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Miocene to Recent contourite drifts development in the northern Weddell Sea (Antarctica)

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Abstract

Multichannel and high-resolution seismic profiles complemented with swath bathymetry show a variety of contourite deposits in the northern Weddell Sea resulting from the interaction between bottom currents and the seafloor physiography. Seven types of contourite drifts are identified based on the seismic signature, reflector configuration and geometry of the depositional bodies. Giant elongated–mounded drifts are widespread in the area and associated with major channelized contour currents that flow at the base of large ridges. Thick basement/tectonic drifts result from the seafloor disruptions of the currents caused by the irregularities of the near-surface basement morphology. Sheeted drifts occur under the main core of the Weddell Gyre and also in areas of the abyssal plain away from the main flows. Various types of drifts in-fill depressions or are plastered against steep bathymetric ridges that intersect contour currents. The regional distribution of the drifts is mainly controlled by the physiography of the basin and the confined or unconfined nature of the bottom-current flows.

The northern Weddell Sea is a region dominated by contourite processes and thus provides an area to compare contourite drifts with turbidite systems. The giant elongated–mounded drifts have a net asymmetry of the body, in contrast to turbidite channel–levee complexes that develop levees on each side of an axial turbidite channel. The basement/tectonic drifts prograde parallel to the main flow and are plastered following the irregularities of the basement unlike turbidite deposits. Other drifts, in contrast, show internal reflector characteristics similar to turbidite systems, such as the sheeted drifts. In these cases, however, the associations of turbidite and drift deposits are different. The giant elongate-mounded drifts are stacked along the margins and elongate or transverse drift sequences are observed in the basin centre of confined basins. In the unconfined setting, the

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drifts are normally asymmetric in relation to the marginal channel moats and sheeted drifts develop laterally from the ridges. In turbidite systems of confined or unconfined settings, generally symmetrical proximal channel–levee complexes evolve downstream to sheetlike basin plain sequences.

Five main seismic units separated by regional unconformities are recognized above the oceanic basement. The age of the deposits is based on the magnetic anomalies of the oceanic crust and the overlying seismic sequences. The external geometry and acoustic character of the seismic units indicate strong bottom-current processes, except for the basal deposits attributed to the Early Miocene. The development of extensive drifts in the deposits of Unit 4 (~Middle Miocene) shows the initial influence of the Weddell Sea Bottom Water (WSBW). The opening of the connection of Jane Basin with the Scotia Sea also is marked by a regional unconformity that records a reorganization of bottom flows. The two uppermost Units 1 and 2 (Late Miocene to Recent) indicate intensified bottom currents, which may reflect the increased production of WSBW. The evolution through time of the contourite deposits and the distribution of regional unconformities reflect the ice sheet dynamics that controlled the production of Antarctic Bottom Water (AABW).

Keywords: Contourite drifts; Antarctic paleoceanography; Weddell Gyre; glaciations

1. Introduction

The Weddell Sea is an oceanic basin about 1100 km long located south of the southwest Atlantic Ocean, between the Antarctic Peninsula to the west and the coasts of the East Antarctica to the south (Figs. 1 and 2). The magnetic anomalies of the oceanic crust show a Cenozoic age for the eastern part of the northern Weddell Sea (Tectonic Map of the Scotia Sea, herein BAS, 1985; Livermore and Woollett, 1993; Maldonado et al., 1998; Ghidella et al., 2002). The Scotia Sea, together with the Drake Passage, Powell and Jane Basins were created as a consequence of the spreading between South America and the northern Antarctic Peninsula, which was started during the Oligocene (Thomas et al., 2003). The development of these basins influenced the evolution of the continuous, deepwater circulation of the Antarctic Circumpolar Current (ACC). The ACC is proposed to have profound effects on the changes of the Antarctic climate and the north–

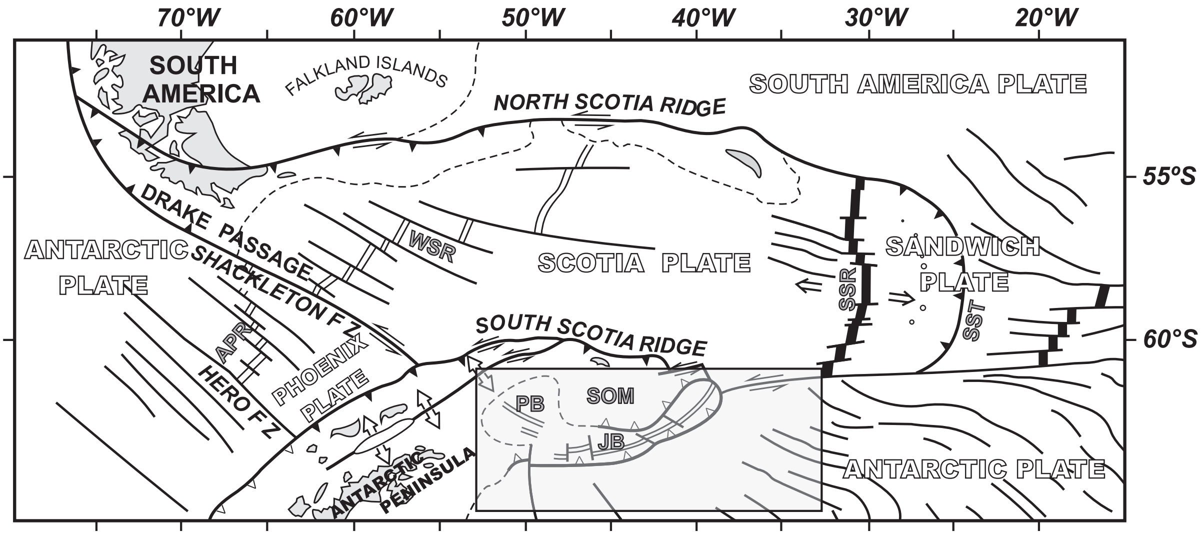

Fig. 1. Geological setting of the northern Weddell Sea. The rectangle indicates the study area. Legend: APR, Antarctic–Phoenix Ridge; F.Z., fracture zone; JB, Jane Basin; PB, Powell Basin; SOM, South Orkney Microcontinent; SSR, Scotia–Sandwich Ridge; SST, South Sandwich Trench; WSR, West Scotia Ridge. Description in the text.