Phytoplankton assemblages and (bio)geochemical proxies indicate enhanced productivity and sea-ice decline in the Ross Sea during Marine Isotope sub-Stage 5e

Julian D. Hartman[1], F. Sangiorgi[1], P.K. Bijl[1], F. Peterse[1], M.A. Barcena[2], S. Albertazzi[3], A. Asioli[4], F. Giglio[3], L. Langone[3], F. Tateo[4], F. Trincardi[5]

[1] Department of Earth Sciences, Utrecht University, Utrecht, The Netherlands (J.D.Hartman@uu.nl);
[2] Departamento de Geologia, Facultat de Ciencias, Universidad de Salamanca, Salamanca, Spain;
[3] Instituto Scienze Marine, Consiglio Nazionale delle Ricerche, Bologna, Italy;
[4] Instituto Geoscienze e Georisorse, Consiglio Nazionale delle Ricerche, Padova, Italy;
[5] Instituto Scienze Marine, Consiglio Nazionale delle Ricerche, Venice, Italy.

Abstract

Sea ice is an important component of the Antarctic cryosphere as it plays an important part in the climate system by limiting atmosphere-ocean exchange. Furthermore, it influences albedo, the deep and surface water currents of the Southern Ocean, and primary productivity. Sea ice has been increasing on average around Antarctica as a result of current global climate change. Nevertheless, long-term model predictions still expect sea ice to decline around Antarctica. To get a better understanding of the changes in sea-ice cover as a result of global warming it is important to look at past warm periods, such as the Last Interglacial (LIG, ~125-119 ka), also known as Marine Isotope sub-Stage 5e (MIS5e). During MIS5e temperatures were on average 2°C warmer globally than present-day, and it is therefore an important time period in light of the recent Paris Agreement. Diatom, palynological, foraminifer and (bio)geochemical data have been analyzed on a sediment core (AS05-10) that was collected on the continental slope of the Drygalski Basin, Ross Sea (2377 mbsl), to investigate the last glacial-interglacial changes in sea-ice cover around Antarctica and related environmental conditions. The core was collected within the frame of the PNRA 2009/A2.01 project, an Italian project with a multidisciplinary approach, and covers approximately the last 350 kyr based on diatom bioevents and cyclostratigraphy. In particular the proxies related to productivity, e.g., excess barium, biogenic silica and diatom abundances show a strong relation to the glacial-interglacial cycles. The deglaciations preceding MIS5e and MIS7e are marked by a release of IRD and reworked material followed by changes in the fossil assemblages and organic geochemical proxies indicative of high nutrient conditions and water column stratification due to fresh water release. Subsequently, peak warmth and decreased annual sea-ice cover maintain relatively high productivity conditions. Diatoms indicate that sea-ice cover was much more reduced during MIS5e than during the other marine isotope stages. Furthermore, there was a brief period of reduced bottom water oxygenation during MIS5e, which has led to enhanced preservation of fossil organic material in the sediments. Possibly, this is caused by a reduced influence of oxygen-rich High Salinity Shelf Water due to freshening of the shelf waters.

Keywords: Ross Sea, Last Interglacial, sea-ice, productivity