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ABSTRACT BOOK

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Sesto Convegno dei geologi marini italiani

La geologia marina in Italia

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Prefazione

Il 17 e 18 marzo 2025 si è svolto il 6° Convegno dei geologi marini italiani, l'appuntamento biennale di riferimento per tutta una comunità scientifica che, con approcci, metodologie e finalità diverse, condivide l'interesse per una disciplina affascinante come la Geologia applicata ad un ambiente ancora più affascinante come il mare. L'incontro non ha la presunzione di rappresentare tutto il panorama della ricerca in questo campo ma di certo ne rappresenta la maggior parte ed i temi affrontati sono un buono spaccato di dove e come sta procedendo la ricerca di base e applicata.

Il convegno unisce infatti ricercatori delle università, degli enti di ricerca, delle società private e degli enti di Stato per la gestione del territorio, in un proficuo scambio di esperienze con un aggiornamento sulle diverse attività in corso.

Il programma del 6° convegno è sempre più fitto, dato il numero crescente dei contributi (quest'anno oltre 70, che raccolgono le ricerche di 350 ricercatori), che richiederebbe una durata dei lavori ben oltre i consueti due giorni in cui il convegno è articolato sin dalla sua prima edizione.

Nonostante il serrato programma scientifico, c'è stato spazio per ripercorrere gli eventi di rilievo dell'ultimo biennio: una relazione ad invito (la prima nei convegni CGMI) sui risultati delle perforazioni IODP nel Mar Tirreno nel 2024; una tavola rotonda sulla cartografia delle aree marine nei fogli CARG, che sono in realizzazione in gran numero; il ricordo della professoressa Maria Bianca Cita, scienziata di spicco della nostra disciplina, che purtroppo ci ha lasciato recentemente. Nel convegno hanno trovato spazio anche la proiezione di un film e di un documentario su tematiche di geologia marina ed un racconto in 70 immagini della storia della nostra disciplina nel Regno d'Italia (1861-1945).

Il convegno ha riproposto la consolidata e apprezzata formula (che si va affermando anche in altri incontri scientifici, ma della quale rivendichiamo la paternità sin dalla prima edizione) di veloci presentazioni orali seguite da approfondite discussioni ai poster, sfruttando anche le potenzialità della Galleria Digitale del CNR che permette di presentare su grandi monitor formato "poster" anche profili, carote e dati sperimentali. Questa formula è ideale sia per franche discussioni nel merito scientifico delle ricerche sia e soprattutto per coinvolgere i giovani ricercatori che qui trovano un ambiente informale ed una palestra dove confrontarsi senza troppa soggezione con ricercatori più "maturi", per conoscere e farsi conoscere dalle aziende che lavorano nel campo.

E' stata ospitata, come di consueto, la riunione annuale della Sezione di geologia marina della Società Geologica Italiana, con la proclamazione del nuovo coordinatore; sono stati assegnati premi speciali alla carriera, premi ai giovani ricercatori per la miglior produzione scientifica, la miglior fotografia e il miglior videoclip, resi possibili dal supporto dalle aziende sponsorizzatrici.

Grazie al loro contributo, all'impegno dei volontari e al Consiglio Nazionale delle Ricerche che da sempre ospita il nostro convegno, è stato possibile mantenere l'appuntamento gratuito anche in questa edizione.

Il comitato organizzatore

Seismo-stratigraphic features of shelf margin prograding wedges along the Western Sicily offshore

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Keywords: seismostratigraphy, shelf margin wedge, sea level change, bottom current, Sicily.

Shelf margin prograding wedges have been shaped world wide by the effect of last glacioeustatic lowstand, when the global sea level fell more than 100 m and the palaeo-shoreline shifted seaward (Patruno & Helland-Hansen, 2018). In addition to this global factor, other ones of local impact (e.g.: tectonics, sediment supply) have influenced the growth pattern of coastal progradational systems that accumulated along the shelf margin during the lowstand.

We present results of seismo-stratigraphic analysis performed, by means of high resolution seismic profiles, on the shelf margin progradational deposits recognized along the western Sicily offshore where the following distinctive sectors have been investigated:

- northern sector of the Adventure Bank (a wide shallow water plateau located in between south-western Sicily and north Africa): here we have recognized some isolated shelf margin prograding wedges; the largest one consists of two main laterally stacked wedges with clinoform reflectors displaying oblique-tangential or sigmoidal configuration. A thin lens of high frequency, laterally continuous, prograding-to-aggrading reflectors lies in between of them, that onlap the top of the lower wedge. The two wedges show different width and vertical thickness, both controlled mainly by depth and dip of the downlap bottom surface;
- western Sicily mainland continental shelf edge: here we have observed a wedge shaped, 25 m thick, sedimentary unit made up by a succession of clinoform reflectors. The bottom surface is characterized by enhanced erosional truncation of underlaying reflectors and by downlapping terminations of the overlaying clinoforms which display an oblique-parallel geometry and erosional truncation of upper termination;
- southern sector of the Egadi Islands plateau: here we have detected a stack of prograding sedimentary wedges, up to 40 m thick, formed by oblique parallel-to-tangential clinoforms.

All the detected shelf margin prograding wedges reveal geometry and configuration related to the cyclic eustatic change occurred during Middle/Late Quaternary, as well as the effects of bottom currents transit: indeed, by means of erosional or depositional processes, bottom currents can shape the morphology of the seabed that in turn can affect the clinoform geometry as well as the thickness of the progradational wedges.

The outcomes of this research suggest that, if a very uneven morphology of the seabed occurs, the bottom currents, besides the tectonics and the sedimentary supply, can play a relevant role in controlling the geometry and the thickness of the prograding shelf margin sedimentary wedges.

Patruno S. & Helland-Hansen W. (2018) - Clinoform systems: Review and dynamic classification scheme for shorelines, subaqueous deltas, shelf edges and continental margins. Earth-Science Reviews, 185, 202-233.

The recurrence of hyperconcentrated flow events in a temperate coastal zone: a source-to-sink approach applied to the eastern coast of the Tyrrhenian Sea

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Keywords: river floods; morphometric analysis; event beds; marine archives; Southern Tyrrhenian Sea.

The continental shelves can act as repositories of event beds originated by hyperconcentrated flows (HFD) from flood-prone rivers. The analysis of HFD recurrence in the shallow marine sediment record may contribute to hydrogeological risk assessment in coastal areas. In accordance with the source-to-sink (S2S) paradigm (Amorosi et al., 2016; Casalbore et al., 2024), we examined the morphometry of the drainage catchments facing the Salerno Gulf (Tyrrhenian Sea) and their proclivity for generating hyperconcentrated flows, downhill. Then, a stratigraphic analysis of the shallow marine sediment record was carried out to verify the occurrence of HFD in the recent past (< 3 ky) (Alberico & Budillon, 2019).

This study aims to learn more about the coastal area dynamics by integrating on land and offshore observations. The methodology here proposed, considers the morphometric properties (hypsometric integral, hypsometric skewness, hypsometric kurtosis, density skewness, and density kurtosis) of the watersheds, the potential rivers' discharge, and sediment flow concentration predicted by using altitude- and extent-based observational lows. This approach enabled the identification of rivers prone to producing HFDs.

Offshore, sand-rich layers potentially linked to HFDs were identified by comparing their sand-mud ratio (S/M) to that expected by applying the relation governing the present-day distribution of sand at the seabed over depth in the Salerno Gulf. The analysis was performed down-core at three sites off the main river mouths (Sele, Tusciano and Solofrone rivers)

We found that a return period of major HF events ≤ 0.1 kyr can be inferred for rivers whose watersheds have a hypsometric index ranging between 0.2 and 0.3, coastal plains not exceeding 30% of the entire catchment area, and a maximum topographic height ≥1000 m and categorized as "dirty rivers", according to Mulder and Syvitski, 1995. A return period of approximately 0.3 kyr has been inferred for rivers whose watersheds develop for about 50% of their extension into low-gradient coastal plains and have hypsometric indexes ranging between 0.09 and 0.2. In this instance, they fall into the "moderately dirty rivers" category.

The method proposed here is applicable to analogous sediment records of temperate continental shelves encompassing the last 3 kyr, a time interval in which oscillations of relative sea level can be overlooked.

Alberico I. & Budillon F. (2019) - A quantitative evaluation of hyperpycnal flow occurrence in a temperate coastal zone: the example of the Salerno Gulf (Southern Italy). Geosciences, 9, 501; https://doi:10.3390/geosciences9120501.

Amorosi A. et al. (2016) - Onshore to offshore anatomy of a late Quaternary source-to-sink system (Po Plain–Adriatic Sea, Italy), Earth-Science Reviews, 153, 212-237, https://doi.org/10.1016/j.earscirev.2015.10.010.

Casalbore D. et al. (2024) - Post glacial sediment partitioning on a tectonically controlled, narrow shelf (Calabro-Tyrrhenian margin, Italy): Issues in defining S2S budget. Earth-Science Reviews 254(2024) 104815, https://doi.org/10.1016/j.earscirev.2024.104815.

Mulder T. & Syvitski J.P.M. (1995) - Turbidity currents generated at river mouths during exceptional discharges to the world oceans. J. Geol., 103, 285-299.

Innovative and integrated solutions for monitoring the gravitational instability at coastal cliffs and shallow water canyon head systems: a contribution from the RISCHiA-Re project

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Keywords: canyon heads, coastal cliff, landslide susceptibility, underwater sonar system, satellite images.

We recently joined the partnership of the RETURN project, Spoke 2 (Multi-risk science for resilient communities under a changing and changing climate, https:// https://www.fondazionereturn.it/spoke2/), with the RISCHiA-Re proposal (Rilievo delle Instabilità Sottomarine e Costiere per Hazard Assessment anche da REmoto), a joint venture between public research institution, ISMAR-CNR, and private companies, Leonardo Sistemi Integrati srl e Planetek Italia srl, funded by PNRR.

The partnership will pursue five integrated activities designed to learn more about specific aspects of the submarine landslide triggers and the failure susceptibility at the canyon heads in shallow water slopes and coastal cliffs. A focus will be placed on Ischia Island, to explore the instability of high coasts and adjacent submarine canyons, considered as a unique geo-morphological system. This choice was driven by the peculiar volcanic and morphotectonic context of the island which has fostered the occurrence of a large number of mass movements on land and offshore over time.

Leonardo SI will develop a feasibility study for a technological solution, designed to continuously monitor shallow water slopes using active acoustic devices, installed on the seabed. The ideal sonar system should aim to detect minor morphological changes that may precede mass failures, enhancing our understanding of submarine slope instability triggers.

Planetek Italia will develop algorithms for the automatic feature detection of canyon heads and niches geometries in shallow waters through satellite images. To this end, a semi-guided selection of high-spatial and temporal resolution satellite images (WorldView-2 series) will ensure the best satellite images for features detection over time.

ISMAR is committed to the creation of a geo-database useful for implementing susceptibility models of mass failures in coastal and shallow marine environments of selected sites in eastern Tyrrhenian Sea. This activity could investigate the relations between gravitational instability features, niches and retreating canyon heads, with morphological and stratigraphic discontinuities, proximity to seismogenic structures, wave erosive action on rocky coasts and beaches.

Additionally, ISMAR will also explore the potential link between morphological changes in exposed cliffs and the adjacent canyon heads and investigate the causes of instability in high rocky coastlines using a multi-scale, multi-temporal integrated approach, based on satellite radar interferometry (MT-InSAR), high precision topographic surveys (digital photogrammetry, terrestrial laser scanning) and monitoring actions in selected sites.

A key objective of the project is also to disseminate knowledge about the risks of submarine and coastal slope instability and raise awareness among stakeholders.

Late Quaternary land-sea correlations from the Tyrrhenian coastal belt of central-southern Italy: seismic vs log data interpretation

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Keywords: Late Quaternary stratigraphy, coastal plains, marine seismic survey, active tectonics, southern Italy.

A crucial point for a fine estimate of coastal hazard factors, referred to both seismicity and coastal inundations, is the age of tectonic deformations and/or subsidence. Geological data here presented allowed us to define a new and more detailed picture of the morphological, tectonic and sedimentary evolution of the alluvial-coastal plains of the Garigliano and Volturno rivers during the Late Quaternary. Based also on data achieved in past studies (Aiello et al., 2021; Corrado et al., 2025) about the stratigraphic setting of the plains and to the validated 3D geological model, this study aims to acquire new elements for a better definition of the chronological intervals of fault activity. To this scope, a multidisciplinary approach including the definition of the sedimentary architecture by the revision of a high number of core data from the plains, the structural analysis of the main faults affecting bedrock units, and the acquisition of offshore seismic reflection data, permitted reconstructing the recent tectono-stratigraphic evolution of the study area. More precisely, the seismic survey was performed on the marine segment along the coast of Mt. Massico horst and contiguous portions of the Volturno and Garigliano coastal plains, whereas the core data came from the southern part of the same Garigliano River plain. The land-sea correlations made it possible to identify different stratigraphic units by their equivalent seismic ones. These units are heavily affected by recent faulting expressed by complex deformation patterns such as flower structures and strike-slip faults.

Aiello G. et al. (2021) - Multiproxy study of cores from the Garigliano plain: an insight into the Late Quaternary coastal evolution of central-southern Italy. Palaeogeography, Palaeoclimatology, Palaeoecology, 567, 110298, https://doi.org/10.1016/j.palaeo.2021.110298.

Corrado G. et al. (2025) - Reconstructing active tectonics from land–sea correlations based on cross-interpretation of core and seismic data for the Tyrrhenian coastal segment in southern Italy. Earth Surf. Processes and Landforms, 50, e6049, https://doi.org/10.1002/esp.6049.

Analisi sismostratigrafica multiscala del margine continentale tirrenico tra Torre Astura e Monte Circeo (Lazio)

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Keywords: analisi multiscala, piattaforma continentale, stratigrafia quaternaria, evoluzione tettonica, tettonica transpressiva.

Lo studio ricostruisce l'assetto sismostratigrafico e l'evoluzione strutturale del margine continentale del Lazio meridionale, da Torre Astura al Monte Circeo, un'area di particolare interesse per la sua complessa ed ancora poco compresa storia evolutiva, avanzando nuove ipotesi sulla dinamica recente dello stesso.

È stato adottato un approccio multiscala, analizzando 1800 km di linee sismiche monocanale a diversa risoluzione, acquisite durante cinque campagne oceanografiche svolte nell'area tra il 1984 ed il 2001, comparandole con sismica esplorativa multicanale, di cui sono state ribattute le rotte. L'integrazione tra sismica monocanale e multicanale ha permesso di combinare le osservazioni delle strutture più profonde con quelle superficiali di maggior dettaglio, derivando dalle prime l'assetto strutturale e dalle seconde il dettaglio delle geometrie e la datazione delle deformazioni.

La piattaforma continentale è stata suddivisa in una zona deformata interna ed in una zona indeformata esterna. Nella porzione indeformata, i depositi hanno geometrie progradanti delimitate da *unconformity* e/o *correlative-conformity* attribuite ai cicli eustatici pleistocenici di 4° ordine (Maisto, 2014), mentre nella porzione deformata i depositi sono dislocati e piegati, creando una blanda anticlinale ad andamento circa appenninico, delimitata verso terra da alcune faglie di cui la maggiore riattivata in un regime transpressivo. La piega e la faglia riattivata hanno permesso di delineare una struttura di inversione positiva.

Le due porzioni del margine (deformata e indeformata) sono separate da due superfici chiave datate in base a correlazione con dati di letteratura (Marani et al., 1986) e ricostruzioni stratigrafico-sequenziali rispettivamente a 1.5-1.2 Ma e 1 Ma. L'individuazione e la datazione indiretta di questi due orizzonti hanno fornito vincoli temporali per l'età della deformazione nella parte interna della piattaforma, facendo ipotizzare un'evoluzione molto recente della tettonica transpressiva (>1 Ma), diacrona lungo il margine muovendosi sia dalla piattaforma esterna a quella interna sia muovendosi dal Monte Circeo (sud) a Torre Astura (nord).

Nello studio si introduce un approccio innovativo nell'analisi dei dati sismici, si delineano nuovi orizzonti e si ipotizza una fase transpressiva pleistocenica, senza escluderne una continuazione in tempi recenti lungo il margine.

Maisto (2014) - Mobilità verticale del margine continentale tirrenico orientale. Tesi di Dottorato in Scienze della Terra non pubblicata, Università Sapienza di Roma, 265 pp.

Marani M.P., Taviani M., Trincardi F. & Zitellini N. (1986) - Pleistocene progradation and postglacial events of the NE Tyrrhenian continental shelf between the Tiber River delta and Capo Circeo, *Memorie della Società Geologica Italiana*, 36, 67-89.

On the submerged sector of the Sheet 646 "Siracusa" of the CARG project

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Keywords: marine geology, CARG project, seabed landform, seismic reflection.

In the frame of the Sheet 646 "Siracusa" for the CARG project, three different oceanographic campaigns were launched to collect both multibeam and Side Scan Sonar data in the inner part of the continental shelf but also 40 seabed sediment samples and nine new Sparker seismic profiles across the whole continental shelf, that complemented the existing literature on the area. This huge quantity of data allowed the identification of the geomorphological elements of the seabed along the continental shelf and the upper slope, the characterization of the stratigraphic setting and the investigation of the tectonic features. The main results are briefly summarized here:

The continental shelf in the area can be separated into an inner and an outer sector; at places the boundary between the two sectors is marked by a steep escarpment at water depth of 40-60 m. Along the outer shelf the seafloor is a smooth, featureless surface almost entirely composed of medium to fine sand except for limited area corresponding to morphological highs. Here we recognised a depositional basin with sediments up to 35 m thick, pertaining to the Late Quaternary Depositional Sequence (LQDS), which has no relevant thickness in the inner shelf area. Along the inner continental shelf, the Meso-Cenozoic carbonate bedrock extensively outcrops down to about - 50 m of water depth or it is covered by a few meters thick sediment and it is crossed by some erosive channels, up to 400 m wide, not filled with late-Quaternary sediment except for a few meters of thickness.

The deformative structures recognized in the area are essentially brittle, attributable to two main extensive fault systems: one oriented NNW-SSE and the other one ENE-WSW. The first system is also in conformity with that recognized in the mainland sector of the sheet and it can be framed in the regional fault system that controls the Malta Escarpment structure. It is responsible for the "fault block structure" that characterizes the entire area of the sheet where structural highs and tectonic depressions are isolated from normal faults. In the area of the Bay of Augusta this setting is characterized by a main tectonic depression bounded to the north from Mount Tauro horst and to the south by the submerged continuation of the Belvedere promontory, both bordered by faults belonging to the above mentioned systems. In the southern sector of the sheet, the NNW-SSE system controls the elevation of the Maddalena Peninsula. The faults of these two systems also control, for some segments, the position and course of the continental shelf edge and many submerged morphological slopes along the continental shelf. The interplay between glacio-eustatic changes and above illustrated morphological elements influenced the development of late-Quaternary depositional systems and therefore the areal distribution of Holocene sediments.

Distribution and origin of sedimentary waves on the insular shelf of Madeira Island: insights from morphological and morphometric analysis of multibeam bathymetry

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Keywords: Sedimentary waves, cyclic steps, turbidity current, insular shelf, Madeira Island.

This study investigates the characteristics of sedimentary waves identified in the multibeam bathymetric data of the southern shelf of Madeira Island, in the Atlantic Ocean. The objective is to characterise them to comprehend the underlying processes responsible for their formation. Data have been provided by Portuguese Navy in 2002 and have been processed using ArcGIS and Global Mapper. Several cross-sections have been made to analyse the morphological characteristics of the sediment waves and to measure their morphometric parameters. The multibeam bathymetry allowed observing the presence of ten main sediment wave fields on the southern insular shelf. According to the results of onshore/offshore characteristics analysis, the sedimentary waves have been grouped into four different classes. Two classes linked to hydrographic basins that show an evident relation with stream outlets onshore whilst offshore they can be divided into occurring inside channels or on top of fan-shaped features. The third and fourth classes are clearly not connected to onshore hydrographic basins and occur offshore tall cliffs or lava deltas. Here, the sediment waves are mostly observed inside channels. For each group, different triggering mechanisms are proposed to initiate the downslope flows. Hyperpycnal flows caused by flash floods are suggested in the case of the sedimentary wave fields found offshore the streams. Offshore the tall cliffs or lava deltas, downwelling currents related to storm waves seem more plausible. In both cases, the initial flow evolves into a turbidity current when it reaches significant break in slope (i.e. the rollover points of subaqueous clinoform bodies). The sedimentary waves were interpreted as cyclic steps, based on their morphological and morphometric similarities to those observed in other submarine environments, including oceanic volcanic settings. (Cartigny et al., 2011; Babonneau et al., 2013; Normandeau et al., 2016). This knowledge is particularly important to assess hazards on anthropic structures and activities that are common on this island, such as submarine communication cables, aquaculture and marine aggregate dredging (Pope et al., 2018).

Babonneau N., et al. (2013) - Direct sediment transfer from land to deep-sea: Insights into shallow multibeam bathymetry at La Réunion Island. *Mar. Geol.*, *346*, 47-57, https://doi.org/10.1016/j.margeo.2013.08.006.

Cartigny M.J.B., et al. (2011) - A comparative study of sediment waves and cyclic steps based on geometries, internal structures and numerical modeling. Marine Geology, 280, 1-4, pp 40-56.

Normandeau A., et al. (2016) - Morphological expression of bedforms formed by supercritical sediment density flows on four fjord-lake deltas of the south-eastern Canadian Shield (Eastern Canada). *Sediment., 63*(7), 2106-2129, https://doi.org/10.1111/sed.12298.

Pope E.L., et al. (2018) - Origin of spectacular fields of submarine sediment waves around volcanic islands. *Earth and Plan.. Sci. Lett*., 493, 12-24, https://doi.org/10.1016/j.epsl.2018.04.020.

Benthic foraminifera in extreme environments and marine-coastal areas affected by anthropogenic impact to improve their knowledge as ecological indicators

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Keywords: benthic foraminifera, microplastics, marine sediments, extreme environments, anthropogenic impact.

Over the last century, marine environments have undergone significant changes, primarily due to the anthropogenic impact in addition to natural variability, more evident along the coast or in the proximity of particularly fragile environments. Environmental indicators are increasingly used to define and monitor these changes, whether natural or anthropic, as well as to assess the ecological status of marine ecosystems. The use of benthic foraminifera as ecological indicators has proven to be a reliable method for representing marine environmental quality. The quantitative analysis of foraminiferal assemblages enables the statistically representative determination of biotic indices describing ecological quality. Furthermore, the study of assemblages in pre-industrial sediments allow us to define the in-situ reference conditions in currently anthropized areas (Romano & Bergamin, 2015).

A collaboration between ISPRA and the Department of Earth Sciences of Sapienza University of Rome was established to investigate the morphological, sedimentological, and textural characteristics of the seabed in selected marine-coastal areas along the Tyrrhenian coast. The aim is to demonstrate how they influence the distribution, composition, and structure of benthic foraminiferal assemblages and, consequently, their applicability as environmental indicators. Extreme environments influenced by volcanic emissions have been also considered to test the response of foraminifera across a broad range of environmental parameters. This research may contribute to potential updates of EU directives on the biomonitoring of coastal marine environments.

Two oceanographic surveys (June and October 2024) were conducted aboard the R/V Astrea, during which sediment samples were collected using van Veen grab or box corer from the continental shelf off Terracina and Civitavecchia and the insular shelf of Ventotene. Sedimentological data, obtained through grain size analysis, will be integrated with multibeam bathymetry and backscatter data, enabling the characterization of the study areas from both a morphological and sedimentological perspective. In this frame, foraminiferal assemblages will be analysed to determine biotic indices as indicators of environmental quality, as well as the geochemical composition of their tests to identify potential causes of morphological abnormalities and their relationship with contaminant inputs. Additionally, the potential presence of microplastics will be investigated in both sediments and foraminifera, serving as markers of microplastic incorporation at the base level of the trophic chain. Furthermore, selected stations have been identified to explore the relationship between the biotic indices of macrozoobenthos and foraminifera.

Romano E. & Bergamin L. (2015) - I foraminiferi bentonici come indicatori ambientali in aree marino-costiere a elevato impatto antropico: 10 anni di studi nel porto di Augusta (SIN Priolo). RETICULA, 10, 35-40.

Spatial and morphometric analysis of submarine landslides distribution along the Calabrian continental margins

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Keywords: Submarine landslides, Morphometry, Geostatistics, Geodatabase.

The Calabrian continental margins are among the most tectonically and seismically active regions in Italy and in the entire Mediterranean (Minelli & Faccenna, 2010). In this geologically active context, submarine landslides are the most widespread features shaping the seafloor. Their variability in shape, size, lithology, and triggering mechanisms presents both a scientific challenge and a significant geohazard (Mountjoy & Micallef, 2018). To gain deeper insight into submarine ground instabilities, this study aims to morphometrically characterize the submarine landslides identified along Tyrrhenian and Ionian continental margins, assessing how they relate to specific geological processes and contexts. A comprehensive database of submarine landslides was developed using data from the *MaGIC project* (Chiocci & Ridente 2011). The landslide events were accurately mapped and enriched with detailed morphometric attributes to thoroughly characterize their geometry and morphology. Statistical analyses were conducted on subsets classified according to their physiographical domain, specifically distinguishing between Canyon & Channel (CC) and Open Slope (OS) environments, to explore the relationships among morphological parameters and geological factors. The results reveal differences between subsets in terms of statistical distribution and relationships among morphometric attributes, allowing the identification of possible trends within the analyzed submarine landslide subsets. Furthermore, the frequency analysis of key variables (e.g., Area, Volume) provides insights into the evolutionary behavior of submarine landslides and helps assess the potential hazard associated with the investigated area. In conclusion, Calabrian submarine landslides generally show high morphological variability. Statistical analyses have highlighted key variables that differentiate the CC and OS domains: slope-related attributes for the CC, and dimensional variables (e.g., Area, Perimeter, Volume) for the OS. Moreover, the correlation analysis reveals lower internal variability in the CC context, suggesting fewer controlling factors and greater event specificity. Future research will focus on expanding the dataset, both in terms of study area and observational data, to better understand the role of geological processes in the genesis and evolution of submarine landslides on the Italian continental margins.

Chiocci F.L. & Ridente D. (2011) - Regional-scale seafloor mapping and geohazard assessment. The experience from the Italian project MaGIC (Marine Geohazards along the Italian Coasts). *Marine Geophysical Research*, 32, 13-23.

Minelli L. & Faccenna C. (2010) - Evolution of the Calabrian accretionary wedge (central Mediterranean). *Tectonics*, 29(4).

Mountjoy J. & Micallef A. (2018) - Submarine landslides. *Submarine geomorphology*, 235-250.

Movimentazione di sedimenti inerti e manufatti in ambito marino-costiero: la gestione delle autorizzazioni in Regione Toscana

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Keywords: tutela delle acque marine, normativa ambientale, caratterizzazione dei sedimenti marini, certificazione dei materiali.

Le attività sulle quali si riferisce nel presente documento vengono realizzate nell'ambito territoriale marino-costiero, elemento di chiaro valore strategico e al contempo complesso interfaccia tra il mare e la terraferma sotto il profilo ambientale, paesaggistico e socio-economico.

Nel dettaglio gli interventi possono essere così riassunti in base alla legislazione statale:

a) immersione in mare da strutture ubicate nelle acque del mare o in ambiti ad esso contigui, dei seguenti materiali:
   1. materiali di escavo di fondali marini, o salmastri, o di terreni litoranei emersi;
   2. inerti, materiali geologici inorganici e manufatti al solo fine di utilizzo, ove ne sia dimostrata la compatibilità ambientale e l'innocuità.
b) immersione in casse di colmata, vasche di raccolta o comunque di strutture di contenimento poste in ambito costiero dei materiali di cui alla lettera a);
c) interventi di ripascimento della fascia costiera;
d) movimentazione di fondali marini connessa alla posa in mare di cavi e condotte non avente carattere nazionale.

Il quadro normativo di riferimento è principalmente costituito da:

– D.Lgs. 3.4.2006, n. 152, art. 109;
– L. 31.7.2002, n. 179, art. 21;
– decreto Ministero Ambiente del 24.1.1996;
– decreto Ministero Ambiente Tutela Territorio e Mare del 07.11.2008;
– L. 28.1.1984, n.94;
– decreto Ministero Ambiente Tutela Territorio e Mare del 15.7.2016, n. 172;
– decreto Ministero Ambiente Tutela Territorio e Mare del 15.7.2016, n. 173.

Tale normativa ha evidenti impatti sull'assetto della costa sia in termini di difesa che di tutela, in considerazione che la costa toscana risulta composta, sotto il profilo geomorfologico, da 247 km di costa sabbiosa (di cui 32 km lungo la costa dell'arcipelago toscano e 215 km lungo il continente), da 178 km di costa alta e da 32 km di costa *"fittizia"* (opere radenti, moli, costa urbana), per un totale di 457 km.

Lungo la costa toscana insistono poi tre porti (Livorno, Piombino, Massa Carrara) inseriti nell'elenco dei Siti di Interesse nazionale ai fini della bonifica, due vasche di colmata (Livorno e Piombino) e altri scali marittimi (Portoferraio, Cavo, Isola di Capraia) gestiti dall'Autorità di Sistema Portuale.

Nel rispetto delle disposizioni della normativa nazionale, la Regione Toscana ha emanato specifiche Linee Guida con Delibera di Giunta n.613/2020, in qualità di soggetto competente al rilascio delle autorizzazioni, per assicurare il coordinamento delle procedure e il raccordo delle attività tecnico istruttorie connesse alla realizzazione degli interventi di recupero e riequilibrio della fascia costiera.

Con le Linee Guida la Regione Toscana ha dettagliato anche alcune definizioni non incluse nel dettato legislativo statale e ha distinto quindi nove differenti tipologie di interventi soggette ad autorizzazione.

Nell'ambito del riparto di competenze marino-costiere risulta di fondamentale importanza l'attività di vigilanza e controllo della Regione Toscana e della Direzione Marittima della Toscana.

A preliminary 3D model for the offshore region of CARG Sheet Villa San Giovanni

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Keywords: Messina Strait, 3D model, CARG, seismic reflection profiles.

The Sheet 588 Villa San Giovanni of the CARG project covers a geologically complex area that includes the Messina Strait and surrounding areas.

The Messina Strait area has long been the focus of geological and geodynamic studies, mainly due to its dynamic tectonic framework that includes active fault systems and ongoing subduction processes. This tectonic setting is responsible for significant seismic activity, with events that can reach great depths, up to about 180 km.

In addition to its geological relevance, the region has attracted considerable socio-economic interest, particularly in relation to the proposed permanent connection between the two sides of the Strait.

Accordingly, the complex geology of the area requires detailed and precise geological modeling.

As part of the CARG project, we constructed a preliminary 3D geological model of the offshore sector that provides information on the subsurface structure.

We used seismic reflection profiles, we converted them from time (TWT) to depth using appropriate velocity models, and, to improve the accuracy of the model, we calibrated the seismic reflection profiles with available well data. The preliminary model we obtained consists of four layers. To highlight the lateral variation of the model, we also constructed thickness maps of each layer.

Future steps in this study include the acquisition of new seismic reflection profiles to have greater areal coverage of the data. The integration of these new seismic profiles, together with other geophysical and geological data, will help to obtain a more accurate and extensive subsurface structure model.

This study is also intended to contribute to a better comprehension of the geological environment in the Messina Strait, providing essential data for seismic hazard assessment.

Submarine enigmatic shelf morphologies: insights from the CORSUB Project

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Keywords: biogeomorphology, rhodoliths, beehive, Holocene, constructional and erosional process.

Punta Licosa Promontory, located in southern Campania (Tyrrhenian Sea, Southern Italy), lies between Castellabate Plain and Ogliastro Bay. On land, the promontory features the San Mauro and Pollica formations of the *Flysch del Cilento* unit (Aiello & Caccavale, 2024), dating from the Early Tortonian to Langhian. Offshore, it extends into the sea, where Quaternary heterogeneous deposits overlay well-bedded arenaceous flysch. Notably, the submerged portion includes several submarine terraces at depths between 8 and 100 meters (Savini et al., 2021), interpreted as remnants of the Upper Pleistocene, or shaped by the Last Glacial Maximum (LGM) regression and subsequent post-glacial sea-level rise.

A 2004 survey identified previously unknown *beehive*-like morphological structures on one such submerged terrace around 100 m of water depth. Only a few grab samples were collected at that time, leading to a preliminary hypothesis of a biogenic origin (Bracchi, unpublished thesis), in need of further investigation. The CORSUB project, funded under the Italian PRIN 2022 program, adopts an interdisciplinary approach, integrating geophysical, stratigraphic, sedimentological, and paleontological methods, to explore these formations' origins, evolution, and ecological significance.

During the CORSUB-1 (06/2024) and TREMOR (12/2024) cruises, the team collected high-resolution data, including side-scan sonar, multibeam bathymetry, sub-bottom profiles, and box-corer sediment samples. The observed features consist of clusters of sub-circular to polygonal weakly convex structures between 78 and 83 m, each less than one meter in diameter and rising less than 50 cm at their centers. Interestingly, the central portions exhibit lower acoustic reflectivity than their surrounding edges. Chirp profiles reveal a thin sedimentary layer overlying a rocky substrate, likely part of the Cilento Flysch. Box-corer samples indicate a stratified sub-seafloor, with coarse biogenic sand and gravel at the surface transitioning to gravelly sand with varying mud content below. Notably, all samples contain dead, centimeter-sized boxwork rhodoliths, buried 8–20 cm beneath the seafloor. Only one sample yielded live rhodoliths undergoing intense muddying.

Based on these results, the hypothesis that these structures could have a biogenic origin stands, potentially linked to past rhodolith bed development during slow phases of Holocene sea-level rise. Alternatively, they may be erosional remnants from glacial and post-glacial sea-level fluctuations, initially forming during the LGM when the studied areas were exposed and later serving as a substrate for biological colonization during the deglaciation and post-LGM transgression.

Further remote and direct analyses, including absolute dating, are underway to clarify the nature and evolution of these intriguing submarine features.

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Bracchi V.A. (unpublished thesis) - Tanatocenosi a molluschi associate a morfologie sommerse di origine problematica (Punta Licosa, Campania). Tesi di Laurea Triennale in Scienze Geologiche e Geotecnologie, AA 2005-2006, Università degli Studi di Milano-Bicocca, Milano, Italia, 101 pp.

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Fluid escape processes studied in Palermo offshore (NW Sicily). Quantitative analysis and modelling analysis of the factor of safety (FOS) of a submarine slope.

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Keywords: Fluid seepage, landslide, marine geohazard, continental slope, submarine canyon.

This study analyzes a submarine sector of Palermo offshore where the multiple cause-effect relationship between pockmarks and submarine landslides are studied by mean Multi Beam Echo Sounder (MBES) morphobathymetric data. This sector is characterized by freshwater continental origin pockmarks whose activity can be considered intermittent as associated with the recharge of the continental aquifer through meteorological events (Pennino et al., 2014).

The integration of MBES data and Sparker seismic profiles allowed us to obtain quantitative measurements of: 1) thicknesses, areas and volumes of sedimentary body altered by upward migration of pressurized fluids; 2) the presence of preferential sliding surfaces (e.g. weak layers) likely responsible of pockmark-associated landslides; 3) tectonic alignments linked to recent geological structures (predominantly N-S oriented) along which the fluids escape structures are detected.

We investigated the possibility that in the nearness of pockmark convergent reflectors, the pressurized fluids caused the loss cohesion resulting in sediments prone to movement. In the case of Palermo offshore, this hypothesis is strengthened by favorable boundary conditions such as: high slope values of the area, surrounding landslides and ongoing fluid escape processes.

The identification of areas and volumes of altered sediments, together with a critical review of literature, allowed us to develop a qualitative model regarding the potential future retrogressive evolution of these areas and, also the computation of the pockmark related Factor of Safety (FOS, Noda et al., 2013; Sultan et al., 2004). Preliminary results highlight that the pore overpressure, in intra-pockmark area, strongly influence the equilibrium of the slope and, thus, can be considered as a predisposing factor for submarine gravitational processes. Moreover, the identification of potential landslide volume could allow to investigate possible landslide triggered - tsunami waves hazard scenario.

This study was carried out within the RETURN Extended Partnership and received funding from the European Union Next-GenerationEU (National Recovery and Resilience Plan – NRRP, Mission 4, Component 2, Investment 1.3 – D.D. 1243 2/8/2022, PE0000005).

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A model of double tombolo formation: The case of Orbetello, Italy

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Keywords: Sub-bottom profiles, GPR profiles, Orbetello Tuscany, Regressive sand barrier, Composite tombolo.

The double tombolo of Orbetello developed during the Holocene behind the former island of Monte Argentario around an ancient central isthmus. It has long been believed that its Holocene sand barriers initially formed as sand spits attached to the mainland Tuscany, growing seawards until they reached Monte Argentario, before enlarging seawards during the rest of the Holocene. To test this hypothesis, we conducted extensive coring in the tombolos, along with comprehensive imaging of their internal structure using sub-bottom acoustic surveying (high-frequency seismics) offshore and in the lagoon of Orbetello,As well as GPR (Ground Penetrating Radar) onshore. The chronology of tombolo development is constrained by ^{14}C, luminescence, and U/Th. Our results indicate that the Orbetello lagoon, located between the Holocene sand barriers, did not form by progressive isolation from the sea, behind growing sand spits. Rather, the Holocene barriers accreted directly on the flanks of the preexisting central Tombolo (which supports the town of Orbetello) when sea level was − 7 ± 1 m lower than today and expanded out by sand accretion as broad regressive strandplains. Tracking sea level rise over the past 7 kyrs, these strandplains rose outwards and upwards, while their oldest, lowest-lying inner beach ridges were progressively being flooded into the lagoon that separates them today. Our acoustic profiles further allow us to convert planform enlargement rates into sand volume accretion rates. Enlargement rates decreased throughout the Holocene, allowing tall foredunes to accumulate above the youngest beach ridges. Anthropogenic disturbance during historical times, allowed blow outs to form, feeding extensive transgressive dune tracts. The central peninsula of Orbetello was emplaced much earlier, during the last interglacial; it is composed of regressive sand barriers accreted around a MIS 5.5 (Tyrrhenian s.s.) barrier during the falling stages MIS 5.3 and MIS 5.1. Using Orbetello as a case study, we explore the broader mechanisms of double tombolo formation. We find that that double tombolo formation is likely a frequent, albeit short-lived stage, that punctuates the development of enlarging single tombolos under the effects of oscillating sea level.

Seasonal Grain-Size Variability in the Ombrone Delta beaches

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Key words: Ombrone Delta; grain-size parameters; sediment transport; seasonal variations.

Deltaic environments are influenced by the interactions between riverine and marine processes, with sediment transport and deposition controlled by seasonal fluctuations in river discharge. Hence, it is essential to understand how seasonal changes in riverine input affect granulometric parameters for sediment transport and deposition modeling. This study focuses on the wave-dominated Ombrone Delta, on the Tyrrhenian coast (Italy), an excellent case study due to minimal anthropization. 84 sediment samples were collected in summer and winter from six sites -three north and three south of the river mouth- across two different hydrodynamic zones: the berm and the shoreface (at 1 m depth). Grain-size analysis was performed with sieving at ¼ φ intervals. Statistical calculations of D50 (ϕ) and skewness (SK) were conducted using the Method of Moments (Blott & Pye, 2001). Berm sediments showed minimal seasonal variation in D50, with low Median Absolute Deviation (MAD), indicating a relatively stable grain-size distribution within the sites. SK shows a similar trend, except at the site farthest from the river mouth, where a seasonal change was detected, with coarser values in summer. This suggests an accumulation of coarse-grained particles, likely due to seasonal shifts in hydrodynamic conditions (reduced wave energy in the summer). Thus, coarser sediment is deposited in the berm, and due to this low wave energy, these particles are not removed and alter the overall sediment distribution. A Mann-Whitney test (MW test) comparing berm samples from summer and winter showed no significant seasonal change in D50 but highlighted a statistically significant variation in SK, with coarser values in summer ($p = 0.049$). This trend was evident in the southern sector of the delta ($p = 0.01$). D50 remained stable throughout the year in the shoreface, except at sites far from the river mouth, where coarser sediments occur in summer. Northern sites exhibited higher D50 MADs, possibly due to episodic riverine input and erosion of relict sediments, while southern sites appeared more stable. SK remained consistently coarse-skewed across the seasons. MW test for the shoreface data shows no significant seasonal variations in either D50 or SK, implying that hydrodynamic conditions in this zone are relatively unaffected by seasonal changes. Since predictive models of sediment transport and deposition rely on D50 and SK as crucial parameters (e.g., Gao & Collins, 1994), this study underscores the need to better study seasonal fluctuations in SK within berm of wave-dominated deltas, as they may affect model accuracy.

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A newly developed Shoreline Extraction tool from satellite imagery: case studies in Sicily (Central Mediterranean region)

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Keywords: Shoreline extraction tool, FAIR principles, Geosciences.

The recent development of the remotely sensed shoreline extraction technique improved investigations about Shoreline Change Analysis. These techniques, allow to quantify the recent coastal landscape evolution and facilitate inferences about its main driving forces, climate changes, tectonics, and anthropic processes, improving and providing critical information for forecasting future coastal landscape scenarios essential for better coastal management and mitigating the natural hazard linked to erosion processes.

Here, we propose the use of a newly developed Isoradiometric shoreline extraction Method (IM) that allows delimiting the shoreline with subpixel accuracy using optical satellite imagery, and the production of time series.

Such a tool was designed, tested and validated through a GNSS-delimited shoreline from field surveys on three sandy beaches in Sicily (Central Mediterranean), and was then applied on over than 60 km of Sicilian coastline using up to 40 years of freely available satellite products.

The tool is designed to be released in the frame of the Geosciences IR - National Recovery and Resilience Plan (PNRR) and will respect the FAIR (Findable, Accessible, Interoperable, and Reusable) data principles of the Research Data Infrastructures (RDIs).

The proposed shoreline extraction tool could represent a very fast task for coastal management and coastal erosion risk detection and mitigation and could also support researchers in data management and collaborative analysis.

Evolution of Coastal Environments under Inundation Scenarios due to RSLR

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Keywords: relative sea level rise (RSLR); MED 16; EGMS and LC/LU; coastal flooding maps; climate change.

A new methodology to map Italian coastal areas at risk of flooding is presented (Cappucci et al., 2024). This approach relies on detailed projections of the future sea level from a high-resolution, three-dimensional model of the Mediterranean Sea circulation, on the best available digital terrain model of the Italian coasts, and on the most advanced satellite-derived data of ground motion, provided by the European Ground Motion Service of Copernicus.

To obtain a reliable understanding of coastal evolution, future sea level projections and estimates of the future vertical ground motion based on the currently available data were combined and spread over the digital terrain model, using a GIS-based approach specifically developed for this work.

The climate models used for the latest IPCC report may be adequate at global scale, but SL results from these models often need further refinement in marginal seas. This applies to the Mediterranean Sea, which is connected to the Atlantic Ocean through the Gibraltar Strait, a narrow passage hosting complex, small-scale dynamics induced by the local bathymetry and tides (Sannino et al., 2022). Therefore, studying SL variability in the Mediterranean Sea requires the use of high-resolution regional models that downscale external forcings, initial and boundary conditions of global climate models. Within the study areas, the available data of ground motion (time interval 2016-2021) were acquired directly from the EGMS Copernicus system raster with a spatial resolution of 100×100 m.

The coastal plains of different Italian regions were selected as test cases for the new approach. These coastal stretches are important for the ecosystems and the economic activities they host and are relatively stable areas from a geological point of view (Antonioli et al., 2017). Flood maps were constructed for these areas, for the reference periods 2010–2040, 2040–2070, and 2040–2099.

Where possible, the new maps were compared with previous results, highlighting differences that are mainly due to the more refined and resolved sea-level projection and to the detailed Copernicus ground motion data. Coastal flooding was simulated by using the "bathtub" approach without considering the morphodynamic processes induced by waves and currents during the inundation process. The inundation zone was represented by the water level raised on a coastal DTM, selecting all vulnerable areas that were below the predicted new water level. Consequent risk was related to the exposed asset.

Land flooding impacts both natural and anthropic environments, in ways that may be difficult to predict. Using the Corine Land Cover, we determined the assets exposed to inundation within the five coastal areas. Cropland, Open Space with Little or No Vegetation (where present, like in the study area of Alghero-Fertilia) are the most impacted ecosystems, followed by Wetland (in Follonica and Pontina's plains) and Water.

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Rapid morphological variations in a shallow-water mud volcano offshore Scoglio d'Affrica (Northern Tyrrhenian Sea) through the integration of repeated multibeam bathymetries and video footages

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Keywords: mud volcano, ROV, seafloor changes, Scoglio D'affrica, fluid seepage.

A violent gas outburst occurred in March 2017 offshore Scoglio d'Affrica islet in the Tuscan Archipelago, with the generation of columns of dirty water rising up to 10 m above the sea surface, as reported by local fishermen. Based on the integrated analysis of morpho-bathymetric data and seafloor video footage, this transient phenomenon has been linked to the activity of a shallow-water mud volcano, made up by two mounds with their top located at water depth less than 10 m (Casalbore et al., 2020). Since then, the collection of repeated multibeam bathymetries coupled with seafloor observations realized through ROV and scuba dives between 2017 and 2023 evidenced small-scale morphological changes on the top of this mud volcano due to the interplay between fluid seepage processes and sediment reworking by wave action (Saroni et al., in press). In detail, shallow dynamics during fluids upwelling are responsible for two types of morpho-evolutions in the area. When the fluid rises constantly, the top of the mud volcano is characterized by different emission points of fluid and sediments, as observed in the northern mound. Differently, the occurrence of main craters and lobate flows along the southern mound of this mud volcano coupled with cyclic vertical movements, recording inflation/deflation stages, are likely the results of a repeated blockage of the conduit and can lead to violent and larger eruptive transient events, as occurred in 2017. The results presented in this study provide useful insights for better understanding the evolution of these active and shallow-water mud volcanoes and by this to carry out a preliminary geohazard assessment associated with fluid-related features in the study area.

Casalbore D., Ingrassia M., Pierdomenico M., Beaubien S.E., Martorelli E., Bigi S., ... & Chiocci F.L. (2020) - Morpho-acoustic characterization of a shallow-water mud volcano offshore Scoglio d'Affrica (Northern Tyrrhenian Sea) responsible for a violent gas outburst in 2017. Marine Geology, 428, 106277.

Saroni A., Maurantonio F., Casalbore D., Chiocci F.L., Cimenti E., Coltorti M., Demarte M., Pierdomenico M., Spatola D. & Ivaldi R (2025) - Seafloor morphology and recent dynamics in the Scoglio d'Affrica (Northern Tyrrhenian Sea). In press on Marine Geology.

Assessing slope stability at the Squillace submarine canyon head: Integrating shallow geophysics, AUV/ROV remote sensing and geotechnical evidence from the ERODOTO cruise

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Keywords: Slope stability, submarine canyon head, submarine landslides, Calabrian Ionian margin.

The ERODOTO Cruise, funded by the Eurofleets+ programme, took place in the Ionian Sea, July 2023, aboard the Greek research vessel *R/V* Aegaeo. The mission aimed to analyze and quantify the active dynamics of the Squillace submarine canyon (Calabrian Ionian margin), a nearshore, shelf-incising system closely linked to ephemeral river systems known as *fiumare*. This study serves as a model for geohazard assessment and risk management in similar environments and has been presented as a natural laboratory for the PNRR project RETURN (Multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate).

The cruise employed a multidisciplinary approach, including high-resolution acoustic mapping with the VLIZ Gavia AUV (sub-metre scale) and visual inspections of canyon walls using the HCMR ROV Max Rover. Additionally, 13 gravity cores were collected and analyzed for geotechnical properties, MSCL, XRF, foraminiferal assemblages, and sediment provenance.

This work presents preliminary findings and insights gained for future monitoring efforts in similar coastal canyon systems. The ERODOTO cruise provided a pilot framework for semi-autonomous hazard monitoring in shallow coastal areas affected by suspected retrogressive erosion driven by sediment flows.

Preliminary Results:

- Geomorphic Indicators of Sediment Instability: AUV sidescan sonar and sub-bottom data revealed detailed canyon head morphologies, including cracks, developing scarps, creep, furrows as well as Posidonia patches and trawling marks. These data also allowed the identification of unstable areas on the shelf and slope.
- Slope Stability Modeling: Geotechnical analyses of shelf sediments – including undrained consolidated triaxial test, grainsize distribution analysis, consolidation test, shear vane tests, and Atterberg limits classification were conducted on the gravity cores. Combined with seabed mapping and high-resolution seismic data interpretation, the results suggest that seismic activity has a strong impact on the slope instability at the canyon headwalls.
- Sediment Flow Dynamics: Provenance analysis (SEM, grain size, bedform morphology, foraminiferal distribution) combined with the mapping of connections between *fiumare* and the canyon head, supports the hypothesis that high-energy debris flows triggered by extreme events, such as flash floods, have transported coarse sediments, disrupting the dominant hemipelagic sedimentation of plastic clay and silt in this area.

These findings contribute to the development of a blueprint for coastal hazard assessment and monitoring in submarine canyon environments.

Seabed habitat mapping on the south-eastern Sicilian continental shelf close to the "Plemmirio" marine protected area

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Keywords: habitat mapping, marine conservation, *Posidonia oceanica*, coralligenous, Sicily.

Mapping of *Posidonia oceanica* meadow (a priority habitat *sensu* Habitat Directive, 1992/43/CEE) was carried out along a selected sector of the continental shelf offshore south-eastern Sicily, in order to widen the area under environmental protection managed by the Special Area of Conservation "Fondali del Plemmirio", which was established in September 2011.

To this end, a bathy-morphological mapping was carried out by a simultaneous swath bathymetry and side scan seabed survey, integrated with: i) sediment samples collected by a Van Veen grab; ii) video transects recorded by a Remote Operating Vehicle; iii) video recorded by a Baited Remote Underwater System. A synthetic map (scale 1:10.000) of morpho-sedimentary features and benthic habitat distribution was produced using a GIS software.

The analysis of the morphological and sedimentological data allowed us to interpret and map the physiography and the sedimentary setting of the investigated area. It is characterized by large outcrops of carbonate bedrock alternating with areas of mostly sandy but also gravelly sediments; the boundary between the two features being often represented by morphological steps up to 10 m high.

A well-preserved *Posidonia oceanica* meadow is widespread in the depth range between 10 and 30 m, but small patches of *P. oceanica* have been detected down to about 40 m water depth. A few sparse patches of Coralligenous habitat have also been recorded at depths between 15 and 50 m.

Overall, the following habitats have been mapped: hard substrate assemblages carpeted by photophilous algae; coralligenous assemblages; superficial fine sands; well-sorted fine sands; fine sands and gravels under the influence of bottom currents; *P. oceanica* meadows; mixed assemblages of *P. oceanica* and photophilous algae; sparse meadows of *Cymodocea nodosa*.

This research provides new insights on the benthic habitat distribution along the southern Sicily continental shelf and offers scientific-constrained information that is useful for planning and sustainable management of the coastal zone. In relation to the main purpose of this study, it is evident that the protection of the *P. oceanica* meadow can be expanded to encompass additional 210 hectares, thereby covering the 26 % of the newly investigated area. This substantiates the necessity for the extension of the jurisdiction of the Plemmirio MPA.

Analysis of the seismic P-waves average velocity: the examples of Famoso-1 and Grifone-1 exploration wells (middle/southern Adriatic Sea)

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Keywords: ViDEPI Project, sonic log, lithostratigraphy.

Within a larger project of seismic P-waves average velocity analysis of the lithostratigraphic units drilled in the middle and southern Adriatic Sea, the results from the Famoso-1 and Grifone-1 exploration wells are here presented. For this analysis, publicly available data files FAMOSO_1.csv and GRIFONE_1.csv (Cicala et al., 2023) have been used. These files consist of two columns A and B of data, i.e., interval transit time Δt [μs/ft] (ft = feet, μs = microseconds) and depth [m] (m = meters), respectively, picked from the raster sonic log graphs of the related two exploration wells, that are freely accessible at the ViDEPI Project (www.videpi.com) of the Ministry for the Economic Development of the Italian Government.

To determine the seismic P-waves average velocity for each lithostratigraphic unit in the Famoso-1 and Grifone-1, the following steps were performed: (i) identifying the depth range of each lithostratigraphic unit from the raster stratigraphic log; (ii) calculating by the use of MATLAB© the average value of Δt_{av} for each identified depth interval, based on the corresponding values in column A; (iii) obtaining of the seismic P-waves average velocity (v_{av}), by solving the simple equation $v_{av} = 1/\Delta t_{av}$; (iv) conversion of the v_{av} values from ft/μs in m/s (s = seconds), considered that μs = 10^{-6} s, and ft = 0.3048 m.

The obtained results cover most of the Triassic – Quaternary lithostratigraphic units drilled in the middle and southern Adriatic Sea (from bottom to top, *Burano, Calcare Massiccio, Corniola, Marne di Monte Serrone, Rosso Ammonitico Marchigiano, Calcari ad Aptici, Maiolica, Marne a Fucoidi, Scaglia, Calcari a nummuliti di Peschici, Scaglia Cinerea, Bisciaro, Schlier, Gessoso-Solfifera, Colombacci* and *Argille del Santerno*) thanks to the remarkable depths of the considered exploration wells, i.e., Famoso-1 and Grifone-1.

Cicala M. et al. (2023) - Data extraction from vintage well sonic log graphs in the ViDEPI project (offshore the Apulia, southern Italy): A multi-useful dataset. Data in Brief, 46, 108814, https://doi.org/10.1016/j.dib.2022.108814.

Geobiological and Technological Interdisciplinary Approaches to Study Coralligenous Bioconstructions: Insights and Advances

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Keywords: bioconstructions, coralligenous, geobiology, technological innovation.

Among the bioconstructed habitats of the Mediterranean Sea, Coralligenous is undoubtedly the most important ecosystem because of its extent, complexity and heterogeneity, which supports very high levels of biodiversity. Coralligenous is a hard-biogenic substrate mainly produced by the superposition of several generation of calcareous red algae. These bioconstructions are characterized by a low accretion rate and a high sensitivity to natural and anthropic impacts. For these reasons, Coralligenous has since long time been the object of special interest by the UNEP RAC/SPA and considered among the priority habitats for monitoring and conservation by the EU.

In the frame of the project "FISR-CRESCIBLUREEF" a ROV-based technology for minimally invasive sampling of marine bioconstructions has been developed. In the new project *"Tech4You PP2.3.1, Action 1: Development of hardware and software systems for three-dimensional detection, sampling and mapping of underwater environments" (CUPH23C22000370006),* the system is being enhanced through the integration of robotic and AI-based computer vision technologies to carry out a more accurate 3D reconstruction, sampling, and mapping of marine bioconstructions.

Coralligenous core samples, collected from Marzamemi (Sicily, Italy) with ROV-based technologies, were compared with data obtained from coralligenous build-ups sampled in the same area by scuba-divers. Comparison between microfacies of core-samples and those of "*tale quale*" build-ups revealed no significant differences in terms of abundance and relationship between skeletal and non-skeletal carbonate components, despite the much smaller size of the core samples. These results allow to consider the ROV-based system as a powerful tool to obtain representative samples of bioconstructions for geobiological studies without making invasive sampling.

Moreover, an integrated geochemical-geobiological approach has been applied in order to identify possible *proxies* for environmental studies. This multidisciplinary approach showed an evident relationship between the chemical composition of the minerals and the waters in which Coralligenous forms. Particularly, anomalies in heavy metals (*e.g.*, Pb and Zn) were found in bioconstructions and surrounding seawaters. Such enrichments could result from natural sources (*e.g.*, hydrothermal upwellings) or pollutants introduced into the marine system by human activities. These data allow to consider coralligenous build-ups as environmental database that continuously record environmental disturbance (both natural and anthropic), enabling temporal reconstruction of the marine environment over time.

Preliminary results from ultra-high-resolution 3D seismic imaging of fault networks in the Campi Flegrei Resurgence (Naples, Italy)

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Keywords: UHR3D seismic data, Fault network, Volcano-Tectonic deformations, NYT Caldera.

Volcanism, hydrothermal activity, and caldera floor uplift (resurgence) at the Neapolitan Yellow Tuff (NYT) caldera (Campi Flegrei – Gulf of Pozzuoli) have spurred considerable research aimed at defining its structural framework and evolutionary history (e.g. Sacchi et al., 2014; Corradino et al., 2021; Natale et al., 2022) using 2D seismic reflection data. However, the complex fault network geometry developed at a decimetric scale, specifically in the apical zone of the resurgence, remains poorly constrained. Also, the relationship between fault networks and fluid circuation, which can lead to stress distribution variations and potentially earthquakes, is unknown. This is primarily due to the limitations of 2D seismic data, lacking resolution and spatial coverage to capture small-scale fault geometries and often affected by seismic artefacts, such as out-of-plane reflections, which can blur and distort subsurface structures.

This study uses ultra-high-resolution 3D (UHR3D) seismic reflection data to investigate the fault network geometry (strikes, dips, and spatial extent) developed within the NYT resurgence apical graben. Data were collected utilizing innovative technologies during an oceanographic cruise organized in the frame of a joint project involving the University of Palermo, Catania and Napoli Federico II, CNR of Napoli and INGV Roma, and two companies, the Geo Marine Survey System (The Netherlands) and GeoSurvey (Portugal). The data processing employed advanced techniques developed to optimize UHR3D shallow marine seismic surveys.

Seismic interpretation and attribute analyses reveals a complex fault network of more than 60 predominantly normal faults, striking NE-SW, and extending from the seafloor to at least approximately 120–170 meters depth. Amplitude anomalies, bright spots and localized velocity variations indicate the presence of active fluid pathways and how they are connected to the fault network.

This research refines knowledge on understanding the process responsible for the formation of complex fault-network geometry and their potential as fluid conduits within the resurgence apical graben. The new findings underscore the critical importance of accurately identifying resurgence structures for improving forecasts of caldera behavior during periods of unrest.

Corradino M. et al. (2021) - Resurgent uplift at large calderas and relationship to caldera-forming faults and the magma reservoir: New insights from the Neapolitan Yellow Tuff caldera (Italy). Journal of Volcanology and Geothermal Research, 411, 107183.

Natale J. et al. (2022) - Fault systems in the offshore sector of the Campi Flegrei caldera (southern Italy): Implications for nested caldera structure, resurgent dome, and volcano-tectonic evolution. J. Struct. Geol. 163, 104723.

Sacchi M. et al. (2014) - The Neapolitan Yellow Tuff caldera offshore the Campi Flegrei: Stratal architecture and kinematic reconstruction during the last 15 ky. Marine Geology, 354, 15-33.

From fissural to central volcanism in back arc spreading ridges: reconstruction of Vavilov plumbing system (Tyrrhenian Sea)

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Keywords: magmatic plumbing system, seafloor morphology, magnetic anomaly, inverse model.

Located at the centre of the southern Tyrrhenian Sea (Italy), the Vavilov basin represents a back arc basin active since the Pliocene time related to the eastward migration of the entire Apennine-Maghrebide system (Malinverno and Ryan, 1986; Doglioni, 1991). The basin shows a roughly triangular shape with major escarpments (i.e Selli line), which separate it from the continental margins (Cornaglia Terrace; Demarchi Smt and Flavio Gioia Smt). At west the basin is featured by set N-S oriented ridges as expression of injection of basalts- like type magma during (or post) mantle exhumation (i.e Gortani ridge).

Approximately at the centre of the basin, a 60 km long, 32 km wide volcanic edifice rises from the depth of 3600 m below sea level (b.s.l, hereafter) reaching a minimum depth of 795 m. b.s.l. VAV consists of three main volcanic units: W-tilted pillow lava flows (beneath 1500 m deep), radial lava flows (from 1500 m to 1000 m deep), scoriaceous lava flows (from 1000 m deep to the summit. K-Ar dating of fragments of pillows sampled along the eastern flanks at depth of 1000 m shows Pleistocene ages of 0.37 and 0.09 Ma (Robin et al., 1987), according with magnetic pattern (Savelli & Ligi, 2017). This latter shows a positive anomaly of the shallower portion of the volcano related to the Brunhes geomagnetic chron in contrast to negative pattern observed in the outer flanks and surrounding basin.

Here we present a magnetic and morphologic study of Vavilov aimed to characterize the inner plumbing system and its relationship with the surface volcanic and tectonics structures. We propose an inverse model capable of depicting internal structural elements related to the feeding system of both the primary spreading ridge and the later central plumbing system. Results show that the spreading ridge of small back arc basin like the Vavilov may be characterised by a polyphase evolution from fissural to central-type volcanism and developing a multi-level plumbing system. In addition, we provide evidence for the migration of activity related to asymmetric spreading processes in the Vavilov basin which also led to the asymmetric growth of the seamount.

Doglioni C. (1991) - A proposal for the kinematic modelling of W-dipping subductions - possible applications to the Tyrrhenian-Apennines system. Terra Nova, *3*(4), 423-434, https://doi.org/10.1111/j.1365-3121.1991.tb00172.x.

Malinverno A. & Ryan W.B.F. (1986) - Extension in the Tyrrhenian Sea and shortening in the Apennines as result of arc migration driven by sinking of the lithosphere. Tectonics, *5*(2), 227-245, https://doi.org/10.1029/TC005i002p00227.

Robin C. et al. (1987) - Vavilov seamount: A mildly alkaline Quaternary volcano in the Tyrrhenian Basin. Marine Geology, 78(1-2), 125-136, https://doi.org/10.1016/0025-3227(87)90071-5.

Savelli C. & Ligi M. (2017) - An updated reconstruction of basaltic crust emplacement in Tyrrhenian sea, Italy. Scientific Reports, 7(1), 18024, https://doi.org/10.1038/s41598-017-17625-2.

Hydrogeological investigation of the Venetian-Friulian Plain and North Adriatic Basin: assessing onshore dynamics and offshore freshwater availability

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Keywords: Hydrogeology, Geological modeling, Groundwater modeling, Offshore freshwater, Northern Adriatic.

The Venetian-Friulian Plain (VFP) hosts a complex confined aquifer system that is both highly productive and heavily exploited for industrial, agricultural, and drinking water purposes, even within its lagoonal areas. A more in depth understanding of its offshore component, which is currently unknown, can contribute to monitor the coastal fresh groundwater depletion, as well as identify potential new resources. This study investigates the groundwater dynamics of VFP and the adjacent North Adriatic Basin (NAB) with particular focus on offshore freshened groundwater availability. The study is conducted through three main working steps: geological modeling, aquifer environmental depositional analysis, and numerical groundwater modeling.

Geological models were built with multi-approach techniques, among which Geostatistics, on a 3D onshore-offshore region that extends 15 km into the NAB, and laterally 60 km along the coast direction, and approximately 250 meters below sea level. The resulting models show the geometries and extent of the aquifers, suggesting the offshore continuation of the onshore aquifer-bearing formations. These sandy aquifers are stratigraphically linked to cyclothems, i.e. the geological deposits associated to post-mid-Pleistocene sea-level fluctuations. Depositional environment analysis, based on lithostratigraphic data, suggests that the aquifers are likely made of coastal sandy deposits, and are the relicts of past sea-level transgressions in the plain.

By integrating the geological modeling results with the depositional analysis, we propose that the North Adriatic Basin hosts permeable sandy formations that are potentially saturated with freshwater. The preliminary groundwater numerical modelling based on the geological model aimed at investigating the presence of an offshore-directed freshwater flux. The simulation was run for the last 2 decades with Modflow 2005 and calibrated with 180 monitoring wells. The results of the budget analysis reveal a bidirectional water exchange: an offshore-directed flux of freshwater toward the NAB (~4 m^3 sec^{-1}), and an onshore-directed flux (0.5 m^3 sec^{-1}), suggesting the risk of saline intrusion in coastal aquifers.

Side Scan Sonar data in Taranto area (CARG Project)

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Keywords: marine geology, CARG, offshore, multidisciplinary.

The project focuses on the Marine Geology aspects of the offshore submerged area of Taranto. It is also a cartographic project that aims to give its own contribution to the national cartographic project CARG coordinated by ISPRA. All the acquired data are updated and unpublished, allowing us to obtain a comprehensive assessment of the seabed with a multidisciplinary approach, studying the interconnections between sedimentological, eco-biological and anthropogenic dynamics.

The study area of Taranto (Northern Ionian Sea) is particularly interesting not only from a geological point of view. The area includes three different marine basins: a semi-enclosed, shallow basin (Mar Piccolo), a deeper open basin (up to 1,500 meters - Northern Ionian Sea), and a circular basin (Mar Grande) with intermediate hydrodynamic features and depths between the other two. The submerged sector of the area hosts great biodiversity but is affected by intense anthropogenic impacts.

The applied research method is almost the standard one proposed by ISPRA, which comprehends in direct and undirect surveys. The data acquisition that we have done with En.Su. Environmental Surveys and ISMAR – CNR, consisted in low and high frequency simultaneous acquisitions with Multibeam Echosounder, Side-Scan Sonar, Sub Bottom Profiler and Ultra High Resolution multichannel seismic streamer, and all the data were correlated with data coming from boreholes, samples and literature.

The morphological survey was conducted using a KLEIN 3000 Side-Scan Sonar with simultaneous dual frequency (100 kHz - 500 kHz). SSS morphological data were recorded in XTF (eXtended Triton Format) and SDF (Sonar Data Format) formats and then processed to produce georeferenced acoustic images (mosaics) with 0.50 m resolution. The mosaics were then imported to GIS platform for morphological classification of the seabed and the subsequent interpretation and digitization phase.

These high-resolution SSS data, integrated with seismic and bathymetric data acquired with SBP and MBES, allowed a detailed lithological classification of the seafloor to be obtained, enabling the production of a litho-geomorphological map of the seafloor, validated by the results of core samples analyses.

The SSS data allowed us to recognize and produce the map of the distribution of habitats on sea floor, like seagrass meadows and bioconstructions. This map has been produced correlating the backscattering signal to the type of substrate, the degree of light penetration and depth.

Finally, the mosaic resolution enables the recognition of morphologies on the seabed as consequence of different anthropogenic activities. Due to the large extent of the areas affected, and the density of the traces recognized, only their areal distribution has been mapped.

The collected data will give stronger foundations to support the ecological transition and conservation of marine ecosystems, promoted in the Blue Economy sections of several development plans.

The opportunity of deep-sea geophysical exploration offered by ROV-surveys. Some examples from Tyrrhenian and eastern Mediterranean

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Key words: ROV, sub-bottom profilers, multibeam echo-sounders, seismo-genetic faults, cold seeps.

The importance of near field geophysical surveys for the deep-sea exploration for scientific or industrial purposes has been increasingly recognized in recent years. The technique of acquiring data from ROV/AUV mounted sensors, flying at few tens of metres above the seafloor, can enormously improve the capacity necessary to detect small-scale geological features. For instance, at 10 m depth (or flying altitude), latest multibeam sonars have an average 0.5 x 0.1 m acoustic footprint whereas such footprint decreases to 6 x 22 m at 1000 m depth resulting in a two orders of magnitude loss of spatial resolution. A similar decay of the resolution power with depth applies also for hull-mounted sub-bottom profilers.

Here we provide some cases extracted from ROV-surveys in the Tyrrhenian, Aegean and eastern Mediterranean basins over their continental slopes until the basin plains at approximately 2000 m depths. Joint interpretation of high resolution multibeam, side-scan and sub-bottom data allow to detect with unprecedented accuracy active, seismo-genetic faults or seabed features associated to cold seeps and their structural control. The data presented must be considered still proprietary products and for this reason are not geo-referenced but only referred to their geographical context.

Several fault splays including dip-slip, strike-slip or reverse have been observed in southern Tyrrhenian and in the Aegean in correspondence to main, regional seismo-genetic structures. The resolution provided by sub-bottom data allow to accurately measure the throw and assess the age of deformation which are key parameters in paleo-seismicity studies. In eastern Mediterranean south of Cyprus acoustically transparent sequences recalling homogenite-like deposits (Polonia et al., 2023) have been found at great depths (2000 m) and suggest possible tsunamigenic, earthquake-related source.

Seabed features associated to gas venting have been systematically encountered over a wide depth range along slope and basin areas. Pockmarks size range from hundreds of metres to few metres of diameter in few cases associated to mud-diapirs. Side-scan high backscatter and high-resolution bathymetry indicate the occurrence of Methane-Derived Authigenic Carbonates (MDAC, Hovland et al., 1984) often inside pockmarks or at shallow sub-bottom depth covered by hemipelagic muds. Acoustic data, coupled with visual inspections, have also revealed unusual seepage features, frequently controlled by faults or failure cracks. Other features like “pingos” or comet-shaped depressions (Chen et al., 2020) which were previously unknown in the Mediterranean have been also recognized.

Chen T. et al. (2020) - Discovery of numerous pingos and comet-shaped depressions offshore southwestern Taiwan. Geo-Marine Letters, 40, 407-421, http://doi.org/10.1007/s00367-019-00577-z.

Hovland, M. (1984) - Characteristic features of pockmarks on the North Sea Floor and Scotian Shelf. Sedimentology 31, 471-480.

Polonia A. et al. (2023) - Large earthquakes along slow converging plate margins: Calabrian Arc paleo seismicity based on the submarine turbidite record. Geosciences Frontiers, 14, 101612, http://doi.org/10.1016/j.gsf.2023.101612.

Beach ridges as indicator of the post LGM sea level rise

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Keywords: Cold phases, Older Dryas; Younger Dryas, 8.2ka event.

The detail mapping of the continental shelf of the northeastern sector of the Sardinian coast, between Olbia and Posada, has allowed the recognition of several seafloor geomorphic features. These have been related to the geological and climatic history of the area from the Last Glacial Maximum (LGM) to the early Holocene. During the LGM sea level was about 130 below the present and cuspate delta systems fed by rivers crossing the entire continental shelf formed. The post LGM eustatic sea level rise caused submersion of the exposed continental shelf and changed the dominant sedimentary processes. The rise was however not continuous but punctuated by stillstands during which the environmental conditions were stable and sea level rise slow enough that suites of beach ridges had time to develop. The mapped ridges have been grouped in three systems (BRS1, BRS2 and BRS3**)** and, on the base of their depth, correlated to specific post-LGM sea level stillstands. These fit pretty well with the cold phases that punctuated the post LGM warming phase; that is, the Older Dryas (17-15 ka), Younger Dryas (12.9-11.6 ka) and the 8.2-kiloyear event (8.7-8.2 ka).

Multidisciplinary approaches to large-scale Posidonia oceanica restoration in Asinara Gulf (northern Sardinia)

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Keywords: Posidonia oceanica, geological survey, environmental engineering, marine habitat restoration, sediment analysis.

In the Mediterranean Sea, habitat restoration has focused especially on the endemic seagrass Posidonia oceanica, which is crucial for sediment stabilization and protection against coastal erosion. Despite numerous transplanting experiments, large-scale restoration projects remain relatively few, with limited knowledge of their long-term success. This study presents a large-scale restoration project on a degraded P. oceanica meadow in northern Sardinia, Italy. The restoration was conducted using cuttings harvested from a donor meadow at risk of destruction due to a harbor expansion.

The selection of the restoration site was made through a multidisciplinary survey integrating geological and ecological methods. Acoustic mapping investigated the seafloor bathymetry and substrate conditions, while remotely operated vehicle (ROV) surveys provided benthic habitat imagery. Sediment features were analyzed to determine substrate suitability for P. oceanica growth. In addition, a temporal satellite imagery analysis over a decade assessed the long-term stability of the site and environmental conditions (De Luca et al., 2025; Boudouresque et al., 2009).

The restoration involved manual removal of P. oceanica plants from the donor meadow, followed by selecting and transplanting cuttings within 24 hours using environmental engineering techniques. The cuttings were positioned onto biodegradable mats made of coconut fibers, reinforced with a double-twist steel mesh to anchor them to the seafloor. This approach ensured transplant stability under dynamic Mediterranean hydrodynamic conditions.

A total of 7,000 patches consisting of 20 cuttings were transplanted in three phases: June–July 2022, October–November 2022, and February–March 2023. These periods were chosen based on seasonal variations in water temperature, light, and sediment stability, which affect seagrass transplantation success. One year later, 58% of the patches remained in situ, with an overall survival rate comparable to previous small-scale projects, supporting its applicability for large-scale habitat restoration.

The success of this project highlights the potential of biodegradable materials for application in restoring marine ecosystems, offering a valuable tool for geologists and environmental engineers. The integration of geological and ecological data in site selection was crucial in identifying optimal conditions for P. oceanica restoration. This approach serves as a model for future large-scale restoration projects in the Mediterranean Sea.

De Luca M., et al. (2025) - "Restoration of Posidonia oceanica Meadow Using Cuttings from an Area Impacted by Harbor Extension Project." J. Mar. Sci. Eng., 13, 3.

Boudouresque C.F., et al. (2009) - "Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances." Bot. Mar., 52, 395-418.

Importance of data collection and integration with different resolutions and exploration depths. Case study: Gulf of Cagliari

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Key words: seismic profiles, seismic resolution, Gulf of Cagliari.

The MaGIC project has provided the scientific community with very important information about the morphologies, sediment deposition and outcrops that represent the seabed. Often, the shape and distribution of these features are strictly related to the buried structures and their trends produced by previous tectonic events. Very often, if we could analyse the deeply buried structures, we could observe their close relationship with the seabed and we might be able to better understand their origin and perhaps even their future evolution.

For this reason, it should be very important to integrate all the geological and geophysical data present on a marine study area, and in particular we would like to focus on the need to draw on all the existing available data. We know that hydrocarbon exploration has provided huge amounts of data, only partially accessible to researchers. But we also know that small or large datasets exist often in our offices or in our secret drawers. The scarcity of research funding, combined with the increasingly difficult acquisition new multichannel seismic profiles, which require sources that disturb the aquatic fauna, make it urgent to recover and share this treasure and heritage of the scientific community. The ViDEPI project has been an important first step in this process, which we think should be rejuvenated and carried forward.

As an example, I present a case history in the Gulf of Cagliari based on several profiles of different resolution, also considering important information from the literature on the morphology of the sea bed and the Plio-Quaternary sedimentary sequence (Lecca et al., 1998). The results synthetize some published and submitted papers focused on different exploration depths along the same seismic dataset. (Caradonna et al., 2025; Caradonna, Frisicchio et al., submitted; Del Ben et al., submitted).

Caradonna M.C. et al. (2025) - Recent mass transport deposits in the Gulf of Cagliari, Marine Geology (2024), https://doi.org/10.1016/j.margeo.2025.107515.

Caradonna M.C. et al. (submitted to Geomorphology) - Submarine canyon Morphology and Evolution along the Western and Southern margins of Sardinia.

Del Ben A. et al. (submitted to Basin Research) - Geodynamic evolution of the Gulf of Cagliari.

Lecca L. et al. (1998) - The sedimentary framework of Cagliari Basin: a Plio-Quaternary underfed rift basin in the southern Sardinia margin. Alpine and Mediterranean Quaternary, 11(2), 301-318.

Unraveling seafloor dynamics: backscatter Multibeam mapping and sedimentological insights from the Marzamemi offshore (South-eastern Sicily, Italy)

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Keywords: Multibeam mapping, paleo-lagoonal systems, sedimentary environments, karstic processes.

Coastal and shallow-marine environments exhibit complex sedimentary dynamics influenced by Quaternary sea-level fluctuations, hydrodynamic forces, and biogenic processes. The study of geomorphological structures and sedimentary facies through high-resolution acoustic mapping and sedimentological analyses provides critical insights into past marine transgressions and sediment transport mechanisms.

The Marzamemi seabed represents an ideal study site to characterize these processes, as it is characterized by a complex mosaic of sedimentary environments, shaped by Quaternary sea-level fluctuations. High-resolution backscatter Multibeam mapping and acoustic facies analysis have provided new insights into the region's paleo-environmental and geomorphological evolution. The mapping of seafloor morphologies was enhanced by integrating sedimentological data obtained from samples collected along transects on the northern beach of Marzamemi village. In order to calibrate the reflectivity facies of the Multibeam maps, these samples have been processed with statistical softwares. This approach ensured a more accurate correlation between acoustic backscatter response and sediment features, allowing for a refined interpretation of the seabed composition and its variability in terms of physical and textural properties.

Three distinct paleo-lagoonal systems have been identified at depths of -45 m, -35 m, and -20 m, respectively, marking former shoreline positions associated with past transgressive phases. These systems exhibit various sedimentary facies, ranging from fine sands in protected settings to coarser deposits influenced by tidal currents. Coralligenous formations and *Posidonia Oceanica* meadows play a significant role in shaping the seabed, acting as sediment stabilizers and biodiversity hotspots. The distribution of these biogenic structures correlates with substratum composition and hydrodynamic conditions, influencing sediment transport and accumulation patterns.

Karstic processes have significantly contributed to the morphology of the Marzamemi seabed. The presence of submerged sinkholes, depressions, and stepped bathymetric features suggests dissolution events that were later modified by marine transgression. The interaction between karstic topography and sedimentary infill processes has resulted in a heterogeneous seabed characterized by contrasting acoustic signatures.

The integration of geomorphological, sedimentological, and acoustic data contributes to a refined understanding of past marine transgressions, biogenic accretion, and sediment transport mechanisms. These results offer a valuable baseline for future coastal management and marine conservation strategies, emphasizing the importance of preserving geomorphological and ecological heritage in shallow-marine environments.

Submarine volcanism in the Sicilian Channel revisited

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Keywords: Submarine volcanism, Continental Rift, Sicilian Channel, Bathymetry, Magnetometry.

The origin and role of volcanism in continental rifts remains poorly understood in comparison to other volcano-tectonic settings. The Sicilian Channel (central Mediterranean Sea) is largely floored by continental crust and represents an area affected by pronounced crustal extension and strike-slip tectonism. It hosts a variety of volcanic landforms closely associated with faults which can be used to better understand the nature and distribution of rift-related volcanism. However, a paucity of appropriate seafloor data has led to uncertainties regarding the location, volume, sources and timing of such submarine volcanism. To improve on this situation, during a recent geophysical campaign in the Sicilian Channel with the German R/V METEOR (July-August 2023), a series of geophysical data (multibeam bathymetry, high-resolution seismics, magnetometry) were acquired and rock samples were taken in different sectors where volcanic structures had been previously identified. In the course of these investigations, three new volcanic structures were discovered. These are in addition to the six volcanoes discovered in the Sicilian coastal region between Mazara del Vallo and Sciacca during a campaign conducted by OGS with the R/V OGS Explora in 2019. The analysis of these data offers a complex scenario of different magmatic sources and provides the foundation for an updated tectonic and magmatic framework for the Sicilian Channel (Micallef et al., 2024). Moreover, our investigation allowed us to check the reliability and accuracy of the current bathymetric maps. It turned out that several morphological elements represented in the maps are not real. These new discoveries show that there are still large areas in the Mediterranean that are practically unknown, even though they have been navigated by ships of all kinds since ancient times. The Sicilian Channel is one of them. Today we have the appropriate technologies to reconstruct the morphology of the seabed to the finest detail; we need the will and the means to carry out these projects, which have a fundamental impact on the safety of navigation, the management of fisheries, the planning of port works and infrastructures, the mitigation of coastal risks associated with climate change and the study and protection of the marine environment in all its forms.

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Distribuzione verticale e superficiale di IPA e mercurio nei sedimenti marini raccolti durante la campagna oceanografica PIONEER

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Keywords: PIONEER, Taranto Valley, Idrocarburi Policiclici Aromatici (IPA), mercurio (Hg), datazione della carota.

La campagna oceanografica PIONEER (Processes in the IONian Sea: Exploring, Experimenting, Researching) aveva l'obiettivo di testare i nuovi strumenti a bordo della nave e di condurre un'ampia ricerca multidisciplinare nel Mar Ionio, una regione meno conosciuta rispetto ad altre aree del Mediterraneo, ma caratterizzata da forti influssi antropici, soprattutto nelle aree costiere di Taranto e Crotone. Nell'ambito di questa ricerca, sono stati condotti studi sulla contaminazione da IPA e mercurio su una carota di sedimento prelevata al di fuori della Taranto Valley, scelta come sito di riferimento e su campioni di sedimento marino superficiale raccolti lungo il transetto costa-largo della Taranto Valley.

Per il campionamento dei sedimenti è stato utilizzato il box-corer. I profili di porosità e suscettività, costanti con la profondità, insieme al profilo di attività del piombo (^{210}Pb), che segue un andamento esponenziale, indicano che la carota campionata al di fuori della Taranto Valley, ha registrato una sedimentazione costante nel tempo. Assumendo l'assenza di bioturbazione, è stato applicato il modello empirico CF-CS (Constant flux-Constant sedimentation) per il calcolo dei tassi di accumulo del ^{210}Pb, ottenendo un tasso di 0.24 cm/y. Tale velocità di sedimentazione e le caratteristiche dell'ambiente sedimentario sono confermati dal profilo di ^{137}Cs, che mostra un picco a 14.5 cm di profondità, corrispondente all'anno 1963.

Il profilo del mercurio (Hg) mostra le minori concentrazioni con valori costanti negli strati più profondi della carota (ultimi 15 cm), seguite da un incremento con un picco (0.10-0.12 mg/kg) nella parte centrale della carota, e una successiva diminuzione verso la superficie. L'andamento del Hg è coerente con una sedimentazione indisturbata, e ha permesso di determinare i valori di riferimento nella parte inferiore della carota (circa 0.04 mg/kg). L'arricchimento nei sedimenti più recenti, che varia da 2 a 2.8 volte rispetto ai valori più bassi, indica un aumento della deposizione di Hg negli ultimi cinquanta anni.

Le concentrazioni di IPA totali riscontrate nella carota di sedimento hanno mostrato valori compresi tra 33.5 e 267.5 ng/g, dw, con una media di 168 ng/g, dw. I valori più bassi (<150 ng/g, dw) si riferiscono al periodo che va dal 1938 al 1888, con un picco inferiore nel 1900 (39 ng/g, dw). Mentre i valori più alti (230–270 ng/g, dw), sono stati registrati tra il 1990 e il 1963, con un lieve calo nel 1982 (160 ng/g, dw). L'analisi temporale delle concentrazioni di IPA totali, caratterizzate da un'alta variabilità, evidenzia il loro legame con eventi storici significativi, come l'industrializzazione, il consumo di carburante pro-capite e l'aumento di autoveicoli.

Nei sedimenti superficiali del transetto Taranto Valley, la concentrazione di Hg varia tra circa 0.07 e 0.08 mg/kg, mentre la contaminazione da IPA presenta valori che variano da 110 a 311 ng/g, dw, con una concentrazione maggiore nel sito più vicino costa.

Submarine canyon origin and evolution on the western Sardinian margin

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Keywords: western Sardinian margin, canyon, geomorphology, seismic interpretation, Plio-Quaternary

Submarine canyons play a key role in sediment transport and continental margin evolution. The western Sardinian margin hosts a network of submarine canyons whose morphologies reflect their response to environmental and geological controls over time. This study investigates their morphological characteristics and evolutionary history using high-resolution bathymetric data, seismic reflection profiles (low, medium, and high resolution), and geomorphometric analysis.

Three canyon systems have been identified, some of which were already mapped (Ulzega, 1988). They exhibit low sinuosity and orthogonally engrave the western Sardinian margin. These systems, named Alghero (ACS), Catalano (CCS), and Oristano (OCS), are oriented NE-SW, E-W, and E-W/SE-NW, respectively. They are shelf-incising and range from a few hundred meters to several kilometers in width, and from tens to a few hundred meters in depth.

On the continental shelf, old Messinian canyons were filled with Plio-Quaternary (PQ) sediments, whereas the more recent canyons on the outer shelf and continental slope erode the PQ layers. While previous studies (Harris & Whiteway, 2011; Migeon et al., 2012) suggested that canyons in the western Mediterranean originated during the Messinian Salinity Crisis, our analysis demonstrates that those evident in the bathymetry of the western Sardinian margin developed during the Quaternary. Seismic reflection data confirm that in most cases only Quaternary sediments are incised, while in certain locations, canyons also reach the Messinian reflector, due to thinner PQ deposits or increased erosive power. Several branches of these recent canyons on the shelf were active during the early Quaternary but have since been filled, as evidenced by draped structures and fill facies. Their present-day inactivity is also indicated by the recent horizontal stratification above the filled branches, with only one branch remaining active on the outermost shelf. Additionally, some canyon branches are aligned with structural weaknesses, such as fractures that favor fluid migration, forming pockmarks on the outer shelf seafloor.

The evolution of these canyon systems was likely driven by a combination of margin tilting and Quaternary glacio-eustatic variations, which promoted slope instability processes and accelerated canyon formation, contributing to the sedimentary architecture of the region.

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Salt tectonics in the Tyrrhenian Sea: centripetal salt deformation in a back-arc basin

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Keywords: Salt diapirs, salt gliding, Sardinia continental margin, Campanian continental margin.

The Tyrrhenian Sea salt is part of the Messinian Mediterranean salt giant. Its regional distribution was mapped during the early exploration of the Tyrrhenian back-arc basin. We present the first basin-scale interpretation of a combined data set of multibeam bathymetry and seismic lines. In the relatively flat, proximal areas of the Cornalia and the Campania Terraces, vertical rise of diapirs is the dominant style of salt movement.

Whereas most of the diapirs are buried, some of them emerge at the seafloor and their circular form of salt stocks is apparent. Widespread extensional faulting of the overburden is indicative of reactive diapiric rise and control the location and evolution of local depocentres. Large parts of the Tyrrhenian Sea dip, towards the central deep Vavilov and Marsili Basins. Thus, salt gliding is the prevalent style of salt deformation. In the Sardinian margin, a belt characterized by salt gliding spans a length of 230 km and is up to 130 km wide, reaching the Vavilov Basin in the centre of the back-arc system. In the Campanian margin a more equant salt gliding area has a length of 106 km and a width of 80 km. Smaller areas with evidence of salt gliding are located at the foot of the base-of-slope escarpment in the northern Sicilian margin to the south of the Vavilov Basin. Salt gliding results in discrete lobes with complex pattern of deformation.

Deformation in the overburden often originates polygonal networks of grabens, scalloped scarps, circular or elongate mini-basins, growth anticlines and synclines. When the halokinetic structures reach the seafloor, their relative importance in the different sectors of the main lobes is apparent, with discrete zones of deformation, and a highly 3-D style of salt gliding and overburden deformation. Belts dominated by strike-slip deformation separate the different sectors of the main lobes and are often associated with salt stocks or faults. They are indicative of the linkage between discrete salt gliding systems with different movement direction. A complex deformation style and movement is thus evident in the Tyrrhenian Sea and the deformation of the overburden indicate the recent or active character of salt flow.

Our analysis illustrates the processes and elements that characterize salt tectonics in irregular continental slope, with divergent gliding, and where different system interact. At the basin-scale, salt deformation style does not comply with the simple patterns often observed in passive margins, consisting, moving seaward, of three domains: extensional, translational and contractional. In the Tyrrhenian Sea a more complex pattern is evident and can be related to the trend of the peripheral zone of the gliding salt masses inherited from the rifting stage. The crustal evolution and magmatic history of the basin also influences the discrete, but kinematically linked, slat gliding domains.

La Geologia Marina a Pisa

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Keywords: Corso di Geologia Marina, Università di Pisa, Progetto Speciale della Didattica, Georischi.

La Geologia Marina a Pisa sta intraprendendo un nuovo corso con il crescere dei gruppi di lavoro all'interno del Dipartimento di Scienze della Terra; diversi sono infatti i settori scientifico disciplinari che si occupano dello studio di questa disciplina, dalla sedimentologia alla geomorfologia, passando inevitabilmente per la micropaleontologia. Di recente è stato riattivato l'insegnamento "Geologia Marina" nell'ambito del Corso di Laurea Magistrale in Scienze e Tecnologie Geologiche, come caratterizzante del curriculum "Geologia Strutturale, Geologia Stratigrafica, Sedimentologia e Paleontologia" e come affine-integrativo del curriculum denominato "Georischi" (parte del programma prevede lo studio e l'analisi dei fogli *Magic);* in questo stesso curriculum è invece caratterizzante l'insegnamento denominato "Rischio Costiero", attivo ormai da diversi anni insieme ai corsi di "Dinamica Sedimentaria Costiera" e "Micropaleontologia" (entrambi insegnamenti che figurano nel curriculum "Geologia Strutturale, Geologia Stratigrafica, Sedimentologia e Paleontologia"). La collaborazione tra i docenti di questi corsi ha portato, nel 2023, alla realizzazione del progetto speciale per la didattica "*Universitatis II*", che, grazie anche alla collaborazione con la società "Geo Coste", ha reso possibile per studenti e studentesse del Dipartimento attività che hanno spaziato dal rilevamento costiero a quello sottomarino, con strumenti quali livelle ottiche, drone, e multibeam. Il futuro della Geologia Marina a Pisa, sia dei sistemi profondi che costieri, è garantita da un folto gruppo di dottorandi e assegnisti, tra micropaleontologi, sedimentologi e geomorfologi, che stanno coltivando con passione le loro ricerche e che contribuiscono attivamente alla crescita di questa disciplina anche attraverso attività di supporto alla didattica e di divulgazione.

The Seagap Fault offshore Tanzania: Tectonic significance in the microplate framework of the West Somali Basin (Indian Ocean)

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Keywords: East African rift, strike slip fault, tectonic, seismic data.

The current architecture of the East African continental margin is the result of two major tectonic events: the opening of the West Somali Basin (WSB), which took place between the Middle Jurassic and Lower Cretaceous, and the tectonic processes that, since the mid-Cenozoic, have driven the development of the offshore branch of the East African Rift System (EARS). Offshore Tanzania, tectonic activity associated with EARS is primarily concentrated along two major north-south trending structures:

The Davie Ridge, a prominent bathymetric feature that has accommodated east-west extension since the Late Eocene to Miocene.

The Seagap Fault, a less documented structure exhibiting left-lateral strike-slip motion since the Late Eocene.

Both features are believed to be reactivations of older structures, primarily formed during the opening of the WSB, which also influenced the geometry of the Mesozoic ocean-continent transition (OCT) offshore Tanzania. However, the lack of deep seismic imagery and detailed stratigraphic data limits our understanding of the origin and nature of the Seagap Fault. The interpretation of five deep 2D seismic reflection profiles (10s TWT) and 3D seismic datasets provides new insights into the deep architecture of the crustal basement and the Seagap Fault offshore Tanzania. The results indicate that the Seagap Fault zone consists of large-scale localized structures that affect the seafloor and exhibit growth geometries across most of the Miocene sedimentary sequences. The evidence of continuous tectonic activity observed in our seismic mapping, along with data from previous 2D deep seismic studies, suggests that between the Middle-Late Jurassic and approximately 125 Ma, the Seagap Fault functioned as a regional structure, parallel to and coeval with the dextral Davie Fracture Zone.

From a tectonic perspective, the Seagap Fault has played a dual role in the geological evolution of the region. Evidence suggests that, at least between 8° and 9°S, it acted as a continental transform margin during the opening of the WSB, sharply juxtaposing oceanic crust to the east against thinned continental crust to the west. In more recent times, the Seagap Fault appears to have been reactivated within the framework of the offshore East African Rift System, resulting in left-lateral transtensional movements. This reactivation may be linked to the clockwise rotation of the Rovuma microplate.

Stratigraphic and Sedimentological Characterization of the Reitano Flysch: a multidisciplinary approach

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Keywords: Turbidites, Reitano Flysch, organic matter, aero-photogrammetry.

Turbidite-filled basins represent good repositories for organic matter and excellent archives of tectonic and climatic events in the geological record. With this in mind, we focus on the Reitano Flysch in Sicily (Italy), whose age, source area and sedimentary processes are still a matter of debate. The Reitano Flysch, orogen-derived turbidite, (northeastern Sicily) is characterized by an alternation of siliciclastic sandstones and clays, deposited in a thrust top-basin setting onto the deformed tectonic units of the Apenninic-Maghrebian Chain.

This study is part of the PRIN PNRR 2022 project (P2022T3A4E) "TOOLS: Testing the efficiency of submarine landslides On Organic carbon sequestration over geological timeS".

Main aims of TOOLS are the following: 1) To understand architectural geometries and processes, that ensured deposition and exceptional conservation of organic matter; 2) To reveal the type and transformation of organic matter and its role in carbon cycle; 3) To understand basin deformation and configuration, sedimentary processes and provenance of sediments; 4) To reveal the timing/recurrence of turbiditic deposits, which can be linked to different scale climatic events ($10 – 10^2 – 10^3 – 10^4$, Milankovitch cycles) and/or tectonic ones.

To accomplish such goals these steps must be followed: 1) measuring new detailed sedimentological logs together with new aero-photogrammetric geological mapping; 2) geochemistry and organic matter analysis; 3) maturity of organic matter and provenance study 4) integrated biostratigraphy and geochemistry. According to collected paleoflow data and sedimentary facies patterns the Reitano Flysch could exhibit the architectural geometry and sedimentological structures of ''contained turbidites'' The notable characteristics of ''contained turbidites'' (Pickering and Hiscott, 1985) include: (1) the presence of thick mudstone caps overlying sandstone beds; (2) complex paleocurrent directions; (3) dominance of thick beds; (4) complex grading patterns; (5) evidence of dewatering; and (6) onlap of sheet-like bed geometries. The grain size range, the muddy and silty caps and the occurrence of hybrid beds confirm that the Reitano Flysch deposited in a confined-contained environment (ponded basin) (Southern et al., 2015).

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Geological and Geomorphological Characteristics of the Corigliano Gulf (Southern Italy): Insights from Geophysical and ROV Video Survey for Offshore Wind Farm Design

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Keywords: offshore renewable energy, marine geology, morpho-bathymetric mapping, geohazards.

Offshore wind energy plays an increasingly significant role in the energy transition, contributing to the reduction of greenhouse gas emissions and energy diversification. The European Union promotes the development of renewable energy through the Green Deal and the RED II Directive, while in Italy, the PNIEC provides incentives for energy production from renewable sources, including offshore wind power. However, the realization of these infrastructures requires comprehensive environmental and geological investigations to assess site suitability and ensure project sustainability.

This study aims to characterize the morpho-bathymetric and sedimentological features of the seabed in correspondence of a morpho-structural high inside the Corigliano Gulf (Calabria, Italy) selected for the installation of an offshore wind farm covering approximately 140 km². The investigations were conducted using a combination of direct and indirect survey techniques. Specifically, bathymetric surveys were carried out using a multibeam echo-sounder, while the application of a side-scan sonar provided high-resolution images of the seafloor, essential for the detection of targets and potential morphological anomalies. A sub-bottom profiler was employed to investigate the shallow stratigraphy of the area. Additionally, ROV video transects were performed to enable direct visual inspection of the morphological and biological characteristics of the seascape. Moreover, water and sediment samples were collected for physicochemical and sedimentological analyses to assess the site's environmental quality and the nature of marine deposits.

This work enabled a detailed definition of the seabed morphology, sediment distribution, and shallow stratigraphy of the study area. The results provide essential insights for assessing the geological and environmental conditions, offering key information for the design of the offshore wind farm. The production of thematic maps (*e.g.*, morpho-bathymetric and sedimentological maps) represents a useful tool for identifying potential critical issues (*e.g.,* stability of wind turbines anchors and cable conduits) and mitigating impacts during the construction and operational phases of the infrastructure (*e.g.,* trigger of submarine landslides, interference with seabed currents). Finally, this study highlights the importance of integrating multidisciplinary methodologies for the characterization of sites designated for marine renewable energy projects, ensuring a sustainable and informed approach to the planning and development of offshore wind energy.

A Jewel of Mediterranean Biodiversity and Geodiversity: The Linosa Island

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Keywords: Multibeam data; seafloor classification; coralligenous de plateau; rhodolith beds; benthic foraminifera.

Here, we present recent studies that underscore the distinctive features of Linosa Island, emphasizing its remarkable biodiversity and geodiversity, intricately linked to its volcanic and morphological characteristics.

Linosa, a volcanic island in the Sicilian Channel, in the last decade has been the subject of extensive seafloor surveys using geophysical and ground truth data, along with sampling and ROV investigations (Tonielli et al., 2019). Three primary habitats have been identified as dominant in Linosa's marine environment: *Posidonia oceanica* meadows, rhodolith beds, and coralligenous habitats, which include extensive coral forests. In addition, the assemblages of benthic foraminifera, which serve as valuable environmental indicators, have been studied in this area, for the first time, to investigate their correlation with the topography of the seafloor (Ferraro et al., 2020). The combined dataset from these studies has been used to create a comprehensive map of the seafloor at a 1:15,000 scale, aiming to highlight the island's high degree of marine biodiversity (Innangi et al., 2024a).

Moreover, a recent study of the Linosa Island shelf (Sicilian Channel, Mediterranean Sea), at depths ranging from 34 to 152 meters, has revealed a previously undescribed morphotype of coralligenous assemblages. These structures, which feature planar to conical shapes and can range from single to multilayered formations, exhibit slight elevations (20-30 cm) and display concave to convex arrangements. These coralligenous formations primarily cover the seabed between 80 and 100 meters of depth and develop on a sedimentary substrate rich in biogenic elements, especially rhodoliths. This discovery aligns closely with the concept of "coralligenous *de plateau*" as originally defined.

Finally, we present suitability maps derived from both qualitative and quantitative analyses of ROV investigations (Innangi et al., 2024b). In regions with limited field data, predictive habitat mapping proves to be a powerful tool for understanding species-environment relationships and advancing our knowledge of the spatial distribution and complexity of benthic habitats. Species distribution models (SDMs) are vital in supporting science-driven ecosystem management. Given the typically high costs of direct surveys to observe mesophotic species such as gorgonians and black corals, predictive models can play a key role in forecasting their distribution based on seafloor physical parameters. This approach is crucial for enhancing conservation strategies within existing and newly established Marine Protected Areas (MPAs).

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Gravitational, erosional, sedimentary, and volcanic processes on the submarine environment of ocean volcanic islands: The case studies of Porto Santo Island (Madeira Archipelago) and Corvo Island (Azores Archipelago)

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Keywords: Volcanic insular shelves, Post-volcanism evolution, Marine erosion, Sedimentary dynamics, Mass-wasting processes.

Volcanic ocean islands are shaped by a complex interplay of volcanic, erosional, sedimentary, and marine processes (Ramalho et al., 2013). While their subaerial evolution is generally well-documented, their submarine portions remain underexplored. Of particular interest are the shallow water areas, which hold key insights into the islands' development.

This research investigates the post-volcanism evolution of insular shelves by integrating onshore and offshore datasets from two case studies: Porto Santo (Madeira Archipelago) and Corvo (Azores Archipelago). These islands, despite both being of volcanic origin, exhibit distinct geological histories, oceanographic conditions, and morphological characteristics, making them ideal for comparative analysis.

A multidisciplinary approach was employed, combining high-resolution bathymetric surveys, seismic reflection profiling, sediment sampling, and geomorphological analysis. Porto Santo's southern insular shelf was studied using existing geophysical datasets and sediment samples, while Corvo's submarine environment was newly mapped through targeted oceanographic campaigns. Data processing involved acoustic imaging, stratigraphic interpretation, and sedimentological assessments to reconstruct the evolution of their submarine landscapes.

The results indicate that both islands are shaped by a combination of subaerial and wave-induced erosion, sediment deposition, and gravitational mass-wasting processes at different magnitudes. Porto Santo has reached a mature stage of development, featuring an extensive bioclastic sandy beach that transitions into depositional bodies on the shelf, dominated by present-day carbonate factory. In contrast, Corvo exhibits a rugged landscape, characterized by steep cliffs and a high-energy marine environment shelf dominated by mass-wasting deposits and terrigenous (volcaniclastic) depositional bodies, with extremely low bioclastic contribution. The comparative analysis underscores the influence of sea-level fluctuations, island age, and oceanographic dynamics in controlling shelf morphology and sedimentary architecture.

These findings enhance our understanding of volcanic island evolution and provide valuable insights into coastal stability, marine resource management, and natural hazard assessment. The research results contribute to sustainable development initiatives, particularly in mitigating erosion risks, managing marine aggregates, and preserving marine ecosystems.

Ramalho R. et al. (2013) - Coastal evolution on volcanic oceanic islands: A complex interplay between volcanism, erosion, sedimentation, sea-level change and biogenic production. Earth-Scientific Reviews, 127, 140-170, https://doi.org/10.1016/j.earscirev.2013.10.007.

Submerged coastal systems along the Western Sardinian shelf (Mediterranean Sea)

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Keywords: submarine depositional terrace, barriers, sea level rise, meltwater pulses, holocene.

The results of a geophysical study of the seabed of the continental shelf of the western Sardinia margin (Mediterranean Sea, Italy) are presented. The focus of the study was to provide evidence of the various submerged coastal systems associated with the last eustatic cycle.

In particular, the study focused on beach barriers, submerged depositional terraces (SDT), submerged dunes and the current infralittoral prograding wedges (IPW). The activity was carried out by interpreting multibeam echosounder data, side-scan sonar photomosaics, reflection seismic data and aerial orthophotos. A total of 48 sediment samples were collected and analysed to validate the interpretation data. The formation and evolution of the submerged coastal systems were considered in relation to the present coastal systems of the study area and were related to the available models of the last sea level rise from the Last Glacial Maximum (LGM) to the present day, denoting a pulse pattern mainly triggered by Meltwater Pulses. Along the last eustatic cycle, following the LGM, sea level rose by about 125 m, reaching a near still-stand around ~4,000 y BP (Lambeck et al., 2014).

Consequently, the SDTs, found in the study area, can be traced back to past IPWs of the coastal system (Budillon et al., 2022). At the same time, morphologies such as barriers or beachrocks can be associated with the past shorelines (De Falco et al., 2015). Thus, both morphologies can be linked with still-stands or slow rises in sea level since the LGM, around 24 ky to 21 ky BP, and during the post-LGM transgression, making them as relicts. A clear submerged coastal system was mapped at ~65 m depth. Considering both location and elevation, this submerged system, is interpreted as formed during a phase of relative still-stand of the sea level associated with the Younger Dryas period (12.8 ky - 11.5 ky BP), between the MWP-1A and MWP-1B (Zecchin et al. 2015). Of particular interest is the submerged beach system in front of the Piscinas-Scivu beach. In this area it is possible to clearly identify the shoreline and the current IPW, located at ~26 m depth, at a distance of about 1,200 m from the current coastline. Moving offshore we found two barriers at depths of 34-32 m and 38-43 m, NNE-SSW oriented. In addition, a system of submerged paleo-dunes was observed between the two sets of barriers. The paleo-dunes are located at a depth of ~35 m, elevated about 8 m above the seabed, NWW-SEE oriented. The submerged dunes appear to be similar in shape, dimension and orientation, to the current emerged dune system of the adjacent Piscinas beach.

Budillon F. et al. (2022) - Present-day infralittoral prograding wedges (IPWs) in Central-Eastern Tyrrhenian Sea: Critical issues and challenges to their use as geomorphological indicators of sea level. Marine Geology, 450(2022), 106821, https://doi.org/10.1016/j.margeo.2022.106821.

De Falco G. et al. (2015) - Early cementation and accommodation space dictate the evolution of an overstepping barrier system during the Holocene. Marine Geology, 369, 52-66, https://doi.org/10.1016/j. margeo.2015.08.002.

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Integrated GIS Database for beach evolution monitoring along the Western Coast of Sardinia (Mediterranean Sea)

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Keywords: GIS, Coastal monitoring, beach morphodynamics, DSAS, SLR, Mediterranean Sea.

The preliminary results of the implementation of an integrated GIS database for monitoring and management of the evolution of Sardinian beaches (Mediterranean Sea) are presented.

The aim of the work is to develop a single database that brings together: morphometric information, evolution trends of the coastline, the shoreline retreat in relation to the rate of sea-level rise (SLR), presence of geological, biological and anthropic constraints that can limit the adaptation of beaches.

The investigated area includes different beach types: from large open beaches up to geologically controlled and embayed beaches. The data model of the GIS database essentially integrates three main methodologies of data entry, allowing the application of specific formulas and models.

The first consists in the surveying of morphometric parameters on the base of aerophotogrammetric images. These parameters can provide information on the relationships between the factors that control beach dynamics (e.g. incident waves, lateral constraints, sheltered beach area, etc.). Once the values of the morphometric parameters were calculated for each beach, is possible to estimate their embayment degree using a classification parameter called Embayment Morphometric Parameter (Fellowes et al., 2019).

The second method is based on a historical study of shoreline trends. Aerial photographs covering a time interval of almost 70 years (from 1954 to 2022) are used to study shoreline trends. Shoreline positions aredigitized from each image at a scale of 1:500 and trends in shoreline position are calculated using the Digital Shoreline Analysis System (DSAS) application.

DSAS provides several indicators of shoreline variability, in particular we considered the Shoreline Change Envelope (SCE). The SCE represents the maximum variation (as a distance) that occurred among all digitized shorelines (Simeone et al., 2024).

The third method develops a procedure for processing previous data by cross-referencing it with other mapped data, such as the position of the depth closure and the extent of the emerged beach. The methodology is suitable for estimating the Retreat (R) using different formulas proposed by different authors in relation to the beach type (es. Bruun, 1962), with reference to the most recent evaluation of the SLR rate (Vacchi et al., 2021).

The result of the R associated with the SCE is then plotted on a map to graphically may represent the area in which the shoreline can migrate in relation to the SLR at 2100.

The landward migration of the shoreline can be compared with the current characteristics of the back beach, considering the physical constraints both natural or anthropic. The collection of a large amount of data using different methods within the same GIS framework can significantly improve the interpretation of the future evolution of the overall environmental characteristics of a coastal area.

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Stratigraphic, sedimentological and geomorphological features of the southern Sicily continental shelf between Capo San Marco and Capo Bianco (Sicily Channel)

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Keywords: continental shelf, fluid seepage, sea level change, seismostratigraphy, Sicily Channel.

In the framework of the research activities carried out to the geological mapping of the n° 628 Sheet "Sciacca" (CARG Project; Sulli et al., 2024), a number of seismo-acoustic, sedimentological and video data have been collected in the southern Sicily offshore between Capo San Marco and Capo Bianco (Sicily Channel). The results of these surveys allowed us to unravel new insights on the geomorphological and sedimentary setting of the continental shelf and its morpho-sedimentary evolution during the Late Quaternary.

In the study area, characterized by current tectonic activity and high sediment supply, the continental shelf extends up to about 15 km from the coastline, and it is bounded by a depositional shelf break developing at water depth in between 115-125 m. The stratigraphic setting is characterized by an aggrading to slightly prograding Holocene succession which unconformably overlies a seaward dipping, mostly silico-clastic, Pleistocene succession upward topped by an erosional truncation surface (U horizon).

The present day sedimentary setting is characterized by a general graded distribution, from gravels to clays moving far from the coast, of hybrid sediments, but exception to this regular trend is represented by two elongated patches of sands located in the inner continental shelf and surrounded by extensive sandy muds, which could be the consequence of local gyres of bottom current. In front of the Platani River mouth, bottom currents swept the seabed sediments forming sedimentary structures as subacqueous dunes with > 2 m wavelength at about 15 m of water depth, NNW-SSE trending.

A different morpho-sedimentary setting has been recognized in the Capo San Marco offshore, where a number of scattered carbonate bedrock outcrops have been detected, that are bounded by up to a few meters high slope breaks. In this sector small fields of pockmarks and isolated mud volcanoes have been mapped, small contourite mounds accumulated in between the bedrock outcrops, and well preserved coralligenous concretions overlay the outcropping carbonate bedrock down to about 40 m of water depth.

The sea level change has played a fundamental role in controlling the morpho-sedimentary evolution of the continental shelf during the latest Quaternary. The U unconformity formerly originated as subaerial erosion surface during the most recent sea-level fall culminated in the eustatic lowstand correlatable to the MIS 2; subsequently it was shaped as ravinement surface during the last sea level rise and following Holocene transgression. During the lowstand, up to 10 m thick prograding, regressive deposits accumulated close to the position of the current shelf-break; then during the subsequent sea level rise, the shoreline migrated landward and coastal deposits accumulated as backstepping, transgressive parasequences. The modern deposition has built an up to 20 m thick, laterally extensive wedge of aggrading-to-slightly prograding, littoral-to-neritic sediment.

Mapping of active faults and geo-hazards elements offshore Ionian Islands (Western Greece)

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Keywords: Active tectonics, geo-hazards, Cephalonia Transform Fault.

The area offshore the central Ionian Islands (western Greece) is among the Mediterranean regions one with the highest seismic activity and tsunamigenic potential. A series of destructive earthquakes, such as those of 1953 (Mw > 6.6) that destroyed the islands of Kefalonia and Zakynthos, or more recent events such as the 28 October 2018 Mw 6.8 earthquake in Zakynthos, have affected the area and most of these had their epicentre offshore. The earthquakes are controlled by Africa – Eurasia convergence, across the Ionian Sea, and focused along the Cephalonia Transform Fault. The Cephalonia System plays a crucial role in this domain as the main transfer zone of convergent motion between the Mediterranean Ridge, off Kefalonia and Zakynthos, and the Dinarides front, off Albania. However, a complete mapping and understanding of the entire Cephalonia Fault System band of the geological risk elements affecting the Ionian islands has not yet been produced to date, except for the area south to Cephalonia and Zakynthos (Loreto et al., under revision). During two recent surveys, carried out in June 2023 on board of the R/V Laura Bassi - the POSEIDON project supported by the Eurofleet+ program and the IONIANS cruise carried out in May 2022 on board of the R/V G. Dallaporta, supported by the Italian CNR, a multiscale geophysical dataset has been collected.

The new high-resolution multichannel seismic data, integrated with high-resolution bathymetry, have allowed us to define the deformation of marine sediments at the intersection of the Cephalonia fault and the front of Hellenic Arc. To the southeast of the Cephalonia slope, a series of small bulges interpreted as reverse faults have been mapped, bounding SE-dipping positive flower structures. Towards the south, the Cephalonia Fault is composed of a 25 km-wide fan of elongated sigmoidal positive flower structures. Towards the north, offshore Cephalonia, the fault system narrows to a 6 km-wide strike-slip structure. More north (west and north or Lefkada), the new high-resolution bathymetry combined with sub-bottom profiles (TOPAS) allowed us to map for the first time the seafloor displacement of the Cephalonia Fault and to determine a fault length of over 120 km. South of Zakynthos the deformation regime change resulting dominated by extension; translational slides of more than 10 km-width affect the surface sediments. All geological hazard elements, such as canyons, slide scarps, landslide bodies and fault scarps were also mapped. The transition between the strike-slip and compressional domains, more complex than previously thought, has been analyzed in detail obtaining for the first time the geometries of the main fault systems.

Loreto M.F., Ferrante V., Ligi M., …. & Nomikou P. (2025) - Anatomy of the Right-Lateral Strike-Slip Cephalonia Fault to the Western Hellenic Arc Frontal Thrust. Under review in Tectonics.

Large-Scale Gravitational Collapse and Seabed Morphology in the Crotone Basin (Ionian Calabria)

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Keywords: Crotone Swell, Squillace Complex, Punta Stilo Swell, gravitational collapse.

The offshore sector of the Crotone Basin (CB), located in Ionian Calabria (Southern Italy), is characterized by three prominent morphological highs: the Crotone Swell, the Squillace Complex, and the Punta Stilo Swell. This study integrates 2D/3D seismic reflection data, borehole analysis, and bathymetric datasets to clarify the structural framework and driving mechanisms of these features, which may represent potential geohazards in the region.

Our results highlight that the Crotone Swell corresponds to the compressional counterpart (toe region) of an outcropping SE-dipping arcuate listric fault system (headwall region), linked via a buried seaward-dipping basal detachment surface (BDS).This structure forms a ~2000 km² mass-transport deposit (MTD) that started sliding during the Zanclean and experienced a paroxismal event at the transition between the Zanclean and the Piacenzian; these events were followed by a paucity phase during the Early Calabrian and a reactivation in the Mid-Pleistocene, correlated with regional uplift (>0.45 Myr) (Zecchin et al., 2018; Mangano et al., 2020).

In the Gulf of Squillace, the Squillace Complex exhibits a NE-striking headwall transitioning to a W–E-directed movement at the toe. The gravitational collapse initiated in the Zanclean (~4 Ma) and continued into the Gelasian (~2.1 Ma) at a rate of 1.9 mm/year, slowing down to 0.1 mm/year from the Calabrian to the present. The predisposing factors resposnible for the evolution of both Squillace Complex and Crotone Swell include slope oversteepening just after the Messinian and the Zanclean, together with the lithological contrast between shaly and evaporitic layers (Mangano et al., 2023b).

The structural evolution of the Punta Stilo Swell is the result of different tectonic phases, from the Messinian to late Pliocene/Pleistocene along the Soverato-Lamezia Fault Zone (SLFZ). The Messinian contractional phase and the early Pliocene extension reactivated older contractional and extensional structures respectively, while the late Pliocene/Pleistocene transtensional phase inverted a pre-existing positive flower structure of the SLFZ. These tectonic phases controlled the deposition of the Plio-Quaternary sedimentary succession and significantly influenced the present-day seabed morphology of the PSS (Mangano et al., 2022).

The evolution of such geological features reflects the geodynamic history of the central Mediterranean. Temporary halts in the Calabrian Arc migration caused slope oversteepening and gravity sliding, while its SE migration, alongside Tyrrhenian oceanization, controlled gravitational stability and the modern physiography along the PSS (Zecchin et al., 2018; Mangano et al., 2022; Mangano et al., 2023b).

Mangano et al. (2020) - Large-scale gravity-driven phenomena in the Crotone Basin. southern Italy. Marine and Petroleum Geology 117, 104386.

Mangano et al (2022) - Mid-miocene to recent tectonic evolution of the punta stilo swell (Calabrian Arc, southern Italy): an effect of calabrian arc migration. Mar. Geol. 448, 106810.

Mangano et al. (2023b) - A new large-scale gravitational complex discovered in the Gulf of Squillace (central Mediterranean): tectonic implications. Scientific Reports 13(1), 14695.

Zecchin et al. (2018) - The Crotone Megalandslide, southern Italy: architecture, timing and tectonic control. Sci. Rep. 8(1), 1-11.

Preliminary results from a 3D slope stability analysis along a canyon headwall in the Gulf of Squillace

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Keywords: submarine canyon headwalls, Ionian Calabrian margin, slope stability.

Submarine canyons are complex seabed features recognised worldwide as major conduits of sediments, where landslides characterise their headwall domain. The factors contributing to their evolution, among pre-conditioning and triggering factors (Vanneste et al. 2014), are still poorly constrained due to complex geological settings and lack of in-situ sediment sampling.

The offshore sector of Southern Italy, in particular the Ionian Calabrian Margin (ICM), is severely incised by multiple submarine canyons that exhibit complex headwalls with multiple branches. The area is tectonically active and seabed features indicative of geohazard have been extensively mapped and qualitatively described (Ceramicola et al. 2024).

In 2023, during the ERODOTO research campaign, a collection of high resolution data and gravity cores was collected to investigate the evolution and the principal factors that generated the retrogressive headwalls of the Squillace submarine canyon.

High-resolution bathymetry and seismic data revealed the presence of multiple landslide scars and seabed bedforms, indicative of active sediment transport and slope instability.

Following a series of geotechnical tests conducted at the Ifremer Geotech Lab on the gravity cores, a 3D slope stability analysis was conducted, to assess which factors have contributed the most to destabilize the seabed. The results suggest a predominant effect due to seismic activity on decreasing the Factor of Safety (FoS) values up to <1 in the study area.

This study provides new insights on the evolution of submarine canyon headwalls in the Squillace Gulf, with quantitative information from geotechnical analysis and 3D slope stability modelling. Our results provide a valuable contribution in assessing critical areas for new offshore infrastructures.

Ceramicola S. et al. (2024) - Geohazard Features of the Ionian Calabrian Margin. Journal of Maps, vol. 20, no. 1, 2349785, https://doi.org/10.1080/17445647.2024.2349785.

Vanneste M. et al. (2014) - Seafloor instabilities and sediment deformation processes: the need for integrated, multi-disciplinary investigations. Marine Geology, vol. 352, p. 183-214.

A QGIS-Based Approach Using Acoustic Data for Mapping Benthic Habitats: Focus on Coralligenous Bioconstructions

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Keywords: bioconstructions, GIS-based protocol, benthic habitat mapping.

Coralligenous is a biocenotic complex mainly formed by the accumulation of calcareous encrusting algae growing in dim light conditions, able to forms 3D biogenic build-ups. By producing various morphotypes, Coralligenous contributes to seascape formation and transformation over geological time. Although Coralligenous bioconstructions occur along almost the entire Mediterranean continental shelf, they have been mapped in only a few areas, and their distribution remains underestimated. Moreover, due to its importance as a biodiversity hotspot, the European Community considers Coralligenous among the most critical habitats to monitor and protect, given its low accretion rate and high sensitivity to natural and anthropogenic changes. For these reasons, acoustic instruments are optimal tools as they allow for the rapid recognition and mapping of benthic habitats without direct contact, which could threaten these vulnerable ecosystems.

In this study, a semi-automated GIS-based protocol for benthic habitat mapping was developed and tested in the shallow coastal waters of Capo Bianco, within the Isola Capo Rizzuto Marine Protected Area (Crotone, Southern Italy). The method integrates high-resolution bathymetric and backscatter data from Multibeam Echosounder surveys with geomorphological and geomorphometric indices to develop innovative approaches for eco-geomorphological and geobiological characterization. The proposed protocol has proven effective not only in identifying marine bioconstructions but also in quantitatively defining their spatial and three-dimensional distribution in terms of covered surface, volume, and height relative to the substrate from which they develop.

For these reasons, the proposed protocol for benthic habitat mapping represents a powerful tool for accurately delineating the extent and assessing the evolution of bioconstructions over time in response to natural and/or anthropogenic changes. Moreover, the model was performed using open-source software, providing a detailed workflow that can be freely reproduced and adopted by organizations involved in research, monitoring and conservation of marine habitats. Furthermore, combining this mapping protocol with minimally invasive sampling systems and geobiological-geochemical characterization of marine bioconstructions may provide a potent tool for monitoring these delicate habitats.

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Tracing glacial-interglacial water mass changes during the last 450 ka in the Gulf of Corinth (IODP Expedition 381) using ostracod assemblages

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Keywords: Corinth Rift, Glacial Terminations, Sea level rise.

The Gulf of Corinth, a tectonically active rift basin in central Greece, serves as a natural laboratory for investigating sedimentary processes and environmental changes during the Quaternary. The International Ocean Drilling Program Expedition 381 retrieved sediment cores from this region, providing valuable archives for reconstructing past paleoenvironmental and paleoceanographic conditions (McNeill et al. 2019). Among the various proxies available, ostracods are key indicators of past environmental changes due to their sensitivity to salinity, temperature, and water depth fluctuations.

This study analyzes two IODP cores: M0080 from the Alkyonides Gulf and M0078 from the central Gulf of Corinth, focusing on Quaternary sea-level changes over the past 450 ka based on the stratigraphic distribution and ecological preferences of ostracod species. The results reveal multiple cycles of alternating brackish lake and fully marine environments, driven by Quaternary orbital-scale global climate and sea-level oscillations. These fluctuations were primarily controlled by the inflow of Mediterranean waters into the Corinth Basin through the shallow Rion and Acheloos sills (at -60 m and -50 to -55 m depths, respectively) on the west side of the Basin. Connectivity was also influenced by the Corinth Isthmus on the eastern side (Mazzini et al., 2023), as indicated by the brackish ostracod assemblage, with over 90% of the identified species commonly occurring in the waters of the Ponto-Caspian basins (Parisi et al. 2024).

Rapid sea-level rise during glacial Terminations I, II, and V, corresponding to MIS 2/1, 6/5, and 12/11, suggests high deglacial sea-level rise rates of approximately 10-30 mm/year. These findings enhance our understanding of deglacial sea-level rise, complementing coral terrace records and deep-sea oxygen isotope data, while also shedding light on the complex interplay between climate, sea level, tectonic activity, and sedimentation in an active rift setting.

Mazzini I. et al. (2023) - A new deglacial climate and sea-level record from 20 to 8 ka from IODP381 site M0080, Alkyonides Gulf, eastern Mediterranean. Quat. Sci. Rev. 313(2), 108192, https://doi.org/10.1016/j.quascirev.2023.108192.

McNeill L.C. et al. (2019) - High-resolution record reveals climate-driven environmental and sedimentary changes in an active rift. Scientific Reports. 9, 3116, https://doi.org/10.1038/s41598-019-40022-w.

Parisi R. et al. (2024) - A new species of benthic ostracod Tuberoloxoconcha: A proxy for glacioeustatic sea-level changes in the Gulf of Corinth. Pal, Pal, Palaeoecology. 655, 112483, https://doi.org/10.1016/j.palaeo.2024.112483.

Il Foglio n° 524 “Foce del Sinni” (progetto CARG): stato dell’arte e nuove prospettive

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Keywords: Cartografia geologica, Foce Sinni, Golfo di Taranto, Progetto Carg.

Si illustrano i dati relativi ad un’area sommersa del Golfo di Taranto, nel Mar Ionio, corrispondente al Foglio n. 524 “Foce del Sinni” alla scala 1:50.000 (Progetto CARG).

L’area di riferimento si estende dalla piattaforma continentale alla scarpata, lungo il settore settentrionale della costa ionica, tra la foce del fiume Agri a nord e Roseto Capo Spulico a sud.

I dati analizzati sono stati raccolti nel corso di due campagne oceanografiche condotte tra il 2005 e il 2006. La prima campagna, mirata all’acquisizione di dati batimetrici multibeam, ha permesso di ottenere una mappatura ad alta risoluzione della piattaforma e della scarpata continentale. Contestualmente, sono stati acquisiti profili di sismica a riflessione di tipo sub-bottom e Sparker.

Nell’aprile del 2006 è stata condotta una seconda campagna di acquisizione, focalizzata principalmente sul campionamento dei sedimenti mediante carotaggi a gravità. Sono stati prelevati 40 campioni, con i siti di campionamento selezionati sulla base delle ecofacies individuate attraverso i profili sismici.

Le indagini hanno evidenziato la presenza di forme di fondo di particolare interesse. Nella porzione più esterna della piattaforma è stata individuata un’area, estesa per circa 10 km², caratterizzata da onde di sedimento. Queste strutture, localizzate prevalentemente tra Lido di Policoro e la foce del fiume Sinni, presentano una lunghezza d’onda media di 200 m e un’altezza compresa tra 2 e 7 m. La scarpata continentale si sviluppa tra 130 e 800 m di profondità, estendendosi verso est per circa 15 km e mostrando pendenze comprese tra 2 e 4°.

I risultati preliminari includono immagini ad alta risoluzione dei dati batimetrici, profili sismici e log stratigrafici rappresentativi delle situazioni geologiche più interessanti fin qui osservate. Questi dati contribuiscono, inoltre, a definire lo stato attuale delle conoscenze geologiche relative al Foglio “Foce del Sinni” e costituiscono la base per la pianificazione di indagini future mirate. In particolare, è prevista una nuova campagna di acquisizione che includerà l’impiego del side-scan sonar per la raccolta di dati di riflettività acustica e il prelievo di ulteriori campioni di sedimento per una caratterizzazione dettagliata del fondale. Queste attività consentiranno di affinare il riconoscimento delle associazioni di litofacies presenti, di elaborare la carta geologica dell’area secondo gli standard CARG e individuare i principali elementi deposizionali del sistema di piattaforma e scarpata continentale dell’area rilevata.

Stratigrafia, morfodinamica recente e assetto strutturale nel Golfo di Genova (Mar Ligure, Italia): nuove evidenze dai rilievi CARG

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Keywords: Piattaforma continentale, canyon, evoluzione tettonica, risalita di fluidi, Golfo di Genova.

Presentiamo i principali risultati del completamento del settore marino del Foglio 213-230 "Genova", pubblicato per i settori a terra nel 2010, e che comprende l'intero Golfo di Genova. Tale area corrisponde a un ampio settore di piattaforma continentale coincidente con il passaggio tra il margine alpino e quello appenninico del Mar Ligure. La piattaforma, costituita da uno spesso cuneo sedimentario Plio-pleistocenico, si articola in strette depressioni tettoniche orientate longitudinalmente (circa Est-Ovest) e trasversalmente (circa Nord-Sud) allo sviluppo del margine, le cui antiche propaggini settentrionali si individuano, attualmente, lungo alcuni settori costieri, dove affiorano i depositi marini pliocenici delle "Argille di Ortovero". I tratti tipici della sequenza tardo-quaternaria caratterizzano la copertura superficiale di una piattaforma che appare solcata da vistosi arretramenti delle testate dei canyon del Polcevera e del Bisagno.

L'integrazione di nuovi dati geofisici e il riesame di dati pregressi hanno permesso di ottenere importanti risultati, tra i quali spiccano:

- la dettagliata ricostruzione della distribuzione della coltre olocenica lutitica lungo la piattaforma e in prossimità del prisma costiero dove si raggiungono i massimi spessori dell'unità (fino a 30 metri);
- la caratterizzazione degli effetti dei processi erosivi e gravitativi recenti e attivi lungo i bordi e sui fianchi delle testate dei canyon con segnalazione delle zone di instabilità attiva o incipiente. Le morfologie che attestano tali tendenze (gullies, nicchie di frana, etc.) si associano spesso a forme del fondale (pockmarks e affioramenti litoidi) connesse a risalite di fluidi, che contribuiscono all'instabilità dei fondali. La loro genesi è confermata dalla corrispondenza con tipiche facies acustiche prodotte da sedimenti saturi di fluidi o soggetti a migrazione degli stessi (e.g. fluid escape chimney, acoustic blanket etc.);
- la mappatura delle aree dove si concentrano le risalite dei fluidi poste sul ciglio della piattaforma e lungo i bordi dei canyon, spesso coincidenti con lineamenti tettonici sepolti;
- l'individuazione, in aree del ciglio della piattaforma poste ai bordi del Canyon del Bisagno, di ondulazioni del fondale marino (sediment wave) di notevole dimensione ed argini con strutture di crescita (depositi di overbank) attribuibili all'azione di intense correnti trattive e/o flussi torbiditici;
- una migliore ricostruzione dei caratteri dei corpi sedimentari tardo-quaternari con particolare attenzione ai corpi trasgressivi appartenenti a paleo-sistemi barriera-laguna (pale-cordoni litorali e depositi di laguna) caratterizzati nel settore occidentale da una spiccata continuità laterale;
- la definizione più dettagliata del quadro strutturale e sismo-stratigrafico del settore orientale dell'area marina del Foglio 213-230 "Genova" posta al largo di Voltri e al largo del Porto di Genova.

Low level of microplastics in marine sediment from a shallow-water mud volcano (Northern Tyrrhenian Sea)

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Keywords: Microplastics, marine sediments, mud volcanoes, Mediterranean Sea, FTIR spectroscopy.

Microplastic (MP) pollution represents a worldwide problem, with plastic particles being widely dispersed throughout the marine environment.

The present study aims at investigating MPs presence in marine sediments on and around a shallow-water mud volcano located offshore Scoglio d'Affrica islet (Northern Tyrrhenian Sea), a geologically active area, characterized by low anthropogenic pressure and far from terrestrial sources of plastic pollution. Grain size analyses on sediment samples were also carried out to evaluate potential relationships between MPs accumulation and sediment texture. The analyzed samples showed on average 33.7 (± 16.9 standard deviation) items/kg of dry sediment, with fibers being the predominant shape of plastics. No significant correlations with sediment texture were found; conversely, a positive trend was observed between MPs abundance and sampling depth. The presence of low-density polymers on the summit of active mud volcanoes suggests a rapid MPs sequestration from water in the seafloor compartment.

Findings from this study highlight the pervasiveness of plastic pollution problem even in nearly pristine settings and show the need for assessing MPs contamination across different geological settings and depth ranges, to fully understand MPs presence and distribution within marine sediments, providing novel insights and hints for future research challenges.

Extensional Basins in the Civitavecchia offshore (Northern Tyrrhenian Sea): structural setting and sedimentary processes

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Keywords: Rift tectonics, bottom-contours, Messinian reflectors, Plio-Pleistocene sedimentation.

The northern portion of the Tyrrhenian Back-Arc Basin has been the subject of numerous studies, mainly focusing on its overall structure, inferred through sparse, regional seismic lines. On the contrary, detailed studies of specific sectors of the Tyrrhenian Sea are still few. In this contribution one of such studies is presented through the interpretation of seismic profiles and multibeam bathymetric data in the offshore of Civitavecchia. The horizon corresponding to the M-surface, the top of the Messinian units, is represented by a strong seismic reflection with often erosional character. It has been picked on the available seismic profiles and digitized with the software SeisPrho. The horizon has been then extrapolated in 3-D with QGis to build a surface representing the isochrone map of the top of the Messinian. Since tectonics was mainly active up to the Messinian, the M-surface approximates the morphology at the end of the rifting. It shows that extensional tectonics formed a series of graben and half-graben basins, separated by horsts. The high-angle extensional features had mainly a NNW-SSE and NW-SE trend. Frequent flips in the dip of the master-faults, en-echelon faults distribution, and relay ramps make the extensional setting very complex. In addition, secondary structures were identified with varying geometries and spacing within the main structures, further complicating the setting of the study area. A map of the thickness of the Plio-Quaternary sediment has also been compiled. The Plio-Quaternary sediments have a post-tectonic setting and passively infill the previously formed basins. They have been divided into different units. The lower unit resemble the lower Pliocene Trubi Formation with low-amplitude reflections and represents a homogeneous lithological assemblage most likely consisting of hemipelagites. The upper sequence has high-amplitude high-frequency reflectors and can be associated with alternating coarser and finer-grained intervals. Thus, an abrupt change in sedimentary dynamics has occurred in the study area, presumably during the middle part of the Pliocene. It can be related to changes in oceanographic or paleogeographic condition. In some of the areas, the upper sequence shows characteristics that can be explained through the action of contour currents. We thus conclude that the abrupt passage to well-reflective facies can be indicative of oceanographic changes and the activation of bottom-current. The change in seismic facies is not synchronous in the area, meaning that the tectonic grain exerted a local control on the pathway of bottom currents. In general, our contribution highlights the structural style of a poorly known sector of the Tyrrhenian Sea back-arc Basin. It shows that the Latium-Tuscany offshore has a structural setting similar to that of the adjacent coastal regions. In addition, it stresses, for the first time, the important role of bottom current along the Latium-Tuscany Tyrrhenian margin.

Comprehensive global inventory of submarine mud volcanoes

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Keywords: Seafloor fluid flow morphologies, mud volcanoes, geodatabase.

Systematic morphometric studies of submarine mud volcanoes (MVs) are still limited (Kopf, 2002; Kioka & Ashi, 2015) despite their relevance. To address this gap, a comprehensive inventory of submarine MVs was developed and subsequently analyzed, including their spatial distribution, morphological classification and morphometric characteristics (Napoli et al., 2024).

First, submarine MVs show significant variability in terms of size (from very small to giant) and shape (e.g., from flatter to domed to slightly conical to conical), with a mean *H/R ratio* of 0.14 ± 0.08. Mud pies are generally smaller than mud cones and lack very large examples (mean diameter >10 km). The smallest mud cones with volumes of ~100 m³ represent the morphometric starting points (MSPs) from which different morphometric trends found depart. These MSPs resemble simple conical shapes of arc volcanoes found in other geological settings.

Giant mud cones (e.g., MV55) and mud pies (e.g., MV74) in the South Caspian Sea are the closest in size to the serpentinite mud volcanoes of the Marianas. These outlier MVs in the Marianas, including Quaker, Conical, Celestial, Honza, and Big Blue, are the largest globally (Wheat et al. 2020) with volumes ranging from ~212 km³ to ~1092 km³.

The Mediterranean Sea shows a multiplicity of sedimentary volcanism-related landforms, with heights up to 500 m and mean diameters up to 8000 m, distributed at depths of 5-3600 m. The West Nile deep-sea fan has the highest density, with 8 submarine MVs per 100 km².

This study, including basic marine geological and applied geohazard aspects, represents a first step towards promoting shared knowledge on MVs, improving the understanding of their genesis and facilitating societal decisions on submarine geohazards.

Kioka A. & Ashi J. (2015) - Episodic massive mud eruptions from submarine mud volcanoes examined through topographical signatures. Geophysical Research Letters, 42(20), 8406-8414, https://doi.org/10.1002/2015GL065713.
Kopf A.J. (2002) - Significance of mud volcanism. Reviews of geophysics, 40(2), 2-1, https://doi.org/10.1029/2000RG000093.
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Wheat C.G. et al. (2020) - Fluid transport and reaction processes within a serpentinite mud volcano: South Chamorro Seamount. Geochimica et Cosmochimica Acta, 269, 413-428, https://doi.org/10.1016/j.gca.2019.10.037.

Innovazione nella Rilevazione Costiera: Approcci Integrati di Fotogrammetria con Drone e Indagini Geofisiche nelle Coste Siciliane

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Keywords: indagine geofisica, CSV (Compact Survey Vessel), fotogrammetria, multibeam, side scan sonar.

Le recenti attività geofisiche marine eseguite dalla GEO BIO TEAM Group s.r.l. hanno adottato un approccio innovativo alla raccolta di dati utili alla comprensione dei fondali marini, della geologia e delle dinamiche ambientali.

Diversi progetti hanno previsto sia indagini in mare per mezzo di Multibeam e Side Scan Sonar sia rilievi topografici delle zone *onshore* utilizzando la fotogrammetria tramite drone, integrata con il sistema di posizionamento GNSS RTK.

I dati illustrano i rilievi fotogrammetrici e/o geofisici di diversi settori costieri siciliani descrivendo strumentazioni e metodologie adottate per ottenere i migliori risultati.

I rilievi fotogrammetrici sono stati eseguiti con due droni quadricotteri DJI nelle aree di Alcamo Marina (TP) lungo la costa tirrenica e Petrosino (TP) lungo le coste del Canale di Sicilia. Questo nuovo approccio rappresenta un elemento fondamentale per creare continuità tra i dati topografici raccolti a terra e quelli batimetrici acquisiti in mare poiché esso non si limita a rilevare i settori emersi e la linea di costa, ma è in grado di acquisire anche dati batimetrici fino a una profondità dai 2 ai 3 m, poco oltre la *surf-zone*, quando le condizioni del mare sono favorevoli dunque con mare calmo, alta visibilità del fondale e vento ridotto o assente. Il collegamento dei dati da terra verso mare è stato possibile grazie all'utilizzo di un *Compact Survey Vessel* (CSV), una moto d'acqua di recente acquisizione lunga 3m e larga 1.6m, che prevede la presenza di un pilota e di una postazione di supporto a terra che garantisce un controllo in tempo reale del dato. Tale imbarcazione, altamente manovrabile, è ideale per eseguire indagini geofisiche in ambienti costieri e lagunari, dove la profondità limitata rende difficoltosa l'operazione di veicoli più grandi come, ad esempio, l'M/B Orca 2 (Orca Commercial H&O Spill Srl), di cui usufruiamo per gestire *survey nearshore* più impegnative che raggiungono lo *shelf break*.

Le potenzialità del CSV sono state confermate a seguito di uno dei rilievi a bassa profondità effettuati nella località di Marina di Ragusa (RG), lavoro che ha previsto l'acquisizione di dati morfo-batimetrici su una porzione di cavo sommerso utilizzando il Multibeam Norbit Winghead i77h Ultra High Resolution 400kHz. Questo strumento ha permesso di ottenere dati con risoluzione di 0.05m e di ricavare un dato *backscatter* alla stessa risoluzione.

Alcuni progetti in corso lungo le coste settentrionali della Sicilia, i cui dati fotogrammetrici sono in fase di elaborazione, prevedono un collegamento da terra verso mare con le metodologie e i mezzi sopra descritti.

Il nostro approccio innovativo, che prevede l'uso integrato di droni e di imbarcazioni leggere come il CSV consente, quindi, di ottenere dati continui, accurati e affidabili, in grado di supportare valutazioni geologiche e di impatto ambientale, nonché il monitoraggio di infrastrutture costiere sommerse o studi preliminari di posa cavi e condotte.

Oceanic geodiversity along back-arc spreading centers reveals analogies with mid-ocean ridges

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Keywords: oceanic geodiversity, spreading ridges, Bathy-morphological analysis, magnetic data, plate kinematics.

Geodiversity allows quantifying geofeature variations across space and/or time. Although marine geodiversity provides essential information on the dynamics of the Earth, the geological diversity of the ocean floor, which makes up >70 % of the Earth's geodiversity, remains largely unexplored. In a recent scientific paper (Palmiotto et al., 2024), we explored oceanic geodiversity investigating morphological and kinematic characteristics and relationships between depth axis and spreading rates along the Mariana Spreading Center (MSC), the East Scotia Ridge (ESR) and the spreading centers along the Central-Southern part of the Lau Basin (CSLB). These three examples of back-arc spreading centers (BASCs), all caused by extensional tectonics along ocean convergence, show evidence of geodiversity. Our bathymetric analyses contributed to refine the segments of microplate-plate boundaries with high resolution relative to those previously used in literature (DeMets et al., 2010), such as the Philippine Sea – Mariana, Scotia – Sandwich, and Australia – Tonga divergent boundaries. Furthermore, our analysis revealed differences in the depth of the BASCs, on average about 4.5, 3.5, and 2 km respectively, at the MSC, ESR, and CSLB. The analysis of magnetic profiles provided additional kinematic information along those boundaries with new full spreading rate data. We suggest a strong correlation between axial depth and full spreading rates along BASCs, a relationship that allows a similar description of these divergent plate boundaries within the mid-ocean ridge (MOR) classification, generally classified according to "spreading rates" (Dick et al., 2003). Despite the strong morphological and kinematic geodiversity, our results show that (1) the MSC resembles slow and ultra-slow MORs; (2) the ESR resembles intermediate MORs; (3) the CSLB resembles fast MORs. Thus, the geodiversity of the mature BASCs, forming along oceanic subduction zones, correlates perfectly with the geodiversity of the global MOR system along divergent plate boundaries. Finally, we computed the subduction velocity (Ficini et al., 2020) along Mariana, South Sandwich, and Tonga, showing how hinge kinematics affects the relationship between convergence along subduction zones and spreading rates along BASCs and contributing to understanding how oceanic geodiversity is directly related to geodynamic processes.

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The Microbial dominated giant Pliocene cold-seep system of the Crotone Basin (South Italy)

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Keywords: Authigenic carbonates, chemosymbiotic fauna, cold seep, conduit, microbialites, pavement.

The Pliocene cold-seep carbonate of the Crotone Basin (South Italy) represents a key site for dimension, outcropping exposure and quality. These deposits form a large carbonate (calcite) body (350m long, 100m wide and 40m thick), and are characterized by a conduit facies made of authigenic calcite interpreted as previously active gas/fluid escape pipes and by a pavement facies, depicted as the surrounding early calcite-cemented bioclastic and siliciclastic sediments. Pavement facies are commonly colonized by chemosymbiotic and non-chemosymbiotic macrofauna (Lucinid and Solemyid bivalves, gastropods and serpulids). The conduit microfacies is characterized by the inward accretion of dark micritic laminae alternating with whitish sparitic layers. The micritic laminae show a microbial peloidal to dendrolitic fabric, which commonly incorporates planktonic foraminifera and coprolites, whereas the crystalline layers consist of microsparitic and sparitic crusts of prismatic zoned calcite crystals. The pavement facies shows more variability, because it is typified by laminated microbial boundstones, chemosymbiotic–bivalves packstone, foraminiferal packstone/wackestone and hybrid arenites. The stratigraphic constraint coupled with the foraminiferal assemblage (planktonic taxa) suggest a deep-water setting occasionally affected by siliciclastic sedimentary flows. The pavement facies also shows common brecciation features, suggesting the establishment of post-depositional overpressure conditions due to the early cementation of the conduits, which triggered localized rock failure. Stable isotope analysis of the different facies reveals overall negative $\delta^{13}C$ values (-6.8 to -37.4‰ Vienna PeeDee Belemnite), indicating the presence of a complex mixture of methane with other hydrocarbons consumed microbially via anaerobic oxidation of methane; whereas $\delta^{18}O$ is relatively positive (0.0 to 3.4‰ Vienna PeeDee Belemnite) suggesting the possible dehydration of clay minerals and/or destabilization of gas hydrates. This study, besides helping in the definition of the migration pathways and modality of accumulation of hydrocarbon-rich fluids, can also help in building more and more realistic models for the complex genesis of coldseep carbonates.

Recent morphological evolution of submarine volcanic environments through repeated bathymetric surveys and ROV footage: an example from Vulcano Island

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Keywords: volcano, ROV exploration, Multibeam bathymetry, Bathymetric changes.

Flanks of active volcanic island are very dynamic environments due to the interplay between eruptive dynamics and erosive-depositional processes, however relatively few studies attempt to integrate observations from marine geophysics and video footages of the seafloor to reconstruct their rapid morphological evolution. In this study, we show the main results of such methodological approach at Vulcano Island, located in the Aeolian Archipelago in the southern Tyrrhenian Sea. This study focuses on two areas: the northern sector of the island, where the submerged portion of La Fossa Caldera is located, and the southern sector, offshore the small Gelso dock. Both sectors are characterised by a dense network of channels and small gullies that cut back up to the shallow-water sectors. The availability of repeated multibeam bathymetric surveys collected between 2003 and 2024, along with the integration of seafloor imageries acquired from Remotely Operated Vehicles (ROV) between 2022 and 2024, enabled the reconstruction of their morphological evolution. In this timeframe, both the study areas were affected by bathymetric variations, with a) marked seafloor erosion likely due to flash-flood hyperpycnal flows in the southern part of La Fossa Caldera, b) the formation of coaxial train of upper-flow regime bedforms generated by sedimentary gravity flow in the northern part of La Fossa Caldera, c) lateral and axial erosion of a small canyon just off the Gelso dock. In the latter case, erosive processes are undercutting the foundations of the dock, thus representing a potential geohazard for the infrastructure and underscoring the need of future monitoring activities.

Microplastics distribution in marine sediments offshore the Tiber River mouth (Central Tyrrhenian Sea): the role of sedimentary processes

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Keywords: microplastics, marine sediments, Tiber River delta.

Plastic litter is nowadays ubiquitous in the marine environment and rivers are globally recognized as main entry points for plastic at sea. However, our knowledge of the processes driving land-to-sea transfer and dispersal patterns of plastics is still limited, as well as its distribution on the seafloor, which represents a poorly assessed environmental compartment despite it is considered as a major sink for plastic. In this work, we investigated the distribution of MPs in marine sediments off the Tiber River mouth from 10 to 100 m depth. The Tiber River, i.e. the second italian river by catchment area, contributes ~20% to the fluvial input in the Tyrrhenian Sea and it is affected by a strong anthropogenic pressure, especially near its mouth by the city of Rome (~3 Millions inhabitant). Sediment sampling strategy was aimed at assessing MPs distribution and composition in different morphological zones of the submarine delta, from the inner delta front to the lower prodelta slope, in order to evaluate the role of sedimentary processes on the transport and deposition of MPs. To assess potential relationships with sediment texture, grain size analysis on sediment samples was also carried out. Results show a large variability in the abundance and polymeric composition of MPs across the study area, with concentrations ranging from 100 to over 2000 items/kg. The highest abundances are found on the upper prodelta slope, at 40-50 m depth, an area with high sedimentation rates and silty sediments. Much lower concentrations are observed in the shallower stations on the delta front characterized by sandy sediments, suggesting MPs bypass over the inner delta front likely facilitated by wave-induced resuspension. Furthermore, the stations north to the river mouth show higher abundances compared to those located in the southern prodelta, possibly indicating a lateral deviation of MPs transported by the river plume in response to the main northward-flowing Tyrrhenian currents. The most abundant polymers are polyesters and EVA, accounting together for the 43% of total MPs, pointing out land-based activities linked to textiles and clothing as important sources of MPs pollution in the area. Findings from this study suggest that deltaic environments may act as a sink for MPs, also highlighting the importance of taking into account sedimentary dynamics to deepen our knowledge regarding plastic distribution and accumulation hotspots.

Dal Mar Ionio al Mar Ligure: Indagini Geofisiche Integrate Nearshore e Offshore tra Calabria, Puglia e Toscana con Risultati Preliminari

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Keywords: geofisica marina, multibeam, side scan sonar, sismica, ispezioni video.

Il presente lavoro descrive le tecniche di indagine geofisica e illustra i risultati preliminari di rilievi morfo-batimetrici e sismici effettuati tra il Mar Ionio e il Mar Ligure, nei settori della Piattaforma Salentina, della Calabria orientale e nel settore dell'Arcipelago Toscano.

Le campagne oceanografiche sono state effettuate nell'estate del 2024 a bordo del M/B Orca 2 per i settori *nearshore* e M/V Denar Explorer per i settori *offshore*. Esse sono state suddivise in due fasi: la geofisica seguita da ispezioni visive (ROV).

La fase geofisica ha previsto, per il settore *nearshore*, l'acquisizione di dati batimetrici con Multibeam Norbit Winghead B41, dati Side Scan Sonar con Klein 3000, dati Sub Bottom Profiler con GeoPulse Compact e dati Sparker con Geomarine Mini-Spark 1000; per il settore *offshore*, ha previsto l'acquisizione dei dati batimetrici con Multibeam Kongsberg EM71, dati Side Scan Sonar e Sub Bottom Profiler con Edgetech 2300 e dati Sparker con Geomarine Geo-Source LW400.

Le fasi di ispezioni visive hanno previsto l'utilizzo del ROV di categoria "Observation Class" SAAB Falcon Seaeye 12399 nel settore *nearshore* e del ROV di categoria "Work Class" modello SubAtlantic Tomahawk della Forum Energy Technologies per il settore *offshore*, attrezzati con videocamere con risoluzione pari a 480 TVL.

Il set di dati ha permesso di fare un'interpretazione preliminare delle aree oggetto di studio, mettendo in luce le peculiarità geologiche dei settori rilevati.

Inoltre, i dati di Side Scan Sonar hanno mostrato non solo la presenza di molteplici aree di interesse archeologico, ma hanno permesso di individuare aree in cui le attività di pesca a strascico risultano essere molto intense, come del resto la presenza di strumenti utilizzati per la cattura di crostacei (come ad esempio le nasse).

Le ispezioni video ROV, in accordo con il DM 24/01/96 e D.Lgs 152/2006 e con le linee guida ISPRA, hanno previsto sia ispezioni puntuali su punti specifici sia uno studio biologico delle specie bentoniche presenti. I transetti navigati sono stati selezionati sulla base dell'interpretazione dei dati geofisici e geologici acquisiti. Le registrazioni hanno rivelato sia aree colonizzate da biocenosi di organismi bentonici calcarei (incrostanti di tipo "coralligeno") sia aree caratterizzate da substrato prevalentemente fangoso.

Questo studio documenta la perfetta integrazione di un'ampia varietà di dati geospaziali *nearshore* e *offshore* mostrata attraverso dati batimetrici, immagini acustiche e dati sismici ad alta risoluzione.

Reconstruction of Sea Surface Temperatures during the Late Pleistocene and Holocene in the Sicily Channel

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Keywords: Paleoclimatology, Sea Surface Temperatures (SST), Planktonic Foraminifera, Mediterranean, Sicily Channel.

This study reconstructs Sea Surface Temperature (SST) oscillations over the last 20 kyr using fossil archive of marine sediments from the Sicily Channel documenting the climatic variability in the central Mediterranean Sea and key global events.

We analyzed the gravity core ND11_2013 (475 m depth) from the NW Sicily Channel, recovered during the NEXTDATA 2013 expedition aboard R/V CNR-Urania. The 489 cm-long core consists of grey hemipelagic sediments. This research integrates geochemical (Mg/Ca ratio on *G. bulloides* and *G. ruber* white) and quantitative planktonic foraminifera analyses, supported by AMS14C dating.

During the Last Glacial Maximum (19.8-17.3 kyr BP), SST ranged between 11-14°C; foraminiferal assemblages were dominated by cold-water and nutrient-rich species (*G. ruber* white*, G. bulloides, G. glutinata, T. quinqueloba*). The Heinrich Stadial 1 (17.3 -14.7 kyr BP) shows a cyclic pattern with two cold phases (HS1a 7°C; HS1c 13.5°C) and an intermediate warm one (HS1b 18°C). Cold phases were marked by an increase in cold-water species (*N. pachyderma* dx*, G. scitula*) those decrease during warm ones. During the Bølling-Allerød (14.7-12.5 kyr BP), SST increased up to 22°C; abundance of warm-water species (*G. ruber* white*, O. universa, G. siphonifera* gr.), along with an increase in *G. inflata*, are indicative of strong water mixing. The Younger Dryas (12.5 – 11.5 kyr BP) was marked by an abrupt SST decline (18°C to 13°C); decrease in warm-water taxa and increase in *N. pachyderma* dx, *T. quinqueloba* and *G. bulloides*, are indicative of nutrient-rich surface waters. During Sapropel S1 like (10 BP – 6.4 kyr BP) SST reached up to 21°C, and the planktonic assemblage is dominated by warm, oligotrophic species (*G. ruber* white and pink*, G. quadrilobatus, G. siphonifera* gr.), interrupted by a phase characterised by cooler and nutrient-rich species (*G. glutinata, G. bulloides, N. pachyderma* dx*, G. inflata*). The increase in *N. pachyderma* dx abundance at ca. 8 kyrs BP marks a short time interval of bottom water re-ventilation that chronological correspond to the Sapropel S1i interval in the eastern Mediterranean. The Middle - Late Holocene (last 6.4 kyr BP) has significant climatic events, including the end of the African Humid Period (5.0-4.5 kyr BP), Early Bronze Age warming (4.4-3.8 kyr BP, 20,5°C), Roman Period warming (2.4-1.4 kyr BP, up to 21°C), and the Little Ice Age (700-100 yr BP). Around 4,5 kyr BP, the appearance of *G. truncatulinoides* indicates a major oceanographic shift associated with the transition from humid to semi-arid conditions in the central Mediterranean.

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Offshore 3D geological model of the 628 Sheet "Sciacca" (Progetto CARG)

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Keywords: 3D geological model, Sicilian Fold and Thrust Belt, fluid seepage, active tectonic.

The offshore sector of southwestern Sicily, as represented in the Sheet 628 "Sciacca", is part of the external segment of the Sicilian Fold-and-Thrust Belt (SFTB) and has recorded a complex geological evolution. The integration of marine geophysical data, seismic stratigraphy, and well-log interpretations has allowed for a detailed reconstruction of the 3D geological model down to a depth of 5 km, correlating tectonic structures between offshore and onshore sectors.

The main stratigraphic setting of this sector consists of Meso-Cenozoic carbonate successions (Saccense domain) overlain by Neogene-Quaternary syntectonic deposits, with the Pleistocene terrigenous sediments recording the most recent tectonic deformation.

The regional Neogene to Quaternary tectonic evolution of this sector of the SFTB is defined by a multi-stage deformation history: i) Messinian to Early Pliocene compressional event resulted in south-east vergent folds in the post-early Jurassic portion of the sedimentary succession with local decollement surfaces at different stratigraphic intervals, ii) the Late Pliocene–Early Pleistocene compressional stage generated high-angle thrusts responsible for the exhumation of main carbonate reliefs and the development of the a new forward thrust system named Gela Thrust Wedge; this last was also responsible for the occurrence of structures generated by gravity processes; iii) a post-Early Pleistocene compressional-transpressional event activated major tectonic structures, including a conjugate NNE-SSW-oriented left-lateral transpressive fault (pop-up structure). This structure is recognizable in the western offshore sector (Capo San Marco).

The integration of seismic-stratigraphic and structural data has provided insights into the linkage between deep and shallow geological structures. The gravimetric anomaly map reveals a NE-SW-trending positive Bouguer anomaly, consistent with subsurface tectonic features. Heat flux data confirm the relationship between deep aquifer systems within fractured Mesozoic carbonates and offshore fluid escape structures, linking the Sciacca Geothermal Field to offshore thermal anomalies.

Analysis of high-resolution single channel seismic profiles provided for a detailed assessment of most recent tectonic activity, that is responsible for NNE-SSW trending high angle faults affecting the seabed, as well as pockmarks, chimneys, and gas flares, concentrated in the western and central offshore sector (Capo San Marco and Verdura River mouth, and indicating active fluid migration. These morphological features are strongly correlated with the most recent buried tectonic structures here reconstructed, providing evidence of active tectonics. Finally, the 3D geological model has delineated the extent, thickness, and fault boundaries of buried tectonic units, refining our understanding of the region's tectonic evolution and the relationships between deep geological structures and seabed morphological features.

Multidisciplinary approach for the assessment of industrial pollution in the Augusta harbour (Sicily, Italy)

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Keywords: harbour sediments, environmental pollutants, action levels.

The Augusta harbour hosts a large petrochemical center that was established in the late 1950s and, since then, has released enormous quantities of contaminants in the environment; in the last decades' many studies were carried out to determine and quantify the contamination and anthropic impact on the sea-bottom, also to define any environmental restoration and remediation interventions.

Sediment pollution, mainly due to extremely high levels of Hg and polychlorinated biphenyls (PCBs), but also hexachlorobenzene (HCB) and polycyclic aromatic hydrocarbons (PAHs), was found by many researchers (Croudace et al. 2015; Romano et al., 2021) as well as the key role played by the Augusta basin (southern Italy) in the mercury contamination of the Mediterranean Sea (Sprovieri et al., 2011).

All these data will be able to quantify specific action levels for every pollutant to use as a reference above which intervention measures on the site must be undertaken. A sampling campaign to characterize marine seabed sediments of Augusta harbour, collected by box corer in 70 stations from physical (grain size), chemical, and ecotoxicological viewpoint, was carried out in September 2024 together with a study on mussel watch and necto-benthic organisms (fishes at different level of trophic chain). In the same station of sediments also the study of benthic foraminifera was considered.

The analytical activities are now in progress and the results will provide information on the current levels of contamination in sediments and their toxicity. It will also be proved if pollutants enter into biota from the analyses of mussels and fishes. Finally, the benthic foraminifera will inform us of the degree of environmental stress in the harbour.

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Shallow-water submarine landslide susceptibility map: the example of the Capo D'Orlando continental margin (Southern Tyrrhenian Sea)

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Keywords: Submarine landslides, Slope instability, Susceptibility map, Weight of Evidence, Capo D'Orlando.

Submarine landslides are one of the main marine geohazards, since they can result in tsunamis, cause the destruction of seabed infrastructures and the collapse of coastal areas into the sea. Hence, the elaboration of landslide susceptibility maps is of primary importance for a first assessment of the related geohazard. In this work, the submarine landslide susceptibility map of the tectonically active Capo D'Orlando continental margin is addressed using the Weight of Evidence method, which quantifies the strength of the association between a landslide inventory and the predisposing factors. The study area is largely affected by extensional faults (Sulli et al., 2013) and characterized by a narrow shelf carved by canyons that intercept the longshore currents and are frequently connected to short and steep rivers (Gamberi et al., 2015). The morphological evolution of these canyons is mainly related to the occurrence of retrogressive submarine landslides affecting their flanks and head, which led to their progressive widening and coastward retreat through time.

In detail, we performed a detailed geomorphological analysis of the continental shelf and the upper slope down to 300 m of depth, enabling the realization of a landslide inventory consisting of 449 landslide initiation points. From the contrast analysis resulted that the most favourable conditions for predisposing slope instabilities in order of importance are: slope with ranges between 5°-15°; distance from river mouth < 4 km; distance from faults < 1 km; consolidated lithologies on the slope and sandy depositional terraces; slopes exposed toward NE and E. The landslide susceptibility map in the Capo D'Orlando continental margin shows that a very low susceptibility characterizes the continental shelf, while the shelf edge and the upper slope present values ranging from low to very high susceptibility. High to very high susceptible areas are located in canyon head and flanks but also in undisturbed portions of the slope just behind canyon heads, where potentially future retrogressive landslides may happen. While some large undisturbed portions of the slope are characterized by moderate susceptibility. The results of our analysis are very promising and suggest that our approach can be applied to obtain preliminary susceptibility assessment also in areas where some of the geological factors are not very well known.

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Integration of bathymetric data, backscatter, and seafloor sampling for the morphosedimentary characterization of the Ventotene insular shelf

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Keywords: insular shelf, Ventotene, sedimentation, backscatter, multibeam.

In this work, we investigate the insular shelf developed around the islands of Ventotene and Santo Stefano forming the eastern sector of the Pontine Archipelago (central Tyrrhenian Sea). The study is based on both pre-existing data, collected within the framework of the MaGIC Project, and more recently within the CARG project to produce the geological map sheet 414 "Terracina." Specifically, an integrated analysis of high-resolution bathymetric data, backscatter (acquired using both Multibeam and Side Scan Sonar), and seafloor sampling by using Van Veen grab and box-corer devices was performed. This analysis shows that the study area has been strongly influenced by erosive-depositional processes linked to the last emi-eustatic cycle. In the area the seafloor topography is generally very rugged due to the presence of submarine depositional terraces and rocky outcrops that are colonized by marine phanerogams up to 40 m, and coralligenous indeeper sector . Additionally, there are steep escarpments , bedforms with wavelengths up to 50-60 m related to bottom currents, and circular to elongate depressions related to fluid flow processes (i.e., pockmarks) organized as isolated or alignment along preferential structural trends affecting the area. The analysis of seafloor sediment samples shows a grain-size ranging from coarse sands to mud, with a general decrease of grain-size with increasing depth, except for areas characterized by local accumulations of bioclastic material. A qualitative compositional analysis of the samples shows an overall decrease in the volcanoclastic content with respect to the bioclastic one with increasing depth (less than 25% at a depth of around 70 m), similar to what has been observed in other inactive volcanic islands (Sanè et al., 2016; Reblelo et al., 2018; Zhao et al., 2022; Jeong et al., 2022). The main results of this study provide the base for the realization of the newgeological map at 1:50.000 scale of the area, where nine depositional units have been recognized: "Prateria a fanerogame", "Substrato indistinto con fanerogame", "Depositi del prisma littorale", "Corpi litoidi organogeni (Bioherma)", "Depositi bioclastici da smantellamento di Bioherma", "Depositi bioclastici", "Depositi bioclastici rielaborati da Corrente", "Deposito palinsesto" e "Deposito pelitico".

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Primi risultati dall'applicazione di modellistica costiera in epoca storica nella baia della Penisola di Miseno (Campi Flegrei, Campania)

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Keywords: Campi Flegrei, porto Miseno, geomorfologia costiera, bradisismo, modellistica costiera.

La baia di Miseno, sul margine orientale della caldera dei Campi Flegrei (Somma *et al.*, 2023), rappresenta il bordo morfologico del cratere vulcanico in tufo (*Porto Miseno tuff ring, ca. 6 ka*), dove i Romani scelsero di realizzare una poderosa infrastruttura portuale militare in età augustea (Porto di *Misenum*). Il porto militare accolse per quasi cinque secoli la flotta navale romana (*Classis Misenensis*) di stanza nel Tirreno centrale e sorgeva tra Capo Miseno e Punta Pennata. Il porto era delimitato a nord da Punta Pennata e a sud da Punta Terone, con un ingresso delimitato da due moli formati da arcate su *pilae*. I frequenti fenomeni bradisismici portarono ad una lenta fase di declino di *Misenum* per le modifiche della linea di costa e della morfologia dei fondali, e agli inizi del VI sec. d.C. la flotta fu trasferita definitivamente a Ravenna. L'evoluzione geomorfologica dell'area di Miseno negli ultimi duemila anni si inquadra nel complesso fenomeno di sollevamento e abbassamento del suolo per azione del bradisismo. Il lento innalzamento relativo del livello del mare è stato rilevato dalle strutture archeologiche sommerse del porto di Miseno conservate nella porzione più orientale di Punta Pennata e da quelle della peschiera di Punta Terone (una serie di indicatori sul livello medio del mare all'epoca della sua costruzione compresi tra circa 3 e 4 metri al di sotto del livello attuale). Viene poi preso in considerazione l'importante ruolo, sullo studio della dinamica dell'area, della deformazione del profilo idraulico correlato alle canalizzazioni di epoca romana in prossimità del porto di Miseno, in particolare quelle collegate alla *Piscina Mirabilis*.

Attualmente è in corso un'attività di ricerca finalizzata alla caratterizzazione meteo-marina ed idrodinamica della baia di Miseno, mediante modellistica numerica. Lo scopo dello studio è evidenziare i possibili impatti reciproci tra le variazioni della morfologia costiera, i fenomeni connessi al bradisisma ed il regime idrodinamico nell'area. Tali informazioni, inoltre, potrebbero essere utilizzate per comprendere più a fondo l'utilizzo della baia di Miseno ed il suo sviluppo in epoca storica.

I primi risultati dello studio in corso sono presentati e discussi nel presente contributo, insieme alle attività programmate per il proseguimento della ricerca.

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First Pockmark Susceptibility Map of the Italian continental margins

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Keywords: Fluid flow, Pockmarks, Italian Continental Margin, Susceptibility Map, Bathymetry.

Scientific progress often stems from key discoveries and technological innovations that expand the frontiers of exploration. In geosciences, research on natural hazards has largely focused on land-based environments, while submarine environments remain less studied due to limited high-resolution data, especially in deep-sea areas. However, recent advancements in explainable machine and deep learning techniques have shown great potential for improving geohazard prediction, enhancing both the accuracy of predictions and the understanding of underlying processes.

A notable submarine geohazard involves fluid flow processes that shape seabed morphology (e.g., pockmarks) and influence geological activity. Pockmarks seafloor depressions created by fluid flow are found across various geodynamic settings, yet their formation mechanisms remain poorly understood. This study examines ca. 6,000 pockmarks identified along the Italian continental margins, mostly situated on gently sloping, muddy sand seafloor with Plio-Quaternary sediment layers reaching up to 400 meters in thickness. The distribution of these pockmarks appears to be strongly associated with fault systems.

By combining field observations with machine and deep learning methods, we developed a neural network-based model for assessing pockmark susceptibility including the first "Pockmark Susceptibility Map" for the Italian continental margins. Susceptibility maps, commonly used in geohazard evaluations, distinguish between high- and low-risk zones based on historical data and predictive models. The obtained map in this study, holds great potential for guiding the development of submarine and floating infrastructure, enhancing navigation safety, and informing environmental research on fluid seepage, climate change, and marine biodiversity. Additionally, the map may have economic implications, as pockmarks are often associated with hydrocarbon or offshore freshwater.

Our findings deepen the understanding of submarine geohazards and highlight the promising role of artificial intelligence in advancing geoscientific analysis. Finally, this study highlights the importance of incorporating more high-resolution data to improve model accuracy and expand assessments to a broader scale, such as the entire Mediterranean region.

New findings of shallow sandy carbonate contourite drifts in the Malta-Gozo Channel (Pelagian Platform): Implications for central Mediterranean ocean circulation

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Keywords: Moat, Drift, Bottom current, Infralittoral wedge, Bathymetry.

An increasing number of studies have reported the presence of sandy contourites in modern marine environments. However, their detailed characteristics and relationship to oceanographic processes remain poorly understood. Similarly, the dynamics of bottom current circulation on the Pelagian Platform (central Mediterranean Sea) and its underlying mechanisms are largely unknown. To address these knowledge gaps, we analyze newly acquired high-resolution geophysical and sedimentological data, revealing the presence of small-scale sandy contourite drifts (EM1-5) in shallow waters (50-100 m depth). These deposits provide valuable insights into local current circulation around the Maltese archipelago, offering information on bottom currents based on their spatial distribution and stratigraphic characteristics. Using a dense network of high-resolution seismic profiles, multibeam bathymetry, and sedimentological analyses, we examine the internal and external geometry, morphology, and sedimentary composition of these contourite drifts. Multibeam data indicate that EM1a, EM1b, EM1c, EM2, EM3, and EM5 are small, elongated mounded structures situated on the seafloor, whereas EM4 is a buried mounded deposit in the southern part of the study area. Correlation of seismic units with sedimentological analyses from boreholes and grab samples indicates that EM1-5 consist of light grey, fine- to coarse-grained sands with high carbonate content. In view of that, the mapped deposits may represent the first documented case of modern carbonate-rich contourites in a temperate setting of the central Mediterranean Sea. Additionally, in the central region, at the base of a ~10 m high cliff on Comino Island, we identify an infralittoral prograding wedge (IPW1) with an internal aggradational/prograding structure, likely reflecting the influence of downwelling storm currents at depths shallower than 40 m. The spatial distribution of these drifts suggests their formation under the influence of a mesoscale anticyclonic gyre, possibly linked to the Malta-Sicily Gyre, with currents modulated by interactions with seafloor topography. Although direct age constraints (e.g., radiocarbon dating) for these contourite deposits are currently unavailable, a post-8.6 ka age is hypothesized, as the Malta, Gozo, and Comino channels remained connected until that time. This study highlights the importance of integrating very high-resolution geophysical, sedimentological, and oceanographic data to elucidate the complex interactions shaping shelf environments. The observed features provide a critical framework for understanding past and present sedimentary processes on the Pelagian Platform and contribute to broader knowledge of modern contourite systems in shallow marine settings.

From Subsurface to Seafloor: Identifying Fault Activity through Pockmarks and Seismic Attributes in the NW Sicily Channel

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Keywords: Pockmarks, Fluid Migration, Seismic Attributes, Machine Learning, Sicily Straits.

This study explores fault activity and fluid migration in the NW Sicily Channel, focusing on the Adventure Plateau, using 2D seismic data, multi-attribute seismic analysis, and machine-learning-based fault detection. By applying seismic attributes such as fault probability, similarity, dip variance, and textural entropy, we assess the structural controls on fluid escape pathways and pockmark formation.

Our findings reveal that pockmarks are spatially confined near structural highs, where near-vertical faults cross-cut the Terravecchia Formation and extend to the seafloor. Additionally, polygonal faults—despite hosting biogenic gas—do not contribute to pockmark formation, suggesting that tectonic discontinuities, rather than sediment compaction alone, govern active seepage.

To enhance fault characterization, we introduce a machine-learning-derived Fault Probability Section, providing a quantitative assessment of fault likelihood, surpassing traditional seismic interpretation. Our study proposes that pockmarks serve as proxies for active faulting, offering a new approach for offshore fault characterization. This method holds implications for seismic hazard assessment, hydrocarbon exploration, and geohazard monitoring.

Instability and landslides within the Angitola Canyon, offshore Calabria, Tyrrhenian Sea

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Keywords: canyon, Tyrrhenian, offshore Calabria, morphologic evolution.

The Aeolian Canyon System is situated in a parallel alignment with the volcanic arc, extending from the island of Vulcano in the south to the island of Stromboli in the north. This system includes the Gioia Tauro canyon, which is aligned approximately east-west in the stretch between Cape Vaticano and Stromboli. High-resolution bathymetric data acquired by Fugro Italy in 2020 reveal a morphological complexity that is relatable to the evolution of the volcanic arc itself. The summit zone of the canyons, at around 700 m depth, shows a currently active rectilinear talweg incising a complex of fossil meanders suspended about 200 m above the flow line. This morphological evidence indicates an evolution of the canyon head. If the meanders are morphologies in equilibrium with a weak slope gradient of the bathyal plain, the transition to a single rectilinear channel could indicate an increase in slope of the talweg in the canyon head zone. This process can be driven by the progressive subsidence of the canyon terminal zone: the Tyrrhenian normal fault systems may play a significant role, as may lithospheric deflection caused by the Aeolian Arc loading. However, evolution in sedimentary supply, related to on land climatic changes, may also contribute to the observed morphological transformations (Sultan N. et al., 2007; Milia A. et al.,2009; Pierdomenico M. et al., 2016).

Milia A. et al. (2009) - Four-dimensional tectono-stratigraphic evolution of the Southeastern peri-Tyrrhenian Basin (Marin of Calabria, Italy). Tectonophysics 476, 41-56, https://doi.org/10.1016/j.tecto.2009.02.030.

Pierdomenico M. et al (2016) - Seafloor characterization and benthic megafaunal distribution of an active submarine canyon and surrounding sectors: The case of Gioia Canyon (Southern Tyrrhenian Sea). Journal of Marine Systems, vol.157, 101-117, https://doi.org/10.1016/j.jmarsys.2016.01.005.

Sultan N. et al. (2007) - Analysis of slope failures in submarine canyon heads: An example from the Gulf of Lions. Journal of Geophysical Research (JGR) Earth surface (0148-0227) 112, 1-29, http://dx.doi.org/10.1029/2005JF000408.

Microplastic and their involvement in coastal sedimentary processes. The case of a southern Mediterranean beach (Sicily)

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Keywords: marine pollution, beach pollution, plastic pellets, sedimentary processes, coastal environment.

Most marine waste (95%) accumulated on beaches and land comprises plastics and microplastics. These include plastic pellets (PPs) a virgin pre-production material used to make plastic products through different processes. PPs have a regular shape and size of less than 5 mm and in recent years it has become one of the most abundant pollutants in oceans and beaches, including the Mediterranean Sea.

Plastics with a bulk density higher than seawater can accumulate on the seabed, while particles with a low bulk density tend to float on the sea surface and can be transported on beaches as in the case of PPs.

Numerous studies have reported the surface distribution of PPs along beaches while few studies provide a distribution of these particles deep below the topographic surface.

In this study, a new sampling method is applied for the first time to detect the presence of PPs along the beach and in particular in depth. The studied beach (Lascari-Campofelice beach) is located along the northern sector of the Sicilian coast and is limited westward with an important commercial harbour belonging to the Termini Imerese town, while eastward is separated from the Cefalù beach by the promontory of Capo Plaia.

The sampling was done in 5 transects across the coastline where 5 points were sampled according to the main morphological variations of the beach profile. For each point, a cylinder 50 cm high and with a diameter of 26 cm was used for the sampling. The sand collected from the cylinder was sieved on-site in a wet state with a mesh size of less than 1 mm.

The data obtained from sampling confirm the presence of PPs on the surface (e.g. storm berm) and buried at an average depth of 20 cm (dune foot), showing how these particles, resulting from human activity, have become part of the lithological cycle.

Sedimentological analysis of the PPs was carried out to establish the transport and sedimentation processes that introduce these particles into the coastal system until their burial.

Due to low bulk density, the PPs are transported by sea (floating) and a storm event determine their accumulating on the beach surface. The action of wind (creep and saltation) plays an important role on the distribution of the PPs in the backshore determine their burial mainly on the dune foot.

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