GEOLOGICAL STRUCTURE AND BATHYMETRIC CHARACTERISTICS OF THE ADRIATIC COASTLINE: SEMAN REGION, ALBANIA

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ABSTRACT

This study provides a concise lithostratigraphic description of the rocks constituting the geological structure of the Seman region, as well as an overview of its geological and tectonic characteristics. Additionally, it presents a bathymetric map of the coastal area in front of the power plant site in Seman, Fier, Albania. The study incorporates graphic materials analyzed and interpreted by the author. Based on stratigraphic and tectonic data, the study area is part of the depositional coastal section extending from Vlorë to Shkodër. This section is characterized by interactions between the hydrological network and sea wave activity. The coastline features bays, beaches, and marshes in areas of lower elevation. The geomorphology of the region is relatively stable and flat, while the bathymetry of the coastal zone reveals a gentle underwater slope. A predominant feature of this sector is the continuous deposition of sediments from rivers and streams, flowing east to west, coupled with the effects of tides and sea waves. Consequently, the coastline's shape is influenced by changes advancing eastward. In areas with continuous river flow, the coastal morphology is shaped by the interplay of sea wave intensity, river sediment lithology, and tectonic and neo-tectonic processes. Using bathymetric data from the Adriatic Sea, a detailed bathymetric map has been created, highlighting the area's underwater features.

***Keywords*:** gould computer, Megaseis software system, Electronic Computing Center (Fier, Albania), Adriatic Sea, shelf zone, sediment deposition, coastal geomorphology

1. INTRODUCTION

The Seman region, located along the Albanian coastline of the Adriatic Sea, exhibits a fascinating geological and bathymetric profile. This area is crucial for understanding the interplay between lithostratigraphy, tectonics, and hydrological processes that shape its coastal and underwater landscape. Based on isobathic data, the region can be divided into three distinct zones: the shelf, the slope, and the abyssal plain.

The shelf zone, characterized by depths ranging from 0 to 200 meters, displays a relatively calm and gentle seabed gradient. This area extends westward with notable shallowness and straightness, defining a stable depositional environment. Beyond the 200-meter mark, the slope zone emerges, where the seabed exhibits a steeper submersion angle.

Although narrower than the shelf, this zone is a prominent feature, indicating a transitional area between the shallow shelf and the deeper abyssal plain. The abyssal zone, beginning at depths exceeding 700 meters, represents the deepest part of the study area. Located along the western border of Albanian waters and extending westward, this region provides valuable insights into the broader geological and oceanographic dynamics of the Adriatic Sea.

An analysis of the bathymetric map reveals a significant widening of the shelf zone westward of the coastline. This feature is closely linked to the dense network of rivers flowing into the sea from the east. These rivers, carrying substantial sediment loads, have played a pivotal role in shaping the coastal morphology and the underwater landscape. Their persistent activity continues to influence sediment deposition patterns, underscoring the dynamic interactions between terrestrial and marine processes in the region.

This study aims to provide a comprehensive overview of the geological structure and bathymetric characteristics of the Seman region, contributing to a better understanding of its natural dynamics and the factors driving its evolution.

2. MATERIALS AND METHODS

The study area is situated within the Peri-Adriatic Depression, a significant geological structure along the Albanian coastline. This region's stratigraphy is composed of sediments ranging from the Serravallian age to the Quaternary, illustrating a comprehensive depositional history. The

Serravallian sediments (N_1^{2s}) exhibit a considerable thickness variation, ranging from just a few meters to approximately 3000 meters.

Lithologically, these deposits primarily consist of argillaceous materials, mudstones, and wackestones, interbedded with sandstone strata containing small to variably sized particles. Occasional packstone layers are also encountered within this sequence, adding to the lithological diversity. This non-uniform stratigraphic pattern highlights the interplay of tectonic activity, sediment supply, and depositional processes in shaping the geological framework of the Seman region, (Fig. 1÷4 and 6).

Lithologically, the Serravallian sediments are composed of argils interbedded with sandstone and wackestone strata, containing particles ranging from fine to coarse, as well as grainstone and packstone layers. The Messinian sediments (N_1^{3m}) are extensively distributed in the region, with thicknesses varying from several meters along the edges of the Peri-Adriatic Depression to approximately 2000 meters at its center. These sediments consist of argils, alevrolites, conglomerates, sandstones, packstones, and other lithological types.

The of Lower Pliocene sediments (N_2^1) are widespread throughout the region, with thicknesses ranging from several meters to 1300 meters in the central Peri-Adriatic Depression, tapering toward the west near the coastal area.

Lithologically, they are represented by argil, sandstone, and grainstone rocks. Similarly, the sediments of the Middle Pliocene (N_2^2) exhibit a comparable distribution, reaching maximum thicknesses of up to 1200 meters in the depression's center, with a gradual decrease westward toward the coast.

These deposits are composed of argil, mudstone, wackestone, sandstone, and grainstone rocks. Upper Pliocene sediments (N_2^3) are predominantly located in the coastal areas of the Peri-Adriatic Depression. Their thickness varies from a few meters to approximately 600 meters.

Lithologically, these sediments are represented by argil, mudstone, wackestone, and sandstone rocks. Pliocene sediments can be categorized into two distinct lithological suites: i) **Helmes Suite** – Dominated by argil, with minor contributions from wackestone and sandstone and, ii) **Rrogozhina Suite** – Characterized by coarser-grained lithological elements, with grainstone being the predominant component.

These suites exhibit distinct facies, reflecting different sedimentation conditions. The Helmes Suite represents deeper facies, while the Rrogozhina Suite transitions to shallower depositional environments. This gradual facies change underscores the dynamic geological processes shaping the region over time.

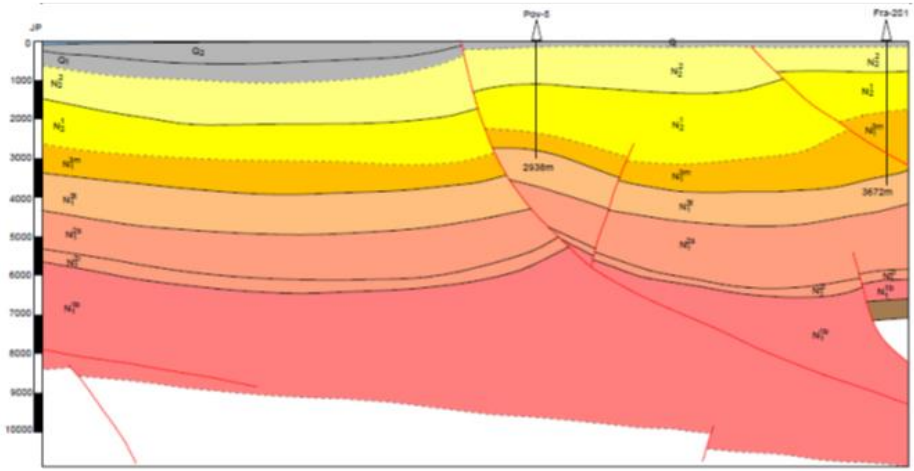

Fig. 1: Geological cross section (onshore+offshore) no. 1-Seman area, Fier Albania Scale 1:50.000.

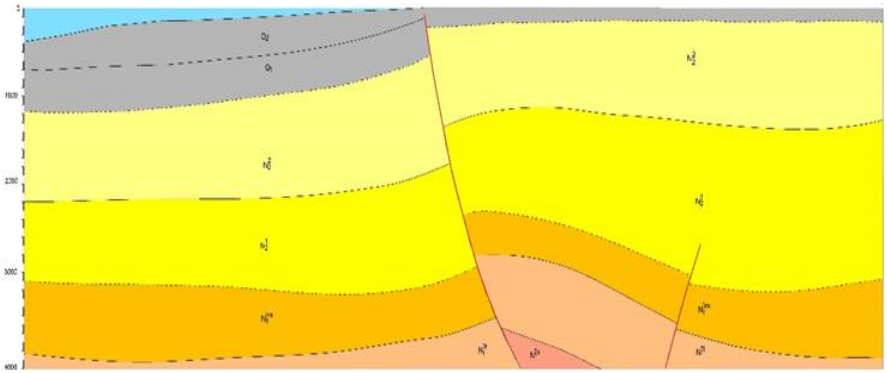

Fig. 2: Geological cross section (onshore+offshore) no. 2-Seman area, Fier Albania Scale 1:50.000.

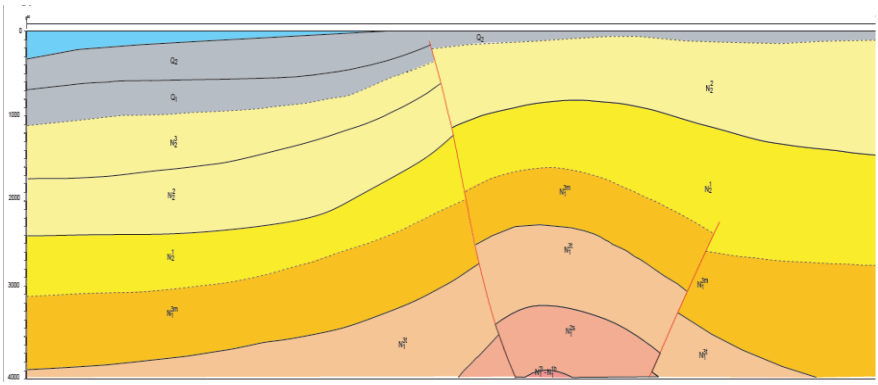

Fig. 3: Geological cross section (onshore+offshore) no. 3-Seman area, Fier Albania Scale 1:50.000.

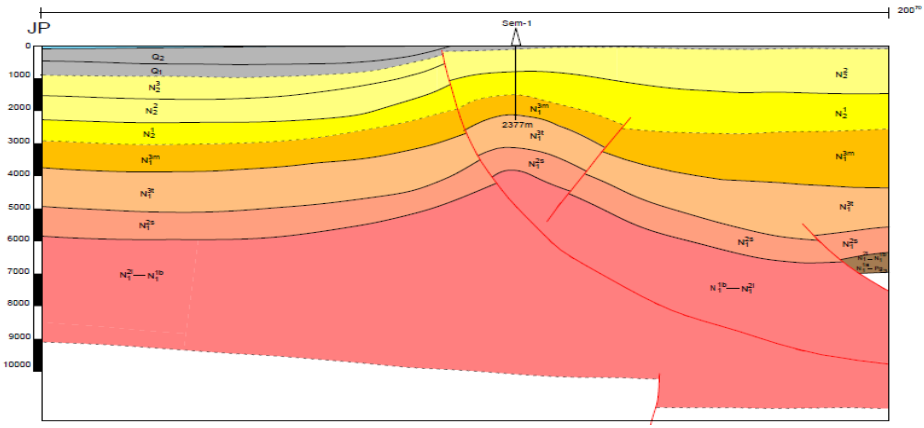

Fig. 4: Geological cross section (onshore+offshore) no. 4-Seman area, Fier Albania 1:50.000

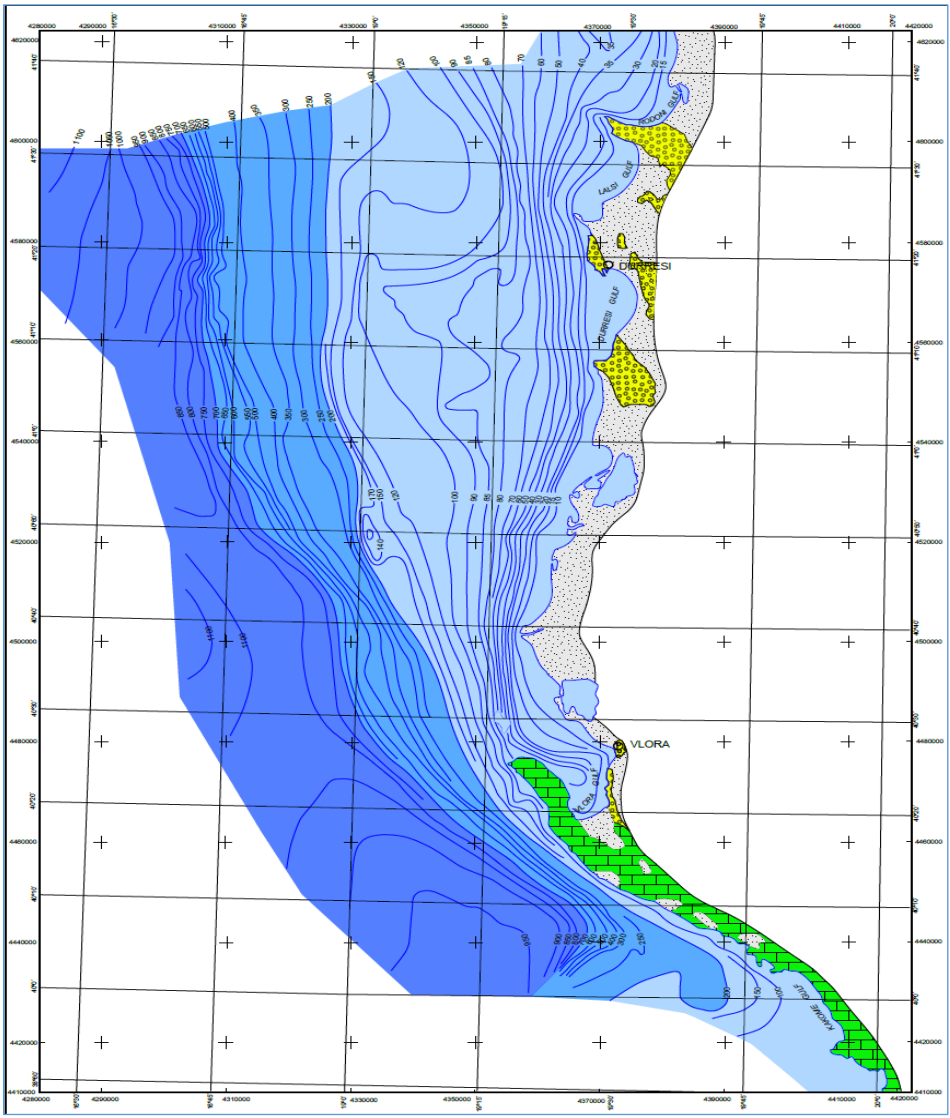

Fig. 5: Bathymetric map of the Adriatic Sea, Albania at the scale 1:500 000

Fig. 6. Bathymetric map of in front of the power plant site, Seman area Albania at the scale 1:500 000.

Quaternary sediments are observed throughout the study area and, from a stratigraphic perspective, are divided into two groups: the Pleistocene (Q_1, Q_2, Q_3) and the Holocene (Q_4). The thickness of these sediments varies significantly, ranging from several meters in the peripheral parts of the region to as much as 1500 meters in the coastal zone (Fig.1÷4 and 6). ithologically, Quaternary sediments comprise a mix of

argil, sands, gravels, mudstones, and wackestones, highlighting the diverse depositional environments that characterized this period (Yzeiraj and Silo 2004).

The Peri-Adriatic Depression area, both at the surface and at depth, is characterized by various structural units, including anticlines, synclines, and monoclines. These individual structures, through their interconnections, form larger tectonic structural units referred to as anticline, syncline, and monocline structural ranges. In the study region (Seman), a comprehensive analysis of geological and geophysical data allows for the identification of the Aliban – Poro – Povelçë – Seman anticline structural range. This range extends from Aliban in the south to Seman in the north, encompassing a sequence of sediments from the Serravallian to the Quaternary period (Hysenaj and Dorre 2020).

The Aliban – Poro – Povelçë – Seman structural range is composed of two distinct structural units: i) Structural Nose Aliban-Poro-Povelçë: This unit extends in a south-north direction, exhibiting a relatively calmer form in the Povelçë area and, ii) Seman anticline: Located to the north of Povelçë, this anticline is separated by a defining neck, creating a distinct structural feature. On the western side of this structural range, a tectonic overlay is identified with an eastern incidence, while in the eastern part, an overlaying tectonic fault with a western incidence is present. In addition to the primary overlaying tectonic accidents, several secondary overlaying faults with inverse incidence are recognized, though these have smaller amplitudes compared to the main ones. The formation of these tectonic accidents is closely related to the folding process and the pressure exerted from the east to northeast on the sediments of the Peri-Adriatic Depression area.

In 1990, the Albanian government permitted foreign companies to conduct seismic surveys for hydrocarbon exploration in the Albanian Sea (Fig. 7). The first companies to sign agreements for hydrocarbon exploration included DEMINEX, OMV, Occidental Co., Chevron, Hamilton Oil, and AGIP. These companies conducted 2D seismic surveys along the entire coastline, extending to the middle of the Adriatic Sea, in designated blocks Gr. (1÷5, 7) (Dorre and Silo 2001; Dhima and Gjermani 2003).

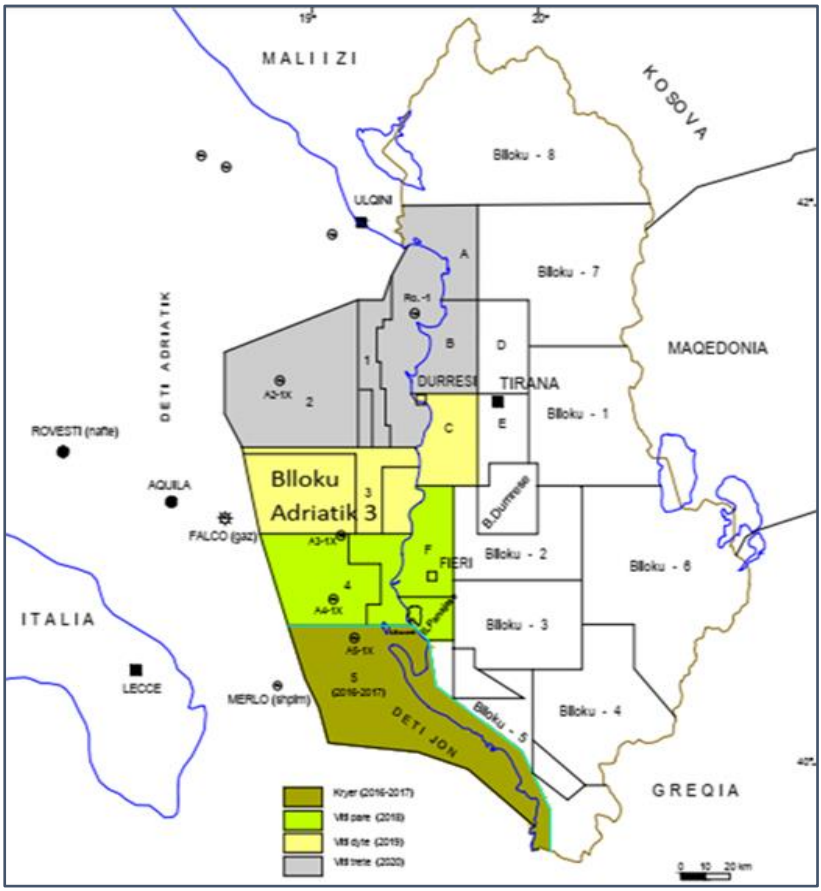

Fig. 7: Seismic works performed by foreign companies through the years.

The digital processing and interpretation of seismic data were conducted at the Electronic Informatics Center in Fier using the "GOULD" computer and the "MEGASEIS" software system (Silo and Bushati 2017). Two of these seismic profiles are presented in Figures (8, 9). Through the geological interpretation of seismic profiles from both land and sea, a comprehensive sea bathymetry map was also created (Fig. 5 and 6) (Silo *et al*., 2012; Hysenaj and Dorre 2020).

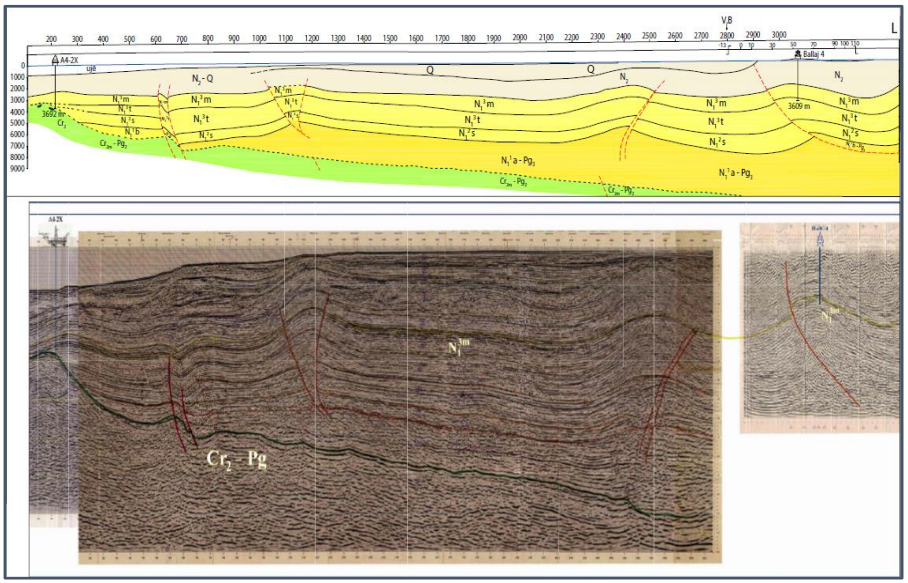

Fig. 8: Seismic line recorded in the Adriatic Sea (see block 3, fig.7).

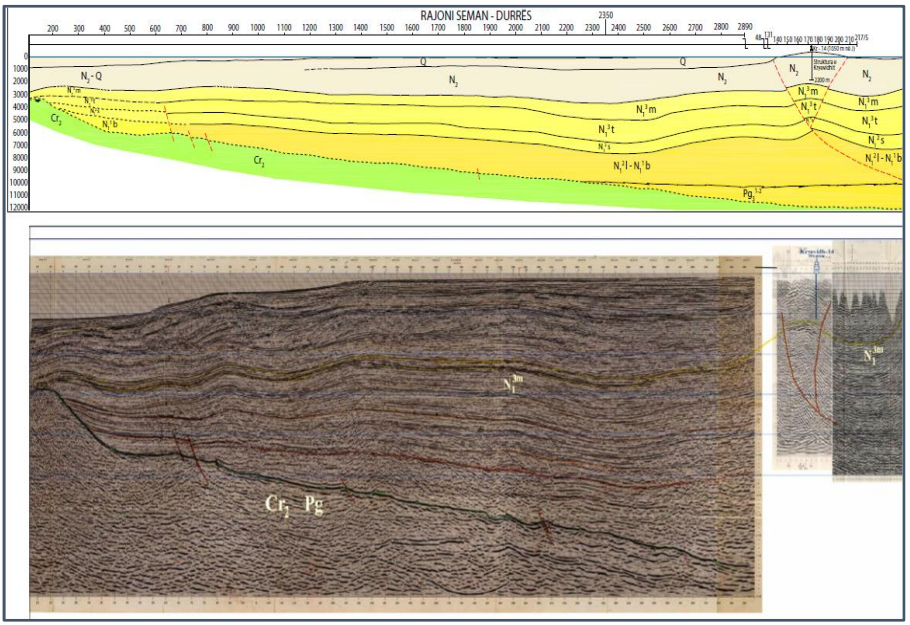

Fig. 9: Seismic line recorded in the Adriatic Sea (see block 3, fig. 7).

3. RESULTS AND DISCUSSIONS

Based on the stratigraphic and tectonic data, the study area is part of the Vlorë-Shkodër depositional coastal section. This section is characterized by the interaction between the powerful hydrological network and the activity of sea waves. The coastline is marked by the formation of bays, beaches, and marshes, particularly in areas where the elevation is lower.

The geomorphology of the study area is relatively stable, and the bathymetry of the coastline is characterized by a gentle slope. The dominant feature in this region is the continuous deposition of sediments carried by rivers and streams, flowing from east to west. The tidal variations, along with the influence of sea waves, further contribute to sedimentation. As a result, the coastline exhibits changes that advance eastward. In regions with continuous river flows, the shape of the coastline is influenced by the interaction between the intensity of sea waves, the lithology of river sediments, and tectonic and neotectonic processes.

Based on seismic data from the Adriatic Sea, a bathymetric map has been created (Fig. 5 and 6), clearly illustrating the diving elements. In the study area, starting from a depth of 0–200 meters, a gentle descent is observed, which is interpreted as the sea shelf. This area is characterized by its shallowness, particularly towards the west.

In the 200–700-meter depth range, there is a noticeable increase in the slope of the seabed, which defines the slope zone. This area is clearly evident but has smaller dimensions compared to the shelf. Beyond 700 meters, the region is interpreted as the abyssal zone, located at the western edge of Albanian waters, extending further westward (Fig.1÷6, 8, 9).

4. CONCLUSIONS

In the study region, surface sediments span a wide range of geological ages, from the Serravalian period (N_1^{2s}) to the Quaternary period, which includes both the Pleistocene (Q_1) and Holocene (Q_4) epochs. These sediments are primarily composed of alternating layers of argils, sands, mudstones, wackestones, and sandstones, with packstones appearing less frequently. The variation in sediment types provides valuable insights into the environmental conditions and depositional processes that have occurred over millions of years in this region.

Geological interpretation of seismic profiles has revealed the presence of complex anticline structures in the area, with several tectonic complications that contribute to the region's structural complexity (Fig. 1÷4, 8, 9). These structures are crucial in understanding the tectonic evolution of the area and how they have influenced sedimentation patterns and bathymetric characteristics over time.

When considering the bathymetric map, it becomes evident that the shelf zone widens to the west of the coastline, where an extensive network of rivers continuously flows into the sea. This significant fluvial activity suggests that sediment deposition in this region has been highly active over long periods, and continues to be intense today, as large quantities of sediment are carried from the east and deposited along the coast. This ongoing process plays a vital role in shaping the morphology of the coastal zone.

The sea bathymetry of the region can be clearly divided into three primary zones: the shelf, slope, and abyssal regions (Fig. 5 and 6). Each of these zones has distinct geological characteristics and plays a key role in the overall sedimentation and tectonic processes of the area. The shelf zone, in particular, reflects the shallow, relatively stable area influenced by riverine and tidal forces, while the slope and abyssal zones show deeper, more complex geological features shaped by both sediment deposition and tectonic activity.

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