IGC 2024

The 37th International Geological Congress 2024

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International Union of Geological Sciences

IGC 2024

The 37th International Geological Congress

Abstract Book

Busan, Korea

25-31 August 2024

www.igc2024korea.org

Current-controlled sedimentation in the Charlie Gibbs Fracture Zone (North Atlantic)

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Abstract

The Charlie-Gibbs Fracture Zone (CGFZ) is the main transform system in the North Atlantic. It serves as a primary deep-water gateway for the current of the Iceland-Scotland Overflow Water (ISOW), which is part of the lower limb of the Atlantic Meridional Ocean Circulation that strongly modulates regional and global climate. The aim of this study is to determine the sedimentary processes in the area of a tectonically active deep-water gateway and to reconstruct the bottom current variability as reflected in the bottom sediments.

New geological and geophysical data were collected during the cruises of R/V Akademik Nikolaj Strakhov in 2020 and R/V Akademik Sergey Vavilov in 2021. The surveys included bathymetric studies using a deep-water multibeam sonar system, high-resolution subbottom profiling (2-6 kHz), and retrieval of two sediment cores using a gravity corer. Stratigraphic subdivision of the sediment cores is based on the micropaleontological analysis, ice-rafted debris (IRD) counts, calcium carbonate content and three radiometric 14C dates. Grain-size, bulk mineralogical, geochemical, and magnetic susceptibility analyses were used to distinguish lithological facies.

On the basis of the sub-bottom profiling, the current controlled sedimentation was inferred. Three types of local contourite drifts were identified in the valleys of the inactive fractures and the active transform: (1) channel-related drifts, (2) confined drifts, and (3) fault-controlled drifts. The ISOW current is the main agent controlling the drift formation in the northern valley. The influence of the Denmark Strait Overflow Water of northern origin and/or Low Deep Water of southern origin was also suggested for the southern valley. Tectonic deformations of the sedimentary strata have been detected within the valleys of the active and inactive transforms.

Studies of sediment cores have revealed of six sedimentary facies. During the Holocene, contourite sedimentation dominated with admixture of pelagic settling. The gradual increase of the ISOW current flow from the Late Pleistocene to the Middle Holocene was identified by the consistent disappearance of amphibole from the sediments. During the glacial intervals of the Late Pleistocene, the hemipelagic sedimentation with high input of ice-rafted debris prevailed in the fracture valleys. The acoustic stratification of the sediments is caused by the alternation of glacial

and interglacial intervals, at least in the upper part of the profiles. North Atlantic Ash Zone 1 layer, diatom ooze and turbidites were identified in the sediment cores, indicating short-term events.

Although the valleys of the CGFZ are well known as conduits for the ISOW flow, this is the first time that the contourite drifts have been revealed here. Therefore, our study highlights the importance of oceanic fracture zones in their role as deep-water gateways. They intensify the bottom currents that leave remarkable sedimentological imprints. Decoding these imprints helps to reconstruct the behaviour of the bottom current in the past and provides essential information for palaeoclimate reconstructions.

Study was carried out with the financial support of RSF, grant No. 22-17-00170, https://rscf.ru/project/22-17-00170/.

Keyword

deep-water gateway, contourites, Iceland-Scotland Overflow Water, subbottom profiling, sediment cores