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Recognition of contour-current influence in mixed contourite-turbidite sequences of the western Weddell Sea, Antarctica

Klaus H. Michels*, Johannes Rogenhagen and Gerhard Kuhn
*Alfred-Wegener-Institut für Polar- und Meeresforschung, Postfach 12 01 61, 27515 Bremerhaven, Germany; *Author for correspondence (Tel: +49-471-4831 1206; Fax: +49-471-4831 1149; E-mail: kmichels@awi-bremerhaven.de*

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Abstract

Sedimentary processes and structures across the continental rise in the western Weddell Sea have been investigated using sediment acoustic and multichannel seismic data, integrated with multibeam depth sounding and core investigations. The results show that a network of channels with associated along-channel ridges covers the upper continental slope. The seismic profiles reveal that the channels initially developed as erosive turbidite channels with associated levees on their northern side due to Coriolis force. Later they were partly or fully infilled, probably as a result of decreasing turbidite activity. Now the larger ones exist as erosive turbidite channels of reduced size, whereas the smaller ones are non-erosive channels, their shape being maintained by contour current activity. Drift bodies only developed where slumps caused a distinctive break in slope inclination on the upper continental rise, which served to initiate the growth of a drift body fed by contour currents or by the combined action of turbidites and contourites. The history of sedimentation can be reconstructed tentatively by correlation of seismo-stratigraphic units with the stages of evolution of the drifts on the western side of the Antarctic Peninsula. Three stages can be distinguished in the western Weddell Sea after a pre-drift stage, which is delimited by an erosional unconformity at the top: (1) a growth stage, dominated by turbidites, with occasional occurrence of slumps during its initial phase; (2) during a maintenance stage turbiditiy-current intensity (and presumably sedimentation rate also) decreased, probably as a result of the ice masses retreating from the shelf edge, and sedimentation became increasingly dominated by contour current activity; and (3) a phase of sheeted-sequence formation. A southward decrease in sediment thickness shows that the Larsen Ice Shelf plays an important role in sediment delivery to the western Weddell Sea. This study shows that the western Weddell Sea has some characteristics in common with the southern as well as the northwestern Weddell Sea: contour currents off the Larsen Ice Shelf have been present for a long time, probably since the late Miocene, but during times of high sediment input from the shelves as a result of advancing ice masses a channel-levee system developed and dominated over the contour-current transport of sediment. At times of relatively low sediment input the contour-current transport dominated, leading to the formation of drift deposits on the upper continental rise. Seaward of areas without shelf ice masses the continental rise mainly shows a rough topography with small channels and underdeveloped levees. The results demonstrate that sediment supply is an important, maybe the controlling factor of drift development on the Antarctic continental rise.

Introduction

The formation of sediment bodies at oceanic margins is most often controlled by both gravitational processes and processes related to alongslope currents. The result of this combined action are interbedded and mixed sediment sequences showing a variety of structures, which cannot always be assigned unequivocally to turbidity or contourite current origin.

A basic shortcoming is the lack of clear sedimentological characteristics for contourites. Whereas turbidites are generally related to channel-bound deposition, the possible range of settings and appearances of contourites is much broader. Furthermore, compared to turbidites, contourites are less studied and described.

A number of publications dealing with a basic description of contourite characteristics and numerous examples from different areas and settings document an increasing interest in this topic during recent years (e.g. Faugères and Stow, 1993; McGinnis and Hayes, 1995; Rebesco et al., 1997; Massé et al., 1998; Stoker, 1998; Faugères et al., 1998, 1999). This paper presents a case study dealing with multichannel seismic and Parasound data obtained from the western Weddell Sea. The seismic data from this area are unique because of the difficult access due to the permanent sea ice cover. Our special interest in this area is based