The evolution of Circum-Antarctic oceanic crust since the Cretaceous

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INTRODUCTION

Gondwanaland break-up together with ongoing changes of the South Pacific tectonic regime led to the opening of new oceanic domains around Antarctica since the Late Jurassic. On a geological timescale, first-order changes in palaeo-climate, palaeo-oceanography and marine sedimentation are controlled by plate tectonics through the distribution of land masses and ocean basins (geometry and geography), the opening and closing of oceanic gateways, and changes in topography both on land and at sea. New geological and geophysical datasets and refined tectonic models offer the opportunity to re-examine the evolution of oceanic crust of the circum-Antarctic realm since the Cretaceous. Seafloor spreading around Antarctica is illustrated by reconstructing gridded ocean floor ages and plate boundary configurations in a fixed mantle reference frame.

OCEANIC PALAEO-AGE GRIDS AROUND ANTARCTICA

New magnetic anomaly data from the Enderby Basin, off the East Antarctic margin, has been used to construct a revised breakup and seafloor spreading history between Madagascar, Sri Lanka, India, Australia and Antarctica (Brown et al., in press; Gaina et al., 2003) (Fig. 1). The new construction of seafloor spreading isochrons in the Enderby Basin, around 35°E –75°E, has filled in one of the last major unknown areas of seafloor age in the Circum-Antarctic region. A new tectonic model of the opening of the Tasman Sea, east of Australia (Gaina et al., 1998), has been combined with new models that document incipient motion between East and West Antarctica (Cande et al., 2000) (Fig. 1), indicating the formation of a triple junction off Victoria Land in the Paleocene. Relative motion between East and West South Tasman Rise and the final detachment of the latter from Antarctica led to the opening of the first gateway (Exon et al., 2001) that enabled changes in the oceanic circulation patterns.

In addition to the preserved oceanic crust, subducted oceanic crust in the South Pacific has been reconstructed by creating "synthetic plates" whose locations and geometry are established on the basis of preserved magnetic lineations, palaeogeography, regional geological data and the rules of plate tectonics. Based on the new set of palaeo-isochrons, palaeo-age grids have been constructed in order to estimate seafloor spreading/subduction rates, and to analyze the global distribution of oceanic crust ages for the last 130 million years (Fig. 2).

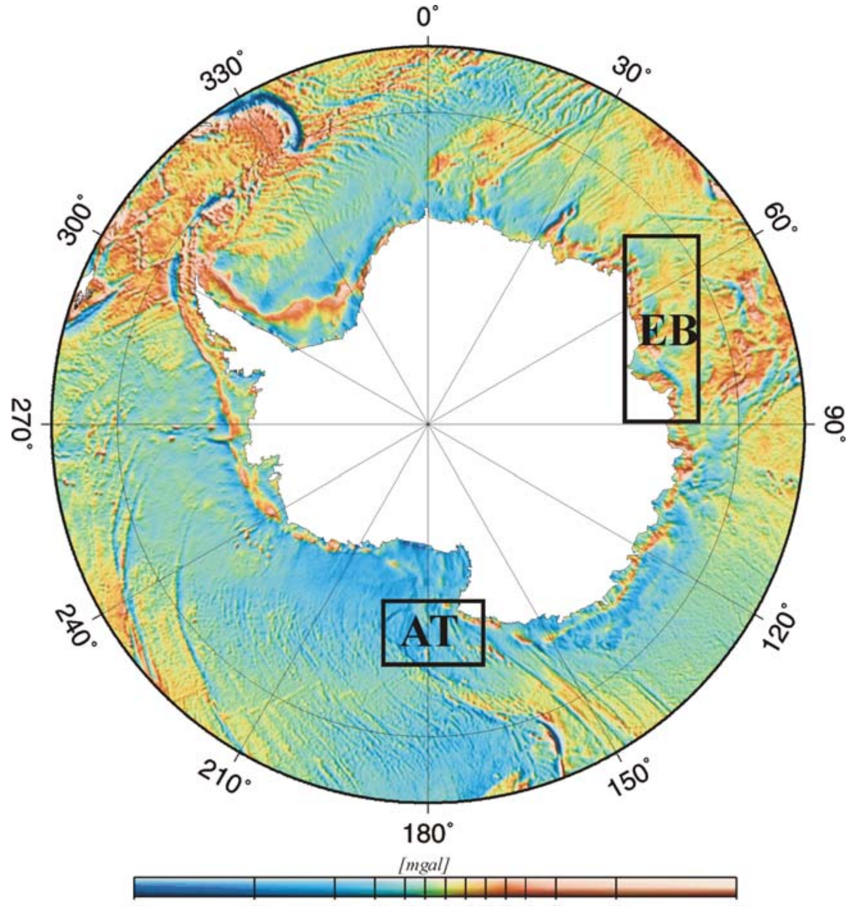

Fig. 1 - Circum-Antarctic gravity anomaly from satellite altimetry (Laxon and McAdoo, 1997). EB stands for the Enderby Basin and AT for the Adare Trough.area.

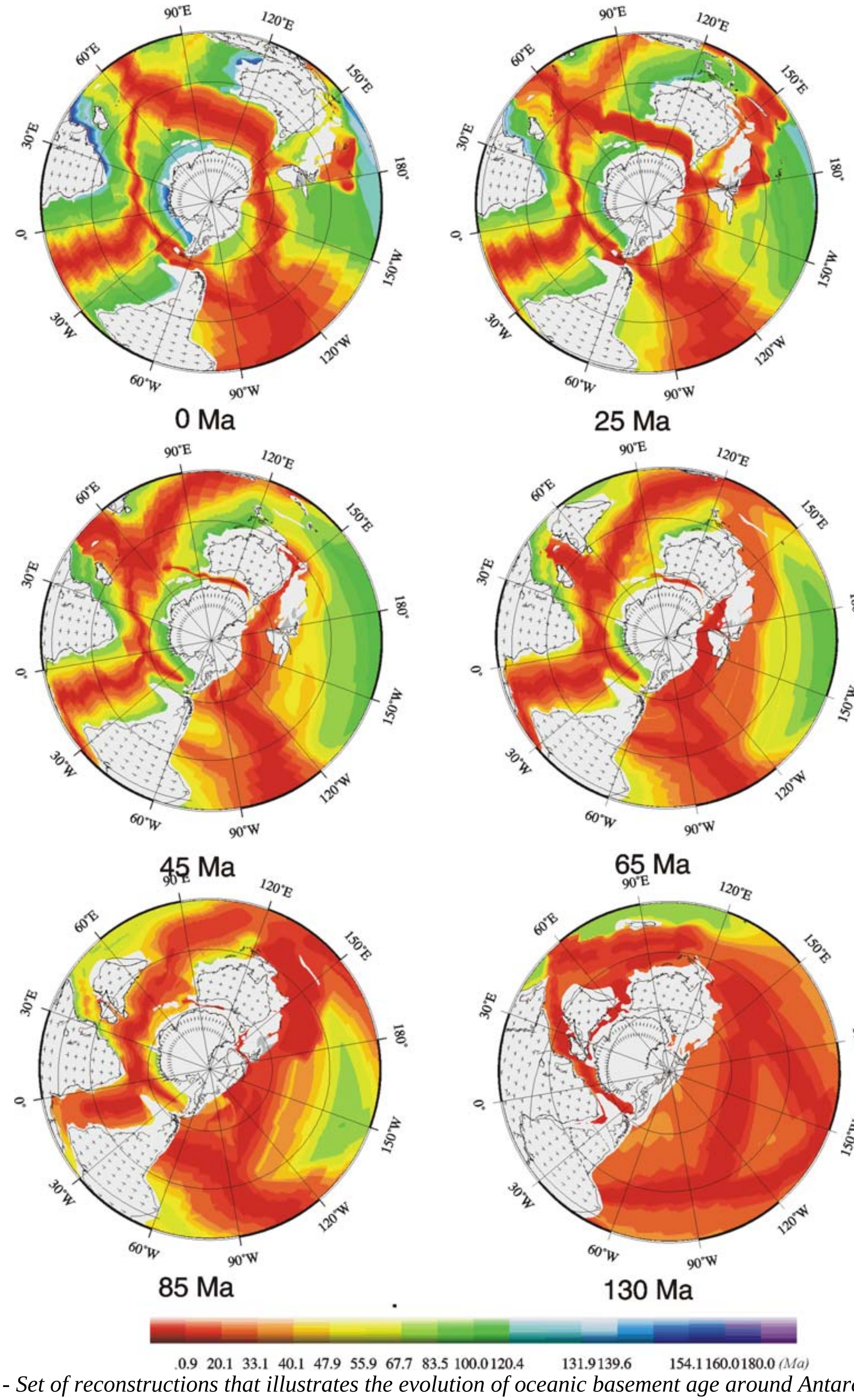

Fig. 2 - Set of reconstructions that illustrates the evolution of oceanic basement age around Antarctica from 130 million years to the present. Colour scale shows age of the oceanic basement in million years at a given reconstruction time.

FUTURE RESEARCH

Palaeo-age grids will be used to create a series of palaeoceanic basement-depth grids, based on a thermal boundary layer depth-age model. In addition, the effect of sediment loading and expected sediment thickness based on present day age grids and National Geophysical Data Center (NGDC) present day sediment thickness grid will help to model the corrected palaeo-bathymetric grids. The new set of palaeo-bathymetric grids would be a valuable tool to assess boundary conditions for fully coupled ocean circulation and climate models; in particular it would help assess deep-water circulation and related climate change further back in geological time.

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