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Results from Bathymetric Scanning in the Area of South Bay, Livingston Island, during the 33rd Bulgarian Antarctic Expedition

Kiril Velkovsky[1, 2]
[1] N Center for Underwater Archaeology – Sozopol, Bulgaria
[2] KV Solutions Ltd., Sofia, Bulgaria, kvelkovsky@gmail.com

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Summary
During the 33rd Bulgarian Antarctic Expedition, the first detailed bathymetric and hydrographic survey of Emona Bay near the Bulgarian Antarctic Base on Livingston Island was conducted. A MB1 ODOM-Teledyne multibeam echosounder, StarFish 450H side-scan sonar, and DGPS system were mounted on a Zodiac boat. Between 4 Jan–7 Feb 2025, 12 missions covered over 14 km², including parts of Johnson Dock Bay. Data processing produced a 3D seabed model and a side-scan sonar mosaic outlining substrate zones. Results show significant glacial retreat—up to 1450 m compared to 1991 and 450 m since 2009. Morphology reveals unexpected deepening in the eastern sector (to 192 m). This study delivers the first complete bathymetric model of the bay, serving as a baseline for geological, ecological, and navigational applications.

Introduction

This paper reports the implementation of marine geophysical and hydrographic surveys in the area of Emona Bay, adjacent to the Bulgarian Antarctic Base on Livingston Island, and the results achieved. The surveys were carried out within the framework of the 33rd Bulgarian Antarctic Expedition and represent the first large-scale and detailed scanning of the bay's entire aquatic area.
The expedition was realized as a joint initiative of the Center for Underwater Archaeology – Sozopol (CUA), the Bulgarian Antarctic Institute (BAI), and the Polar Research Center of Sofia University.
The main objective was to conduct seabed mapping using a multibeam echosounder and side-scan sonar. Based on the acquired data, a terrain model of the seabed was constructed, and, as far as possible under the specific conditions, information on the bottom substrate units was obtained.



Figure 1. Survey setup with the instruments and the team that carried out the investigations.

Preliminary preparation took place in Bulgaria during October–November 2024. At the Antarctic base, the equipment was assembled and mounted on an open Zodiac-type motorboat (Fig. 1). The main field measurements were carried out between January 4 and February 7, 2025. Over the course of 12 field missions,

an area exceeding 14 km² was surveyed, primarily in Emona Bay, with additional coverage of parts of Johnson Dock Bay.
Field activities involved Eng. M.Sc. Geophysicist Kiril Velkovski (CUA), Captain Elka Vassileva, and Eng. Rosen Stefanov.

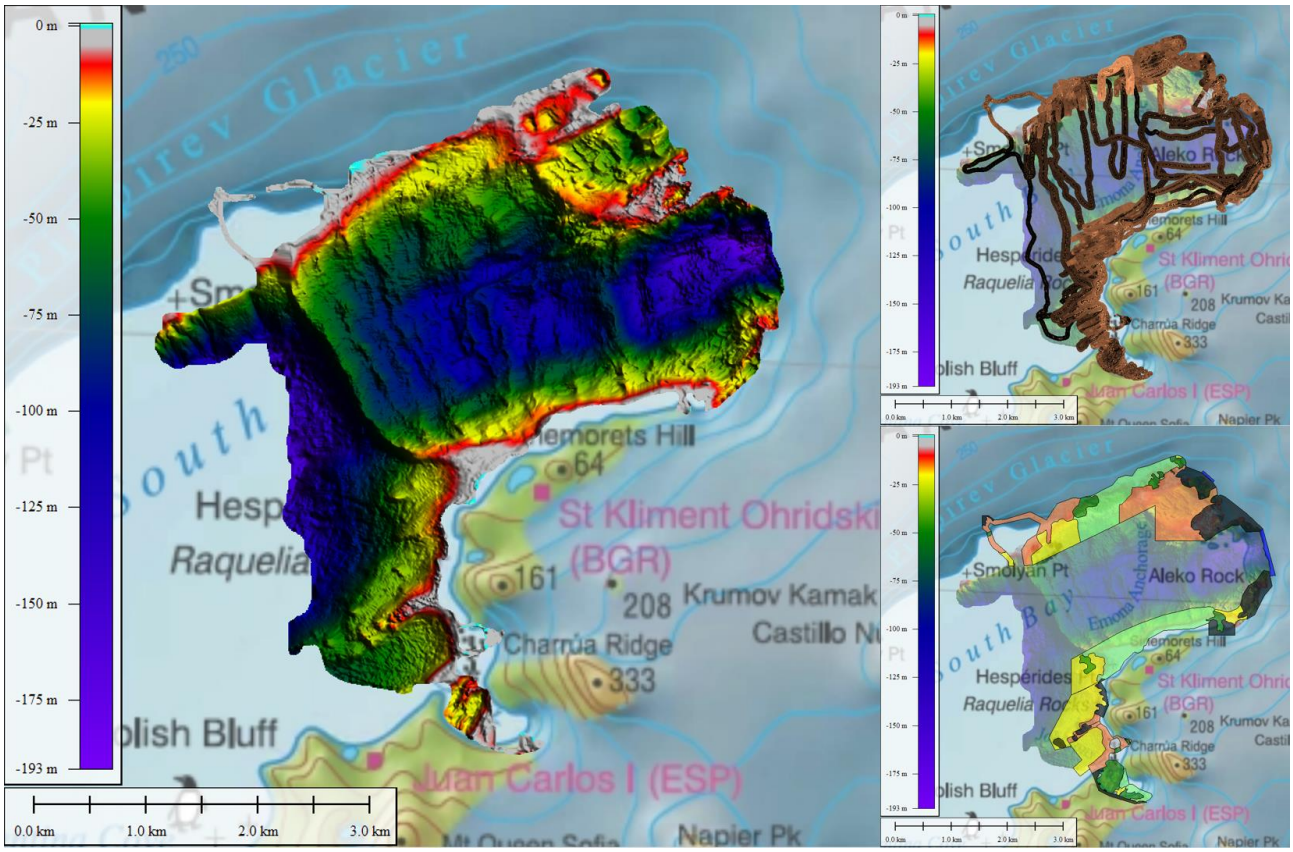


Figure 2. Survey coverage and obtained results.

Equipment and Methodology
Bathymetric data were processed using standard multibeam data protocols, applying differential corrections for sound velocity and system calibration. A terrain model of the seabed was generated with 5×5 m resolution, refined to 2×2 m in depths shallower than 20 m (Fig. 2).
Side-scan sonar records were processed into a composite raster mosaic. Distinct acoustic reflectivity zones were outlined, provisionally interpreted as different seabed substrate units after analysis (Fig. 2).
Both datasets, together with supplementary raster and field information, were integrated into a 4D environment, enabling the construction of a comprehensive model of the area.

Conclusions and Discussion
The obtained results meet the accuracy requirements and objectives of the survey.
Glacial observations:

- Comparison with a georeferenced Spanish chart (1991) [2] shows that the bay was considerably smaller eastward, occupied by a glacial mass now absent. The difference between the 1991 contour of the Pimpirev Glacier and current measurements reaches up to 1450 m eastward. Missing ice is also evident northwards, near Smolyan Point and along the northern shore.
- Comparison with the 2010 topographic map [1] indicates glacial retreat of up to 450 m since 2009, mostly along the northern and eastern shores.

Seabed morphology:

- • Contrary to expectations, the eastern part of Emona Bay (in front of Pimpirev Glacier and the Aklakov Rocks) deepens instead of shallowing, reaching a depth of 192 meters. (Fig. 2).

- At the bay's western entrance (traverse Punta Hesperides – NW shore), depths range 60–70 m, influenced by a ridge spanning the bay.
- A relatively shallow platform structure was observed north of Aleko's Rocks.

Substrate zones:

- The delineated substrate units should be considered provisional, requiring calibration through seabed sampling and other control methods. At present, they serve as a valuable baseline for future studies.

Main conclusion

Since 1991, the surveyed area of Emona Bay has undergone significant glacial retreat along the coastline. Seabed morphology suggests that the bay deepens towards the glacier and may potentially cut across the island beneath the ice.

Significance

This is the first project to deliver a detailed bathymetric model of the entire Emona Bay and the first side-scan sonar survey producing a composite mosaic with substrate classification. The results are relevant to geology, geomorphology, ecology, and biology, and have direct practical applications for navigation in the area, particularly the operations of the Bulgarian research vessel RSV 421 Sts. Cyril and Methodius.

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Резултати от батиметрично сканиране в района на Саут Бей, остров Ливингстън, по време на 33-тата Българска антарктическа експедиция

Кирил Велковски[1, 2]

[1] Център за подводна археология – Созопол, България

[2] КВ Солюшънс ЕООД, София, България, kvelkovsky@gmail.com

Ключови думи: Антарктика, морска геофизика, хидрография, батиметрия, картографиране на морското дъно, картографиране на пластовете

Резюме

По време на 33-тата българска антарктическа експедиция е извършено първото детайлно батиметрично и хидрографско проучване на залива Емона до Българската антарктическа база на о. Ливингстън. Използвани са многолъчев ехолот MB1 ODOM-Teledyne, страничен сонар StarFish 450H и DGPS система, монтирани на моторна лодка тип Зодиак. В периода 4.01–7.02.2025 г. са проведени 12 мисии, обхващащи над 14 km², включително части от залива Джонсън Док. Обработените данни позволяват изграждане на 3D модел на релефа и мозайка от страничния сонар с очертани зони на различен субстрат. Резултатите показват значителен ледников отстъп – до 1450 m спрямо карта от 1991 г. и до 450 m спрямо данни от 2009 г. Морфологията разкрива неочаквано задълбочаване в източната част (до 192 m). Изследването създава първия пълен батиметричен модел на залива и база за бъдещи геоложки, екологични и навигационни приложения.