) calculated as the number of lithic grains (grains/cm²/kyr) from Kawagata et al. (2005); c) ostracode accumulation rate (OAR) (valves/cm²/kyr); d-f) relative abundance for dominant taxa *Krithe*, *Cytheropteron*, and *Henryhowella*; g) Margalef's diversity index used to compare ostracode diversity among samples.

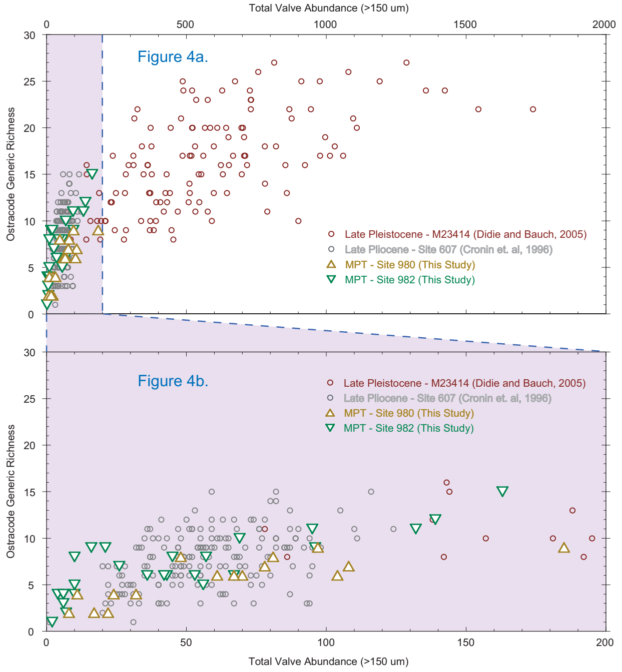
OSTRACODE FAUNAL PATTERNS (OR LACK THEREOF) THROUGH THE MID-PLEISTOCENE TRANSITION

The resulting ostracode assemblages from intermediate (1,145 m) and deep (2,168 m) water paleoenvironments show no clear correspondence to G-I cycles through the MPT in terms of ostracode accumulation rates (OAR; Figure 3c). Lower OAR at both study sites tend to coincide with peaks in ice rafted debris accumulation rates during glacial maxima (Figure 3a-b), and this likely reflects a relative dilution of ostracodes. However, the marked OAR increase at Site 980 during 600-700 kya cannot be readily attributed to a simple increase in IRD AR, but is consistent with Kawagata et al.'s (2004) interpretation of increasing ventilation at this site during the MPT benthic foram extinction (see Figure 5a).

Sites 980 and 982 are dominated by *Krithe* (Figure 3d) and occasionally *Cytheropteron* at Site 982 (Figure 3e), while numerous other taxa are present at relatively low abundances (e.g., *Henryhowella*; Figure 3f). Evidence for patterns in ostracode diversity responding to G-I cycles, calculated by the Margalef's diversity index, show marked responses at both sites through the MPT. However, no apparent correlation in sample diversity can be established to G-I variations (Figure 3g). The lack of any ostracode faunal patterns during G-I variations, despite a low-resolution sample distribution, is consistent with the relatively stable thermohaline circulation during this time as proposed by Raymo et al. (2004).

COMPARISON TO LATE PLEISTOCENE AND LATE PLIOCENE NORTH ATLANTIC DEEP-OCEAN OSTRACODE STUDIES

In contrast to our MPT results, North Atlantic ostracode assemblages from the Late Pliocene (Cronin et al., 1996) and the Late Pleistocene (Didie and Bauch, 2000) appear highly sensitive to G-I cycles (e.g., distinct and recurrent species abundance peaks within G-I cycles; higher diversity during glacial cycles, etc.). To ensure that our "evidence of absence" is not simply an artifact of insufficient sample abundances, we examined the abundance-richness relationships for all three studies (Figure 4a). While the Late Pleistocene faunal data show markedly higher abundances and generic richness than either the MPT or Late Pliocene, these latter two time intervals have comparable abundance-richness relationships (Figure 4b). Thus, the "evidence of absence" of G-I cycles in the MPT interval does not appear to be an artifact of inadequate abundances.



MID-PLEISTOCENE BENTHIC FORAMINIFERA EXTINCTION

Kawagata et al. (2004) documented a gradual decline and eventual extinction of elongated cylindrical infaunal benthic foraminifera from ~810 to ~640 kya at ODP Sites 980 and 982 (Figure 5a). Prior to the event, this extinction group comprised ~20% of the total benthic foraminifera richness at bathyal depths. Kawagata et al. (2004) attributed this biotic response to an increase in oxygenation, which may have led to out-competition by more oxyphyllic taxa. Accumulation rates of foram and ostracode benthic faunas at Site 980 covary through the MPT with a marked increase during the extinction interval (Figure 5b). In contrast, at Site 982, accumulation rates experience no marked change through the MPT while AR covary through the extinction interval (Figure 5c).

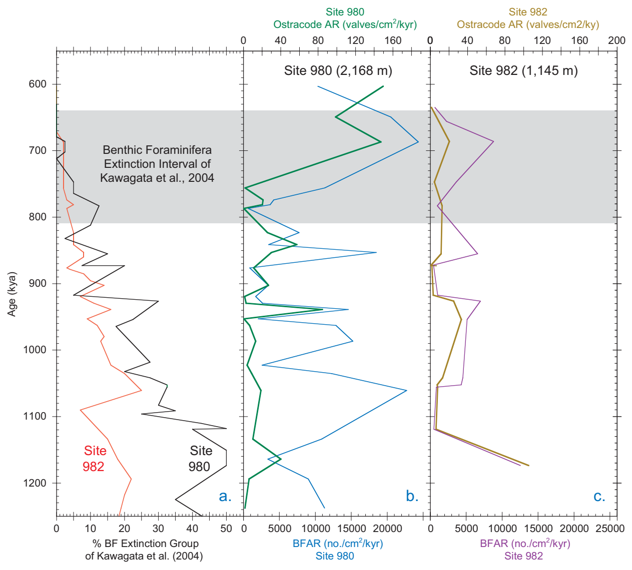


Figure 5. Infaunal benthic foraminiferal (BF) extinction interval (~810 to ~640 kya) from Kawagata et al., (2004) based on the gradual decline of elongated cylindrical species (gray band). a, the relative abundance of the extinction group (Kawagata et al., 2004); b, comparison of benthic foraminifera accumulation rates (BFAR) to ostracode accumulation rates (OAR) through the MPT and recognized extinction interval; c, Site 982.

CONCLUSIONS

- In contrast to Late Pliocene and Late Pleistocene intervals, ostracode faunal assemblages through the Mid-Pleistocene Transition show no clear or consistent relationships to glacial-interglacial cycles.
- A marked increase in OAR at Site 980 is consistent with Site 980 BFAR supporting the oxygenation at bathyal water depths discussed by Kawagata et al. (2004).
- Results from ODP Sites 980 and 982 is consistent with stable North Atlantic thermohaline circulation conditions as discussed by Raymo et al. (2004).

ONGOING AND FUTURE WORK

- Comparison of MPT OAR to Late Pliocene and Late Pleistocene glacial-interglacial cycles
- Higher resolution analyses of specific G-I cycles through the MPT
- Estimation of surface export productivity through the MPT

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