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Benthic foraminiferal distributions in Chilean fjords: 47°S to 54°S

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Abstract

Surface sediment samples collected from the fjord region of southern Chile (47° to 54° South) were analyzed for benthic foraminifera. A total of 175 species were identified including agglutinated and calcareous benthic taxa. Hierarchical cluster analysis of the foraminiferal data resulted in the recognition of three distinct biofacies: inner-fjord, intermediate fjord and channel, and oceanic biofacies, geographically controlled by relative position between the Pacific Ocean and fjord heads. Similarity percentage (SIMPER) analysis identified key taxa in the definition of the biofacies that include *Globocassidulina rossensis*, *Cassidulina laevigata* and *Bulimina notovata*. Principal components analysis resulted in two principal components representing sediment size, and bottom water temperature and salinity.

Regional distributions are strongly controlled by the oceanographic conditions influenced from the Pacific in the west and the glacial/freshwater input from the east. Localized distributions of foraminifera are controlled by conditions influenced by the physiography of the individual fjords and channels. The distribution of Chilean fjord foraminifera and their environmental associations are consistent with results from other temperate to high latitude fjord foraminiferal studies.

Keywords: Chile; benthic foraminifera; recent; Cimar; fjords; channels

1. Introduction

The Patagonian fjord region of Chile, from Penas Gulf to Tierra del Fuego (Fig. 1), represents a climatic transition from the sub-Antarctic in the south to the temperate region in the north. Paleoclimatic records from this region indicate the presence of significant glaciers throughout the Quaternary (Rabassa and Clapperton, 1990; Rabassa et al., 1990; Gordillo et al., 1993) with their former presence revealed in the labyrinth of fjords and channels and their vestiges the Patagonian ice fields. Terrestrial data indicates paleoclimatic fluctuations throughout the Holocene (Mercer, 1970; Heusser and Rabassa, 1987; Rabassa and Clapperton, 1990; Rabassa et al., 1990; Gordillo et al., 1993) but little paleoclimatic or paleoceanographic information from marine records exist (Gordillo et al., 1993; Shuckstes, 1995; Kilian et al., 2003) to provide a link to the deep-sea paleoclimate record.

Foraminifera are the most widely used marine proxy for paleoceanography and paleoclimatology. Assemblage data and geochemical analyses of calcareous foraminiferal tests provide useful information of environmental conditions (temperature, salinity, dissolved oxygen, nutrients, etc.) of both surface and

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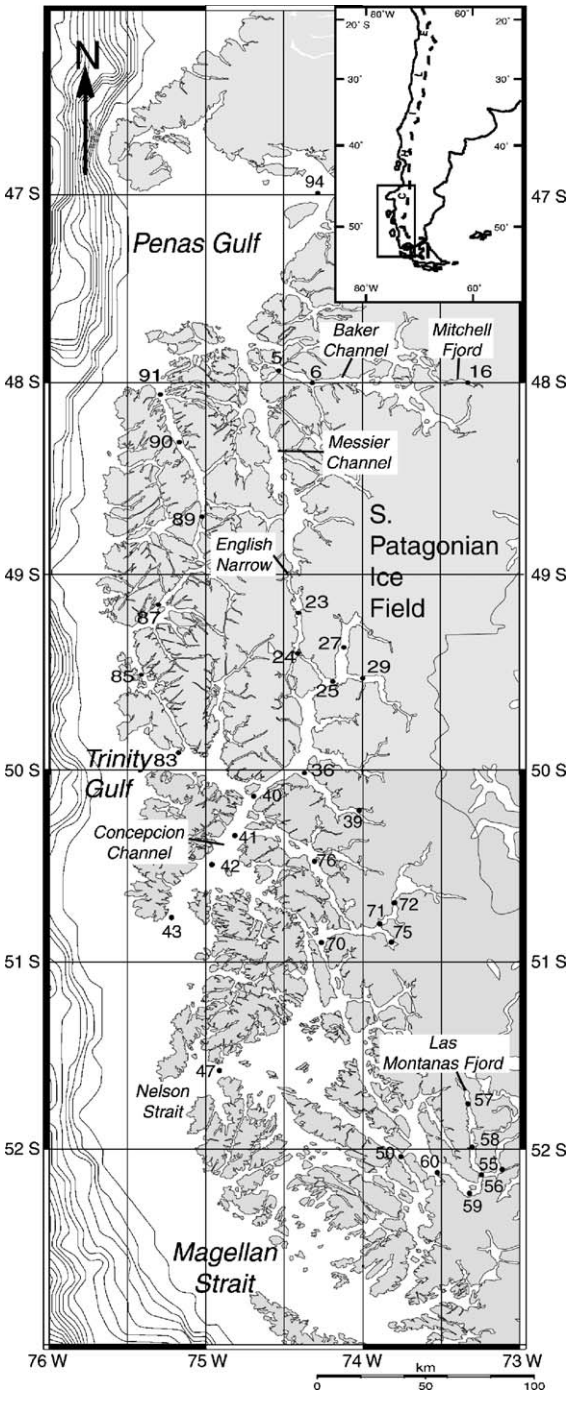

Fig. 1. Map showing the study area in southern Chile. Sample sites are marked with solid circles and labeled with the sample number.

bottom water masses. The understanding of physical and chemical controls on the distribution of foraminifera is essential for their use as paleoceanographic and paleoclimatic proxies. Foraminiferal distribution studies for southern South America have focused primarily on shelf and deeper water environments of the South Atlantic, sub-Antarctic and Antarctic sectors (Heron-Allen and Earland, 1932; Earland, 1934a,b; Boltovskoy, 1964, 1976; Lena, 1966; Herb, 1971; Thompson, 1978; Boltovskoy et al., 1980, 1983). Studies of modern foraminiferal distributions from the Pacific sector of South America have been restricted to deep-water sites off of the central and northern regions of Chile (Boltovskoy, 1972) and from the Peru–Chile Trench (Bandy and Rodolfo, 1964; Ingle et al., 1980; Resig, 1981; Boltovskoy and Totah, 1987). Few studies exist for the southernmost region of the Chilean coast (Ishman and Martinez, 1995; Hromic, 1999, 2001; Violanti et al., 2000). This paper presents the results of foraminiferal analyses of surface sediment samples collected from the fjord region of southern Chile, and shows associations between foraminiferal distributions and oceanographic and sedimentological conditions.

2. Setting

The western margin of southern Chile is comprised of an intricate series of fjords and channels connected to the Pacific Ocean and adjacent to the North and South Patagonian Ice Fields. Marine basins within the fjord region receive large volumes of terrigenous sediment through the melting of glaciers and riverine input (Hoskin and Burrell, 1972; Powell and Molnia, 1989). Domack and Ishman (1993) and Griffith and Anderson (1989) have shown that oceanography is a dominant control on sedimentation within fjords of the Antarctic Peninsula, but that climatic controls are important as well. Changes in climate can alter the processes by which sediment is supplied, and may have an effect on the circulation, and physical and chemical properties of the waters within the fjord. These conditions are controlling factors of the distribution of the biota living within the fjords.

2.1. Oceanography

The oceanography of the coastal region of southern Chile (46° to 53°S) is generally estuarine, being influenced by the complex shoreline and bathymetry of the fjord region. Details of the oceanography are presented in Palma and Silva (2004) and Sievers et al. (2002), and are summarized below. This region is physically separated into two distinct basins, a north and south basin, by the shallow (<50 m depth) sill at the English Narrows in the Messier Channel. The water masses within the fjords and channels in each of these