Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Global and Planetary Change 50 (2006) 127–147
GLOBAL AND PLANETARY CHANGE
www.elsevier.com/locate/gloplacha

Late Miocene paleoenvironment of the Lambert Graben embayment, East Antarctica, evident from: Mollusc paleontology, sedimentology and geochemistry

Jason M. Whitehead [a,*], Werner Ehrmann [b], David M. Harwood [c], Claus-Dieter Hillenbrand [d], Patrick G. Quilty [e], Charles Hart [f], Marco Taviani [g], Vanessa Thorn [h], Andrew McMinn [a]

[a] *Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Private Bag 77, Hobart, Tasmania 7001, Australia*
[b] *Institut für Geophysik und Geologie, Universität Leipzig, Talstrasse 35, D-04193 Leipzig, Germany*
[c] *Department of Geosciences, University of Nebraska — Lincoln, Lincoln, NE, 68588-0340, USA*
[d] *British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, United Kingdom*
[e] *School of Earth Sciences University of Tasmania, Private Bag 79, Hobart 7001, Tasmania, Australia*
[f] *Center for Geochronological Research, INSTAAR, University of Colorado, Boulder CO 80309-0450, USA*
[g] *ISMAR-Marine Geology Division, Consiglio Nazionale delle Ricerche, Via Gobetti 101, I-40129 Bologna, Italy*
[h] *Antarctic Research Centre, Victoria University of Wellington, PO Box 600, Wellington, New Zealand*

Received 1 December 2004; accepted 25 July 2005
Available online 23 March 2006

Abstract

The Upper Miocene (10.7–9.0 Ma) Battye Glacier Formation was deposited ~250 km inland from the modern Amery Ice Shelf edge in Prydz Bay, East Antarctica. The composition of clay minerals distinguishes a Lower Member, which reflects regional erosion of Precambrian metamorphic basement, from an Upper Member, which records increased erosion of local Permian–Triassic Amery Group strata. The Upper Member was deposited in an ice-proximal environment akin to the modern fjords of East Greenland, with substantial diamict deposition resulting from melting iceberg discharge. The Lower Member was deposited in an ice-distal environment and included the accumulation of the fossil-bearing McLeod Beds. The McLeod Beds contain much siliceous biogenic sediment (≤15% opal), which is rare to absent in the predominantly hemipelagic mud of modern East Greenland fjords. The McLeod Beds also contain largely monospecific in situ *Hiatella* sp. mollusc assemblages suggestive of environmental stress, potentially caused by low salinity melt-water and a high input of terrigenous sediment, which excluded most other benthic taxa. Geochemical results from primary aragonite in *Hiatella* shells imply large freshwater input into the marine environment during mollusc growth, causing low $\delta^{18}O$, Na, Mg and high Fe values. The present study indicates that iceberg melt-water influence entering the marine environment was greater during the Late Miocene than today around Antarctica, and documents the paleoenvironment associated with a discrete period of ice margin retreat and marine incursion into the Lambert embayment.

Keywords: Battye Glacier Formation; Amery Oasis; mollusc; fjord; East Greenland

* Corresponding author. Fax: +61 03 6226 2973.
E-mail address: jason.whitehead@utas.edu.au (J.M. Whitehead).

0921-8181/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.gloplacha.2005.07.003

1. Introduction

There has been considerable debate over the timing and nature of Neogene Antarctic climate change during the interval spanning the Middle Miocene to Late Pliocene (Miller and Mabin, 1998). Deep-sea isotope and Antarctic geomorphological data have been interpreted as evidence for East Antarctic Ice Sheet (EAIS) stability since the Middle Miocene and accompanying establishment of modern Antarctic climatic conditions (Barker et al., 1988; Flower and Kennett, 1994; Marchant et al., 1996; Sugden and Denton, 2004). Alternative fossil evidence suggests the EAIS continued to vary in size until the Late Pliocene and that a warm glacial regime had persisted long after the Middle Miocene (Hill et al., 1996; Harwood and Webb, 1998). Much of this debate has centred upon evidence found in the Transantarctic Mountains, but new evidence about the dynamics and paleoenvironment of the EAIS is emerging from research on the Pagodroma Group in the Prince Charles Mountains (Hambrey and McKelvey, 2000a,b; McKelvey et al., 2001; Whitehead and McKelvey, 2001; Bloemendal et al., 2003; Ehrmann et al., 2003; Whitehead et al., 2003).

Cenozoic glacimarine strata of the Pagodroma Group occur in the Prince Charles Mountains (PCM), East Antarctica, ≥250 km inland from the modern edge of the Amery Ice Shelf in Prydz Bay (Fig. 1) (Hambrey and McKelvey, 2000a). The Pagodroma Group was deposited largely seaward of fast flowing, polythermal, tidewater glaciers, in the absence of ice shelves, which differed greatly from the modern glacial setting. A large quantity of terrigenous sediment from melting icebergs formed thick diamict and minor hemipelagic mud and sand in the Pagodroma Group, akin to sediments in the modern fjords and on the continental shelf of East Greenland (Dowdeswell et al., 1994; Hambrey and McKelvey, 2000a). Prydz Bay receives little terrigenous detritus today although it is seaward of the Lambert Glacier–Amery Ice Shelf drainage system yet diatom production here results in the accumulation of biogenic siliceous mud (Domack et al., 1994; Harris et al., 1997). One Pago-

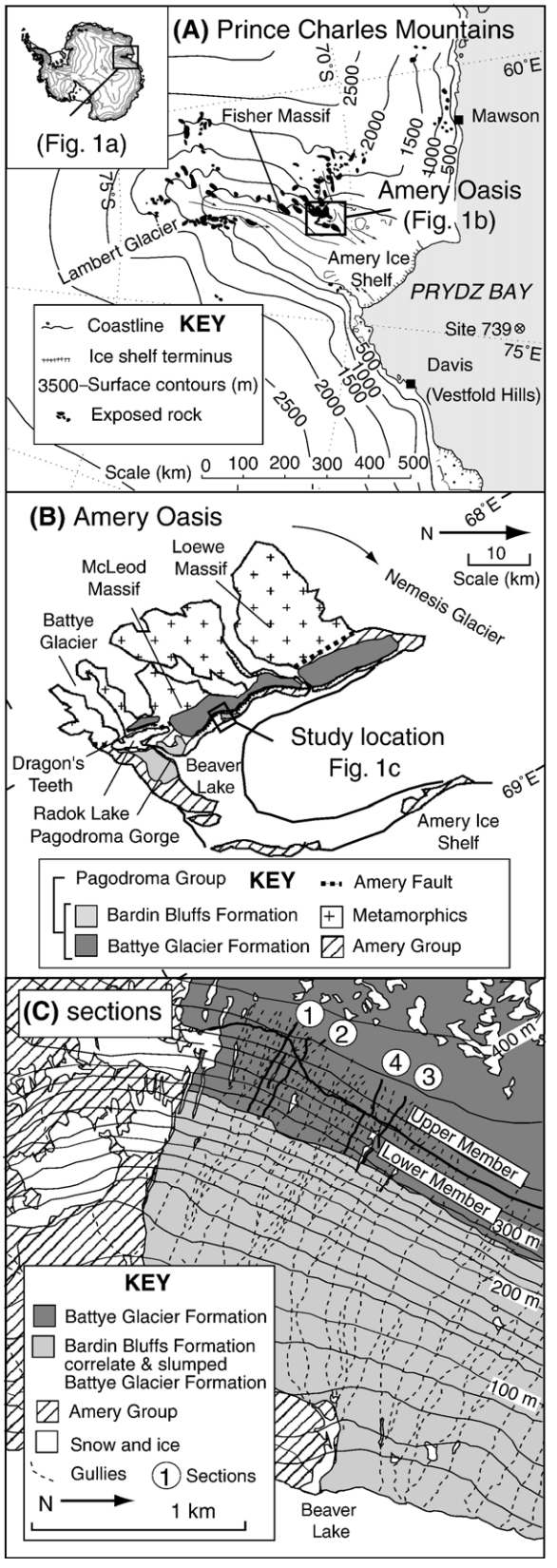

Fig. 1. (A) The Amery Oasis in the Prince Charles Mountains, East Antarctica (B) consists of Proterozoic metamorphic and Permian–Triassic sediments of the Amery Group that are partly overlain by the Late Neogene glacimarine Bardin Bluffs and Battye Glacier formations. This region drains a substantial volume of the East Antarctic Ice Sheet through the Amery/Lambert Embayment into Prydz Bay.