International Conference

"Marine Geology: Marginal Seas - Past and Future"

December 14-17, 2021

Abstracts

Guangzhou Marine Geological Survey,

China Geological Survey,

Guangzhou, P.R. China

Conference Session's Information

1. Advances in Marginal Sea Research

Conveners: Peter Clift (USA), Jan Harff (Poland), Jennifer McKinley (UK), Susan Nash (USA), Qiuming Cheng (China)

Abstract

Marginal seas and their coasts play an increasing role in marine geo- and environmental sciences and the development of sustainable development strategies. The application of big data analyses, functional numerical models and AI approaches can help to keep the balance between the protection of the natural environment of marginal seas and the economic use of their resources. The precondition is a deep understanding the functioning of marginal seas' dynamics on different time and spatial scales and demands interdisciplinary co-operation. A Marginal Seas Task Group has been established within the frame of the Deep-time Digital Earth (DDE) Big Sciences Program of the IUGS in order to foster this co-operation. Methodologically a co-operation with the International Association for Mathematical Geosciences (IAMG) is intended. For the effective application of the methods to be developed stakeholders are invited to join across international programs in marine environmental sciences.

2. Coastal morphodynamics and driving forces

Conveners: Wenyan Zhang (Germany), Tarmo Soomere (Estonia), Xinong Xie (China)

Abstract

Coasts constantly change their shape due to multiple physical and biological interactions that lead to sediment erosion and deposition. As the interface between land and sea, coasts are very sensitive to climate change and anthropogenic environmental impacts. They are increasingly threatened - depending on their location - by rising sea-level, floods, storms, tsunamis, coastal erosion and environmental hazards that endanger livelihoods. To mitigate the threats, cross-bordering sustainable management is becoming a mutual task for coastal lands and beyond. Management strategies need to consider the "geo-environmental" change in the past and future to separate natural and anthropogenic driving forces. Learning from recent history will help to understand the coastal change in near future. This session aims to bring international expertise together to provide an overview of current research status of coastal morphodynamics and future perspectives.

3. Ecosystem dynamics

Conveners: Andrzej Witkowski (Poland), Jean-Luc Mouget (France), Yahui Gao (China), Jinpeng Zhang (China), Yenny Risjani (Indonesia), Hung Duc Nguyen (Vietnam)

Abstract

Out of the complicated system of MS ecology, we decided to include only a part of it as a subject of a session. Thus, we take into account an important group and start with the primary producer – diatoms (Bacillariophyceae) as a target for this session. The main topic is "Recent and fossil diatom flora of the South China Sea - with particular reference to habitat characteristics and biogeography" which has been quite well studied from the diatom side in the last few years, either in terms of its geological past and its recent development. Diatom evolution extends back to the Mesozoic era and through time they became an important group of primary producers in oceanic (plankton) and coastal marine environments (benthic) with a species number estimated to exceed 100,000. With technological progress diatoms have become also a target for the marine blue biotechnology as a source of valuable metabolites. During this session we will also present the most recent works on the blue *Haslea* funded with H2020 program GHaNA. While, we still open the abstract contribution from other fields in ecosystem dynamics.

4. Methodological approaches and Geodata management (including GIS and RS)

Conveners: Federica Foglini (Italy), Joanna Dudzinska-Nowak (Poland), Yuanzhi Zhang (HK-China)

Abstract

The comparative studies of marginal seas (from mapping to process modeling) including both historical reconstruction and future projection requires fast and convenient access to databases containing necessary geological, oceanographic, bathymetric, ecological and climate data including Remote Sensing data. For a reflection of geoprocesses by models from the global to the regional level, a harmonization of geodata and their international accessibility are required. A basic task is also the visualization of maps of both empirical data and model results using GIS tools and mapping techniques. The main focus of this topic is on formatting, harmonizing, processing and mapping marginal sea data and the presentation of methodological approaches to manage geodata and to make the spatial database FAIR (Findable, Accessible,

Interoperable and Reusable) through the implementation of dedicated Marine Spatial Data Infrastructure at different scales.

Abstracts Outline

Conference Keynote Speeches

Deep time Digital Earth (DDE) an IUGS science program aimed for data driven discoveries in Geosciences.

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Abstract:

Data-driven techniques transform research in geosciences. Accessibility and possible use seem more important than the amount of data since geo-data refer to deep time in the history of our planet. Deep-time Digital Earth (DDE) as a science program aims to harmonize deep-time Earth data (DDE-MISSION), share global geoscience knowledge aiming to transform geosciences (DDE-VISION) by facilitating data-driven discovery of Earth's evolution. Major challenges are the facts that substantial volumes of deep-time Earth data are not readily available; databases do not comply with the FAIR (findable, accessible, interoperable and reusable) principles; standard knowledge graphs for deep-time Earth data are to be developed. DDE was initiated by the International Union of Geological Sciences (IUGS) and developed in cooperation with national geological surveys, professional associations, academic institutions, and scientists around the world. The main scientific goal is a better understanding of global issues such as: Evolution of materials, Evolution of geodynamics, Evolution of life, and Evolution of climate. DDE relies on the work of its working groups and seeks to coordinate the efforts. Besides developing data tools DDE grants research programs on: ICS timeline; Geological Map; China Country Node; Geosciences Data Standards; and Marginal Seas. A future call is envisaged.

Keywords: Data-driven discovery, Deep time data, Harmonization, FAIR (findable, accessible, interoperable and reusable)

Crust structure and tectonic evolution of the southwest sub-basin and its conjugate margins, in the South China Sea

Yan Qiu[1, *], Jun Wang[1], Manuel Pubellier[2], Sung-Ping Chang[2], Xin Nie[1], Matthias Delescluse[2] Wen-kai Huang[1], Wen-bo Du[1], Michael Nirrengarten[2], Ju Dong[1], Geoffroy Mohn[2]

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Abstract:

The South China Sea (SCS), as the largest marginal basin in western Pacific Ocean trench-arc-basin system, is characterized by a breakup and subsequent seafloor spreading during Cenozoic. The conjugate margins of the Southwest Sub-basin (SWSB) with similar crust structure, including Penxi micro-block at North and Zhenghe micro-block at South, tightly linked to the opening of the SWSB and SCS as well. The rift-zones with NE-SW trend in these two micro-blocks, formed by persistent subsidence and detached extension in Paleogene, are bounded by detachment normal faults, most of which were dipped seaward. Two sedimentary syn-rift layers inside these rift-zones were separated by an unconformity. The layer syn-rift I shows a wedge-shaped geometry, while the layer syn-rift II shows a relatively homogeneous thickness. Margins' tectonic evolution included rifting-subsidence, extension and fault-detachment, uplift and erosion, breakup propagator in the SWSB and syn-spreading residual extension subsidence. Those geo-processes made a result that burial depth of Moho under the conjugate margins shallows gently seaward within a few hundred kilometers.

Opening of the East Sub-basin (ESB) with spreading direction of N-S in 32Ma was the first phase of seafloor spreading in the SCS. This break-unconformity corresponded to the unconformity between layer syn-rift I and layer syn-rift II, which hints that the syn-rift I formed before the first oceanic opening stage. The extension and fault-detachment together with rifting subsidence were still taken place at the conjugate margins of the SWSB during opening of the ESB, causing formation of layer syn-rift II on top of the unconformity. The persistent extension and subsidence enlarged rift-zones, making

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crustal thickness under these zones to thinner and thinner. As the pressure released along these zones, magma in deep bathy-crust should accumulate under the thin crust. Due to tectonic incident's influence happened around 23.8Ma, the oceanic-mid-ridge in the ESB jumped southward. Meanwhile, under stress effect, the crust and lithosphere started breakup along the thinnest and/or the biggest rift-zone. Since oceanic-mid-ridge in the ESB was nearby these rift-zones following spreading migration, the approximate concurrence of oceanic-mid-ridge jumped and the opening of the SWSB with lithosphere breakup were interacted. The mid-ridge jumped mechanism should connect the breakup rift-zone. The extensive and spreading orientation of the SWSB without doubt followed the NE-SW trend of the rift-zone. Thus, that the direction of seafloor spreading of the SCS changed from N-S into NE-SW should happen in the second spreading phase.

The tectonic, geodynamic, and paleogeographic evolution of the elusive Proto South China Sea marginal basin

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Abstract:

A range of interpretations of regional geology have led to diverging models describing the elusive predecessor marginal basin to the South China Sea, with significant implications for interpreting regional extrusion tectonics and volcanic episodes. Interpretations contrast between the presence or absence of the Proto South China Sea, while models arguing for a Proto South China Sea also diverge in the geodynamic origin of the marginal sea as either 1) a trapped piece of proto Pacific (namely, Izanagi) crust, or 2) sourced from back-arc opening along the east Asian margin. In this presentation I will provide a comparison of proposed models for the Proto South China Sea, and I will argue that the existence of a Proto South China Sea is a necessity for reconciling multiple and independent geological constraints. First, a back-arc basin along east Asia in the Late Cretaceous helps explain tectonic subsidence curves, the presence of Late Cretaceous ophiolites on Mindoro, and also the abandonment of Andean-style arc volcanism on the continental margin. Second, regional basin histories and even the tectonic structure of Luzon Island and northwest Borneo suggest continental or arc fragments from east Asia were accreted in both settings. And finally, the subduction-related volcanic history on Borneo, the presence of mapped sutures, evidence of subducted slabs in seismic tomography, requires significant south-dipping subduction of a Proto South China Sea. However, interpretations of a number of features, including the Billiton Depression, the Bentong-Raub Suture, and the West Baram Line on Borneo, and the Natuna Islands continue to provoke continued divergence in models for the region. Reconciling these interpretations will improve our understanding of paleogeography, basin evolution, sedimentary provenance, and regional geodynamics.

Keywords: Tectonics, Geodynamics, Proto South China Sea, Subduction

Session One: Advances in Marginal Sea Research

Sediment Transport, Chemical Weathering in the South China Sea

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Abstract:

The South China Sea is supplied by sediment by a variety of both large and small rivers draining southern China, the Indochina peninsula and Borneo. The export of sediment into the deep basin is strongly controlled by the geometry of the continental shelves and the sea level. Coarser sediment in particular tends to be ponded near river mouths during highstand sea levels and only be deposited into the deep water during glacial lowstand times. In particular, in southwest South China Sea the Sunda Shelf represents the biggest low latitude continental shelf on Earth and during sea level low standards must be supplying sediment from the Malay Peninsula and the catchment of the modern Chaophraya River. Chemical weathering on the exposed continental shelf combined with the growth of tropical forests would be important in drawing down atmospheric CO_2 and intensifying the global cold period. Drainage reorganization of the major rivers flowing across this and other shelves affects the dispersal of sediment into the South China Sea, as well as acting as a significant control on biodiversity within this hotspot region. Rising sea levels across the region, particularly in the Gulf of Thailand, help in the establishment of coastal wetlands which are one of the largest sources of methane to the modern atmosphere. The continental shelves of Southeast Asia appear to be acting as amplifiers to the global climate in making the warm phases warmer and the cold more intense. Synthesizing the existing data sets that constrain our understanding of sediment dispersible across continental shelves using big data and artificial intelligence methods is critical for modelling the performance of the continental shelves in the near future, especially in the context of sealevel rise driven by global warming over the next century. Understanding how to control the sediment flux will be important in moderating the impact of sealevel rise on coastal environments across the region.

"Urban Seas" in the _U.N. Decade of Ocean Science_ (2021-2030)

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Abstract:

Coastal embayments or estuaries hosting major densely populated port-cities may be called "Urban Seas". Such major trading/industry population centers are "hot spots" within a broader climate change framework. As loci of the most intensely focused impacts of human society on our global ocean, more than 100 such huge, ecologically stressed enclaves line the periphery of Earth's Ocean. The net impacts that fluxes from these coastal urban centers may have on the global ocean are unknown, and the complexities of these enclaves include severe environmental stresses linked to key economic vitalities of global-regional trade activities. Sustained efforts to ensure resilience within such human-ocean systems requires that delicate balances be sought regarding: 1) environmental compromise, 2) economic health, 3) national security, & 4) cultural awareness. Bold steps toward insightful long-term management of these urbanized ocean systems will require in-depth, sustained studies of the complex interactions among human society and natural marine/terrestrial ecosystems. A focused, but enduring **Urban Seas Initiative** (USI) could meet many challenges advocated by the _U.N. Decade of Ocean Science for Sustainable Development (2021-2032)_. Studies of this type offer an excellent focus for integrated international collaboration. Rapid progress could be achieved by involving cutting-edge technologies, like fleets of highly intelligent fixed & mobile autonomous sensor platforms deployed above, on, & within the waters of the Urban Sea drainage basin. Each platform involves standard & innovative data collection. Real-time delivery of all information to accessible data hubs could rapidly change the efficiencies of modelers crafting highly reliable 'Digital Twins' of key ecosystems within Urban Sea systems. This concept was recently discussed in a workshop that addressed resiliency in the Salish Sea, on the Pacific Coast that is shared by both Canada and the United States.

Keywords: Marginal Sea, Urban Sea, Long-term, Autonomous Vehicles,

"Digital Twins"

DDE Marginal Seas Task Group

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Abstract:

The Marginal Seas Task Group has been established within the frame of the Deep-time Digital Earth (DDE) program initiated by the International Union of Geological Sciences (IUGS). The general target of the Task Group is the development of a strategy to describe marginal seas' processes holistically as an interaction between geo-, ecosystem, and climate during the late Pleistocene, Holocene and the interaction with socio-economic systems during the Anthropocene. This strategy will include big data analyses, functional numerical models and AI approaches to answer three basic questions:

- How did marginal seas of different climatic zones and tectonic settings change their paleo-geography, -oceanography, and -environment during the natural climate and environmental variation of the Last Glacial Cycle?

- What are the future expectations for the development of marginal seas and their coastal zones facing the challenge of climate change and increasing human impact on the environment for this century?

- What strategies for sustainable development of the marine and coastal realm can help to mitigate the major threats to marginal seas driven by rising sea-level, floods, storms, (meteo) tsunamis, coastal erosion, silting and environmental hazards.

The main action of the Task Group in 2021 was the initiation of a DDE international research project "Morphological Evolution of Coastal Seas – Past and Future".

The time scale considered within the project will cover the last 130 kyr for paleo-scenarios and the time by 2100 AD for future projections (the time span of future climate modeling).

Three years goals for 2021-2023 of the DDE Marginal Seas Task Group can be summarized:

- to foster the DDE internal co-operation and scientific exchange with other Working- and Task Groups the external international multidisciplinary scientific co-operation,
- to develop the co-operation with international science programs and societal stakeholders to generate strategies for sustainable development of marginal seas and their coastal zones,
- to expand the team's creativity by involving young scientists in particular by developing the cooperation with the International Association for Mathematical Geosciences (IAMG).

Marine Traffic and Clean Energy Potential of the Marginal Urban Salish Sea

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Abstract:

Urban seas are marginal seas with large populations and industries dependent upon their use for commerce, food, recreation, transportation, tourism, and associated employment. Many urban seas, like the Salish Sea are inland estuarine seas that include archipelagos with narrow passages that constrict tidal flow. This geometry and physical conditions impede navigation that can lead to environmental impacts while the geology and oceanographic combination enhances clean sustainable renewable energy development. Potential for oil spills within the San Juan Archipelago (central Salish Sea), a diverse ecological attraction, is of increasing concern. Proposed shipping of diluted bitumen (dilbit) from pipelines along mainland B.C., Canada will increase cross-border tanker vessel traffic seven-fold, increasing the risk of a collision or groundings that may lead to a significant oil spill. Geomorphic interpretation and ArcGIS mapping of multibeam echosounder data were undertaken to determine the behavior and fate of sunken dilbit and the potential to impact critical marine benthic habitats. Sunken oil dispersal corridors, embedment sites, accumulation locations, and traps are identified on an "Oil Spill Assessment Map" along with critical subtidal habitats (e.g., rockfish, forage fish habitats) that might need protection. Dispersal corridors are areas of concentrated tidal flow and, therefore promising tidal turbine sites for electrical power generation. The consequences of both oil spill impacts from fossil fuels and the potential of clean renewable energy within the Salish Sea were entertained during the first workshop recently held to organize teams for the Salish Sea Solutions project. Cooperation with similar international teams working on common problems inherent to marginal seas, such as with the EMS Initiative was enthusiastically endorsed at the workshop.

Keywords: Urban sea, Marginal sea, Oil spill, Tidal power, Benthic habitats

Inception of a global atlas of Holocene sea levels

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Abstract:

Determining the rates, mechanisms and geographic variability of sea-level change is a priority science question for the next decade of ocean research. To address these research priorities, the HOLocene SEA-level variability (HOLSEA) working group is developing the first standardized global synthesis of Holocene relative sea-level data to: (1) estimate the magnitudes and rates of global mean sea-level change during the Holocene; and (2) identify trends in spatial variability and decipher the processes responsible for geographic differences in relative sea-level change.

Here I describe efforts of the working group to compile the database, which includes over 12,000 sea-level index points and limiting data from a range of different indicators across seven continents from the Last Glacial Maximum to present. All data were compiled following standard protocol that incorporates full consideration of vertical and temporal uncertainty for each sea-level index point, including uncertainties associated with the relationship of each indicator to past sea-level and the methods used to date each indicator. I describe the composition of the global database and identify gaps in data availability. Finally, I demonstrate some applications of the database to answer questions about a) patterns of spatial variability in Holocene sea-level change and their driving mechanisms and b) ecosystem response to past changes in climate.

Keywords: Global mean sea level; Holocene; Sea-level reconstruction; Glacial isostatic adjustment; Machine learning

Paleomagnetic Secular Variations spanning the late Holocene in the northern South China Sea

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Abstract:

Paleomagnetic methods have been widely applied to construct high-resolution paleosecular variation (PSV) records, in order to understand the geodynamo processes (e.g., Davies and Constable, 2017). Paleomagnetic secular variations were obtained from various materials over the globe, such as archeological materials, volcanic rocks and widespread sediments (e.g., Snowball et al., 2007). Both sides of the Atlantic region witnessed the blooming progresses of the PSV studies, yielding the development of Geomagnetic field model associated with the well-known flux lobes in the Northern Hemisphere (e.g., Avery et al., 2017). Such study about the regionally geomagnetic variations in East Asia is still rare (e.g., Zheng et al., 2014). In this study, a paleomagnetic analysis was performed on samples from the coastal area in the northern part of the South China Sea, based on the CN-PL Project Expedition. A new high-resolution record of paleomagnetic secular variation since in past 2000 years /ca. 2 ka BP was evaluated. Rock magnetic properties revealed the dominance of a pseudo single domain ferrimagnetic component. Distinct variations of magnetic concentration between the upper and lower parts could potentially correspond to magnetic transformation under various redox conditions (Roberts et al., 2013). There are continuous negative inclinations that may indicate a possible geomagnetic excursion in the late Holocene. However, due to no excursion within this time interval was reported in previous studies, this possible excursion should be considered discreetly and needs more work to verify. Thus, comprehensive and multicore analysis of paleomagnetic study is still necessary to understand the mechanism of remanence acquisitions in this

area, and then would provide alternative tool of the chronological frame establishment for paleoenvironmental research.

Beach placer deposits in Guangdong province, South China

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Abstract:

The REE (Rare Earth Elements), known as a critical resource for high technique, has driven an attention from academic and commercial fields in worldwide. In the prior tasks of finding more economical rare earth deposits, and recycled using with tailings management, there have plenty of scientific research should be operated as urgent behavior. The placer deposit, as one of important REE deposit types, is characterized by HREE (heave rare earth elements; Gd - Lu + Y), which is especially critical and scarcer than LREE (light rare earth elements, La - Eu). Some placer-type REE deposits and many REE ore assemblages are found from the coastal areas in South China. However, as the shortage of funds and limitation of technology, the exploration and study of these deposits had been halted for almost 30 years. The purposes of this lecture are to discuss predicament of South China Placer-type REE deposits exploration, as well as the improvement of exploration methods and research methods in recent years.

Keywords: Beach placer, REE resources, South China

Marginal Sea Research and Mathematical Geoscience

-- the International Association for Mathematical Geosciences (IAMG) Keynote

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Abstract:

The International Association for Mathematical Geosciences (IAMG) was founded in 1968 in Prague, with a mission to promote worldwide the advancement of mathematics, statistics and informatics in the geosciences. Currently the IAMG has membership from 63 countries across the world. The IAMG is an affiliated association of the IUGS and IUGG. IAMG is pleased to be a Founding member of the first IUGS-recognized big science program - Deep-time Digital Earth (DDE) – which was officially launched at the 73rd IUGS Executive Council Meeting and DDE Forum, February 2019 in Beijing, China. The Marginal Eurasian Seas is a joint Initiative by IAMG and IUGS-DDE which was first presented at IAMG2019 in Penn State, US, August 12-16, 2019 with a further planned presentation at a joint symposium on 'Geoscience Information-Integration' with the CGI-IUGS, OneGeology and CCOP, at [36]th IGC2020, March 2-8, 2020. The IAMG supports research innovation through deep data learning, spatial data analysis, numerical modelling and informatics in marine geo- and environmental sciences with the goal of developing sustainable strategies in marginal sea research.

Keywords: IAMG, Mathematical geosciences

Marginal Sea Research in Myanmar: Past, Present and Future

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Abstract:

Myanmar, third largest marine territory in ASEAN, had missed the opportunities for five decades, while Myanmar's neighbors and other ASEAN members are efficiently exploiting the marine frontier for their economic growth and investing in research. Those opportunities were marine science education, offshore oil and gas exploration, and lack of coordination and governing in marine investigations, such as seabed mapping, geohazard and environmental monitoring.

Few geoscientific research expeditions were conducted by international institutions, CIRCE (1968-69/US), Andaman (2000/France), IMJOSC (2002/India), KH13-4 (2013/Japan), and their findings indicated both exciting new results and concerning facts on disaster risks and environmental impacts that needs immediate actions. With the changing social and educational reforms, capacity building activities in the marine geosciences education and research are in progress in the last 10 years and Japan, China and US engaged most.

There were two major research projects are in planning recently, one from SCSIO-GMGS, China and another from LDEO, US. SCSIO-Myanmar project plans to investigate the structure, evolution and catastrophic potential of the Andaman Sea Basin and the Sunda subduction zone, and LDEO-JAMSTEC-Myanmar project focus in offshore Rakhine near border with Bangladesh.

In the future, consultation with the Seabed 2030 Project and UN Ocean Decade organizers may produce a seabed mapping cooperation project as well as some UN Ocean Decade actions. Compiling existing dataset from various ministries is first step to start and then organize cruises for mapping in missing areas and training marine geoscientists under the international cooperation through EMS initiative network and international partners. New results from Andaman Sea will have great impact to the regional marine geoscience.

Keywords: Myanmar marine geoscience, Andaman Sea

Artificial Intelligence and Machine Learning in the Geosciences

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Abstract:

Data analytics have become increasingly important in geosciences and are used in all aspects of the science. Recent breakthroughs have occurred with the advent of dramatically expanded capabilities in cloud computing, and in the collection, processing, and storage of data. This presentation focuses on three key examples of breakthroughs: AI in the use of identification and classification of lithological, paleontological and surface geology; ML to merge, combine and quality-control large data sets; ML to be able to develop simulations used in creating geological models of the subsurface for uses such as geothermal energy, climate change, and tectonism. The presentation will also discuss the new capacities developed by the Deep-time Digital Earth initiative.

Keywords: Artificial intelligence, AI, Machine learning, Geosciences, Deep learning, Data architecture, Data analytics, Geological models, Simulations, Climate change simulations, Identification, Classification, Data management, Data architecture

Genesis of the carbonate bedrock fragments from Mendeleev Rise based on its isotope-geochemical characteristics

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Abstract:

The Arctic Ocean and its marginal seas have a variety of geological structures, representing issue of current interest due to their origin. One of them - the Mendeleev Rise belonging to the Central Arctic rises, considered as an Arctida fragment that has tectonically connected to the Eastern Siberia continental margin. Since this region is difficult to access, the reliable data about geological characteristics is highly valuable. Such example of the data could be the bedrock fragments sampled from Mendeleev Rise during the Russian Arctic expeditions of 2000-2012 organized by Russian Ministery of the Mineral Resources and Russian Minestery of Defence. The principal problem in studying these deposits is to distinguish products of bedrock destruction and the Ice Rafted Debris (IRD) which were moved from the original location by floating ice and icebergs. Revealing the source of IRD-rocks is the other issue. For the long time the Canada Arctic Archipelago is hypothesized as the main, or even, the only source of carbonate rocks in the IRD. This source of rocks is represented by the Paleozoic Victoria Island formation and the Neoproterozoic Shaler Supergroup formations (Wynniatt, Kilian, etc.). Another potential source of carbonates is in IRD - the Northern Chukotka region and adjacent deep-water area. A geochemical dataset for these regions is available and allow to reveal the geochemical features based on isotopic composition of carbon ($\delta^{13}C$), oxygen ($\delta^{18}O$), and strontium ($^{87}Sr/^{86}Sr$) in dolomite and limestone samples, as well as distribution of rare earths elements (REE). It is shown that Wynniatt Formation reveals much heavier carbon characteristics than the IRD samples, and the Paleozoic carbonates of Victoria Island show higher $\delta^{18}O$ values. Paleozoic carbonates of the Chukotka belt located in a separate area of lower oxygen values and heavy carbon composition. Available data of rare earth elements distribution is also show differences in spectrum shape. The Victoria Island Formation carbonates are depleted in all REE; the Wynniat Formation carbonates are depleted in heavy REEs and have convex spectra

in the middle of REE distribution. Chukotka carbonates have peculiar spectra; many samples are characterized by Ce- and Y-anomalies. Eventually we have distinguished geochemical and isotopic features for each group of considered region (Canada Arctic Archipelago, Mendeleev Rise, Chukotka region). These results could provide preliminary criteria for discrimination of carbonate rock fragments into autochthonous and allochthonous clusters and distinguishing their sources.

Human impacts and their interactions in a large northern marginal sea (Baltic Sea region)

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Abstract:

Coastal environments, in particular heavily populated semi-enclosed marginal seas and coasts like the Baltic Sea region, are strongly affected by human activities. A multitude of human impacts, including climate change, affects the different compartments of the environment, and these effects interact with each other.

As part of the Baltic Earth Assessment Reports (BEAR), we present an inventory and discussion of different human-induced factors and processes affecting the environment of the Baltic Sea region, and their interrelations. Some are naturally occurring and modified by human activities (i.e. climate change, coastal processes, hypoxia, acidification, submarine groundwater discharges, marine ecosystems, non-indigenous species, land use and land cover), some are completely human-induced (i.e. agriculture, aquaculture, fisheries, river regulations, offshore wind farms, shipping, chemical contamination, dumped warfare agents, marine litter and microplastics, tourism, coastal management), and they are all interrelated to different degrees.

We present a general description and analysis of the state of knowledge on these interrelations. Our main insight is that climate change has an overarching, integrating impact on all of the other factors and can be interpreted as a background effect, which has different implications for the other factors. Impacts on the environment and the human sphere can be roughly allocated to anthropogenic drivers such as food production, energy production, transport, industry and economy.

We conclude that a sound management and regulation of human activities must be implemented in order to use and keep the environments and ecosystems of the Baltic Sea region sustainably in a good shape. This must balance the human needs, which exert tremendous pressures on the systems, as humans are the overwhelming driving force for almost all changes we see. The findings from this inventory of available information and analysis of the different factors and their interactions in the Baltic Sea region can largely be transferred to other comparable marginal and coastal seas in the world.

New model of seafloor spreading in the Eurasian basin (Arctic Ocean)：insights from the analysis of the sediment basin architecture

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Abstract:

For the first time tectonic reconstructions was carried out along the entire seismic dataset, including both Russian and international seismic lines. The sedimentary structure of the Amundsen basin is apparently different from the above idealistic model. There are two successive sedimentary sub-basins, separated by regional seismic reflector. Sub-basins show different basement inclination trend. If the upper shows inclination from spreading axis to the basin age, then the lower displays the opposite one. Rift valley is infilled with 1000-1500 m of hemipelagic deposits. The uppermost 300-600 (!) m thick hemipelagic sediment unit covers the entire basin. The age of the unit calculated through the sedimentation rate is at least 30 Ma even next to the rift valley.

Based on the analysis of the sedimentary cover of the Eurasian Basin (Arctic Ocean), four stages of evolution of the sedimentation system were identified. During the first, Cretaceous - Paleocene stage, vast axisymmetric epicontinental Amundsen and Nansen paleo basins were formed on the shoulders of the continental rift. Similar rifting environments of the second half of the Cretaceous were recorded along the entire periphery of the Arctic Ocean from Greenland and Svalbard to the Chukchi Borderland. The second (Eocene) stage was characterized by gradual expansion of the sedimentary basin up to its present-day size, caused by accretion of oceanic crust in the Gakkel Ridge and seafloor spreading. The Eurican orogeny, which formed dextral De-Geer transform zone, was suggested as a main tectonic driver of the spreading stage. The third (Oligocene–Miocene) stage corresponds to the accumulation of undisturbed veneer of hemipelagic sediments of 300–600 meter thick, which covered the entire Eurasian Basin. Accumulation of undisturbed sediment sequence throughout the

Eurasian Basin indicates the cessation of seafloor spreading in the Gakkel Ridge and the establishment of a tectonic dormancy regime. The termination of the tectonic as well magmatic activity is recorded along the entire periphery of the Arctic Basin. The resumption of the seafloor spreading in the Gakkel Ridge occurred during the fourth (Pliocene–Quaternary) stage. We suggest that the re-spreading process in the Eurasian basin has tectonically been triggered by the activation of the similar process in the Norwegian–Greenland Basin.

Submarine ridges of the East Siberian Sea: lithology, morphology, genesis

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Abstract:

Submerged ridges located on the East Siberian Sea bottom around the New Siberia Island and near Kolyma River has been defined several decades ago based of nautical maps analysis, but their lithology morphology and genesis was a subject of speculations and discussions due to absence of geological and geophysical data. There was two main hypothesis of submarine ridges formation – Middle Pleistocene end-moraine ridges or longshore sand bars.

In 2020 VSEGEI has organized field marine cruise in frame of project of 1:1M scale State Geological Mapping. During expedition on board of R/V "Captain Voronin" 1300 km of subbottom acoustic-seismic survey, side-scan profiling, and multibeam echosounding were undertaken; 22 sediment cores (14.5 m total length) were sampled. Geophysical and geological (grain-size, geochemical, pollen, diatom analyses and radiocarbon dating) allowed subdivision of upper part of geological sequence into five acoustic-seismic units; the upper four units were sampled with gravity corers.

It was found that submerged ridges around New Siberia Island can be subdivided into two types according to their sediment composition and morphology. Ridges located at the distance less than 30 km from the coastal line composed on will sorted fine-grained sand; they have steeper marine and gentle coastal slopes. Ridges of this type are interpreted as Holocene longshore sand bars. Submerged ridges, located at the distance more than 30 km from the shoreline are characterized by opposite morphological features. Ridges consists of very dense homogenous silty-clays (clayey silts) without coarse material and dated from 13,5 kA BP (top) to 15,5 kA BP (bottom). These data contradict to hypothesis if glacial origin the ridges.

Keywords: East Siberian Sea, Quaternary deposits, Submerged ridges

Sea Level Changes in the Straits of Malacca During Late Pleistocene to Holocene Based on Sediment Records

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Abstract:

The sea-level rise following the Last Glacial Maximum (LGM) was the most important events in shaping present-day continental shelves. Understanding how LGM-Holocene sea level behaved and its subsequent effects on the development of seabed and coastal landforms constitute the basis for understanding and forecasting of future sea level trends and is an important and critical especially in addressing the management of the seabed and coastal resources. The aim of this study is to reconstruct the paleo-environmental changes in the Straits of Malacca using sediment characteristics and geochemical records and their potential use to establish the sea level index points and construct a new relative sea level (RSL) curve during the Late Pleistocene-Holocene epoch. A total of fifteen (15) sediment cores from three (3) different regions of the Straits of Malacca were selected and analysed for grain size, carbonate and organic contents, geochemical elements (major, minor, trace and REEs) and radiocarbon dating (C14). The results indicate the sedimentation rates in the northern region (offshore Perlis) is 0.33-0.50 mm/year, middle region (offshore Kedah and Penang) is 0.01-2.00 mm/year and southern region (offshore Perak and Selangor) are higher of 0.50-6.96 mm/year during late Pleistocene to Holocene epoch. Based on the distribution of sediment characteristics such as grain size, organic and carbonate contents showed, the transportation of sediments in Straits of Malacca and their behaviour is dependent to the source of sediment, current circulations and rate of sea level rise. The distribution of major, minor, trace and REEs elements also have shown different patterns with strong correlations indicated different types of sediments lithology deposited in different environment. The rates of Relative Sea Level Rise (RSLR) are identified in

this study indicate that between 15,470 to 6,985 cal year BP, the Straits of Malacca was inundated with rate of sea level rise between 2.10 mm/year to 25.95 mm/year during late Pleistocene to Holocene period. In conclusion, with the given importance for the Straits of Malacca as a far-field region, the paleo sea level rate found could serve as a strong base-line data for future sea level forecasting and modelling and its implications in Malaysia.

A Coupled Thermo-mechanical-Surface-Processes Model in the Northern Passive Continental Margin, South China Sea

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Abstract:

The northern basin in South China Sea (SCS) is a promising area of passive continental margin for exploration of oil, gas and natural gas hydrates. We study on how the erosion and deposition are coupled with thermodynamic processes involved in the deep evolution through numerical modelling in this northern passive continental margin of SCS. The transformation of subsidence, erosion and depositional patterns in different tectonic movement stages can be described by the context changes in process of lithospheric deformation (rifting, bidirectional expansion, unidirectional subduction and extension, passive compression). However, previous models cannot simultaneously explain the coupling spatiotemporal changes, and overestimate the complexity of deep evolution and the effectiveness of simplified deep dynamics process on the surface process constraints. We assume that weakening of lithosphere will balance the deformation through extended flow of the lower crust in numerical simulation. Thus, interaction between the lower crustal flow, thermal evolution, and sediment loading/unloading can explain the complex tectonic deformation and basin evolution recorded in this passive continental margin. We perform a series of fully coupled three-dimensional thermal-mechanical numerical experiments in three stages, including thermal-mechanical and surface process coupling with different initial models and physical parameters. The complex interaction of tectonics and surface processes in the passive continental margin can be illustrated through numerical modelling, including three stages as follow.

1) Continental rifting: The lithosphere was stretched rapidly to form a graben, and differential strain leads to differential erosion and deposition, forming a staggered and "stepped" uplift and depression.

2) Oceanic basin expansion: As the lithosphere became thinner and the asthenosphere upwelled, a full lithospheric-scale macroscopic strain field coupled with changes in the layered lithospheric viscosity. Upper crustal-scale strain bars were formed in the center of the ocean ridge. Those control differential erosion and deposition of the vertical ridge axis of ocean basin and distribution of the platform along ocean ridge axis.

3) Ocean ridge migration: Far from ocean ridge, the northern part was more likely to form thicker deposits in the early stage, while the sedimentation in latter was controlled by terrestrial source supply. Transform faults played a role in controlling the formation and evolution of large strike-slip basins and uplifts, such as the Baiyun oil and gas depression, out of Pearl River Mouth area.

Evaluation of the Geological Environment Quality in the Northwestern South China Sea

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Abstract:

In order to promote the construction of marine ecological civilization a comprehensive marine geological environment quality assessment is operated in a marginal sea area between Hainan Island and Zhongsha Atoll in the northwestern South China Sea (NW SCS), after utilizing large quantity of data and documents from series of marine geological survey results.

Based on the different aspects about the geological background, we select topography and geomorphology, environmental geology, and nature resources as three index layers. Meanwhile we sort 16 evaluation factors: 1) water depth, 2) slop, 3) tidal sand ridges, 4) scarps, 5) underwater landslides, 6) buried ancient river channels, 7) ancient deltas, 8) depressions, 9) active faults, 10) seabed pockmarks, 11) shallow gas, 12) diapir, 13) geochemical anomalies of heavy metals, 14) oil and gas formation reservoir assemblages, 15) oil-gas field distribution and 16) solid mineral prospective areas.

Numerical quantification of a unified evaluation for all evaluation factors is build. Through a comprehensive weighted index model and attribute superposition and calculation functions of geographic information system software, we assess the geological environment quality in the NW SCS. Ultimately, after final calculation results from these works, the evaluation area is divided into four geological environment quality grade areas. And geological environment characteristics and quality quantification a result of each area is respectively summarized as follow.

Zone I, is mainly in shallow water less than 100 m water depth with relative flat topography and relatively coarse substrate, getting index of 4.24 - 4.86 as great level of geological environment quality. The buried ancient channels are local geological hazards. The Placer is main mineral resource at here, and some small locations have heavy metals' content abnormity. This zone has most intensive human activities, and a hot spot with human development constructions.

Zone II, is mainly on the outer shelf and top areas of the Xisha Atoll and Zhongsha Antoll platforms, less than 200 m water depth, but far away from mainland, with relatively flat topography (mostly less than 3°gradient) and silt type of sediments, getting index of 3.68 - 4.24 as good level geological environment quality. Buried ancient river channels, ancient underwater deltas and local small-scale landslides are the mainly geological hazards. Placer abnormalities are in some areas, while oil and gas resources are relatively rich. Although exploration and construction are difficult at there, this zone is also a focus of human development activity at present and will be in the future, due to abundant oil and gas resources.

Zone III, is mainly on the upper to middle slope, with large area of about 200 – 3000 m water depth, with relatively steep, occurred underwater terrains (3°- 5°gradient) and with diversity substrate of silt, sandy silt and sandy mud, getting index 3.11 - 3.68 level of normal. The environmental geological factors are more complicated in this zone, and geological hazards are small-scale landslides and active faults. This zone has certain potential for oil and gas resources, with large thickness of sedimentary basin and prospect of natural gas-hydrate. While, the development and utilization of this area is relatively difficult, comparing to Zone I and II.

Zone IV, is mainly on the outer shelf to upper slope, with 200 - 1000m water depth ranges, with very steep topography, getting index below 3.11 as a poor level. Due to lots of seabed terrains, canyons genesis, ranging gradient from 5° to 24°, geological hazards are manifested as large-scale submarine landslides and collapses. The geological environmental factors are more complicated, with active faults and unnormal local heavy metal content. This zone crosses the Qiongdongnan Basin to Xisha Trough Basin, with natural oil and gas, gas-hydrate prospects. Micro-manganese nodules appeared with a prospective view for construction sand and heavy minerals. Although here is rich in resources, but engineering geological condition is very poor. In exploration and development activities, it is necessary to take precautions against geological disasters.

Session Two: Coastal morphodynamics and driving forces

Linking oceanographic processes to contourite features: Numerical modelling of currents influencing a contourite depositional system on the northern South China Sea margin

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Abstract:

Combining high-resolution bathymetry and 2-D seismic data with 3-D hydrodynamic numerical simulation results to identify quaternary plastered contourite drifts in the South China Sea northern margin (i.e., the Jianfeng and Yitong slopes), this study aims to disentangle the impacts of bottom currents associated with the intermediate and deep-water masses.

Upslope parts of plastered drifts (~1000–1200 mwd) are smooth and gentle (up to 1°) surfaces, which can also be classified as contourite terraces. They are characterised by non-deposition and sheeted deposition that indicate dominant flow conditions capable of transporting sediments. The responsible hydrodynamic forcing here is the anticyclonic South China Sea Intermediate Water currents, which flow eastward with a mean velocity of 2–3 cm/s. These are sporadically enhanced and can exceed 6 cm/s during high-energy intermittent events such as deep-reaching eddies.

The central parts of the plastered drifts, located seaward of the terraces, present a subtle mounded morphology (1°–2°, ~1200–1500 mwd) partly perturbated by wavy bedforms. The downslope parts of the plastered drifts feature step-forming slides/slumps with steep slope gradients (1°–5°, ~1500–2000 mwd). According to our simulation results, the depth range of the plastered drifts overlaps the transition zone between the intermediate and deep-water masses, wherein the simulated mean current velocity is 0–2 cm/s with variable directions, suggesting its deposition-favourable environment.

Steep (>2°) slopes beneath the plastered drifts (below ~2000 mwd) present along-slope truncations, including contourite channels and moats that indicate enforced currents

capable of erosion. Responsible hydrodynamic forcing is the cyclonic South China Sea Deep Water currents, which flow westward with a mean velocity of 3–5 cm/s and exceed 15 cm/s during high-energy intermittent events.

Effects of tides on river delta front morphodynamic evoltuion at tide-dominated funnel-shaped estuary, case study at the Pearl River Estuary (the Lingding Bay)

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Abstract:

This study examined river delta front morphology and depositional processes in a tide-dominated funnel-shaped estuary, such as the Lingding Bay in South China Sea. The results obtained from an analysis of historical bathymetric maps and numerical experiments of the morphodynamic dynamics are consistent and indicate that tides predominate the morphological shaping of the river delta front morphology (i.e. the west shoal of the bay). Accordingly, the eastward progradation of the shoal areas decreased from the upper to lower estuary. The resultant estuarine morphology could be characterised by exponentially decreasing cross-sectional bathymetric areas from the lower to upper estuary. This morphological evolution occurred despite intensive human disturbances. Reduced tidal influences may enhance the southeastwardly deposition of riverine sediments, while increased influences would enhance the erosion of the river delta front shoals. Furthermore, in cased of decreased tidal influences in the bay, higher discharges at the eastward channels than the southward channels, which promote the formation and development of the eastward channel. Also, less sediments are in suspension and deposited at the river delta front area, which make the estuary less funnel-shaped. Hence, the understanding of unique morphodyanmic evolution of the delta front at the funnel-shaped estuary significantly impacted by anthropogenic activities is important for the sedimentological restoration for the ecosystem as well as estuarine long-term management and planning.

Keywords: River delta front, Funnel-shaped estuary, Tide, Morphodyanmic evolution, Sedimentological restoration

Seamount related contourite drifts in the southern South China Sea: implication for complex seafloor morphology and ocean circulation

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Abstract:

Alongslope bottom currents are one of the major factors modifying the seafloor morphology. Sediments can be eroded, transported, and deposited by bottom currents, forming erosional and depositional morphological features. Topographic obstacles (i.e. seamounts, structural highs, diapirs) have significant impact on the behaviour and pattern of the bottom currents. Bottom currents are split up into several pathways because of the presence of the seamounts. The resulted sedimentary features generally show complex morphology and distributed in association with the bottom current pathway. However, the detailed interactions between seamounts and bottom currents remain poorly understood.

Seven seamounts that are located at the depth range of the South China Sea Deep Water (DW) are recognized in the southern South China Sea, providing a unique opportunity to exam such interactions. In this work, three moats and four contourite drifts are identified in association with the Changjun Seamount based on the interpretation on the multibeam bathymetry, oceanography, and seismic data. Moats have asymmetric U-shaped bottom profiles and are distributed along the northern foot of the Changjun Seamount. Contourite drifts show moderate-high amplitude, sigmoid to subparallel reflectors with the mounded geometry. These features are located at the core of the DW between 1200-2000 m water depth.

The interactions between bottom currents and the Changjun Seamount have two characteristics. 1) Sedimentary depositional processes occur on lee side of the seamount. DW-related bottom currents have relatively low energy and the eddy sheds from the main flow. 2) Contourite features are only generated on the gentle slopes slope (1-15°) of the Changjun Seamount. Submarine channels that are created by the gravity flow are

developed on the steep slopes (15-20°) of the seamount. The occurrence of the slope instability is observed when the slope gradient ＞20°．

A hypothesis - the 2021 physics Nobel prize significant for understanding the variability of marginal sea morphology?

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Abstract:

A 2021 recipient of the Nobel prize in physics was Klaus Hasselmann, who was recognized "for the physical modelling of Earth's climate, quantifying variability and reliably predicting global warming.". Is there something to learn for marginal sea studies? It is hypothesized that this is so, with taking Hasselmann's seminal paper "Stochastic Climate models" from 1976 as point of departure. According to this "Brownian motion"-ansatz, short-term, unprovoked fluctuations cause long-term variations. Thus, any long-term change reflects a mixing of forced and unforced variability. Does this have significance of the variability of morphology in China's marginal seas? Recently it was shown that in such seas considerable small-scale variations, for instance related to eddies, internal tides, fronts and other phenomena, take place. It is hypothesized that these small-scale (and short term) processes act upon morphology dynamics, which will integrate these variations in the spirit of the "stochastic climate model" so that slow and regional-scale morphological changes emerge. Indeed, CNN reported after an accident with a submarine in the South China Sea: "Those waters' environment and the sea bottom are in a state of slow but inexorable change … It is an area that requires constant bottom contour mapping". In this talk, the stochastic climate model as well as the knowledge about small scale, unprovoked variability in the South China Sea and in the Yellow Sea are presented, and the resulting hypothesis formulated.

Keywords: Stochastic Climate Model, Internal variability, Hydrodynamic noise, South China Sea, Yellow Sea, Morphological change

Barrier coast evolution in the Holocene - example from the southern Baltic Sea

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Abstract:

Barriers are common landform in southern part of the Baltic Sea. The studies were conducted on the barrier coast located in the eastern part of the Pomeranian Bay. Main study goal was to present the evolution of the barrier coast in the Holocene, with particular emphasis on the impact of sea level changes. To achieve this goal archival data from various studies covered the study area was obtained. Moreover, additional fieldworks (boreholes, trenches, GPR transects) and laboratory analyzes (grain-size, diatom, ostracod and mollusc, pollen analysis as well as radiocarbon and OSL dating) were made to supplement existing data.

Based on collected data three basic groups of deposits were identified in the study area: barrier substrate deposits, barrier deposits and Rega river outlet cone deposits. To investigate barrier evolution in the study area, sea level changes were also reconstructed for the last 8 500 years. In the period of 8 500-7 000 yr BP sea level increased from 17.0 m to 5.0 m below present sea level. In the period 7 000-6 000 yr BP sea level rose from 5.0 m to 3.5 m below present sea level. In the last 6 000 years sea level increased by 3.5 m.

In the early Northgrippian (8 000 yr BP) appeared first traces of marine influence in the study area. Coastline was located from 2 km to 12 km north of today's position. In the period 8 000-6 000 yr BP coastline migrated southward (landward) with a rate 2.0-22.0 m/yr. When Littorina Transgression ceased ca. 6 000 yr BP, coastline retreat fell to 0.23-0.65 m/yr.

The research revealed that in the study area occur three scenarios of barrier coast evolution: barrier that evolved from retrogradational to progradational type, barrier that evolved from retrogradational through progradational to retrogradational type and barrier that is retrogradational over its entire time of existence. The main reasons of

different history of barrier coast development in the study area, besides climate and sea level changes, were the barrier substrate relief and the time-varying amount of sand available for barrier formation.

Rate and dynamic of shoreline retreat – case of southern Baltic Sea

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Abstract:

One of the most serious issues in coastal management is coastal erosion. In terms of adaptation and prevention the phenomena it is important to recognize the temporal and spatial scale as well as its causes. The aim of this work is the case study one of the most rapidly eroded stretch of the barrier coast in Poland.

The area of interest is situated on one of the most natural stretches of the coast, free from anthropogenic influences along dozens of kilometers. Analyses of topographic maps and air photos were used to trace changes in the shoreline position from 1875 to the present, and detailed DTMs derived from airborne LIDAR were used to trace elevation changes within the beach and dunes during the last years. The analyses showed that rapid erosion takes place on 2.25 km stretch of the coast. The maximal retreat of shoreline between the years 1875 and 2020 reached ca. 150 m with an average rate 1 m/yr. However, this rate is not constant and can vary in time – for instance during the years 1980 and 2001 an average rate was 1,5 m/yr., while in the years 2010 – 2020 reached up to 5,0 m/yr. Comparison of detailed DTMs from the years 2016 and 2020 also showed dramatically negative trends within the area of interest expressed by the reduction the width of the beach, lowering the height of the beach and dunes.

The seabed morphology (offshore - behind the shoreface) cause that storm waves break closer to the shore within the area of interest than it is on adjacent sections, what is the main reason of the increased coastal erosion.

Keywords: Baltic Sea, Coastal erosion, Erosion rate, Barrier coast

Geomorphology of paleo-channels system on Northern South China Sea Shelf in last glacial maximum.

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Abstract:

To identify the buried ancient valley is obvious significance for understanding coastal sea sedimentation's development history and paleogeographic environment change, what related to land-sea interaction and influenced by global climate and sea-level fluctuation. This study utilizes high-resolution single channel seismic profiles from the northern South China Sea, out of Pearl River Estuary area, to discover geomorphological characters of buried paleo-channel systems in low-stand systems tract in the Last Glacial Maximum (LGM). We obtain preliminary results as follow.

(1) Three dendritic paleo-river networks formed during the LGM in term of low sea-level stage. The main paleo-channel runs from northwest to southeast, and the ancient river section gradually widens to the seaward.

(2) Paleo-channel width-depth ratio and cutting depth abstracted from the seismic profiles show that the main paleo-channel gradually deepened its cutting depth from northwest to southeast.

(3) Geomorphology of down-cut paleo-river channels are including U-shaped, V-shaped, boxlike-shaped (approximately rectangular) and W-shaped paleo-channel sections abstracted from seismic profiles. Boxlike-shaped paleo-channels mainly appear in main paleo-channels and large tributaries, while other types mainly appear in tributaries. Compound and double-layer (multi-layer) are also common, especially in the wider paleo-channels. In addition, asymmetric paleo-channel section is also common in the paleo-river system.

Keywords: Geomorphology of paleo-channels, Last Glacial Maximum/LGM, Single channel seismic profile, Coastal and shelf, South China Sea.

Paleogeographic Scenarios of the Northwestern Shelf of the South China Sea for the Last Glacial Cycle

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Abstract:

Milankovitch 100 to 20 kyr periodicities representing the 4th to 5th order sequence stratigraphic cycles are identified worldwide in the sediment architecture on the continental shelves. Based on this assumption and observations, a global sea-level curve for the Last Glacial Cycle is superposed with the GEBCO Digital Elevation Model of the South China Sea and adjacent areas. The target of this study is in particular to generate paleo-geomorphological models describing the formation of a delta which has been developed between MIS 4 and MIS 3, offshore South-West Hainan Island ("Hainan Delta") in the Beibu Gulf, fed mainly by sediment sources from Hainan Island. The scenarios—at 123, 65, 60.5, 56, 20, and 0.5 kyr BP—showed that the SCS functioned as an oceanographic interface between the Pacific and Indian oceans during the LGC. A Late Pleistocene paleo-river delta (Hainan delta) offshore west of Hainan Island (China) was an important sediment routing system on the NW shelf of the SCS. To understand the origin of the Hainan delta better, paleo-reliefs of DEM56kyrBP and DEM65kyrBP were reconstructed, using seismic stratigraphy, sedimentology, and back-stripping methods. Geostatistical and geometric models of clinoforms and delta geometry, as well as the courses of the reconstructed paleo-distributary channels and paleo-river valleys, supported the interpretation that most delta sediment could be regarded as erosional products from Hainan Island. We hypothesized that an

intensification of sediment supply outpaced SL rise during the Marine Isotopic Stages 4/3 transition, resulting in a normal regression during the formation of the Hainan delta. Morphodynamic modeling and meteorological data reanalysis further supported our interpretation that shifts in the Asian Monsoon system—combined with local meteorological effects on Hainan Island and with global SL changes—were the main drivers for the sediment source-to-sink systems at the NW SCS continental margin, during the LGC.

Session Three: Ecosystem dynamics

Epilithic diatoms along the coast of South Africa: Insights from baseline studies

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Abstract:

Despite the rich information on the taxonomy of marine benthic diatoms of South Africa curated by Prof. MH Giffen, the knowledge on their composition, diversity, spatio-temporal variations, and ecology around the coast of South Africa remains limited. This presentation will provide an overview of the recent benthic (epilithic) diatoms research at the Elwandle Node, showing results obtained from large and small geographical scale studies, revealing highly variable epilithic diatom abundances, species richness, and a patchy distribution along the coastline. Secondly, epilithic diatoms are known and used as indicators of water quality in freshwater systems. Can this be applied to marine waters? Given the susceptibility of our coastal marine waters to pollution, the potential use of epilithic diatoms for monitoring purposes has recently been investigated. Results have illustrated the rapid temporal variation of epilithic diatom assemblages in relation to environmental conditions. The use of diatoms as potential indicators of change along the coastline will be discussed.

Keywords: Coastal nearshore, Biofilm, Diatoms, Spatial patterns, Diversity, Temperature

Are harmful marine microalgal blooms and their societal impacts increasing? A 30 year global data analysis

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Abstract:

Here we mine the global data bases of HAEDAT (Harmful Algae Event Database; 9,503 events) and OBIS (Ocean Biodiversity Information System; 6 million microalgal records) from the period of 1985 to 2018 to test the widely stated contention of increased frequency and distribution of harmful algal blooms (HABs). Total global numbers of HAEDAT events showed a statistically significant increase over time, while the global number of geographic grids with one or more HAB events also increased but this was only weakly statistically significant. Because of large differences in the level of monitoring, HAEDAT trends were examined on a region by-region basis and

corrected for sampling effort using OBIS microalgal species records as a proxy. Based on these adjusted data, no evidence was found of a statistically significant, uniform global increase in the number of HAB events over the period considered. When expressed relative to monitoring effort, the number of HAEDAT events increased in five regions, showed no change in two regions, but decreased in two other regions. Within regions, trends of increase or decrease in HAEDAT case numbers varied and represented different HAB types, while other types decreased or stabilised. Our analysis points to intensified monitoring efforts associated with increased aquaculture production, and the regional emergence of new HAB syndromes or impacts, as key drivers of the increasing number of records of HAB events. Broad statements on global HAB trends increasing are not supported by the present meta-analyses, but trends need to be considered regionally and at the species level.

Diatom flora as a carrier of mercury preserved in the surface sediments of the Puck Lagoon (southern Baltic Sea)

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Abstract:

The aim of this study was to determine the role of the recent diatom assemblage in accumulation of labile and stable forms of mercury. Mercury is strong neurotoxin which can irreversible damages the human nervous system. This metal can contribute to the occurrence of the Parkinson or Alzheimer diseases. Diatoms are the basis of the food web. That why it is important to study accumulation of mercury by this small cosmopolitan group of algae. The surface sediments (129 samples) for diatom and mercury analysis were collected from the Puck Lagoon by Van Veen Grab sampler in August 2019.

The diatom analyses were prepared according to standard Batterbee procedure (1986). The counting method of Schrader & Gersonde (1978) was used. To estimate the concentration of diatom valves in the research material Bodén (1991) method were used. The mercury analyses were performed by thermodesorption method using the DMA-80 analyzer (Saniewska & Bełdowska 2017, Bełdowska et al. 2018). The relationship of five forms of mercury (Hg_{lab1a}, Hg_{lab1b}, Hg_{lab2}, HgS, Hg_{rez}) with the concentration of diatom vales was investigated.

A total of 157 species belonging to 51 genera were identified. The whole study area was characterized by the high frequency of the species preferring higher edaphic requirements such as *Amphora pediculus*, *Cyclotella choctawhatcheeana* and *Planothidium delicatulum*. Our results showed a relationship between the concentration of diatom valves and the concentrations of the total mercury (Hg_{tot}), mercury related to halides (Hg_{lab1a}) and with organic matter (Hg_{lab1b}). Higher concentrations of Hg_{tot} (99,92 ng g^{-1}) and the most toxic mercury associated with organic matter Hg_{lab1b} (93,6 ng g^{-1}) are associated with the vicinity of the Kuźnica Deep. Larger amounts of diatom valves have also been deposited in this area (up to 12,7 x 106 valves/g). In the entire area

covered by the study, the concentration of diatom valves was 0,5 - 12,7 x 10^6 (valves/g). Accumulated mercury by the diatom flora undergoes biomagnification. What is important, the accumulated forms of mercury by diatoms are bioavailable labile forms. This form can be easily transferred to higher levels of the food web and, as a consequence, entered by the human body.

Marine Benthic Diatoms of the Mediterranean Sea coasts of Turkey, with the contribution of rare and interesting taxa

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Abstract:

The interest in marine diatoms enhanced recently with exhaustive studies from different locations of the world oceans. However knowledge on taxonomy and biogeography of diatoms are still improving, the use of diatoms in different areas indicated the importance of the diatom taxonomy and their distribution in the coastal areas. The studies on the Turkish coasts which covers the longest coastline in the Mediterranean Sea had been limited so far. In this study, Turkish coasts of the Mediterranean Sea and the Aegean Sea were investigated in terms of diatom biodiversity and biogeography. Diatoms were collected from submerged stones and rocks from 11 locations. The results revealed that the biodiversity of the Aegean Sea coasts was rich compared to the Mediterranean Sea coasts. Altogether 537 diatom taxa belonging to 126 genera were observed, 152 taxa were observed in the Mediterranean Sea coast and Aegean Sea coasts were represented with 498 taxa. *Nitzschia* was the genera with most species represented with 57 taxa and followed by *Navicula* (52 taxa) and *Amphora* (40 taxa). Furthermore, several species were observed in the Mediterranean Sea for the time first time and in addition, species distributed to warm waters of the oceans were observed and their biogeographic distribution was expanded to the Mediterranean Sea. While The Mediterranean Sea and the Aegean Sea coasts are important touristic destinations, the high biodiversity of our results contributed to the biogeographic knowledge of marine diatoms and could give a better understanding of the anthropogenic impacts on the coasts for further studies.

Trophic Status in the coastal waters of the Sea of Marmara, Turkey

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Abstract:

The Sea of Marmara is a unique ecosystem connecting the Black Sea with the Mediterranean Sea. It is surrounded by the most populated cities of Turkey with more than 25 million residents and hosts the most extensive industrial and agricultural production of Turkey.

In this study, we evaluate the trophic status and water quality of coasts of the Sea of Marmara using the trophic index TRIX based on chlorophyll-*a*, dissolved oxygen, total phosphorus, and total inorganic nitrogen. Sampling was performed in thirty stations that were selected throughout the coastal areas of the Sea of Marmara, including freshwater inputs, industrial and urban locations, marinas, and the two straits in the spring and autumn of 2019 and 2020.

According to the TRIX index, the coasts of the Sea of Marmara were mostly mesotrophic (70%) and eutrophic (16.7%). The Guzelyalı coast of the Dardanelles Strait was the only oligotrophic location in all seasons (mean value: 3.8). The northwestern part of the Sea of Marmara showed mesotrophic conditions (4.2-4.7), while meso-eutrophic conditions were observed on the eastern coasts. The data showed that especially the coastal areas of Gemlik and İzmit Bay showed highly eutrophic characters due to dense population and industrialized areas and high inflow of freshwaters carrying great amounts of nutrients.

Keywords: Sea of Marmara, Coastal Waters, TRIX index, Water quality

The decadal variation of diatom species composition, abundance, and chlorophyll-a concentration in the northern South China Sea

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Abstract:

Diatoms are one of the main phytoplankton groups in the ocean, especially in coastal zones and upwelling systems. In order to explore the relationship between the interdecadal variability of diatoms and the climate change in the South China Sea (SCS), we have analyzed two sediment cores collected from SCS, a 315 cm long sediment core (M4 site, offshore, water depth 1409m) and a 64 cm long sediment core (DS site, nearshore, water depth 41m). Accordingly, the chlorophyll-*a* (Chl-*a*) concentration, and the species composition and valve concentration of diatoms were analyzed.

The sediment deposition rate at the DS site was 1.4375 cm/yr, which means 64 cm long sediment core covered the period from 1927 to 2019 AD. The Chl-*a* concentration was ranged from 17.18 to 162.40 μg/g sediment (wet weight), with an average of 69.39 μg/g sediment. The diatom absolute abundance ranged from 3962-32536 v/g (vales/gram of wet weight), with an average of 12808 v/g. The sediment deposition rate of M4 site is 0.36cm/yr, covering the period from 1144 AD to 2019. The Chl-*a* concentration was ranged from 2.70 to 159.28 μg/g sediment, with an average of 44.92 μg/g. The absolute abundance of diatoms ranged from 16×10^6 to 601×10^6 v/g, with an average of 143×10^6 v/g.

Chl-*a* concentration and the algae species composition and abundance of the two sediment cores were analyzed respectively. The diatom assemblage at M4 site is mainly composed of cosmopolitan, warm-water, and tropical species. The dominant diatom species in M4 includes *Thalassionema nitzschioides, Thalassionema frauenfeldii,*

Thalassiosira leptopus, Synedra gaillonii, Coscinodiscus argus, Thalassiosira oestrupii, Thalassiosira excentrica, Coscinodiscus crenulatus, Hemidiscus cuneiformis, Coscinodiscus asteromphalus, Coscinodiscus nodulifer, Coscinodiscus wittianus and *Coscinodiscus nodulifer*. The dominance of shallow warm-water species of diatoms gradually increased and replaced the deep-water diatom species, indicating the environmental conditions of the northern SCS area have been changed in the past decades. Furthermore, the increment of percentile contribution of cosmopolitan and upwelling-indicator species *T. nitzschioides, H. cuneiformis* and *C. nodulifer,* in recent years, indicates that the northern SCS has been experiencing warm and eutrophic conditions, which might be associated with invasion of the Kuroshio warm current and the Indian Ocean warm currents, climate warming, and the increase in precipitation and river input.

The diatom assemblage at DS site is mainly composed of widespread and warm water species. The dominant species are *Cyclotella comta, Cyclotella striata, Melosira sulcata, Thalassionema nitzschioides, Actinoptychus undulatus, Actinoptychus annulatus,* and *Coscinodiscus marginato-lineatus*，most of them are typical coastal low-salt species or coastal brackish water species. The change of Cha-*a* content at DS site is negatively correlated with diatom concentration, which may be due to the fact that benthic animals feed on diatoms, which affects the corresponding relationship between chl-a and diatom concentration. From near-shore site to far-shore site, the population structure of diatoms is mainly from coastal species to warm-water species and tropical species, indicating the studied area in SCS is mainly affected by the SCS warm current and the northern coastal current.

Keywords: Chlorophyll-*a*, Decadal variation, Diatoms, Environmental variation, Upwelling, South China Sea

Two new genera and two new species of marine benthic diatoms from Southern China

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Abstract:

Diatoms (Bacillariophyta) are the most species-rich group of algae and over 70,000 diatom species have been formally described. They are abundant in marine intertidal environment, showing high diversity in terms of the number of species and the life form. Here, we present two new genera and two new species in the genus *Microcostatus* recently established from the marine intertidal zone in southern China. The first new genus is a second diatom with simonsenioid raphe and it has been accepted for publication in Journal of Oceanology and Limnology (DOI https://doi.org/10.1007/s00343-021-1067-0). This genus is characterized by the simonsenioid type of raphe lacking central nodule and having portulae, perforated fibulae, fenestral bars and hymenate areolae occlusions. Unlike most Bacillariaceae with two plastids including *Simonsenia*, the new genus has one plastid similar to those in *Entomoneis* and *Surirella*. The second new genus validly described as *Scoliolyra* is characterized by the presence of a twisted raphe system, apically elongate areolae, and striae interrupted by longitudinal H-shaped lateral areas in a form of valve face depressions. Two new species of *Microcostatus* are also presented, *M.* sp.1 and *M.* sp.2 are small diatoms with rounded ends, filiform and with slightly curved raphe and two axial depressions on both sides of the raphe sternum. Striae forming macroareolae are externally occluded by perforated hymenes. Molecular phylogenetic analyses revealed that these two species belonged in the Sellaphoraceae, rather than in the Naviculaceae. This study was financially supported by the National Natural Science Foundation of China (Nos. 42076114, 41876146, 41776124).

Keywords: Diatom, Marine, New genus, New species, Morphology

Changes of foraminiferal bio-facies in sub-surface sediment from shallow waters of Malacca Straits

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Abstract:

The Malacca Straits is one of the shallow, hyposaline and busiest shipping route in the world that divided the Sumatra and Peninsular Malaysia. This study assesses the vertical distribution of benthic foraminifera, their preservation, and its relation to the sediment characteristic from Malacca Straits. One short sediment core sample was collected from the south sector of Malacca Straits. The core was then divided into 10 subsamples at every 2 cm intervals. The samples were used for foraminifera identification, grain size and organic matter analysis. From approximately 3000 benthic foraminifera picked and identified, 9 species had >2% relative abundance down core. These species are identified as *Ammonia supera, Asterorotalia pulchella, Bigenerina nodosaria, Bolivina sabahensis, Cavarotalia annectens, Discorbinella bertheloti, Pseudorotalia indopacifica, Pseudorotalia schoerteriana* and *Textularia foliacea*. Among the 9 species, 6 of the species can be categorized as common (i.e., occurred at all core intervals) species which are *A. pulchella, A. supera, C. annectens, D. bertheloti, P. indopacifica, and P. schoerteriana* due to their presence in all samples. Rotaliida dominated the core sediment samples with 91.87%, followed by Textulariida (2.63%), Nodosariida (0.33%) and Lituolida (0.2%). The cluster analysis has showed that there are two biofacoies, both dominated by calcareous taxa. Further analysis by principal component analysis (PCA) has indicated that the agglutinated foraminifera belong to biofacies BF1 (the upper intervals) where the sediment were sandier. Additionally, the agglutinated species seems to disappear down core unlike the calcareous species. Similar finding has been reported from the northern sector of Malacca Straits. We believe that most of the agglutinated taxa do not preserve well along Malacca Straits, but the reasons to this still require further research.

Keywords: Tropical water, Agglutinated, Sediment core, Test preservation, Taphonomy

The genus Haslea at the omic age, not only new wine in old wineskins

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Abstract:

The genus *Haslea* was established in 1974 by R. Simonsen, to group all pennate diatoms with peculiar features of frustule morphology, such as lanceolate cells with acute ends and fine valve striation, and some characteristics only observable using Scanning Electron Microscope, like the structure of the cell wall, made of an inner grid-like layer and an outer layer of longitudinal strips, held together by thin bulkheads called saepes. The type species of the genus is *Haslea ostrearia*, previously known as *Vibrio ostrearius* (1820), then *Navicula ostrearia* (1824). This species has long been considered the only organism to produce a specific water soluble blue pigment, marennine, responsible for the greening of oyster gills. Since 2012, new blue *Haslea* species have been discovered, all of them characterized by the ability to produce marennine-like pigments. In turn, this has stimulated research on the diversity and the biology of these taxa, in particular thanks to the H2020 program GHaNA (The Genus *Haslea*, New marine resources for Aquaculture, 2017-2022). DNA barcoding and genetic characteristics are increasingly used to study this biodiversity, in particular to establish a molecular phylogeny and to develop comparative genomic investigations. The next step will be to obtain a reference genome, which, in turn, will allow conducting both fundamental and applied-oriented research, *e.g.* concerning genome evolution, specific biosynthesis pathways or marennine-like pigment properties. Indeed, possible

industrial applications concern food, feed, cosmetics or health biotechnology, as marenine-like pigments seem to display various biological activities (allelopathic, antibacterial, antioxidant, antiproliferative), which could be exploited if progress is made in the culture of *Haslea* sp. at large scale. Paradoxically, in natural environments, blue *Haslea* are not rare but usually unfrequently observed, to a few exceptions where they can form vast blooms easily observable by naked eye, due the intense emerald color of the biofilm in which *Haslea* cells develop, *e.g.* in Corsica (France), in the Adriatic Sea (Croatia), in North Carolina (USA). A comprehensive study of the development of these blooms could give some cue to achieve mass production of *Haslea* and biotechnology applications.

Keywords: Biodiversity**,** Diatoms, *Haslea*, Genomics, Marennine, Phylogeny

Abiotic factor's effect on the growth, photosynthesis efficiency and blue pigmentation of *Halea nusantara* diatom isolated from island Con Dao, Vietnam

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Abstract:

Diatoms from the genus Haslea are widely distributed in different geographic locations. In the coastal area of Vietnam, we have found 2 species of this genus in different habitats, one species is a non-blue diatom, and the other species derived from Con Dao Island has the ability to produce blue marennine pigment. Morphological and genetic analyzes of the last species were identified as *Haslea nusantara* that has also been found in the marine waters of Indonesia. *H. nusantara* produces a blue marennine pigment that shows a strong potential for many applications in biotechnology and aquaculture. We focus on their capacity of pigmentation and physiological characteristics in the outdoor conditions (30 – 34 $^\circ$C, 2500 – 4500 lux). Monocultures of *H. nusantara* with an initial cell density of 10^4 cells/mL were grown in the 250 mL Erlenmeyer flasks containing 150 mL of F/2 medium. Experiments were designed for two types of F/2 medium at different salinity (2.5% – 3.5%). H. nusantara grows best in media F/2 prepared with natural seawater derived from mangroves at a salinity of 3.5%. In these optimal conditions, after 9 days of culture, cell density at the end of the exponential phase is 16.67×10^4 cells/mL. The Fv/Fm (maximum photochemical yield of photosystem II) values ranging from 0.63 to 0.73 have shown the photosynthetic activity of this diatom has not been affected by these outdoor conditions. The extracellular and intracellular marennine content of the cultures is 34.05 mg/L and 7.81 mg/L respectively. These results have proved the potential to produce stably biomass and marennine of *H. nusantara* in outdoor conditions.

Keywords: Blue diatom, Outdoor cultivation, Marennine, Salinity, Photosynthesis efficiency

Sedimentological and microfossil records of modern typhoons in a coastal sandy lagoon off southern China coast

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Abstract:

To determine the characteristics and potential indicators of modern typhoon deposition in a sandy lagoon off the coast of Guangdong Province (southern China), we analysed the 210Pb, sedimentology, and microfossils of samples from ten cores obtained before and after the passage of Typhoon Rammasun in 2014. Typhoon deposition showed a thinning trend from internal areas of the lagoon to its mouth, with the maximum thickness inside the lagoon of ~35 cm. These typhoon deposits are dominated by overwash and differ from sediments deposited under normal weather conditions. Under normal weather conditions, lagoon sediment has a 210Pb curve that follows a model of exponential decay, has a unimodal granularity frequency curve, and lacks organic matter and microfossils (diatoms and foraminifera). However, 210Pb is low in the typhoon deposits, the grain size is coarse, and the granularity frequency curve is obviously bimodal. There are also abundant foraminifera in the typhoon deposits. We found a clear double-layered structure in the typhoon deposits, which was caused by strong hydrodynamic disturbance that mixed sediments originally from the offshore area with those of the lagoon. The lower layer has coarse-grained particles with medium sorting, low organic matter content, and low diatom content. The upper layer has fine-grained particles with poor sorting, high organic matter content, and abundant diatoms. The rate of fragmentation of diatoms in the upper layer was very high (40%−60%). The diatom assemblage contained offshore and freshwater species carried by storm runoff.

Therefore, we believe that the sediments of this typical sand bar–lagoon environment retain evidence of typhoon events along the southern China coast that is displayed in the marked sedimentological and microfossil characteristics.

Dynamics of the southern Baltic nearshore benthic communities in relation to temporally changing sediment plant material enrichment

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Abstract:

Benthic communities in the nearshore zone are thought to derive much of their nutrition from the input of plant material (PM) produced by the phytoplankton and deposited on the seafloor. As the phytoplankton shows a distinct seasonal signal in terms of temporal changes in the composition (quality) and abundance (quantity, incl. blooms), those changes might be assumed to be reflected in the dynamics of both sediment PM enrichment and benthic communities. To explore potential associations between sediment PM enrichment and the dynamics of benthic communities, we followed, in 2012-2013, temporal (seasonal) changes in the macro- and meiobenthic assemblages at 4 stations in the shallow nearshore area of the southern Baltic Sea. We also recorded concurrent changes in the sediment plant pigment (chlorophyll *a*, phaeopigments) content as a measure of PM enrichment. We observed a marked difference between the two years in terms of the meio- and macrobenthos dynamics and their association with the PM in the sediment. While a distinct seasonal signal was present in the benthos and in the sediment PM enrichment in 2012, such signal was much weaker in 2013. Consequently, the association between the benthos metrics (meio- and macrobenthos abundance, macrobenthos biomass) proved much more accountable, in relation to the sediment PM enrichment, in 2012 than in 2013. Those differences seem to be related, on the one hand, to differences in the strength of the overall phytoplankton bloom between the two years, while on the other, they might be also associated with differences in the *in situ* benthic primary production and its utilization by the zoobenthos, an aspect that merits further study.

Keywords: Baltic Sea, Benthos, Sediment plant material enrichment

Diatom mediated production of gold-silica and silver-silica nanocomposite-characterizations and applications

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Abstract:

Hybrid nanoparticles are of great interest nowadays as they are more stable and effective than single metal nanoparticles. Sometimes, noble metal particles are required to be immobilized by solid matrices like silica to maintain their catalytic activity and to reduce particle's aggregation and precipitation. For this reason, biogenesis of metal-silica nanohybrid with minimal cost and maximal yield are new avenue of nanobiotechnology. In the present investigation, diatoms- "Natural silica-nanofactories" have been found as efficient bioreagent for biogenesis of gold-silica ($Au\text{-}SiO_2$) and silver-silica ($Ag\text{-}SiO_2$) nanohybrid.

In this study, a screening program has been completed in relation to bioconversion of $Au\text{-}SiO_2$ and $Ag\text{-}SiO_2$ nanohybrid from auric chloride and silver nitrate solutions respectively, exploiting different diatom like *Nanofrustulum shiloi* (SZCZM1342), *Gedaniella flavovirens* (SZCZCh1268). *Gedaniella mutabilis* (SZCZCh153), *Phaeodactylum tricornutum* (NCC340), *Halamphora* sp. (SZCZP1454A), *Navicula korzeniowskii* (SZCZP1923). The biosynthesized nanoconjugates were characterized using Uv-vis spectroscopy, Energy-dispersive X-ray (EDAX) analysis, scanning (SEM) and transmission (TEM) electron microscopy. In Uv-vis spectroscopy, $Au\text{-}SiO_2$ and $Ag\text{-}SiO_2$ suspension showed the characteristic absorption bands at ~530 nm and ~420 nm respectively. Energy-dispersive X-ray (EDAX) analysis confirmed the presence of Au/Ag and SiO_2 nanoparticles in a composite form. SEM study revealed the deposition of composite particles on the siliceous frustules of diatom cells. TEM analysis confirmed the synthesis of spherical, triangular, rod, hexagonal, flower shaped metal-silica nanoconjugates with variable size ranges. The synthesized $Au\text{-}SiO_2$ nanoconjugates also showed a strong affinity in binding with DNA without any surface

modification. The particle-nucleic acid conjugate can be used in medical science in future.

It can be concluded that diatoms are potential source for rapid biosynthesis of biocompatible metal-silica nanoconjugates due to their high growth rate and high metal uptake capacity. This eco-friendly method provides a new dimension for production of hybrid nanoparticles in a cost-effective way compared to other physical and chemical methods.

Keywords: Diatoms, Biosynthesis, Nanoparticles

Coastal environments of Southeast Asia – diversity hot spot of brackish and marine Luticola (Bacillariophyceae) species?

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Abstract:

The diatom genus *Luticola* D.G.Mann contains almost 260 taxa which shows great variability in size and shape of the valve, as well as in the types of environment in which they may occur. Among many established taxa, only a few were reported from marine and brackish environments. Most of these species are poorly known or just recently described. The aim of our work was to investigate the diversity of the genus *Luticola* D.G.Mann in coastal waters of the Java Sea and South China Sea. In the studied samples, we observed the presence of eight species, including three that have not been described so far. Moreover, for one of the established species it was the first report on marine

environments. Additionally, due to the occurrence in large numer of some species in the studied materials, it was possible to provied the first detailed description of theier valve morphology.

Across seas and blooms: a study of diatom epiphytic communities of

Padina sp.

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Abstract:

Diatom communities are essential environmental indicators, thus considering their diversity is essential for a better understanding of the biotope dynamics. Benthic diatoms are one of the first components in coastal trophic chains and they play a key role in nutrient cycles and sedimentary flux. However, they remain poorly investigated. For instance, little is known about epiphytic communities of *Padina* sp., a representative macroalgae of costal subtidal landscape in warm temperate and tropical waters. Biotic and abiotic parameters structure the diatom assemblages on macroalgae. *Padina* sp. is an annual taxon so their epiphytic communities should mainly depend on the current year's environmental parameters.

The diatom epiphytic communities on *Padina* sp. were studied in different geographic areas: Mediterranean Sea (Corsica, France, and Croatia), Java Sea (Borneo and Sulawesi, Indonesia) and Indian Ocean (North coast of Madagascar). We also looked

at the evolution of the communities during a bloom of blue *Haslea* diatoms in Corsica and Croatia, where it occurs regularly as in other few natural environments (*e.g*., North Carolina, USA). Blue *Haslea* species are pennate diatoms that synthesize a blue-green watersoluble pigment, like marennine produced by *H. ostrearia* (Gaillon) Simonsen. These 'marennine-like pigments' may have allelopathic, antioxidant, antiviral and antibacterial properties, as demonstrated in laboratory conditions for marennine. Therefor the high density of blue *Haslea* could affect the epiphytic communities.

Diatom community of *Padina* sp. was determined using light and scanning electron microscopy, and when observed, blue *Haslea* species were identified using morphological and molecular approaches. Statistical analyses are currently being conducted to correlate communities' composition to environmental factors and bloom dynamics. This work allows us to increase our knowledge on diatom communities of the algae *Padina* sp., across different latitudes and to observe impacts of blue *Haslea* species.

Keywords: *Padina*, Diatom, *Haslea*, Diversity, Coastal

Reconstruction of post-glacial changes in the ecosystem of the Szczecin Lagoon (SW Baltic Sea) on the basis of geochemical research of its marginal reservoir – Lake Nowowarpieńskie

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Abstract:

The Szczecin Lagoon is a semi-enclosed, brackish water reservoir at the southern coast of the Baltic Sea, as well as a key element in the Oder river estuary system. In the middle of the southern shore of the lagoon there, is located an indented bay called Lake Nowowarpieńskie. The sequence of post-glacial sediments from this area is of bipartite character, indicating two main periods of the reservoir's development. The bottom of the lithological profile is represented by 3 m thick calcareous sediments – calcareous silt and lacustrine chalk, deposited under the conditions of a freshwater lake, fed with $CaCO_3$-enriched groundwater. The process was driven by the climatic factor - postglacial warming leading to the thawing of permafrost, activation of groundwater circulation and leaching of $CaCO_3$ from glacigenic sediments. A radical change in the reservoir's evolution occurred with the water level rise during the Littorina transgression, when marine water created a pronounced embayment, in place of the present-day Szczecin Lagoon. As a result of this hydrological factor, the originally isolated Lake Nowowarpieńskie was connected to brackish waters, what is documented by the geochemical record as well as fossil specimens of marine mollusc (*Cerastoderma glaucum*) preserved in the sediment. From that moment, the sedimentation of the gyttja began, which forms the remainder of the lithological profile. Its upper section reflects sedimentation under lagoonal condition with increasing human impact.

Keywords: Szczecin Lagoon, Geochemistry, Lacustrine chalk, Littorina transgression

Diatoms from sediments in the Taiwan Strait and their environmental indications

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Abstract:

The Taiwan Strait is a critical gateway connecting marginal seas of the East China Sea and South China Sea, with complex hydrodynamic conditions. Based on a study on 32 surface sediment samples from seabed collected in spring of 2016, and a sediment core Y13, the preliminary results are as follows:

(1) 31 genera and 85 species of diatoms were identified from the surface sediment samples. The dominant species are *Paralia sulcata, Cyclotella stylorum, Actinoptychus undulatus*, *Pyxidicula weyprechtii*, *Actioncyclus ehrenbergii*. The average diatom absolutely abundance is about 2160 valves/g. The statistical analysis shows that there is a weak correlation between sub-fossil diatom absolutely abundance and water temperature, salinity, but a strong correlation with water depth and mean grain size of sediment.

(2) 51 diatoms species belonging to 24 genera were identified from Core Y13 samples. The dominant species are *Cyclotella stylorum, Paralia sulcata*, *Pyxidicula weyprechtii*. The diatom absolutely abundance and species diversity of the sub-surface samples were high, and both of them decreased rapidly below the top interval. The average absolutely abundance is about 2160 valves/g.

(3) The average deposition rate in Core Y13 is about 1.27mm/a, by age dating to bottom sediments at about 1040 a. BP. Four diatom zones could be divided inY13 Core: zone I, 132~90 cm bsf. (ca. 976~1071 A.D.) interval was corresponding to a period of continuous warming in early warm period of the Medieval Ages, matching up the sea level rise slightly and climate warm gradually. Zone II, 120~90 cm bsf. (ca. 1071~1315 A.D.) interval was recording a period of relatively cold climate after the peak of warm period, and a slightly decreased sea level. Zone III, 90~22cm bsf. (ca. 1315~1844 A.D.) interval was corresponding to a period from beginning to the peak and end of the Little

Ice Age. Zone IV, 22~0 cm bsf. (since 1844 A.D.) interval has recorded a period of rapid warming since the 20th century, and a continued rising relative sea level.

Late Quaternary paleoenvironment change in NW SCS: the record from fossil diatom

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Abstract:

Diatoms are widely accepted as sensitive proxy indicators for paleoenvironmental reconstruction. On the continental margins, frequent environmental change offers broad ecological conditions for diatom growth and taxonomic diversity. Thus, diatom assemblages provide valuable information on past environment and water parameters. In order to infer Late Quaternary paleo-climatic, -oceanographic and -geographical changes in the Northwestern South China Sea (NW SCS), we studied diatom assemblages (sub-fossil and fossil material) preserved in sedimentary profiles of the Beibu Gulf and Xisha Trough. Results of our study reveal the following relationships between shallow and deep-water sedimentary diatom assemblages:

1) Diatom assemblages from NW SCS deep-water continental slope show significant variation between the eastern and central parts of the northern SCS continental slope. This is emphasized by the Late Quaternary domination of coastal species with higher percentages to the west. **2)** Sea levels significantly influenced NW SCS water depth (bathymetry), reconstructed through diatom assemblage shifts. This is documented by absolute and relative abundance of diatom species composition in studied sediments due to substantial transformation of regional paleoenvironment. **3)** High-resolution diatom profiles (cores from coast and middle part of the southern shelf) reveal eight stages of paleoceanographic and sedimentary environmental shifts since the last

deglaciation (including seven Holocene stages), which relate to ocean transgression and regression sequences that assist reconstruction of regional paleo-sea-level fluctuations. **4)** The NW SCS diatom biostratigraphic units correspond to Late Quaternary glacial-interglacial climatic cycle, indicating regional comparability and prospects for geological applications. **5)** During the "Younger Dryas" cooling event (ca.13 - 11.5 kyr BP), the diatom profile shows an abnormal and continuous paleotemperature increase in the study area. **6)** Diatom profile records sedimentary environment anomalies in the mid-late Holocene. An interesting phenomenon shows coastal sediments that do not contain fossil diatoms, whereas the central southern shelf exhibits a pronounced diatom presence that reveals the paleoenvironmental linkage within the bay. **7)** The "Neoglaciation", "Medieval Warm Period", and "Little Ice Age" are also reflected by shifts in diatom composition, responding to late Holocene global changes.

Keywords: Diatom, South China Sea, Late Quaternary, Paleoclimate, Paleoceanography, Paleogeographical changes.

Session Four: Methodological approaches and Geodata management

(including GIS and RS)

Spatial data integration and harmonization in the Adriatic Sea: How to make geodata FAIR and interoperable

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Abstract:

The Adriatic Sea (a semi-landlocked basin of the marginal Mediterranean Sea) has been the subject of a massive gathering of data from different sources and for multiple scopes by the Italian National Research Council (CNR). This work shows and discusses the main steps and challenges to make this spatial data FAIR (Findable, Interoperable, Accessible and researchable), through the implementation of a Spatial Data Infrastructure (SDI) aiming at harmonize the geodata collected through the years, overcome their heterogeneity and fragmentation, facilitate their integration, and foster their international accessibility. The SDI consists in a Spatial Relational Database Management System' (RDBMS) following the INSPIRE guidelines, linked to a WebGIS, and a metadata catalogue. The compliance with the FAIR principles represents a fundamental step to develop interoperability with National, European and International marine data infrastructures for the sharing and the preservation of multidisciplinary geodata regarding geological, oceanographic, biological, and anthropogenic aspects.

Keywords: Multidisciplinary geodata, Spatial Data Infrastructure, FAIRness, Interoperability

Marine Geological Mapping of Perak River, Perak, Malaysia: River Baseline Data Collection

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Abstract:

Sungai Perak (Perak River), is the second longest river in Peninsula Malaysia spanning approximately 400km flowing to the Straits of Malacca with its river mouth located at Bagan Datoh, Perak. The state of Perak is well known for its vast reserve of tin and other high value metals on land. Kinta Valley in Central Perak was historically was very rich in tin and the mines situated in the valley was amongst the most productive in the world. However, very little is known about minerals underneath the riverbed and seabed surrounding the vastly mineral rich state. A joint survey between the Department of Mineral and Geoscience Malaysia (Technical Services Division) and Wangsa Minerals Sdn Bhd was carried out to acquire seismic and multibeam imaging along the river mouth of Perak River. The survey was conducted via an Unmanned Surface Vessel (USV) called Suraya Surveyor, which was designed and built by Hidrokinetik Technologies Sdn Bhd, a local Malaysian entity. The USV was equipped with an Innomar SES-2000 Compact Sub-Bottom Profiler and a R2Sonic 2022 Multibeam Echosounder during the survey. Based on the multibeam bathymetry and seismic data acquired, our findings include but not limited to paleo-valley and old structures which show the potential of untapped mineral resources underneath the riverbed. In addition, the coastal morphology can contribute to the state's income as well as provide an in-depth understanding of the geopolitics and the evolution of population in the past. Further findings will be discussed in this paper.

Keywords: Sungai Perak, Coastal, USV, River Mining, Paleo-valley

Research on water depth inversion method based on substrate zoning around island's reef via remote sensing

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Abstract:

The bathymetric information around coral reef is out of vessel's investigation results in usually. Using the remote sensing image data to abstract water depth is a valuable selection for shallow water survey. This study selects Yongxing island in Xisha islands, northwest South China Sea to study a remote sensing inversion method which could suitable for obtaining the water depth data around that coral reef. As experiment, GF-1 and Landsat 8 remote sensing image data are carried out, through using the chart depth data. Firstly, an optimal inversion model is determined. After practicing that optimal inversion model, water depth inversion results of single source images are obtained according to substrate zoning results. Then, to merge the results from medium and high-resolution single source images inversion, are basing on the decision-making level classification fusion rules via fuzzy membership. After comparison on results of root mean square error and average relative error from the overall and water depth segmentation inversion results respectively, the experimental results show that:

1) the remote sensing inversion water depth results based on sediment zoning are better than those without sediment zoning;

2) accuracy of multi-source remote sensing inversion water depth fusion results based on seafloor substrate zoning is better than that of single source remote sensing inversion water depth results based on sediment zoning.

Keywords: Coral reef, Water depth retrieval, Remote sending data, Data fusion, Substrate zoning, South China Sea

How estuary evolution impacted on human activities -- a case from ancient harbors in Pearl River Estuary

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Abstract:

Estuary is not only the most variational area in nature, but also reformed frequently by human activities. Guangzhou, China is located on the estuary of the Pearl River and has been functioned as one of important harbor cities in past 2000 years in the worldwide. How evolution of the Pearl River Estuary has impacted on human activities, and how humans can adapt such changes is a very meaningful topic in coastal geoscience. This research has collected a large number of documents and maps, using sedimentology and river dynamics analysis to find results: Early manpower-built harbors on the inner side of estuaries far from the sea, which can greatly reduce the land losses caused by typhoons, and obtain more fresh water resources.

Through the delta body continues to expand seaward, the former harbor abandoned due to river blockage, and the new harbor migrates downstream along the river mouth. The site nearby river gate would be an ideal choice for harbor construction by two reasons: 1) a solid foundation is suit for building large harbor facilities; 2) less sediments load into the channel, which can keep river channel stable, and keep the harbor functional way for a long time. But if the seawater area near the gate silted up, the port would also face silting dangers and would have to be moved further downstream.

Keywords: Harbors, Pearl River Estuary, River Gate

Mangrove extraction and dynamic monitoring based on remote sensing data in Shenzhen and Hong Kong

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Abstract:

With the development of Shenzhen-Hong Kong Port Economic Belt, the contradiction between limited natural resources and the development of surrounding areas becomes increasingly prominent. The original ecosystem of "two bays and one river" in the planned area will be destroyed, and the protection of mangrove wetlands will also face great challenges. It is the basis of mangrove wetland management and protection to know the area, distribution and change of mangrove wetland in different periods. In this study, the area, distribution and dynamic changes of mangroves in Shenzhen Bay from 2000 to 2020 were studied by using Landsat data, Random Forest (RF), Back-Propagation Neural Network (BPNN) and Long Short-Term Memory Neural Network (LSTM). It is found that the combination of spectral information and texture information can obtain high-precision mangrove interpretation results when extracting mangrove areas from remote sensing data, and the LSTM method has the best interpretation effect compared with the RF method and BPNN method. In addition, based on the interpretation results of mangroves, this study analyzed the change of mangrove area and distribution in Shenzhen Bay from 2000 to 2020, and found that the overall mangrove area showed an increasing trend in the past 20 years, but showed a decreasing trend from 2015 to 2020.

Keywords: Mangrove, Remote sensing, Extraction, Dynamic change

Marginal Seas Database Inventory - concept, first approach and future steps

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Abstract:

Morphodynamic modeling of marginal seas requires fast and convenient access to databases containing necessary geological, oceanographic, ecological and climate data; characterized by specified data resolution and scale, satisfactory quality and easy accessibility. However, the process of searching for the appropriate database is time-consuming and the outcome may not be satisfactory. Therefore, a new concept of Marginal Seas Data Inventory (MSDI) was developed. MSDI is a user-friendly tool to support searching and downloading requested data, that can be further used for fulfilling certain scientific tasks. The "Inventory" is designed as an algorithm, asking the user questions, from general to more detailed, as a "pathfinder" to the most suitable platforms for data download. The presented version is a first approach to generate such inventory and is limited to exemplary processes and areas. One of main targets of the prototype is to develop a new approach in data searching by emphasizing the processes to be investigated and filtering databases using universal keywords system. Potential future steps in MSDI development would involve expanding the inventory to more tasks and areas as well as application of more sophisticated programming tools.

Keywords: Data management, Morphodynamic modeling, DDE, Marginal seas

Marine Geological Mapping of Pulau Songsong, Kedah Malaysia:

Coastal Baseline Data Collection

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Abstract:

Pulau Songsong (Songsong Island), Kedah is located about 8 km from the mainland of Peninsular Malaysia on the west coast of Yan Kedah. Pulau Songsong is a geosite in Jerai Geopark and has beautiful natural beaches which make it a popular destination especially among local tourists as vacation destination. Furthermore, the clear sea water surrounding the island allows visitors to witness coral reefs. As a result of the economic and environmental importance of this island, there is a need to collect information on coastal baseline data which includes bathymetry data surrounding the island, beach and near shore profiles as well as the characteristics of the beach sediment. The beaches of Pulau Songsong are made up of shingle beaches at the northeast part and sandy beaches at the south-southeast part of the island adding to the uniqueness of this island. Western and northern part of the island is made up by rocky and cliff coast. The analysis results of the baseline data collection such as bathymetry data, profiles data and sediment data can be used as fundamental information for any development purpose for preservation and conservation of the island. General information about surround depth, coastal morphology and beach characteristic of the island obtained, will be discussed further in this paper.
Keywords: Coastal Profile, Coastal Baseline Data

Sea level change and its impacts in the north of South China Sea

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Abstract:

Sea level change is one of the important indicators of global climate change. There are two main factors causing global sea level change: (1) specific volume sea level change, which is mainly caused by the change of seawater volume caused by the change of seawater temperature and salinity; (2) The mass term sea level change is mainly caused by various mass exchanges between the ocean, the atmosphere and the land (such as glacier melting, rainfall, runoff and evaporation). Over the past century, the global average sea level rise rate obtained from tide gauge data is 1 ~ 2 mm/a.

The sea level change in the northern South China Sea presents complex temporal and spatial scale change characteristics. Studying the behavior of sea level change on multiple time scales can detect the long-term correlation and potential Multifractal of this complex process. The purpose of this study is to explore the changes of sea level in the northern South China Sea in recent 20 years, combined with satellite altimeter data and tide gauge data, and analyze the changes of sea level height under different time scales and different factors.

Keywords: South China Sea, Sea level change, Temporal variation

An Introduction to DDE Metadata Standard

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Abstract:

DDE Metadata Standard has been issued in 2021 for the purpose to provide convenient digital data and knowledge discovery that helps achieve the vision of DDE by setting out requirements for the creation and maintenance of metadata for data sets, data set series, data services and online resources corresponding to the themes of DDE. It covers the appropriate geosciences data and knowledge release/publication and interchange in both spatial and non-spatial formats, and particularly with deep time characteristics of DDE program. Its main contents are focusing on discovery metadata and data services metadata for DDE digital resources classification and category, solution to unified identification, and geological historical time specification.

The draft version of the standard was released in October 2021 based on ISO19115:2014E as the core metadata standard of DDE to meet the needs of development of the program, and demands form DDE Working Groups and Task Groups (DDE WTGs) in particular, with reference to and compatible mostly with well implemented metadata standards of international initiatives and regional programs like OneGeology, INSPIRE, Dublin Core (ISO15836:2003(E)) and CCOP Geoinformation Metadata Standard. It is more normative in structures and definitions, and richer in contents and topic categories, resource origin and generation, earth resources and geological time scales for geoscience application. Following documentation format of ISO 19115:2014(E), it contains 5 entities, 39 elements in which 15 are mandatory, and

11 annex of code lists and 1 example. And its coverage of topic categories and geological history are wider and deeper than any other exist standards.

The DDE metadata standard is currently under review by experts from both DDE WTGs and other organizations worldwide. And an online APP for its implementation is also being developed for metadata collection which allows metadata Reusable online and following FAIR data principles to the most.

Keywords: Metadata, Standards, DDE, App.

Remote-sensing estimation of chlorophyll-a and suspended sediments concentrations in estuarine waters: A case study

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Abstract:

This study presents remote estimation of chlorophyll-a (chl-a) and suspended sediments concentrations via a case study in the Pearl River estuary in China. To test the performance of algorithms for the estimation of the chl-a concentration in these productive turbid waters, the maximum band ratio (MBR) and near-infrared–red (NIR–red) models are used in this study. Specific focus is placed on (a) comparing the ability of the models to estimate chl-a in the range 1–12 mg m−3, which is typical for coastal and estuarine waters, and (b) assessing the potential of the Moderate Resolution Imaging Spectrometer (MODIS) and Medium Resolution Imaging Spectrometer (MERIS) to estimate chl-a concentrations. Reflectance spectra and water samples were collected at 13 stations with chl-a ranging from 0.83 to 11.8 mg m−3 and total suspended matter from 9.9 to 21.5 g m−3. A close relationship was found between chl-a concentration and total suspended matter concentration with the determining coefficient (R2) above 0.89. The MBR calculated in the spectral bands of MODIS proved to be a good proxy for chl-a concentration (R2 > 0.93). On the other hand, both the NIR–red three-band model, with wavebands around 665, 700, and 730 nm, and the NIR–red two-band model (with bands around 665 and 700 nm) explained more than 95% of the chl-a variation, and we were able to estimate chl-a concentrations with a root mean square error below 1 mg m−3. The two- and three-band NIR−red models with MERIS spectral bands accounted for 93% of the chl-a variation. These findings imply that the extensive database of MODIS and MERIS images could be used to quantitatively monitor chl-a in the Pearl River estuary.

Keywords: Chlorophyll-a, Suspended sediments, Reflectance, Remote sensing

A New Correlation between SPT-*N* and SSPT-*N* values for Various Soil types in Peninsular Malaysia

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Abstract:

The Standard Penetration Test (SPT-*N*) is the most common *in situ* test for soil investigations. The Shearing Seismic Standard Penetration Test (SSPT-*N*) on the other hand is a new method using shearing wave with propagation exponent equation between the shearing wave, *Vs*, and hardness, *N* values without any need for borehole data. Due to the fast and accurate results that can be obtained, the SSPT has found many applications such as in the field rectification buried pipe line, the acid tank settlement and foundation design analyses, and the quality control assessment. Many of geotechnical regime and properties have attempted to correlate both the SSPT and the SPT-*N* values. Various foundation design methods have been developed based on the outcomes of these tests. Hence, it is pertinent to correlate these tests so that either one of the test can be used in the absence of the other, especially for preliminary evaluation and design purposes. The primary purpose of this study was to investigate the relationship between the SSPT-*N* and SPT-*N* values for different types of cohesive soil in Peninsular Malaysia. Data were collected from four different sites and the correlations were established between the hardness *N* values, principal stress-strain Mohr circle curve, cohesion, friction angle and vertical effective stress. A positive exponent relationship was found between the shearing wave, *Vs*, and the hardness *N* values of the soil. In general, the SSPT-*N* value was slightly lower than the SPT-*N* value due to the upper limit boundary of the soil layer.

Keywords: In situ Soil determination, Shearing wave, Hardness, Correlation, SSPT-*N*, SPT-*N*

Internal solitary waves observed on the continental shelf in the northern South China Sea from acoustic backscatter data

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Abstract:

Internal solitary waves (ISWs) are investigated offshore of Guangdong in the northern South China Sea (SCS) using high-frequency acoustic backscatter data of 100 kHz acquired in July 2020. Simultaneous XBT profiles and satellite images are incorporated to understand their propagation, evolution, and dissipation processes in shallow water at depths less than 50 m. The water column structures revealed by acoustic backscatter data and XBT profiles are consistent with a small difference of less than 3 meters. A soliton train with apparent vertical and horizontal scales of ~7 m and 100 m, respectively, is captured three times in 20 hours in the repeated acoustic sections, which provides spatiotemporal constraints to the solitons. The characteristics of ISW phase speeds are estimated from acoustic backscatter data and satellite data and using theoretical two-layer KdV and eKdV models. The acoustically observed phase speed of ISWs is approximately 0.4-0.5 m/s, in agreement with the estimates from both satellite data and model results. The acoustic backscatter method could be an effective way to observe hydrodynamic phenomena with high resolution in shallow water. This study improves our understanding of internal wave generation, propagation, evolution, dissipation, and its contributions to ocean mixing, sediment resuspension, and biological processes.

Keywords: Internal solitary waves, Propagation, Acoustic backscatter data, Shallow water, Northern South China Sea

Distribution, source and pollution level of gallium and chromium in Kelantan River sediments, Malaysia

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Abstract:

A total of nineteen surface sediment were collected at the Kelantan River, Malaysia, to evaluate the gallium (Ga) and chromium (Cr) contamination while assessing numerous factors that influences the distribution of both metals along the Kelantan River. The average concentration acquired are 39.22 ± 0.8 µg/g for Ga and 72.67 ± 2.0 µg/g for Cr, both in the sediments. Meanwhile, average concentration obtained in total suspended solids (TSS) was 973.73 ± 73.7 µg/g for Ga and 46.92 ± 3.7 µg/g for Cr, respectively. In this study, anthropogenic inputs along with monsoonal season led to the huge fluctuation along the river. The different concentration occurred in several station suggest that the variation of concentrations was highly depending on rates and source of metal concentration from terrestrial where continuous mobilization may require several successions of deposition onto riverbed sediment and subsequently increasing the metal concentration after several cycles of periodic mobilization. Enrichment factor (EF) and I_{geo} indicates severe enrichment were found along the Kelantan River. Principal Component Analysis (PCA) was employed to reveal the potential relation between different media (sediment and TSS) as pollutant deposition, carrier and the parameters in river channel. Three principal components were extracted in relation to media differences related to anthropogenic and natural sources.

Keywords: Chromium, Gallium, River, Sediment, Pollution