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The Natural Environment of the Mid-Atlantic Ridge

A Case Study of the Potential Mining Site

Springer

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Executive Summary

In 2018, the Government of Poland and the International Seabed Authority (ISA) signed a contract for exploration of polymetallic sulphides in a central section of the Mid-Atlantic Ridge (MAR) (Fig. 1 in Chap. "Introduction"), one of the major geological formations on Earth (Fig. 2 in Chap. "Introduction"), featuring—like other mid-oceanic ridges—active and inactive hydrothermal vent fields with their unusual and unique ecosystems. The commercial interest in MAR exploration is due to the deposits of massive polymetallic sulphides there, formed as a result of hydrothermal fluid precipitation.

Activities associated with exploration of any area should be underpinned by knowledge on what is known about the area and its inhabitants, what gaps in knowledge still exist, what the 'rules of the game' (in the form of legal framework and regulations) are, and what methods should and need to be used to fill the gaps. Therefore, before exploration begins, the existing information on the area, including both its abiotic and biotic components, should be collected, processed, and summarized. The present book is an attempt at such a summary. The Google Scholar lists over 0.5 million scientific papers, notes, and books that mention the MAR, the relevant peer-reviewed papers counting over 60 thousand documents. For the present review, we have selected mostly recent publications dealing with the central part of the MAR, with a particular focus on the area covered by the Polish contract.

With regard to the climate conditions, the contract area is situated in the subtropics, between the easterly and westerly mid-latitude atmospheric circulation (Fig. 1 in Chap. "Hydrological and Meteorological Conditions in the Contract Area"). It is also the area on the edge of the tropical storms and hurricane tracks (Fig. 5 in Chap. "Hydrological and Meteorological Conditions in the Contract Area").

The depth of the ocean in the contract area varies between 720 m and 4900 m; the area—situated within the North Atlantic Gyre—is affected by the Gulf Stream and Canary currents. The complex seabed topography results in a number of local deep currents of smaller magnitude.

The deepwater layers are formed by the North Atlantic Deep Water with temperatures between 1.5°C and 4°C and with the full marine salinity of 34–35.

The water transparency in the area is high, with visibility reaching down to the 50 m depth, as in other mid-ocean gyres, hence the chlorophyll concentration and primary production are low.

The geological age of the seabed in the contract area is younger than 3.3 million years. The contract area features two known vent fields: the Broken Spur and the Lost City (Fig. 8 in Chap. "Seafloor Morphology, Geology, Sediments and Sedimentation Processes"). The sedimentary cover is from few to 20 m thick and is composed mainly of carbonate ooze.

The pelagic environment over the contract area supports typical oceanic microplankton assemblages, with coccolithophores and prominent contributions of diatoms and radiolarians, while the mesozooplankton is dominated by minute copepods, and is often concentrated in the sub-surface layers of 300-100 m depth. Dense concentrations of macroplankton and small fish are recorded in the mesopelagic zone. The pelagic fishery is moderately developed and targets large species such as tuna and swordfish; the commercial bottom fishing is not feasible in the area.

The pelagic vertebrate fauna of the area counts at least 60 seabird species, 28 species of whales, and four sea turtles; all those species are of conservation value, eight species being listed in the IUCN Red Book as vulnerable to critically endangered.

The organisms inhabiting the seabed in the contract area are, to large extent, adapted to the particular conditions of the hydrothermal vent environment. These organisms include chemoautotrophic and methane-consuming microbes (bacteria and archaea), the meiobenthos—an important component of the local fauna because of its diversity and potential utility as an indicator of local conditions, the macrobenthos and the megabenthos. The benthic macrofauna forms dense aggregations; particularly important are deep-sea shrimps and other macrofaunal crustaceans, locally with a record-breaking biomass exceeding 1 kg/m^2.

The endemism (uniqueness) of the deep-sea vent fauna is associated with the whole system of the MAR rather than with individual sites. This is related to a high degree of temporal stability of the benthic communities, on the scale of decades.

The conservation status of deep-sea fauna is regulated by the UN Convention on the Law of the Sea (UNCLOS), which recognizes the deep sea as the common heritage of mankind and expects any activity to observe the precautionary approach, as described in the Convention on Biological Diversity (CBD). Specific recommendations for contract-holders are issued by the ISA, and—on the next level—by the national/governmental regulations. All activities in the area shall be subject to an Environmental Impact Assessment and long-term monitoring of the biota. Methods for studying the extremely difficult deep-sea environment of the MAR involve the use of technologically advanced equipment, a strong emphasis being placed on non-invasive techniques, mainly optical and acoustic remote sensing as well as the use of robots.

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Introduction

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The Polish interest in the study area is reflected by the contract for polymetallic sulphide exploration between the International Seabed Authority (ISA) and the Ministry of Environment of the Republic of Poland, signed in 2018. The Polish exploration contract area is located in the central part of the Atlantic Ocean (Fig. 1) between 26°09′N–32°50′N and 39°38′W–44°43′W near the central part of the Mid-Atlantic Ridge (MAR), one of the major geological formations on Earth (Fig. 2), featuring—like other mid-oceanic ridges—active and inactive hydrothermal vent fields with their unusual and unique ecosystems. The water depth varies from about 740 m above the MAR to more than 4900 m in fracture zones and basins. The Polish exploration blocks are located to the south-west of the Portuguese submission to the Commission on the Limits of the Continental Shelf and to the north-east of the French exploration contract area. The contract area covers 10,000 km^2 and consists of 100 exploration blocks, 10 × 10 km each. The blocks are grouped in 5 clusters (Fig. 1).

In recent decades, the MAR has received extreme attention both for its scientific value and potential commercial interest. The commercial interest in MAR exploration is due to the deposits of polymetallic massive sulphides (PMS), formed as a result of hydrothermal fluid precipitation. Those deposits are considered a strategic

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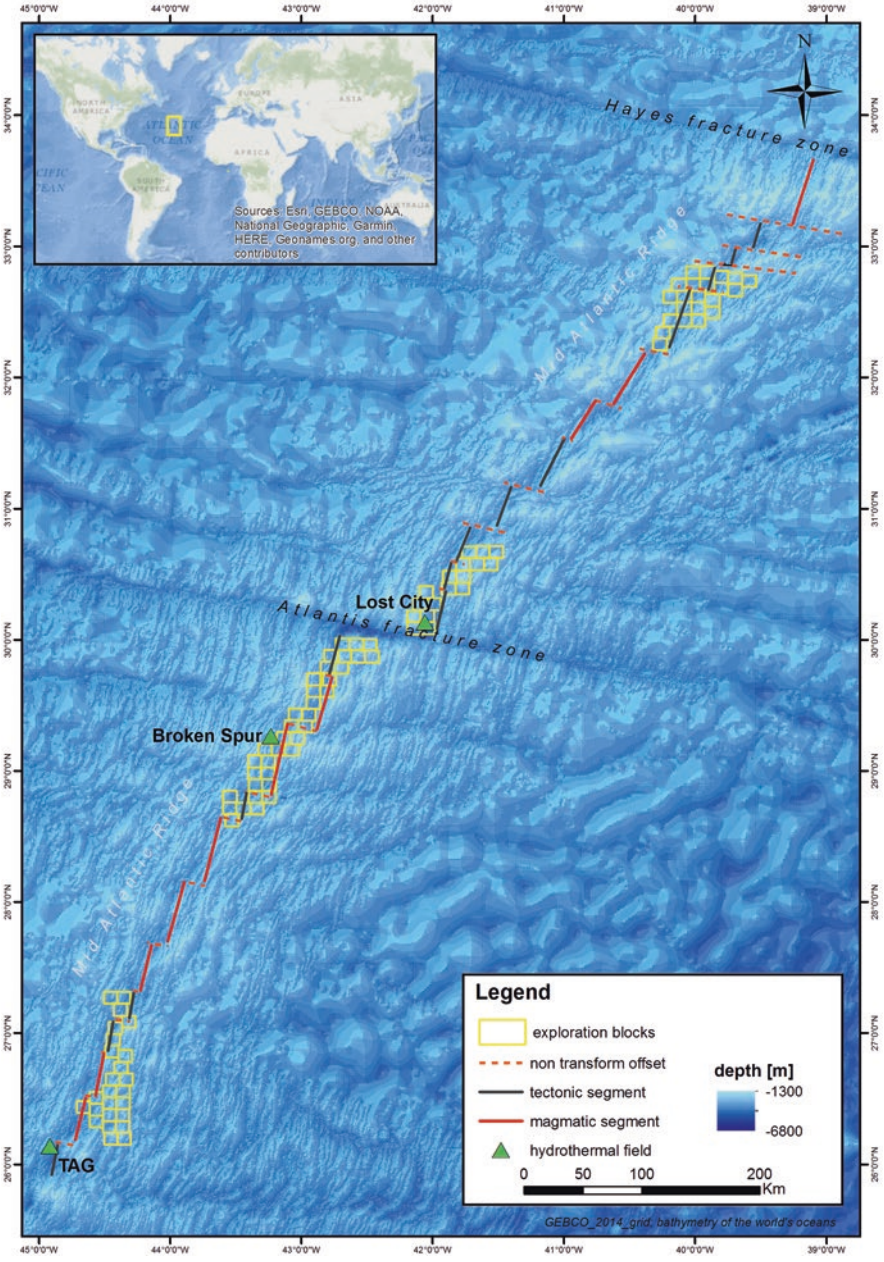

Fig. 1 The Polish contract area on the Mid-Atlantic Ridge (MAR) divided into 5 clusters (Kozłowska-Roman et al. 2019)