THE NATIONAL INSTITUTE FOR RESEARCH AND DEVELOPMENT
ON MARINE GEOLOGY AND GEO-ECOLOGY

INTERNATIONAL SYMPOSIUM

"Ancient and Present River-Delta-Sea Systems modifications under impacts of Human Interventions and Climate Change"

30 years of activity of the National Institute for Research and Development on Marine Geology and Geo-ecology (GeoEcoMar)

ABSTRACT BOOK

Event organized with the support of the Romanian Academy

GeoEcoMar - Bucharest 2023

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Editors: Laura Duţu and Iulian Pojar

GeoEcoMar

Bucharest 2023

Descrierea CIP a Bibliotecii Naţionale a României
International Symposium "Ancient and present river-delta-sea systems modifications under impacts of human interventions and climate change" : 30 years of activity of the National Institute for Research and Development on Marine Geology and Geo-ecology (GeoEcoMar) : Bucureşti, 2023 : abstract book / ed.: Laura Duţu, Iulian Pojar. – Bucureşti : GeoEcoMar, 2023
ISBN 978-606-9658-25-3

I. Duţu, Laura (ed.)
II. Pojar, Iulian (ed.)

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SIMPOZIONUL INTERNAŢIONAL

MODIFICĂRI ALE SISTEMELOR VECHI ŞI ACTUALE RÂU-DELTĂ-MARE SUB IMPACTUL INTERVENŢIILOR UMANE ŞI AL MODIFICĂRILOR CLIMATICE

Aniversarea a 30 de ani de activitate a Institutului Național de Cercetare – Dezvoltare pentru Geologie și Geoecologie Marină (GeoEcoMar)

În anul 1993 Laboratorul de Sedimentologie și Geologie Marină s-a desprins de Institutul de Geologie și Geofizică al României și a devenit Centrul Român de Geologie și Geoecologie Marină, lansându-se în aventura supraviețuirii, a dezvoltării în continuare și a îndeplinirii obiectivelor științifice și socio-economice care i-au fost încredințate.

Care sunt acestea?

Mările și oceanele, care acoperă peste 70% din suprafața planetei noastre albastre, capătă o importanță din ce în ce mai mare atât în menținerea unui echilibru ambiental și climatic favorabil pentru viața pe Pământ, cât și ca o rezervă practic inepuizabilă de resurse naturale minerale și biologice. Aici se descoperă noi resurse energetice convenționale și neconvenționale, noi surse de materii prime indispensabile dezvoltării în continuare a economiei mondiale, se înregistrează progrese importante în domeniul tehnologiilor destinate cercetării, explorării și valorificării acestor resurse, se perfecționează și cadrul legislativ internațional care guvernează aceste activități în Zona Internațională a Fundului Marin, dar și în zonele economice exclusive ale țărilor riverane.

Se crează astfel premizele atragerii în circuitul economic mondial a resurselor marine și aceasta lasă să se întrevadă noi dezvoltări și revoluții ale economiei, noi modificări ale balanței economice și geo-politice internaționale, o nouă lume și noi interese ale țărilor.

Țările, care, având șansa dea fi rive rane unei mări sau oceanului, nu acordă atenție acestui domeniu relativ nou al cercetării științifice și al valorificării sustenabile a resurselor marine își diminuează considerabil șansele de a avea o economie prosperă și în continuă dezvoltare.

Pe de altă parte, menținerea echilibrului ambiental al hidrosferei a devenit o problemă prioritară a omenirii. Schimbările globale rapide din ultimul timp, determinate de cauze naturale și, mai ales, antropogene, trebuie studiate, înțelese și luate măsuri pentru reducerea efectelor lor și de adaptare generală la aceste noi condiții în continuă evoluție.

În situația specială a mărilor închise sau semi-închise, cum este și Marea Neagră, problemele devin și mai presante și imperative. Aici intervin într-o masură și mai mare influențele marilor fluvii asupra condițiilor ambientale și dinamicii maselor de apă marină, dar și asupra vieții în

mod direct. Și lucrurile se complică prin importanța și influențele pe care le capătă situația geopolitică internațională în aceste mări intracontinentale.

Iată multitudinea și complexitatea problemelor care s-au pus în fața Centrului Român de Geologie și Geoecologie Marină.

Centrul a prins rădăcini și s-a dezvoltat destul de repede, astfel încât în trei ani au fost îndeplinite criteriile de calificare ca institut național și astfel, în anul 1996, Centrul s-a transformat în Institutul Național de Cercetare-Dezvoltare pentru Geologie și Geecologie Marină – GeoEcoMar. Iar astăzi, când au trecut deja 30 de ani de activitate și succese, apreciem rezultatele de importanță națională și internațională ale institutului GeoEcoMar.

Conferința internațională care urmează, organizată de INCD GeoEcoMar în colaborare cu Academia Româna, are menirea să facă cunoscută contribuția tinerilor cercetători ai domeniului complex fluvii - mări la descifrarea unei părți a problemelor expuse mai sus. Contribuția întregului institut este mult mai amplă și variată fiind redată în jurnalul științific anual al institutului – GeoEcoMarina, o revistă open-access, publicată în principal on-line în limbi de largă circulație internațională.

În încheiere, urez institutului GeoEcoMar viață lungă cu multe succese în activitatea științifică pe care o desfășoară de 30 de ani, iar tinerilor cercetători care își vor expune rezultatele studiilor pe care le întreprind, mult succes și perseverență în munca lor atât de frumoasă și nobilă.

Academician Nicolae Panin

INTERNATIONAL SYMPOSIUM

ANCIENT AND PRESENT RIVER-DELTA-SEA SYSTEMS MODIFICATIONS UNDER IMPACTS OF HUMAN INTERVENTION AND CLIMATE CHANGE

Celebrating 30 years of activity of the National Institute for Research and Development on Marine Geology and Geo-ecology (GeoEcoMar)

In 1993 the Laboratory of Sedimentology and Marine Geology separated from the Institute of Geology and Geophysics of Romania and became the Romanian Center for Marine Geology and Geo-ecology, embarking on the adventure of survival, further development and the fulfillment of the scientific and socio-economic objectives that were entrusted.

Which are these?

The seas and oceans, which cover over 70% of the surface of our blue planet, are becoming more and more important both in maintaining an environmental and climatic balance favorable for life on Earth, and as a practically inexhaustible reserve of natural mineral and biological resources for mankind.

Here, new conventional and non-conventional energy resources, new sources of raw materials indispensable for the further development of the world economy are discovered, important progress is registered in the field of technologies intended for research, exploration and exploitation of these resources, and the international legislative framework that governs these activities is perfected for the International Seabed Zone, but also for the exclusive economic zones of the riparian countries.

In this way, the premises are created for the attraction of marine resources in the world economic circuit and this allows us to foresee new developments and revolutions of the economy, new changes in the international economic and geo-political balance, a new world, and interests of the countries around the globe.

Countries that, having the chance to be riparian of a sea or of ocean, do not pay attention to this relatively new field of scientific research and the sustainable exploitation of marine resources, considerably diminish their chances of having a prosperous and continuously developing economy.

On the other hand, maintaining the environmental balance of the hydrosphere has become a priority problem for humanity. The recent rapid global changes, determined by natural and, above all, anthropogenic causes, must be studied, understood and measures have to be taken to reduce their effects and to ensure general adaptation to these new conditions in continuous evolution.

In the special situation of closed or semi-closed seas, such as the Black Sea, the problems become even more pressing and imperious. Here, the influences of the great rivers intervene to an even greater extent on the environmental conditions and the dynamics of sea water masses, but also on life directly. And things are complicated by the importance and influences that the international geopolitical situation acquires in these intracontinental seas.

Here is the multitude and complexity of the problems that have been put before the Romanian Center for Marine Geology and Geo-ecology.

The Center took root and developed quite quickly, so that in three years the qualification criteria as a national institute were met and thus, in 1996, the Center turned into the National Research-Development Institute for Marine Geology and Geo-ecology – GeoEcoMar (NIRD GeoEcoMar). And today, when 30 years of activity and success have already passed, we appreciate the results of national and international importance of the GeoEcoMar institute.

The following international conference, organized by NIRD GeoEcoMar in collaboration with the Romanian Academy, is intended to publicize the contribution of young researchers in the field of complex rivers - seas systems to deciphering part of the problems exposed above. The contribution of the entire institute is much wider and varied, being reproduced in the annual scientific journal of the institute – Geo-Eco-Marina, an open-access journal, published mainly online in languages with wide international circulation.

In conclusion, I wish the GeoEcoMar institute a long life with many successes in the scientific activity it is carrying out for already 30 years, and to the young researchers who will present the results of the studies they undertake, much success and perseverance in their so beautiful and noble work.

Academician Nicolae Panin

GAMMA RAY SPECTROMETRY APPLED TO GEOLOGICAL AND ECOLOGICAL STUDIES IN THE RIVER-DELTA-SEA SYSTEM

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Gamma spectrometry is a powerful elemental analysis technique for natural and artificial artefacts which uses high efficiency and resolution detectors for radionuclide identification and activity evaluation. Quality hardware and software tools are available; although we can deal with a large number of samples in little time, some matters remain tributary to fragmentary solutions, especially when it comes to build a database on common ground for several laboratories. Our current need is to generate a consistent analysis protocol, robust but also versatile enough to respond to actual and future needs. Our task is to develop a measurement method for non-standard samples and detection systems, including combined experimental protocols, along with the suitable interpretation, classic and quantum.

This work presents our potential solution for addressing this need, using prior studies and methods, extending the protocol, adding neutron activation and quantum correlated photon analysis. Uncertainty issues along with the simulation effort are considered looking forward to systematizing a procedure which includes isotopic pattern recognition, contamination testing, activity determination and sample dating; this brings robustness and reliability to our protocol, opening the way to trustworthy correlations for databases we are starting to build, the first being related to the Danube River, from the Black Forest to the Black Sea.

As uniformity analysis is proven an important issue, we took another step in this direction, namely concentration analysis of Rn and descendants in typical environmental samples. Common practice analysis of environmental samples is usually performed by assuming Radon and its decay products from the U-Ra natural radioactive series are uniformly spread within the entire sample volume. This uniform distribution is an assumption we intended to test using a volume sample. Our results show that the actual distribution is not uniform and consequently needs to be treated as such for both measurement purposes and related simulations.

Immediate applications include cross-disciplinary activities such as environmental studies, metrology applications and health (radiation hazard). This leads also towards opening the way to new studies in citizen science, for it does not concern only occupational risks.

Our studies also focus on the natural and anthropogenic radioactivity of geological samples from key spots in the lower Danube region. The goal is to confirm gamma spectrometry is an

efficient method for geological sample characterization in terms of isotopic ratios and for evaluating the impact of nuclear activities, namely testing artificial contamination. This type of activity is meant to prove the feasibility of a Danube database for reference materials in terms of sediment via gamma ray spectrometry.

Besides, we intend to evidence the possibility of studying isotopic patterns of various environmental samples by means of gamma-ray spectrometry following neutron irradiation with a small intensity source. Patterns have a natural component due to the natural radioactive series and an artificial one, obtained following neutron irradiation. The goal is to evidence a low cost, rapid and accurate method and show main corrections and optimizations needed to improve actual and future results, that allow material tracking in some cases, including *in situ* gamma spectrometry under water.

Acknowledgements

This work was performed through the Core Program of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), within the National Research, Development, and Innovation Plan 2022-2027, Projects No. 23 30 01 02, 23 30 03 02 and 23 30 03 03, financed by the Ministry of Research, Innovation and Digitization.

EMILIANIA HUXLEYI AND *BRAARUDOSPHAERA BIGELOWII* BLOOMS AND ABUNDANCE VARIATIONS IN QUATERNARY SEDIMENTS OF THE WESTERN BLACK SEA SHELF

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During the Quaternary, the most important groups of primary marine producers are amongst the unicellular algae: the calcareous nannoplankton. In the NW Black Sea shelf area, the calcareous nannoplankton assemblages are made exclusively of two species, namely *Emiliania huxleyi* and *Braarudosphaera bigelowii*.

In the Quaternary, significant fluctuations occur in the abundance of the well-known cosmopolitan species, *Emiliania huxleyi*. Nowadays, in the intra- and intercontinental seas, *Emiliania huxleyi* can be found in the surface-waters of the Sea of Azov at approximately 11‰ salinity, but also in the Red Sea at salinity up to 41‰. The resilient *Braarudosphaera bigelowii* species is also present in the Red Sea, but not in the Sea of Azov. The minimum salinity where *Braarudosphaera bigelowii* can be found is approximately 17‰, in the Black Sea.

During last years, gravity cores have been collected from Romanian inner and outer shelf of the western Black Sea. The *Emiliania huxleyi* and *Braarudosphaera bigelowii* abundance fluctuations observed in these cores unveil the Pleistocene to Holocene paleoenvironmental changes in which these species developed.

As expected, we support the fact that the Unit 3 (= the Lacustrine Lutite) was sedimented in a freshwater environment, overlapping the restricted water circulation interval ("lake" phase) of the Black Sea. During the deposition of Unit 3, the salinity in the Black Sea was lower than 11‰, which is the minimum salinity which *Emiliania huxleyi* may tolerate.

The persistent occurrence of both *Emiliania huxleyi* and *Braarudosphaera bigelowii* over the entire Unit 2 (= Sapropel Mud) suggests a sharp increase in the water salinity, above 17 ‰. We assume for Unit 2 and the youngest, the Unit 1 (= the Coccolith Mud), a stable marine regime settled in the Black Sea basin.

In this paper, we present results of our investigations based on *Emiliania huxleyi* and *Braarudosphaera bigelowii* abundance fluctuations, using cores sampled in the NW Black Sea

shelf. Generally, the fluctuation pattern of *Braarudosphaera bigelowii* is negatively correlated with the *Emiliania huxleyi* one.

Acknowledgements

This work was performed through the Core Programme of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), within the National Research, Development, and Innovation Plan 2022-2027, Projects No. 23 30 02 01 and 23 30 01 01, as well as Project PNIII PFE AMBIACVA, financed by the Ministry of Research, Innovation and Digitization.

CLIMATE CHANGE EFFECTS ON MESOZOOPLANKTON'S TEMPORAL AND SPATIAL DYNAMICS IN THE BLACK SEA

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Along the Romanian Black Sea coastline, 27 mesozooplankton species of holoplanktonic and meroplanktonic nature, belonging to various groups and orders, were identified in the warm season of 2013-2020. Copepods, meroplankton, and cladocerans made up most of the community structure, as SIMPER analysis revealed.

Climate change has led to significant alterations in seawater temperature and salinity patterns. Rising global temperatures are causing an increase in sea surface temperatures, impacting marine ecosystems. This warming is often accompanied by changes in salinity due to various factors, including altered precipitation, river flow patterns, and changes in sea circulation. These shifts in temperature and salinity can affect mesozooplankton's distributions, and influence the functioning of marine ecosystems, underscoring the complex interplay between climate change and sea dynamics.

In terms of quantitative structure, the nonfodder component represented by *Noctiluca scintillans* dinoflagellate recorded the highest density and biomass values at temperatures between 19^0C and 20^0C and at salinities of 12.65-15.39‰. The fodder zooplankton recorded the highest values in shallow waters, where temperature was higher and the lowest densities were reached in the offshore area where the salinity was higher, between 16.99-18.94 ‰.

Acknowledgements

This research has been carried out with financial support from the NUCLEU Programme (CEMAR 2012-2015, PROMARE 2016-2017, SIMAR 2018, INTELMAR 2019-2022) and from the Integrated monitoring program of the marine ecosystem at the Black Sea according to the requirements of art. 11 of the Marine Strategy Framework Directive (2008/56/EC).

TRACE METALS ASSESSMENT IN THE SURFACE SEDIMENTS OF THE NW BLACK SEA SHELF, ROMANIA

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The paper aims at assessing the heavy metal contamination of sediment samples collected from 30 stations within the Romanian shelf (NW Black Sea). Concentrations of seven trace metals Pb, Hg, Cr, Cu, Ni, As and Zn, were determined from surface sediments (0-2 cm depth) using a grab sampler and some specific spectrometric techniques.

In order to assess the sediment quality were applied some pollution indices (e.g., Enrichment factor, Contamination factor and Pollution Load Index) and multivariate exploratory technique and correlation analysis (e.g., Principal Component Analysis) to investigate the metal source and establish the main pollution sources.

Higher values of Cr, Cu, Zn, Pb and Hg concentrations were determined in the Portița Bay (especially in the vicinity of the oil platforms), as well as in the stations in front of the mouths of the Sf. Gheorghe arms and Sulina. Also, Cu, Ni, As and Pb showed high concentrations along the Danube's plume direction. In the shallow waters of the Romanian southern coast, where direct anthropogenic influence on the coastal ecosystem is stronger, heavy metal concentrations did not show high values, except for stations located in front of Mangalia and Constanta ports, where higher concentrations of Cr were also noted.

The values of EF, CF, and PLI indices suggest that the superficial sediments on the Romanian shelf of the Black Sea are generally minorly contaminated, only in the area of direct influence of the Danube, as well as in the area of the oil platforms, the degree of contamination is moderate.

Correlation analysis suggest that As, Cu, Hg, Ni, Pb, and Zn came mainly from Danube water and sediment discharges, containing domestic, municipal, agricultural, and industrial effluents, but also from local anthropogenic sources (*e.g.*, port, construction, and quarring activities, chemical and petrochemical plants, domestic and industrial wastewater discharges, road traffic, offshore oil/gas extraction).

Acknowledgements

This work was financed by the Ministry of Research, Innovation and Digitization, performed through the Core Program of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), Projects No. PN 19 20 01 02 - *Multidisciplinary research for improvement knowledge of the interaction between climate change and anthropic pressures and its effects on the Black Sea ecosystem* and PN 23 30 01 03 - *Improving the monitoring program of the Romanian shelf of the Black Sea in order to increase the capacity to evaluate and predict the impact of multi-stressors on marine ecosystem services.*

DANUBE DELTA AND NW BLACK SEA: A STORY OF WATER COLOUR

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Colour is the property of any object and it results from the way this object reflects or emits light. Colour has enchanted and intrigued both artists and scientist alike. They all tried to understand it and capture its essence. For everyday living, colour was used to assess resources, food for example, and could had meant the difference between starvation and survival. Water colour has been used as an environmental water quality indicator for a long time. It provides information about the presence of suspended or dissolved material, or the presence of phyto- or zooplankton, for example.

The colour of water is given by the optical properties, which can be inherent (i.e., they do not depend on the ambient light field - IOPs) and apparent. The IOPs depend on the composition (i.e., the substances that make up the particles or dissolved substances), morphology (i.e. shape and size of particles), and concentration of water constituents (i.e. the number of particles in a given volume of water or to the amount of a dissolved substance in the water).

The advent of satellite data has given way to study water colour at larger spatial scales and with increased frequency. Water optical typologies has been suggested as a mechanism to delineate water masses based on their optical properties (optically active constituents – water colour).

In the Danube River, Danube Delta and the Black Sea, the work on water colour included understanding its variation and optical water types (OWT), and their link to the natural variability of sediment and phytoplankton concentration. Up to 16 OWT have been identified in the Danube Delta – NW Black Sea area. They vary both spatially but also from season to season.
OPTICAL WATER TYPES can be attributed to: sediment concentration, presence of phytoplankton, high bottom reflectance in shallow or very clear waters, presence of coloured dissolved matter or a combination of factors.

Acknowledgements

This work was supported by the following projects: H2020 CERTO (grant number 870349), DANUBE4all (grant number 101093985), H2020 MONOCLE (grant number 776480) and PN 23 30 03 01 Romanian Core Program for Research, funded by the Ministry of Research, Innovation and Digitization.

OVERVIEW OF HEAVY METALS AND ORGANIC POLLUTANTS ACCUMULATION IN THE MAIN LINKS OF THE FOOD CHAIN AT THE ROMANIAN BLACK SEA COAST

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Globally, population growth and industrialization lead to pollution of the marine environment. The Black Sea ecosystem is affected due to human activities and limited pollution reduction actions. Among the pollutants found in the marine environment, organic pollutants (polycyclic aromatic hydrocarbons, total petroleum hydrocarbons, organochlorine pesticides and polychlorinated biphenyls and heavy metals are of particular importance.

Marine organisms take and accumulate contaminants through bioconcentration, bioaccumulation and biomagnification. This study presents contaminants bioaccumulation data and discuss their biomagnification in marine species from five different trophic levels in the Romanian Black Sea Coast, namely plankton, planktonophage fish, migratory fish, rapacious fish, and predators.

The biomagnification of organochlorine pesticides was highlighted at trophic levels 3 and 5, while biomagnification of polychlorinated biphenyls was observed at 2,3 and 5 trophic levels. Heavy metals, except for nickel showed significantly higher levels in plankton, compared to other trophic levels.

Analysis of contaminants level in the main links of trophic chain of the Black Sea ecosystem, highlighted that the pollutants represent a significant risk for the marine ecosystem. Although not bio-accumulative in many organisms, organic pollutants (polycyclic aromatic hydrocarbons) had the highest concentrations in phytoplankton.

Acknowledgements

This work was performed within the National Research Programme NUCLEU (PROMARE 2016-2017 -''BLUE GROWTH'' ORIENTATED RESEARCH AIMING AT DEMONSTRATING THE BLACK SEA OPPORTUNITIES AND ITS VALUATION), PN16 23 01 03 "*Research on the evolution and interaction of pollutants and chemical parameters of the Black Sea within ecosystem components, in relation to anthropogenic influences and climate change*", developed with the financial support of Ministry of Research, Development, and Innovation.

IMPLEMENTING PHOTOGRAMMETRY IN ARCHAEOLOGY FOR 3D MODELING OF ANCIENT SETTLEMENTS

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Dobrogea is a region located in the eastern part of Romania and it has a significant cultural and historical heritage, predominantly influenced by the classical Greek, Hellenistic, and Roman periods. The archaeological sites in Dobrogea mainly consist of tumuli and ancient settlements like forts, fortresses, towns, and even cities, and most sites can be either on land and easily accessible or submerged and not readily reachable.

Two of the most important ancient settlements are represented by the supposedly oldest Greek settlement established on modern Romanian territory – the Argamum fortress and the largest ancient Roman city in the province of Scythia Minor – Adamclisi.

At the Argamum and Adamclisi archaeological sites, the more exposed and defined areas of 4.62 and respectively 9.67 hectares, were surveyed by using an unmanned aerial vehicle (UAV – DJI Phantom 4 Pro V2.0 Drone) system through which a great deal of information can be obtained just by viewing the subject, or area of interest, from certain distances and angles that are impossible to reach from the ground level.

The employment of UAV and photogrammetry (as a technology) in archaeology can lead to more precise documentation, aid in visualization and analysis, and facilitate the preservation and interpretation of our cultural heritage.

The photogrammetric products, created by processing the images collected during the UAV aerial missions, such as orthomosaics, digital elevation models (DEMs), digital terrain models (DTMs), contours maps, 3D meshes, and textured 3D meshes, can improve the visibility and access to areas that previously could not be identified without working in an intrusive way. In addition, some of the detailed models mentioned above will guide the archaeologists in future diggings by determining the most adequate areas for archaeological excavation.

In this paper, we present the significant contribution of photogrammetry to archaeological research, including its role as a complementary method to geoarchaeology.

Acknowledgements

This work was performed through the Core Program of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), within the National Research, Development, and Innovation Plan 2022-2027, Projects No. 23 30 04 03.

UPPER MIOCENE FORAMINIFERA AND OSTRACODS FROM EASTERN EUXINIAN BASIN (BULGARIA)

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In this paper we present biostratigraphic and micropaleontological data for a Middle Miocene geological located in the Eastern Bulgaria, along the eastern coast of the Black Sea, near the village of Tuzlata. The studied Konkian?, Volhynian and Bessarabian deposits are integrated in the upper part of the Evksinograd Formation.

The section has approximatively 500 m in length and 40 m in thickness. The investigated sediments are represented by gray silts that become more carbonate-rich towards the upper part, with thin intercalations of marly-limestones very rich in gastropods and bivalves (*Mactra* spp.).

The identified microfauna is dominated by foraminifera and ostracods, accompanied by microgastropods, otoliths and other fish bone remains. According to the previous established biozonation, the identified foraminiferal assemblages belong to the *Varridentella reussi* Zone (middle Volhynian), *Elphidium reginum* Zone (upper Volhynian) and *Dogielina sarmatica* Zone (lower Bessarabian).

The ostracod assemblages correspond to the *Cytheridea hungarica-Aurila mehesi* Zone, *Euxinocythere turpe* Zone (Volhynian) and *Euxinocythere grave odessoensis* Zone (lower Bessarabian). The first meters from the basal part of section contains marine foraminifera and ostracods that suggest the late Badenian (Konkian) age, but this aspect should be further investigated.

From a paleoecological perspective, the Sarmatian analyzed microfauna indicates a brackish environment, with salinities of up to 18-20 g/l and inner shelf zone. In terms of paleogeography, the studied area was part of the Eastern Paratethys, specifically the western part of the Euxinic Basin, the present-day Black Sea.

AN OVERVIEW OF ROMANIAN MARINE FISH BIODIVERSITY

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Considering the current global problem of depletion of natural resources and the fact that the fishing resource represents a healthy food option, a sustainable management of aquatic resources is required, and the analysis of marine biodiversity is the basis of this.

Studies carried out three decades ago regarding the biodiversity of ichthyofauna indicated the presence in the Black Sea of more than 140 species of fish. Recent studies have indicated the presence in the Romanian waters of the Black Sea slightly more over 70 species of fish, predominating those from the coastal area and small pelagic species.

In addition to the much smaller number of species identified compared to three decades ago, essential changes were observed regarding the biology of the species, more precisely the average length per age class of the individuals analyzed (anchovy, sprat) was lower than that identified in the past.

Biodiversity monitoring studies and the analysis of the structure and functioning of marine fish populations are extremely necessary to implement sustainable management measures to stop the current problem of the depletion of aquatic resources.

Acknowledgements

This study was carried out in the frame of the POIM Project "Revision of the Danube Delta Biosphere Reserve Management Plan and Regulation SMIS Code 123322" and the SMART-BLUE NUCLEU Programme Project PN 23 30 03 01 „Ensuring sustainable food sources and resilient to climate challenges through the intelligent integration of the ecosystem management of fisheries and the scientific development of marine aquaculture in the Blue Economy strategy" with the financial support of Ministry of Research, Development, and Innovation.

A DETAILED CHRONOLOGY OF THE SEDIMENTATION IN THE DANUBE ABYSSAL FAN RECORDS MAJOR EPISODES OF THE LATE HOLOCENE BLACK SEA EVOLUTION

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The construction for the high-resolution Bayesian sedimentation model spanning the last 5500 years based on 25 AMS radiocarbon dated sediments of bulk organic matter (OM) sampled from the NW Black Sea anoxic waters of the continental slope is presented in this work.

The corrections for the 14C ages due to marine reservoir effect (MRE) and detritus organic carbon are correlated with exogenous information such as 210Pb dating, metallurgy pollution and human-induced soil erosion, highlighting the Danube influence on the geochemistry and chronology of the NW Black Sea sediments through the input of terrigenous organic matter.

The results show excellent agreement with some of the previous studies, supporting a total age offset for the bulk OM of 60 years as MRE and 580 years as detritus organic carbon influence. The revisited chronology pinpoints the first and second invasion of the coccolithophores algae (calcareous nannoplankton) *Emiliania huxleyi* at 2524 ± 87 and 625 ± 65 years cal. BP.

The sedimentation rate shows an increase of about three times with the starting of the late Medieval, which corresponds to the highest observed sediment discharge of the Danube as are considered the last 500-300 years. This type of high-resolution sedimentation model is an important step for constructing the carbon budget in bottom waters of variable oxygen concentration.

QUATERNARY GEOLOGICAL EVOLUTION OF THE NW BLACK SEA CONTINENTAL PLATFORM: PALAEOGEOGRAPHICAL AND PALAEOECOLOGICAL IMPLICATIONS

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The Black Sea is an elliptical basin with an area of 423,000 km^2, a volume of 534,000 km^3, and a maximum depth of 2,212 m. Since the only connection of the Black Sea with the global ocean is through the Bosporus Strait, which is less than 50 m water-depth, this marine basin represents a semi-isolated marginal sea, which sensitively reacts to environmental changes.

Back to the Last Glacial Maximum (LGM), 21,000 years ago, the Black Sea was probably a giant freshwater to semi–brackish-water lake, or at least a brackish enclosed basin. Its water level stood more than 120 m below than today level.

During the youngest Quaternary glaciation, the Black Sea became a giant freshwater lake. The surface of this lake drew down to levels exceeding 100 m below its outlet. During the Early Holocene, around 7,000 years ago, an outstanding event took place in the Black Sea basin, i.e., the reconnection with Mediterranean, which marked the end of the lacustrine phase of this basin and the onset of a marine anoxic regime, similar to the present day one.

Since the LGM, regressions and transgressions produced by the successive sea level variations have controlled the formation and destruction of the paleo-shorelines and corresponding hydrographic networks. Sea level variations have been convoluted with other local, regional or global phenomena, as differential compaction of the young sediments, regional active tectonics and glacial isostatic adjustment.

The aim of the study is to refine the Black Sea paleosetting and the geological evolution corresponding to the Pleistocene to Holocene interval. New data will be acquired (sediment sampling *via* coring) and new geophysical information.

An integration of the lithological data, fossil records (i.e., macrofaunas, microfaunas and calcareous algae), absolute dating, geochemistry (carbon and oxygen isotopes fluctuations for deciphering paleoenvironmental changes, along with high-resolution geophysics (seismics and bathymetry) will be performed.

Acknowledgements

This work was performed through the Core Program of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), within the National Research, Development, and Innovation Plan 2022-2027, Projects No. 23 30 02 01 and 23 30 01 01, as well as Project PNIII PFE AMBIACVA, financed by the Ministry of Research, Innovation and Digitization.

BACTERIAL COMMUNITIES ASSOCIATED WITH THE TUBE-DWELLING POLYCHAETE *MELINNA PALMATA* GRUBE, 1870 AND SEDIMENTS. STUDY CASE: ROMANIAN BLACK SEA SHELF

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Bacteria associated with marine invertebrates play a fundamental role in the biology, ecology and evolution of their hosts, being able to produce secondary metabolites with biotechnological and bioengineering applications. Although many studies have been focused on the microbial populations of benthic and pelagic habitats, our knowledge on bacteria colonizing tube-dwelling polychaetes is still lacking. Therefore, we provide a first characterization of *Melinna palmata*'s microbiome.

Specifically, the main objective of our study was to assess the bacterial diversity, composition and functionality of polychaete *M. palmata* and its surrounding sediments from the Romanian Black Sea shelf, to highlight the extent to which the environment contributes to the enrichment of the species' microbiota.

Our findings showed that tissues harbored a distinct bacterial diversity and composition compared to sediments, but no significant differences between communities along the depth gradient have been observed.

In terms of abundance, Synechococcales, Rhodobacterales, Actinomarinales, Rhizobiales, Planctomycetales, Pirellulales, and Clostridiales orders dominated the tissues, while Microtrichales, Anaerolineales, Caldilineales and Campylobacterales were higher represented within sediments. The amino acid metabolism was the dominant function for bacteria of both analysed matrices, followed by genes involved in carbohydrate, energy, cofactors, and vitamins metabolism, slightly increased within tissues.

The current contribution will serve as a baseline for further research aimed to fully understand the diversity and functions of microbial communities associated with polychaetes.

Acknowledgements
The study was financially supported by the Ministry of Research, Innovation, and Digitization, as part of the CORE Programme, Project PN 23 30 02 02.

ARCHITECTURE OF FAULT DAMAGE ZONE OF THE EASTERN CARPATHIANS, MOINEŞTI AREA

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From a geostructural perspective, within the Eastern Carpathians area, several structural zones are distinguished, corresponding to well-defined structural stages during the evolution of this Carpathian segment.

These zones are arranged along the mountain range, nappes or systems of nappes that are generally younger the further eastward they are located. Starting from the west and moving eastward, they are delineated as follows: the crystalline-Mesozoic zone, the flysch zone (internal flysch, median flysch, and external flysch - Tarcău and Vrances nappes), and the molasse zone (Subcarpathian Nappes).

The study area Moinești is located within Bacău County and, geologically, it belongs to both the Paleogene Flysch (Tarcău and Vrancea nappes) and the molasse area (Subcarpathian Nappes), representing the youngest domain of sedimentation in Carpathians.

Geological and geophysical investigation method are used to reveal new geological models and structures. Hence, 3D seismic methods, tomography in boreholes, "walk away" and "walk above" seismic methods in boreholes, as well as modern borehole geophysics tools such as, QuantaGeo, Formation Micro-Imager, Ultrasonic Borehole Imager (UBI) and Dipolsonic, are employed.

Unlike classical interpretations where the fault zones are presented as a characteristic feature of the Tarcău Nappe, developing to the north of Moinești and in the Târgu Ocna areas, our interpretation reveals that the structure resembles a duplex stack of the marginal fault units. Seismic correlation and borehole data have enabled a much more precise structural interpretation, leading to the development of a new geological model, confirmed by new wells.

From seismic and borehole geophysical data, it can be concluded that the Moinești area is composed of a series thrust faults. This area represents a distinct structural zone, and the structural elements are separated by faults. These findings lead to the conclusion that typical duplex structures are present in the area.

Upon studying the seismic and borehole geophysical data within the studied area it has been observed the typical mechanical characteristics of a "duplex stack". This led to the conclusion that the studied area follows a new and interesting geological and structural model.

META-ANALYSIS OF STUDIES USING EARTH OBSERVATIONS DATA IN WATER QUALITY INDICATORS ESTIMATION FOR DANUBE DELTA AND BLACK SEA

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Black Sea and Danube Delta is a river-sea ecosystem of significant importance, under strain from a non-homogenous set of equilibrium-altering pollutants simultaneously affecting biodiversity and local human communities. A relatively consistent body of scientific literature was published containing reports on estimated water quality indicators for the Danube Delta and Black Sea based on different combinations between remote sensing technologies (active/passive, airborne/in-orbit) and statistical analysis methods (analytical/machine learning), along with different uncertainty measures.

The paper provides meta-analysis of remotely sensed water quality indicators, reported in journals indexed in Web of Science (~50 papers from the past 10 years), in order to provide a coherent and comprehensive overview of the present and future potential pathways of research, namely the impact of sensor class characteristics (corrections/calibration/validation) and data analysis methods on the prediction bias and variability. In addition, we provide a set of minimal recommendation in order to improve transparency, reproducibility and reusability for the data, methods and results reported by researchers.

Acknowledgements

The research was funded by the projects “Analysis of the potential for sustainable use of vegetation specific to the Danube-Danube Delta-Black Sea system”, Code 108630, co-financed by the European Regional Development Fund. This work was performed through the Core Program within the National Research, Development, and Innovation Plan 2022-2027, carried out with the support of MRID, project no. 23020101(SIA-PRO), contract no 7N/2022.

THE FIRST SYNOPTIC SURVEY OF THE BLACK SEA TO ESTIMATE DENSITY AND ABUNDANCE OF DOLPHINS AND PORPOISES

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Population abundance is amongst the most basic and crucial criteria/indicators for the assessment of conservation status.

Three species of odontocetes, all represented by local subspecies, inhabit the Black Sea, i.e., the Black Sea bottlenose dolphin *Tursiops truncatus ponticus*; the Black Sea common dolphin *Delphinus delphis ponticus*; and the Black Sea harbour porpoise *Phocoena phocoena relicta*.

In summer 2019, a synoptic survey was carried out across the Back Sea using visual methods (aerial surveys) and applying line-transect sampling methodology. Using the collected data density and abundance of the species were estimated both through design-based and model-based approaches.

Six sub-areas were defined, covering the waters of Bulgaria, Georgia, Romania, Türkiye, and Ukraine, and were surveyed in June-July (CeNoBS). A line transect distance sampling approach was used, following predefined transects within each stratum, achieving aprox. 5% coverage of the surveyed area.

A total of 9,324.1 kilometers were surveyed by three planes and a total of 1,744 cetacean sightings were recorded with 3669 individuals. The uncorrected (for perception and availability

bias) estimates obtained through the model-based analysis were 90,895 (CV=0.06) common dolphins, 18,091 (CV=0.24) for bottlenose dolphins and 94,219 (CV=0.07) harbour porpoises.

These aerial surveys yielded the first insights on overall abundance, density, and distribution, providing current regional baseline values and density maps for all three cetacean species of the Black Sea during the summer months, to be used for the elaboration of effective conservation measures and to address national and international requirements.

A CHALLENGE TO THE CLASSIC UNDERSTANDING OF ROCK-FORMING BLUE QUARTZ

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The literature on the subject characterizes blue quartz as a rare occurrence which owes its color to the preferential scattering of blue light by nanometric solid mineral inclusions, usually rutile or ilmenite. The age is usually restricted to the Precambrian, and the geographical distribution, while recognized on every continent, is approached at a local or regional scale at best, with little consideration of the continental and transcontinental pattern of occurrence.

An extensive literature review performed by the author has yielded that, far from being rare, rock-forming blue quartz is reported in excess of 600 worldwide occurrences, in close association with magmatic and metamorphic events associated with the assembly and break-up of supercontinents, especially Rodinia, Gondwana, and Pangaea. Furthermore, blue quartz could be a tool for palaeogeographical correlations. For example, the Avalonian terranes in both Europe and North America are devoid of blue quartz, and in a particular case of the blue quartz bearing Crystalline Mesozoic Zone of the Eastern Carpathians, considered by some as a part of Eastern Avalonia, this raises questions.

While it is unclear whether this association is owed to the geochemical particularities of each geological time period, the metamorphic history of each occurrence, or both, the coherence of the global distribution pattern alone warrants a dedicated study based on the premise that regional occurrence clusters are more likely to have a common cause, rather than approaching each individual occurrence as a geological accident reflecting particular local conditions. Furthermore, it became obvious that the definition presented in the first paragraph of the abstract is unnecessarily restrictive. Some quartz occurrences are blue in the absence rutile and ilmenite (or solid inclusions all together) and regarding the Precambrian threshold, the occurrences from peri-Gondwanan Europe are mostly Palaeozoic, the ones in the Canadian Rocky Mountains are Mesozoic, and the Los Pueblitos rhyolite (Mexico) is Quarternary (Pleistocene).

Dedicated studies performed on the blue quartz from the Lower Palaeozoic Albești granite (Romania) have shown characteristics indicative of light scattering, such as the difference in color in reflected and transmitted light, and the rigorous overlapping between the blue colored and opalescent zones of the quartz grains, but the HR-TEM investigations did not detect any characteristic nanometric inclusions. Furthermore, the color progressively fades with increasing temperature, accompanied by the loss of opalescence, and thin section microscopy points to the fact that the recrystallized domains of the quartz grains lack in color.

These observations are at odds with those reported for the Llano rhyolite blue quartz (Texas), on which the “classic” definition of blue quartz is based, but consistent with data gathered by the author on occurrences from Brazil and the Pietrosu Bistriței porphyroid (Romania). It is becoming increasingly obvious that the term “blue quartz” actually designates a wider range of blue quartzes with different coloring mechanisms that could be, given an adequate understanding of the subject, directly linked to particular geochemical and tectonic settings. Thus, blue quartz has the potential to make the leap from geological oddity, to an important petrographic marker.

MORE THAN 15 YEARS OF TSUNAMI RESEARCH AT THE NATIONAL INSTITUTE OF EARTH PHYSICS

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The National Institute of Research and Development for Earth Physics (NIEP) provides seismological research, being responsible for the seismic, geodetic and geophysical monitoring of Romania, focusing on seismo-tectonics and seismic sources, seismic hazard assessment and risk mitigation, engineering seismology and tsunamis.

NIEP is member of the "**Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic,** the Mediterranean and connected seas" (**ICG/NEAMTWS**), attending annual meetings and participating in few tsunami exercises in the past. Our functions within the group are Tsunami National Contact (**TNC**) and Tsunami Warning Focal Points (**TWFP**) of Romania.

There is a moderate tsunami risk in the Black Sea area, consisting of past known activity, with twenty-two evidenced and documented tsunamis. Our area of interest (the western Black Sea) could mostly be affected by earthquakes generated in the Shabla (Bulgaria) area. From the total number of tsunamis, four were in Shabla, with an impact on both Romanian and Bulgarian coasts. The most significant one was on 31st of March 1901, when an earthquake of Mw 7.2 triggered high tsunami waves, according to different authors. The most recent event is from 7th of May 2007, when a submarine landslide induced waves up to 1.2 m height.

In this paper, we will emphasize NIEP's past and current tsunami related projects and other activities (education, dissemination, forewarning). The main directions of tsunami research are: Black Sea seismic sources zonation, seismic and tsunami hazard, tsunami resilience and tsunami modeling simulations (using two different software, Tsunami Analysis Tool and TRIDEC Cloud). The first attempt to study tsunamis was the national project "Multidisciplinary researches on natural hazards. Case study: tsunami type phenomenon in the Black Sea" - **PROFET**, starting with 2007. The most recently finalized tsunami related international project is "Accelerating Global Science in Tsunami Hazard and Risk Analysis" - **AGITHAR**. We also need to emphasize the long-term multi-hazard project, "All Risk Integrated System Towards the Holistic Early-Warning" - **ARISTOTLE**, continuously active since 2016, with worldwide real time monitoring of different hazards, including earthquakes and tsunamis.

Furthermore, we have developed as additional tool, a dedicated website for tsunami warning and real time sea-level measurements. Moreover, an education and awareness direction were mainly developed in the framework of "Assessment, Strategy and Risk Reduction for Tsunamis

in Europe - Black Sea" (**ASTARTE**) project and continued within the ICG/NEAMTWS group, by structuring and/or translating some thematic flyers, posters and roll-ups.

Acknowledgements

This paper was carried out within Nucleu Program SOL4RISC, supported by the Ministry of Research, Innovation and Digitization, project no PN 23 30 02 01.

ANALYSIS OF THE POTENTIAL FOR SUSTAINABLE USE OF VEGETATION SPECIFIC TO THE DANUBE-DANUBE DELTA-BLACK SEA SYSTEM - D3MN -

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Heavy metal contamination of aquatic ecosystems directly threatens the health, production and biodiversity of aquatic and surrounding terrestrial ecosystems, and it represents a serious global problem. Aquatic macrophythes have a major role in absorption and accumulation of heavy metals and thereby in natural water purification.

In the present study, we analyzed the concentrations of $CaCO_3$, TOC, Fe_2O_3, minor components (MnO) but also of some elements (metals) with genetic significance - Rb, Sr, Zr or toxic and potentially affected by anthropogenic influences - Cu, Pb, Zn, Cr, Ni, As and Hg from sediments and from *Phragmites australis* plants (roots, rhizomes, stems and leaves), in the ecosystems of the Danube Delta lakes.

The aims of the study were to define chemical properties of the Danube Delta lakes, determine the concentrations of heavy metals in different plant organs and assess the phytoremediation potential of *P. australis* based on bioaccumulation and translocation factors.

We analyzed 417 sediment samples and 426 reed samples from the Danube-Danube Delta-Black Sea System. The highest amounts of almost all metals investigated in plants from all analyzed ecosystems were found in the roots, their concentrations being positively correlated with the quantities of their forms available in the corresponding sediment.

Much higher concentrations of metal in the roots compared to other organs of the plant clearly indicate that the metals were strongly sequestered in the cortical tissues of the root and were not transferred through the endoderm.

Overall, the presence of the largest amounts of metals in the roots, the high bioaccumulation factor and the low translocation factor show that *P. australis* is an excluding plant species with a good phytostabilization potential.

Acknowledgements

This work was carried out as part of the project "Analysis of the potential for sustainable use of vegetation specific to the Danube-Delta system Danube-Black Sea - D3MN" POC/78/1/2.

MICROPLASTIC INVESTIGATION IN THE SURFACE COASTAL WATERS AND IN AUTOCHTONOUS *ALOSA IMMACULATA* AND *MYTILUS GALLOPROVINCIALIS*, WESTERN BLACK SEA, ROMANIA

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The Danube River, considered an international natural pathway that links the western and central European continent to its easternmost area, has a significant load of pollutants that are transported and accumulated in the Danube Delta and, further, into the Black Sea basin. These once prestine areas are currently under high pressure due to strong turistic activities, intense fishing, regional armed conflict, and inadequate litter disposal on a basin-wide scale.

The unbalanced sedimentary output of Danube, consequence of numerous hydropower plants constructed upstream, combined with abovementioned anthropic factors are endangering the fragile deltaic and coastal ecosystems.

Among the known emerging pollutants, litter is one of the most encountered categories as the anthropic macro-objects can be observed in all natural environments. Microplastics (MPs) are a sub-category of litter, defined by solid petrol-based items, sized between 1 µm and 5 mm, prefabricated within these dimensions or, fragmented from macroplastics due to natural weathering. MPs are known for their potential to swiftly spread in most of the environments, carrying in their porous texture high amounts of other types of pollutants that negatively affects the entire food chain, especially the aquatic species.

Due to the scarce data regarding the MPs pollution in the Black Sea coastal areas the impact of this type of pollution over the natural environment is relatively unascertained. Moreover, the connection between MPs pollution in the aquatic environment and the concentration of MPs inside mussels and fishes has not been yet defined. In order to cover the gaps, we investigated the MPs abundance in the water surface layer (mean concentration of 0.63 MPs/m^3) and two different species: (i) the mackerel (*Alosa Immaculata*, mean concentration of 11.8 MPs/ind) – a pelagic fish captured at the Sf. Gheorghe Danube mouth during their inland migration for reproduction, and
(*ii) Mytilus galloprovincialis* (mean concentration of 6.05 MPs/ind) – a filter feeder mollusc collected nearby the Constanța harbor.
The main MPs morphology encountered in both species is represented by fibers, while in the surface water layer the fragments are dominant. Usually, the fiber particles are the most present

form of MPs, yet we bring evidence that before the touristic season the percentages of MPs types differ. Indeed, the coastal natural factors such as wind, waves, currents etc. may influence MPs variety.

Acknowledgements

This work was performed through the Core Program of the National Institute of Marine Geology and Geo-Ecology (GeoEcoMar), within the National Research, Development, and Innovation Plan 2022-2027, Projects No. 23 30 01 02, as well as Project PNIII 23/30.12.2021 PFE AMBIACVA, financed by the Ministry of Research, Innovation, and Digitization.

SALT, THE SEED OF LIFE: A GEOTOURISM ANALYSIS OF SALT AREAS IN THE BUZĂU LAND UNESCO GLOBAL GEOPARK, ROMANIA

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Located in the Carpathians Bend Area, the Buzău Land UNESCO Global Geopark preserves rich elements of geoheritage, including salt formations, oil and gas triggered phenomena (mud volcanoes, eternal flames, and sulphurous springs), amber deposits and more.

Here we focus on salt, one of the most distinctive rocks in the region. We describe and propose five geosites developed in salt diapirs to be included in salt geotrails: the Salt of Buzău, the Meledic Plateau, the Sările-Bisoca Salt, the Negoșina Salt and the Lacurile Salt. To assess the geotourism potential of salt, we performed a quantitative analysis of their scientific value, potential educational and touristic use and degradation risk.

We propose four geotrails, each with a specific theme:

1 – Salt, Glaciers and Knights;

2 – The Way of the Pickle;

3 – Ups and Downs in Salt;

4 – The Shaping of Salt and the Shaping of People.

Management proposals for the geotrails include interpretive panels, installations, use of Augmented Reality and Virtual Reality technologies, and protection of ephemeral salt landforms. Local salters could be trained for guiding, and a workshop concept with salt extraction tools can potentially be developed in the Geopark area, to offer a hands-on tourist experience.

DIFFICULT CHRONOSTRATIGRAPHIC FRAMEWORK WITH MIXED DATASETS IN EAST CARPATHIANS MIO-PLIOCENE FORELAND BASINS

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The Mio-Pliocene foreland basin covering Romania's territory represents largely the last step in foreland evolution for the Carpathians. The biggest challenge we are facing while interpreting subsurface data in the foreland basin is the proper chronostratigraphic framework, as many formations tops have a lithological origin rather than a chronostratigraphic one.

The available mixed datasets used in the study area are comprised of multiple vintage wells which rarely penetrated the pre-Miocene stratigraphy, of 2D vintage seismic lines and a few scattered wells and modern 3D seismic surveys. Data quality is highly dependent on acquisition parameters, topography, and data processing.

Various models have been proposed to illustrate either the depocenter migration or outcrop driven stratigraphic correlations. While in the past the basin was largely uniformly filled and later eroded, in the present, the basin seems to have been filled in a variable manner, dependent on pre-existing topography, subsidence and orogen uplift. Isotope dating has shown that the orogen has been uplifted in a sequence from NNW to SSE, controlling subsidence and depocenter migration to the South.

Commonly, biostratigraphic analysis is used to determine age and environments, but we are faced with a difficult challenge as many samples taken from what is considered alluvial and fluvial, are reworked, and can give limited biostratigraphic information and limited correlation. Seismic data shows large scale N-S prograding clinoforms, with some indication of mixed clinoform systems with a NE-SW component or even E-W progradation.

The existing fault system is limiting recognition of onlap terminations, is limiting data quality where higher density of fractures and faults exists, and can even play a role in subsidence and sedimentary migration. Main findings show that integrating all available data can lead to an improved model, showing that where biostratigraphy does not help, seismic stratigraphy can compensate together with outcrop to seismic correlations.

Seismic recognized sequence boundaries illustrate many short drops in sea level while the depocenters are migrating within the Sarmatian sequence, which can imply confined deep water sand rich fans. Log analysis within Meotian has shown high sea level cyclicity, with sand deposition in a fluvio-deltaic environment being controlled locally by fault activity.

In addition, modern logs facies analysis integrated with cores illustrates sedimentological details that previously have not been considered. Expectations should be lowered when working at a large scale with mixed vintage data sets with limited coverage, as many suppositions are being made to compensate for either low data quality or lack of data.

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Project funded under PNCDI III, Nr. 23PFE/30.12.2021

ISBN 978-606-9658-25-3