Principal Component and Cluster Analysis for determining diversification of bottom morphology based on bathymetric profiles from Brepollen (Hornsund, Spitsbergen)*

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Abstract

Navigation charts of the post-glacial regions of Arctic fjords tend not to cover regions from which glaciers have retreated. Whilst research vessels can make detailed bathymetric models using multibeam echosounders, they are often too large to enter such areas. To map these regions therefore requires smaller boats carrying single beam echosounders. To obtain morphology models of equivalent quality to those generated using multibeam echosounders, new ways of processing data from single beam echosounders have to be found. The results and comprehensive analysis of such measurements conducted in Brepollen (Hornsund, Spitsbergen) are presented in this article. The morphological differentiation of the seafloor was determined by calculating statistical, spectral and wavelet transformation, fractal and median filtration parameters of segments of bathymetric profiles. This set of parameters constituted the input for Principal Component Analysis and then in the form of Principal Components for the Cluster Analysis. As a result of this procedure, three morphological classes are proposed for Brepollen: (i) steep slopes (southern Brepollen), (ii) flat bottoms (central Brepollen) and gentle slopes (the Storebreen glacier valley and the southern part of the Hornbreen glacier valley), (iii) the morphologically most diverse region (the central Storebreen valley, the northern part of the Hornbreen glacier valley and the north-eastern part of central Brepollen).

1. Introduction

The widespread use of multi-beam echosounders in scientific research permits the collection of complex information in a short time. Much work has been done in recent years in the Spitsbergen region using this technology, which has delivered very detailed maps as well as information on the area's morphological characteristics (e.g. Ottesen & Dowdeswell 2006, 2009, Ottesen et al. 2007, 2008, Forwick et al. 2009, Dowdeswell et al. 2010). But such work requires the use of large vessels; this increases the costs of exploration and it also has its limitations. For reasons of safety, data recording is usually performed in areas already covered by marine publications and charts (e.g. The Norwegian Hydrographic Service and Norwegian Polar Research 1990, United Kingdom Hydrographic Office 2007, Statens Kartverk 2008). It is often the case, however, that existing maps do not show areas from which glaciers have retreated and are insufficiently detailed (Pastusiak 2010). Small boats with a shallow draught then have to be employed, as they provide a safer working environment when sailing in unexplored areas. In such difficult measuring conditions it is usually only single-beam echosounders that can be used. Direct interpolation of the profiles obtained enables geographical regionalisation in that individual bays, once influenced by glaciers, can be identified (Moskalik et al. 2013a) and their shapes characterised (Moskalik et al. 2013b). But again, these properties describe pre-glacial valleys in their entirety but not in fine detail.