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ABSTRACT BOOK

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Faraglione Grande dell'arcipelago Isole Ciclopi, Acitrezza (CT). In secondo piano, il vulcano Etna (Photo credit: Concetto Cormaci).

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**WGSBE: Working Group On Sedimentary Basin Evolution
(DIBEST – UNIVERSITY OF CALABRIA)**

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Keywords: sedimentary basins, biomineral, monitoring.

The Working Group on Sedimentary Basin Evolution (WGSBE) of the Dipartimento di Biologia, Ecologia e Scienze della Terra (DiBEST – University of Calabria) is a research group composed of several professors, researchers, post-doctoral researchers and PhD students.

The WGSBE has a wide expertise on the sedimentology, paleontology, stratigraphy and structural geology of carbonate, evaporite and siliciclastic rock succession. The focus of the working group is deciphering the sedimentary and biosedimentary evolution of the sedimentary basins interpreting them in term of paleotectonic and pelecliclimatic controlling factors.

The main research fields of the WGSBE are: sedimentology, architectural and paleoenvironmental analysis of ancient and modern sedimentary successions and quantitative approaches to the sediment routing systems; stratigraphic, tectonic, sedimentological, petrographical, geochemical, paleontological, and thermal analysis applied to reconstructions of tectono-stratigraphic, thermal and burial history of sedimentary basins; geobiological processes and biomineral precipitation in fossil and recent marine to terrestrial systems as new tool for environmental monitoring and innovative bio-materials; development of new remote based systems for study, monitoring and protection of recent marine bioconstructions; relationship between ground deformation and land use, hydrogeology and tectono-stratigraphic setting; development and implementation of PyQGIS coastal and river sediment balance models forward sediments management and mitigation of coastal and river risks.

The WGSBE works on ongoing and submitted projects such as CARG Project (Sheets: Bisignano 551, Catanzaro 575, Lamezia Terme 574, Villa San Giovanni 588), AZA Project, Next Generation EU–Tech4You Project, and FISR2019_04543 CRESCIBLUREEF Project.

Morphological evolution of the tidal flat in the southern Barbamarco Lagoon (Po Delta, Italy) in the period 2020 – 2024

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Keywords: Po River delta, tidal flat, Geomorphological changes, sedimentation rates.

Coastal environments, such as tidal flats and salt marshes, are subject to rapid changes due to natural processes (waves, wind, and currents) and human interventions. These ecosystems play a crucial role in coastal protection, but they are increasingly threatened by degradation and erosion, making continuous monitoring essential. Remote sensing through drones has proven to be an effective method for analysing the morphological and sedimentary evolution of these areas. This study focuses on the evolution of a tidal flat in the southern part of the Barbamarco lagoon, in the Po Delta, between 2020 and 2024. The results were then compared with data from the 2018-2020 period obtained from previous studies. In February 2024, a fieldwork was conducted using a commercial drone and a GPS-RTK to obtain precise measurements. Nineteen Ground Control Points (GCPs) were placed to ensure the accuracy of the aerial images, and 60 GPS points (called “validation points”) were also collected to validate the Digital Surface Model (DSM) obtained from the drone’s orthophotos. Additionally, comparison of DSMs from different dates were performed to analyse morphological changes obtaining a DEM of Difference (DoD). The Geomorphic Change Detection (GCD) software was used to estimate vertical and volumetric variations by applying a threshold (TCD) to distinguish significant changes, considering the Root Mean Square Error (RMSE) and the propagated uncertainty. This approach was also used to analyse sediment accumulation in the northeastern area of the tidal flat, influenced by canal dredging, to assess its impact on sediment supply. The results showed a positive trend in sediment accumulation between 2020 and 2024. Notably, from February to October 2020, sediment accumulation was higher compared to subsequent years; this increase was attributed to significant river floods, which proved to be more influential than tidal currents. The latter phenomenon is visible through the presence of crevasse splays near channel entrances. Furthermore, the tidal flat is protected in the north by the barrier islands of the lagoon, which mitigate the influence of the waves. An important example of flooding occurred in November 2023, which promoted material deposition near the edges, especially around *Spartina* sp. patches and in the central part of the tidal flat. Meanwhile, erosive processes were less intense than in the past and mainly concentrated along the northeastern margin. Currently, the rate of vertical variation of the tidal flat is around 1.4 cm/year. If this rate remains constant, the interaction between sea level rise and subsidence could reduce the elevation by 1 cm compared to the current level in a pessimistic scenario, while an optimistic scenario predicts sediment deposition that could increase the elevation by 33.5 cm. However, the future of this area remains uncertain, highlighting the need for continuous monitoring and targeted management interventions.

Sedimentological and morphological analysis in the Augusta Bay continental shelf, within the “Siracusa 646 sheet – CARG project”

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Keywords: CARG project, Siracusa, multibeam, sedimentation processes.

The south-eastern Sicilian coast has always been object of several studies to reconstruct the geological framework especially in terms of tectonic evolution and geohazards, due to its position between two important structures in the central Mediterranean region, the Hyblean Plateau and the Hyblean-Malta Escarpment. Our new data implemented the knowledge of the continental shelf area, located from the Augusta Bay to the Maddalena Peninsula (offshore Siracusa), between the eastern Sicilian coast and the Malta Escarpment. The new dataset, acquired during two different oceanographic campaigns, within the CARG project, in autumn 2023 and spring 2024, allowed the re-interpretation of the pre-existing data of this sector. We collected both multibeam data in the inner part of the continental shelf and a Side Scan Sonar mosaic, calibrated by 40 sediment samples from the seabed. The dataset was completed with existing CHIRP sub-bottom profiles and new Sparker seismic reflection profiles. In the continental shelf we distinguished 5 seismostratigraphic units and mapped six depositional systems, from the inner shelf to the outer shelf, where there is 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. Some erosive channels, up to 400 m wide characterize the whole inner shelf in the Augusta Bay. These have a thin sand filling and are up to 3 km long. They have a 30 m mean elevation difference with a slope angle between 0.6° and 0.8°. We have recognized them both in the seismic profiles, on the multibeam data and on the Side Scan Sonar data and we collected some seabed samples. The difference between the erosional character of the inner continental shelf and the depositional character of the outer shelf is reflected in the characteristics of these incisions, which can give us information on the course of the last sea-level oscillation in which they were not buried.

Revising the western Hyblean successions: a comprehensive update of the Oligo-Miocene succession through an integrated stratigraphic study

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Keywords: integrated stratigraphy, sedimentary hiatuses, Hyblean Mts., SE Sicily.

In southeast Sicily, the outcroppings successions in the western sector of the Hyblean Plateau are primarily composed of carbonate sediments interlayered with volcanic rocks, ranging in age from the Early Oligocene to the Quaternary. This succession has recorded the important climatic variations taking place during their formation.

The outcropping sedimentary succession is mainly represented by the Ragusa, Tellaro and Palazzolo Formations, ranging in age from Oligocene to late Miocene.

The results of a refined integrated stratigraphic study, consisting of an accurate field mapping, integrated biostratigraphy (foraminifers and calcareous nannofossils), facies analysis and isotope stratigraphy, has provided the opportunity to carry out a thorough review of the successions cropping out in the area, whose last update dates back to the late '90s.

The results have allowed to provide detailed ages for the different traditional members of the Ragusa Formation (Leonardo and Irminio), highlighting the presence of unconformities between the formation and intraformational unconformities, in some cases, associated with hiatuses and phosphogenesis, framing this process within the context of global climatic changes and regional paleoceanographic evolution.

Through Sr isotope analyses, coupled with detailed nannofossil assemblages' analyses, we identified the most important interval of phosphogenesis and sedimentary condensation, marked by a well evident hardground, at the Leonardo/Irminio boundary.

This hiatus occurs at the base of the Aquitanian (23-22 Ma) thus coinciding with a global cooling event and glacial maximum (Mi-1 Event) and is interpreted as the result of the upwelling of nutrient-rich deep waters, increased weathering and phosphorous availability triggered by global cooling and enhanced circulation in the Mediterranean basin.

Coeval phosphatic hardgrounds also occur in the Oligo-Miocene succession of the Malta Island, lining up from South to North. This correlation supports the interpretation of increased bottom-water currents, which, originating in the deep Eastern Mediterranean basin, rose up to the eastern sides of the Central Mediterranean carbonate platforms during abrupt climate shifts.

CARG Project 575 Catanzaro: preliminary results and future perspectives

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Keywords: CARG project, metamorphic core complex, metasedimentary sequences, database.

In the context of the CARG Project (Geological and Thematic Mapping of Italy), initiated in the '80ies by the Italian Geological Survey, an agreement among Italian Institute for Environmental Protection and Research (ISPRA), Calabria Region and University of Calabria (UNICAL) was undersigned for the realization and computerization of the Geological Sheet No. 575 Catanzaro at a 1:50,000 scale. This project is carried out in strict adherence to the “Guidelines for the Development of Geological and Thematic Maps at a 1:50,000 Scale,” as published in the Quaderni Series III by the Geological Survey of Italy, including all subsequent amendments and updates. The primary objective is the geological survey of the outcropping bedrock and Quaternary deposits at a 1:10,000 scale, using open-source GIS software for personal devices (QField). Key activities encompass stratigraphic, sedimentological, and structural investigations, along with biostratigraphic and geotechnical analyses. Various cartographic products will be also developed, including the bathymetric sheet, along with illustrative notes. The area is characterized by a complex geology, whose history begun with the development of a metamorphic core complex related to the Hercynian orogeny, followed by the accumulation of a Triassic to Jurassic sedimentary sequence. The opening of an oceanic basin in the Jurassic time led to the formation of a serpentinitized crust, subsequently overlain by volcanogenic to non-volcanic turbiditic systems with interbedded olistostromes. In the Paleogene time, all the units were metamorphosed and structured in a thrust-and-fold chain, whose accretion also drove the accumulation of subaerial to submarine clastic sequences. Such belt now emerges from the Neogene to Quaternary marine, fluvial and alluvial deposits. A critical component of the project is the creation of a geological database at a 1:25,000 scale, which will consolidate all geological data collected during the surveys. This derives from a real-time compilation of a large geological dataset gain during fieldwork (e.g., lithologies, bed attitude, stratigraphic boundaries, tectonic structures), all uploaded into a shared QGIS project, integrated with previously collected data (e.g., old geological maps, DTMs). The usage of this workflow already resulted in the revision and partial redefinition of stratigraphy and structural architectures of the investigated area, such as the identification of two compressive phases between the Paleogene and the Neogene, as well as the revision of the tectonic relationship among the Gimigliano, Frido and Fiume Pomo units. The project will have a substantial impact on improved land management, natural hazard assessment, and the enhancement of natural resources management. Finally, all the dataset will populate the ISPRA Geological Survey of Italy database, becoming accessible to any user through the ISPRA Geological Survey of Italy Portal (<http://portalesgi.isprambiente.it/en>).

Geochemistry and petrology of the Bellecombe lava sequence at Enclos Fouqué caldera, Piton de la Fournaise volcano (Réunion, France)

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Keywords: Piton de la Fournaise, Rempart de Bellecombe, Basalts, Crystal Fractionation.

Piton de la Fournaise is an active shield volcano sited in the eastern area of the Réunion Island (Indian Ocean) whose activity consists of lava flow effusion and explosive episodes. The emitted products are generally scarcely differentiated magmas with mostly tholeiitic affinity. The presently active edifice has grown within the Enclos Fouqué caldera, a polylobate plain bounded on its western side by the Bellecombe vertical cliffs that reach a high of 200 m. This escarpment exposes a vertical sequence of 12 lava flows cut by a dike with an age > 5.5 kyrs.

The well-defined geometry of these lava flows and the easy accessibility of the Bellecombe cliff allowed the sampling of all the outcropping lavas with the aim of investigating the evolution over time of the magmatic system feeding the eruptive activity prior to the Enclos Fouqué caldera collapse. A petrological study of the products was conducted by means of X-ray fluorescence, Inductively Coupled Plasma Mass Spectroscopy, Scanning Electron Microscope and X-ray computed microtomography techniques. The results indicate that lava flows share a geochemical affinity with the two main series documented at Piton de la Fournaise, namely, Steady State Basalts (SSB) at the bottom and top of the sequence and Abnormal basalt Group (AbG) with different degrees of differentiation in the central part. The emission of these two different series of products in a restricted area and in a relatively short timespan highlights the dynamic activity of the plumbing system, able to rapidly shift from central to eccentric activity in the recent past.

Unveiling the central Mediterranean Moho and the Ionian subduction zone: key insights for understanding the geodynamics of the area and for tsunami and seismic hazard assessment

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Keywords: Ionian seismogenic volume, Moho map, tsunami hazard, central Mediterranean.

The Central Mediterranean is a geodynamically complex region located at the convergent boundary of the African and European plates. Despite numerous studies, the mechanisms that govern this area remain poorly understood. A key tool in advancing our understanding of its geodynamics is a detailed Moho map, which represents the boundary between the crust and the mantle. Current Moho maps of the Central Mediterranean are either fragmentary or part of larger European models, which do not have the necessary resolution.

Subduction zones, including those in the Central Mediterranean, are among the most seismically active regions globally, responsible for producing the largest earthquakes and the primary cause of tsunamis. Precise knowledge of the location and geometry of the subducting seismogenic volume is essential for assessing both seismic and tsunami hazards. Key characteristics of the subducting slab, such as curvature and width, play a significant role in controlling the magnitude of earthquakes. Highly curved subduction zones tend to limit earthquake size, while wide subduction zones can accumulate larger stresses, leading to more powerful seismic events.

While previous studies have attempted to model the Ionian subducting slab, a comprehensive 3D model of the entire Ionian seismogenic volume has not yet been produced.

In this study, we present a high-resolution Moho map for the central Mediterranean, developed using multidisciplinary data, including seismic reflection profiles, P- and S-wave velocity models, and density profiles. In addition, we provide, for the first time, a detailed 3D model of the Crustal Seismogenic Volume (CSV) for the Ionian subduction zone, derived from statistical earthquake modeling. We analyzed the characteristics of the slab we obtained and compared it with those present in the literature.

Our results contribute to a deeper understanding of the complex geodynamics of the central Mediterranean and provide useful resources for seismic and tsunami hazard analysis. Furthermore, the new models are essential for lithospheric-scale studies, improving the accuracy of earthquake localization and constrain seismic tomography studies.

Neogene cold-seep microbial carbonates (Crotone Basin - South Italy)

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Keywords: cold seep, gas hydrate, chemo-symbiotic fauna, overpressure, conduit, pavement.

For the first time, the Neogene cold seep carbonate deposits of the Crotone Basin (south Italy) are described. These deposits form a carbonate body reaching a maximum length of 350 m and a thickness 40 m and are characterized by a conduit facies made of authigenic carbonates filling the previously active gas/fluid escape pipes. In addition, a pavement facies is observed, which consists of early carbonate-cemented bioclastic and siliciclastic sediments commonly colonized by a chemosynthetic macrofauna dominated by articulated and in life-position Lucinids bivalves. The conduit facies is characterized by the inward accretion of dark micritic laminae alternating with clear crystalline layers. The micritic laminae show a microbial peloidal to dendrolitic fabric, which commonly incorporates planktonic foraminifera and coprolites. These contrast with the crystalline layers, which are characterized by microspar laminae and sparry crusts made of prismatic zoned calcite crystals. The pavement facies is characterized by laminated microbial boundstones, bioclastic bearing micrite, foraminiferal oozes and hybrid arenites. The foraminiferal assemblage is characterized exclusively by planktonic forms, which - together with the relative proportion of sandy/silty grains - suggests a deep-water setting with occasional siliciclastic coarser sedimentary flows. The pavement facies shows common brecciation features, possibly indicating the establishment of post-depositional overpressure conditions due to gas/fluid injection. Clasts of breccias show overgrowth by primary fibrous to acicular isopachous to fan-shaped calcite cement. Stable Isotopes analysis of all the studied facies reveals negative $\delta^{13}\text{C}$ values (-6.82 to -37.39 ‰) and relatively positive $\delta^{18}\text{O}$ values (-0.04 to 3.39 ‰), most probably indicating the presence of a complex mixture of methane with other hydrocarbons and the destabilization of gas hydrates and/or dehydration of clay minerals.

Seismology @UNICT: a tool to understand and monitor our restless Earth

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Keywords: geophysics, volcano seismology, environmental seismology, seismic hazard.

Current research in seismology addresses multiple critical areas for understanding seismic, volcanic, and climate processes and their implications on risk management. In volcanic seismology, significant advancements are being made in analyzing volcanic tremors, infrasound, detecting and characterizing low-frequency events, and studying volcano-tectonic earthquakes. Environmental seismology research investigates the interactions between the hydrosphere and solid earth, examining seismic signals generated by the sea waves and river flows energy transferring. This work helps to analyze meteo-marine and flood events and to develop seismic-based monitoring systems. Additionally, seismic risk research remains essential for assessing hazards associated with tectonic activity, where ongoing studies focus on improving risk assessment methodologies.

The Solid Earth Geophysics Lab (@UNICT) researchers focus their study on these fields considering in particular volcanic monitoring, development of sea state and river flows seismic-based monitoring systems, and mitigating seismic hazards across diverse environments and geological contexts.

Seasonal variations in grain-size parameters of the Ombrone Delta beaches

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Keywords: Ombrone Delta; granulometric parameters; seasonal variations; sediment transport.

This study focuses on the seasonal variation of granulometric parameters of beaches along the Ombrone River Delta, one of the best preserved wave-dominated in Italy located along the Tyrrhenian coast in southern Tuscany (Italy). The fieldwork was conducted every two months from December 2022 to January 2024, collecting samples from six selected sites: three located north of the Ombrone River mouth and three to the south. Two distinct hydrodynamic zones (berm and shoreface at 1 m depth) have been sampled for each site. The sediment samples (N=84) were prepared in the laboratory according to ISPRA guidelines for beach sediment analysis and subsequently sieved at $\frac{1}{4} \phi$ resolution. Grain-size parameters were statistically analyzed with the software Minitab19. Among the various statistical analyses, the analysis mainly concentrated on D50 (ϕ), mean (ϕ), sorting (ϕ), and skewness (ϕ), all calculated using the Method of Moments.

A Mann-Whitney test (u-test) revealed a significant seasonal variation in skewness within the berm, with coarser skewness during the summer (median = -0.51) compared to winter (median = -0.38, $p = 0.049$). More in detail, skewness variations are more marked in the southern sector of the delta, with summer skewness values significantly more negative than winter values (median = -0.53 vs. median = -0.24, $p = 0.010$). These variations, even if subtle as indicated by the p-value, can be attributed to calmer summer wave conditions that allowed the removal of finer particles but could not remove coarser sediments. No significant statistical seasonal variations were found for the other parameters analyzed in berm deposits, including D50, mean, and sorting (p -values > 0.05).

In the shoreface, u-tests showed no significant seasonal variations for skewness, D50, mean, or sorting (p -values > 0.05). This can be explained by the fact that this hydrodynamic zone is influenced by high-frequency processes that continuously rework the sediments, reducing the impact of seasonal changes. Conversely, the berm is affected by lower-frequency processes, allowing for more distinct seasonal variations in sediment characteristics.

In conclusion, the time series analysis of both berm and shoreface sediments did not reveal significant seasonal trends for D50, sorting, or mean, suggesting that these parameters may not be sensitive to seasonal changes. In contrast, skewness exhibits seasonal variation, and this observed variability is crucial in a wave-dominated system, as it plays a key role in depositional and sediment transport models. Fluctuations in skewness with changing seasonal conditions can influence the accuracy of model predictions, potentially impacting the interpretation of sediment dynamics and depositional processes over time.

Evaluating Longshore Sediment Transport: a comparison between empirical formulas and XBeach 2DH numerical model

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Keywords: Longshore sediment transport, Coastal erosion, Empirical formulas, XBeach 2DH numerical model.

Longshore sediment transport (LST) is a crucial process that shapes the coastal environments. In this research, we evaluate the predictive capacity of empirical formulas and the XBeach 2DH numerical model for estimating the LST rate by comparing the results obtained from both methods with field LST data. We chose three coastal areas in Malta Island (Ghadira Bay) and northern Sicily (Cefalù and Campofelice di Roccella sites) based on different characteristics in terms of sediments, coastal type (open or embayed) and morpho-bathymetry. For each site, we analysed wave parameters, grain size of the beach and seabed sediments, coastal morphology, and marine vegetation distribution. Furthermore, we used field measurements to calibrate sediment transport and morphological parameters of the numerical model. Our findings show that the calibrated numerical model provides greater accuracy in LST rate estimation than the empirical formulas. The latter overestimates the LST rates by factors ranging from 435 to 7885, whereas the numerical model overestimates LST rate by factors of 1.8 and 1.9 at the Cefalù site and Ghadira Bay, respectively, and underestimates by a factor of 0.5 at the Campofelice di Roccella site. The good performance of the numerical model is due to its considerations of site-specific factors that influence the LST rate. The parameter values for the model calibration can be used successfully in embayed systems characterized by fine/coarse sandy beaches. Moreover, the numerical model, tested so far only for sandy beaches, works well also on gravelly beaches.

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 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) which 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 valuable task for coastal management and coastal erosion risk detection and mitigation and could also support researchers in data management and collaborative analysis.

An integrated approach for the environmental monitoring of the seafloor in the surroundings of the Vega A platform (Pozzallo off-shore, Sicily)

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Keywords: Environmental monitoring, benthic analyses, Side Scan Sonar, oil platform.

The environmental monitoring of the oil platform VEGA A seabed (Sicily Channel) was performed applying a combined approach which included the Grain-size and Side Scan Sonar (SSS) characterization of the seafloor sediments and the macro- and microbenthic assemblages' analyses. Sediment samples were collected within the oil platform surroundings along four transects (N, S, E, W) at a fixed distance of 25 m between each sampling point, three more sampling points were surveyed at a distance of 1,000 m from the oil platform and used as control sites. For each sample, the grain-size statistical distribution parameters (Mean, Standard Deviation, Kurtosis, Asymmetry) were computed according to the Udden-Wentworth classification and biodiversity indexes and biocenoses were determined through the macro- and microbenthic fauna assemblages analyses. Both statistical analyses allowed us to describe in detail the actual status of the VEGA A seafloor surroundings and highlight significant statistical differences among all the sampling sites themselves and control sites. This integrated approach based on a comprehensive seabed characterization provides a useful tool to quantitatively assess the impact of the extraction field. Indeed, microbenthic analysis revealed well-preserved associations of planktonic and benthic foraminifera in all collected samples. The macrobenthic analysis indicates the prevalence of biocenoses consistent with the sample locations, depths (115 to 130 m), and the sedimentological characteristics of the area. The presence of detrital sediments rich in mollusks shells fragments found close to the platform seafloor suggests some fauna may originate from the jacket's oil platform, carried to the seabed by strong local hydrodynamics.

Furthermore, the study area was investigated through a detailed SSS mapping to provide a textural characterization of the seafloor deposits and to distinguish the main morphological features. Three acoustic facies have been identified, according to increasing backscatter gradients. Facies 1 corresponds with the coarse-grained sediments and dominates in the proximity of the platform: it was interpreted as the presence of both bioclastic and anthropogenic material. Facies 2 corresponds with the sedimentary deposits to intermediate grain sizes. Facies 3 is the most representative of the central study area and is associated with fine-grained sediments. The SSS mapping has also highlighted the presence of sub-linear incisions, named scours. They show a radial distribution concerning the platform and can be attributed to anchor tracks and the mobilization of anthropogenic material. Numerous blocks and depressed areas on the seafloor were also recognized, with a higher concentration in proximity to Facies 1 and Facies 2. Finally, along the central sector, our analysis highlighted the presence of a deposit with a fan-shaped geometry that tends to overlap the sealines and suggests periodic monitoring of the area.

**TaneZrouft sALt flat dEposits (SAhara Desert):
a priority target for a Mars Sample Return mission (AZALEA)**

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Keywords: arid environment, terrestrial analogues, Mars exploration.

The understanding of Mars planetary evolution and its implication on global changes and the related development of conditions suitable for the development of life are the main objectives for space agencies to plan their exploration for in situ human and robotic missions. In particular, the light-toned layered deposits record the water-related sedimentary history of the planet between the late Noachian and the early Hesperian, including obvious fluvio-lacustrine often clay-bearing deposits and sulfate-bearing possibly evaporitic sabkha and aeolian deposits. The stratigraphic relations between these units are not always clear, but at places an upward transition (sometimes gradual, sometimes unconformable) from clay- to sulfate-bearing deposits have been recorded. The control on fluvio-lacustrine and sabkha-aeolian deposits formation and/or preservation appears to be related at least in part to the groundwater activity.

Detailing the depositional processes and environments associated to their formation and the stratigraphic relations between these deposits has obvious implication grasp the reasons and timing of the Noachian-Hesperian global change, but also to provide insights for their habitability potential and to plan effectively future in-situ missions.

From this perspective, the key to understand the complexity of these systems and to plan, develop, and perform effective in-situ exploration is to deepen the scientific understanding and optimize the procedures and operational sequences in appropriate planetary field analogues. In this framework, the 'Tanezrouft salt flat deposits (Sahara Desert): a priority target for a Mars Sample Return mission' (AZALEA) project aims to perform a detailed study of the Tanezrouft Basin in the context of a simulated MSR-like mission.

Situated along the borders of Algeria and Mali, west of the Hoggar Mountains. The Tanezrouft is considered one of the most arid parts of the Sahara Desert. The Quaternary deposits consist of alluvial, sabkha, and aeolian deposits, an environmental association very similar to the one of the light-toned deposits of Mars.

Sampling of the sabkha deposits was performed to characterize their astrobiological potential and to standardize a protocol for sampling, storage, and analysis. To constrain the analogy with the Martian deposits, the realization of a geological context is in progress using remote sensing techniques combined with groundtruth in selected areas.

From the Apulia Foreland to the Bradanic Trough: A one-day geological field trip “jumping” from Cretaceous to Pleistocene in the Murge area (Puglia, southern Italy)

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Keywords: geological fieldtrip, Apulia Foreland, Bradanic Trough, Murge Area.

This one-day field trip offers an opportunity to investigate the stratigraphic and sedimentological features of an area within the Alta Murgia National Park, which includes the geographic boundary between the foreland (Murge) and the foredeep (Premurge) of the southern Apennines orogenic system. The focus of this fieldtrip is on the description of facies associations constituting the outcropping sedimentary units, as well as the relationships between tectonics and sedimentation. The sequence of stops follows a temporal thread, starting with the observation of the stratigraphic architecture of peritidal facies associations in the upper Cretaceous section of *Cava Pontrelli*, an international geosite that hosts one of the largest dinosaur footprint sites in the world. The second stop examines the role of syn-sedimentary tectonics in the deposition of shallow-marine carbonate deposits of the Calcarene di Gravina Fm during the Plio-Pleistocene, along several well-exposed natural sections of the *Gravina di Gravina* canyon. The third stop features a Gilbert-type delta facies association in the Calcarene di Gravina Formation, situated at the base of an escarpment that represents the structural element of conjunction between the foreland and the foredeep. This escarpment corresponds to an ancient fault plane in erosional retreat formed within the Cretaceous bedrock. Finally, the last stop illustrates the historical use of local building and ornamental stones, particularly in relation to the UNESCO World Heritage Site of Castel del Monte, which is also one of the most picturesque panoramic points in the Murge.

Integrated geobiological/geochemical approach for the identification of environmental proxies in coralligenous build-ups

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Keywords: Geochemistry, Biomineral, Environmental proxies.

Bioconstructions are geobiological bodies formed by *in situ* growth of colonial/gregarious skeletal organisms and represent habitats that host a great variety of benthic organisms. They comprise a wide array of dynamic phenomena, resulting from the balance between the action of building, demolishing, and dwelling organisms on a relatively large temporal scale. Among marine bioconstructions, Coralligenous represents one of the most important marine ecosystems in the Mediterranean Sea because of its extent, complexity and heterogeneity. Moreover, it is a prominent geobiological system and a unique hot spot of biodiversity characterized by a low accretion rate and a high sensitivity to natural and anthropic impacts (*i.e.*, climate change). For these reasons, it is object of special interest by the UNEP RAC/SPA and considered among the priority habitats for monitoring and conservation by the European Community.

Since the last century, coastal ecosystems have been increasingly threatened by human activities due to discharge of contaminants which leads to an overall deterioration of the environmental quality. Several studies have been conducted to demonstrate the relationships between metal contents (physico-chemical parameters of seawater) and the occurrence of aberrations in marine organisms. However, these researches focused mainly on the incorporation and effect of major, minor, and trace constituents in the soft tissues of recent taxa (*e.g.*, foraminifers, brachiopods, mollusks and algae). To date, only few studies investigated potential correlations between the composition of skeletal and non-skeletal components of marine bioconstructions and the chemistry of the surrounding seawaters.

In this work, an integrated geobiological/geochemical approach has been utilized in order to investigate the balance between reef status and environmental parameters and to identify possible *proxies* for short- and long-term environmental studies. This multidisciplinary approach showed a good relationship between chemical composition of skeletal and non-skeletal carbonate components and the waters in which Coralligenous forms, especially in term of trace elements. In detail, positive anomalies in heavy metals were found in both bioconstructions and surrounding seawaters. Such enrichments could result from pollutants introduced into the marine system by human activities and recorded by the components of the bioconstructions. These data allow to consider coralligenous build-ups as environmental database that continuously record environmental disturbance (natural and/or anthropic), enabling temporal reconstruction of the marine environment over time.

New frontiers in biomineralization studies: the influence in evaporite deposition

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Keywords: Geomicrobiology, Gypsum, bio-product.

The focus of this research project is to open new frontiers in biomineralization studies investigating the evaporite minerals to clarify the role of microbiological activity in evaporite crystal precipitation and also their potential contributes to the formation of Mediterranean Salt Giant.

Mineral nucleation related to biotic activities is generally termed biomineralization. The processes and the products linked to biomineralization have attracted attention in a wide range of research fields, from geobiology to the bioengineering, during recent decades.

In general, three different mechanisms can be recognized in the production of carbonate biominerals: 1) controlled directly by the organisms; 2) induced by microbial communities; or 3) influenced by organic matter template. The researches are in continuous evolution and the finding of new bio-products are fundamental in in the study of biological evolution and geological processes linked to development of the organisms.

Modelling the microbial populations during phase of salinity crisis would require information about environmental conditions, like sequence of precipitation, basins depth, light penetration, oxygen, nutrient availability, influence on crystallization rates, and crystal morphology. To date, the dynamics of crystal formation in the water columns and its influence on the distribution of microbes (e.g., from the surface to the bottom of the brine) on halite crystals is poorly researched. This gap of knowledge limits the use of biomarkers preserved in the fluid inclusions as palaeoecological and paleoenvironmental indicators. Further geomicrobiological investigations on evaporite crystals will help understanding the extent to which evaporites serve as repository or habitat for microbes. A first attempt in this topic was recently published by Natalicchio et al. (2021), who documented a rich benthic microbial assemblage in Messinian selenite gypsum, utilizing petrographic analysis, molecular fossil investigations, and carbon stable isotope studies.

In order to shed new light on the evaporite formation, in this contribute Selenite gypsum samples from Marcellinara's quarry were studied using Optical microscopy, UV-epifluorescence, microthermometry and micro-Raman spectroscopy. The petrographic, mineralogical, geochemical and biochemical data allow to hypothesize that alternations of cloudy organic and clear inorganic bands point to a double phase of mineralization. In the first phase, a biologically induced/influenced biomineralization is confirmed by the presence of organic matter strictly connected with the cloudy bands. This phase is followed by a pure abiotic mineralization that leads to the formation of clear bands. This model of mineralization is similar to that proposed for primary cements forming in recent and fossil carbonate systems.

New microbial mediated minerals: halloysite and palygorskite biomineralization in an arsenopyrite mine

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Keywords: biomineralization, aluminosilicate, bacteria.

The processes driving eukaryotic biosilicification have been thoroughly investigated, while those governing prokaryotic biosilicification remain comparatively underexplored. It is known that bacteria contribute to the formation of siliceous deposits through both passive extracellular and active intracellular processes. Considering the extremely wide variety of bacteria and archaea, it is plausible that more prokaryotes could be involved in silicate precipitation than those already recognized. Aluminosilicate biomineralization is a complex process involving several stages such as metal-microbe interaction, metal substitution and crystallization. The resulting aluminosilicates, formed by bacterial activity, can display various morphologies, ranging from amorphous to sub-micron or nanometric structures, depending on the water chemistry and bacterial species involved. Moreover, these biominerals can also exhibit different composition, including kaolinite-like, halloysite-like, nontronitic or chloritic. Bacteria are able to nucleate authigenic aluminosilicates in environments like lake sediments and rivers. In addition, amorphous aluminosilicates forming around *Bacillus subtilis* cells have been observed. These so-called bio-clays form under both experimental and natural conditions, but until now they are not described forming bioconstruction-like bodies.

In the frame of this work, unusual dendritic fabric forming in natural environment, inside the Macariace arsenopyrite mine, near the Mammola village (Southern Calabria, Italy) were described. These fruticose structures develop in a decimetric fracture of the cave wall characterized by sub-photic conditions. They appear white and formed by an intricate frame of millimetres convolute tubular structures. The aluminosilicate nature of these structures, suggesting an unusual biomineralization processes involved in their deposition, was confirmed through a set of micromorphological and biogeochemical/mineralogical data of optical microscopy observations, SEM and TEM electron microscopy characterization, XRD analyses, EDS microanalyses, thermal analysis and UV-Epi fluorescence observations.

Whether the detected halloysite and palygorskite mineral precipitation is a process influenced by EPS taphonomy or represents an induced mechanism linked to specific metabolic processes is currently unknown, but the chemistry of the water system, characterized by low pH values (up to 4.8) and Ca-SO₄ compositions suggest the possible role of acidophilic communities involved in the biomineralization processes.

The interplay between sedimentary supply, sea-level rise and tectonics from the Last Glacial Maximum onwards: Insights from the Sant’Eufemia continental shelf (Offshore Calabria, Italy)

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Keywords: paleoenvironmental reconstruction, sea-level change, prograding wedges.

New high-resolution, multichannel seismic data, acquired in the Sant’Eufemia Gulf, provide constraints on the architecture of submarine depositional features (e.g. prograding wedges) formed since the Last Glacial Maximum (LGM). Sedimentological and quantitative micropaleontological analyses of gravity cores integrated with calibrated radiocarbon age of samples allow us to calibrate the seismic profiles, constrain the sedimentation rate and reconstruct the paleoenvironmental evolution of the study area since the earliest Bølling-Allerød. Five sediment grain size intervals and benthic foraminifera assemblages outline the evolution of the sea-bottom environment. Basal coarse sand grains along with shallow water and epiphytic benthic foraminifera (e.g. genus *Asterigerinata*, *Elphidium*) point to an infralittoral environment. After that, we record a progressive grain size reduction culminating at the top core, where dominant silt, clay and benthic foraminifera assemblages point to a muddy bottom circalittoral environment. A reduced organic matter flux is observed in benthic foraminifera after 5.5 ka, supporting the evidence from calcareous plankton. Sedimentation rates vary from 4.9 to 12.9 cm/kyr.

The prograding wedges formed at distinct water depths at which the sea level was stationed or lowered during the relative sea-level rise from the LGM to the basal Holocene. The erosional surfaces and marine terraces result from wave action above the depth of closure. Therefore, the above features are suitable for reconstructing a relative sea-level curve. The error bar includes uncertainties due to the a) seismic velocities used for the time-to-depth conversion of profiles, b) water depth related to the formation of depositional and erosional features, and c) tectonics. The reconstructed sea-level rise curve shows a step-like trend, starting from the Heinrich stadial 1, followed by sea level rise during the warm and ice-melting period of Bølling-Allerød, with a peak of the rising rate during the Melt Water Pulse 1-A. Subsequently, it shows evidence of sea level still standing during the cold stadial Younger Dryas, followed by a rapid increase in sea level during the Melt Water Pulse 1-B. The obtained curve of relative sea-level rise was compared with the a) eustatic sea-level curve proposed by Lambeck et al. (2014) corrected for the Glacial Isostatic Adjustment (GIA), b) relative sea-level curve by Lambeck et al. (2011) for Briatico, seven eustatic sea level curves plus one calculated in the Mediterranean, all corrected for the GIA. The best overlap was obtained with the high-mantle-viscosity from the GIA correction model of the Australian National University (ANU14-HV). It is noteworthy that the eustatic sea-level curve proposed by Lambeck et al. (2014) overlaps our relative sea-level curve throughout the analyzed time interval.

Lambeck K. et al. (2011) - Sea level change along the Italian coast during the Holocene and projections for the future.

Quaternary International, 232(1-2), 250-257, <https://doi.org/10.1016/j.quaint.2010.04.026>.

Lambeck K. et al. (2014) - Sea level and global ice volumes from the Last Glacial Maximum to the Holocene. Proceedings of the National Academy of Sciences, 111(43), 15296-15303, www.pnas.org/cgi/doi/10.1073/pnas.1411762111.

Causes and Effects of Hyperthermal Events from the Mid Permian to the Permian-Triassic Boundary

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Keywords: Permian, Triassic, stratigraphy, paleoclimate, Iran.

This study focuses on two Permian to Lower Triassic key sections in Iran: Abadeh (Central Iran) and Zal (NW Iran), which were deposited during a significant transgressive event linked to the opening of the Neo-Tethys Ocean along the eastern margin of Gondwana. In both sections, the middle to upper Permian interval comprises limestones, marly limestones and rarer marl and shale intercalations. The uppermost part of the Permian succession is marked by thin-bedded, brownish-red limestones, predominantly nodular, with marly limestones and marls. In terms of biofacies, the lower to middle Permian is dominated by shallow water carbonate bioclasts, which become rarer upward, where pelagic fauna and siliceous bioclasts become more prevalent. At both sections, a thin reddish-greenish clay level (Boundary Clay, BC), corresponding to the end-Permian extinction interval, marks the abrupt transition from the underlying limestones. The Permian-Triassic Boundary lies within the first 50 cm of the overlying Elikah Formation, primarily consisting of thin-bedded yellowish limestones alternating with microbial bindstones. The middle to upper Permian units were deposited along a homoclinal carbonate ramp that evolved into more distal and deeper conditions upwards. The BC reflects the maximum deepening and temporary demise of carbonate sedimentation, associated with the mass extinction event. The Lower Triassic microbial bindstones of the Elikah Formation represent the early recovery stage immediately after the end-Permian mass extinction. The concurrent decline in carbonate sedimentation and increase in fine siliciclastics likely resulted from various interacting processes. First, hyperthermal events and global warming tied to the onset of the Emeishan Large Igneous Province (Capitanian, ~262-259 My) and the Siberian Traps (Changhsingian, ~252-250 My) led to rapid, large-scale greenhouse gas release, including CO₂, into the atmosphere and oceans. This caused ocean acidification and a state of carbonate undersaturation. Additionally, intense continental weathering introduced high amount of fine siliciclastics into marine systems. Continental weathering was driven by warm, humid climate and acid rain, conditions correlated with the activities of the two large magmatic provinces. The Permian to Lower Triassic period also experienced significant tectonic activity due to plate reorganization. The Zal and Abadeh areas underwent intense tectonic subsidence from the early Permian into at least the Triassic, associated with the rifting and opening of the Neo-Tethys Ocean.

The impact of an integrated stratigraphic and structural analysis on the updating of the regional tectonic scheme: an example from the Hyblean Plateau (SE Sicily).

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Keywords: Regional tectonics, Hyblean Plateau, Sedimentation.

The local geometry of geological units is the signature of the interaction between the sedimentary regime and the tectonic dynamics of a region over time. The integration of stratigraphic and structural analyses is therefore crucial in geological investigation, since the reconstruction of a geological setting, regardless of the objectives pursued, needs validation for consistency with the tectono-stratigraphic history of the area. This goal is difficult to achieve if stratigraphic and structural investigations are conducted separately and at different periods.

We here would illustrate how an integrated stratigraphic-structural study, focused on mapping of the Geological 1:50.000 sheet "Ragusa" in the frame of the CARG Project, produced a significant updating of the tectonic history of the entire Hyblean Plateau, in SE Sicily. The area is an uplifted portion of the African continental shelf, forming the peripheral bulge in front of the Sicilian orogenic belt. The plateau consists of a culmination of an Oligo-Miocene carbonate succession, now dissected by distinct fault systems, controlling the main features of the landscape inside the plateau and plio-pleistocene depocenters along its borders.

The new integrated studies have resulted, differently from the past interpretation, in some new relevant insights, summarized as follows:

1. The Hyblean Oligo-Miocene succession consists of shallow-water sediments that are very sensitive to bathymetric variations due to syn-sedimentary deformation;
2. A main unconformity, marked by an obvious stratigraphic gap, separates the nearly homogeneous Late Oligocene-Aquitainian interval (Leonardo Fm.) from the early Burdigalian and Early Langhian horizons (Irminio Fm.), which are instead characterized by impressive lateral variability of lithofacies;
3. Heteropies within the Irminio Fm. occur mainly across major fault segments, as a direct response to differential syn-sedimentary movement between hangingwall and footwall structures;
4. An intraformational Burdigalian unconformity within the Irminio Fm. represents a new horizon-key useful for discriminating, among the set of faults active during Early Miocene sedimentation, the segments that reactivated during later deformation phases;
5. The new stratigraphic scheme implies a reassessment of stratigraphic separation across faults, which generally results in a drastic reduction of the cumulative offset;
6. Comparison of tectonic scarps with the geologically recorded offset is the tool for discriminating between fault-line scarps, along synsedimentary faults, and actual fault scarps along segments that reactivated after the area emerged.

We can conclude that most of the tectonic features of the Hyblean region actually formed during the Early Miocene tectonic deformation and conditioned the distribution of structures that reactivated during the successive stage of bulging and intraplate deformation, that dominate the tectonic picture of the region, since the Late Miocene.

BERMS - Beach EnviRonMentS: towards a holistic approach for the study of sandy beaches

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Keywords: beach environments dynamics, Sedimentary Petrography, Applied Geophysics, Marine Biology and Ecology, holistic approach.

The BERMS project deals with the investigation of sandy beaches by integrating sedimentological, compositional, geomorphological, geophysical and ecological analysis. This research combines innovative and classical technologies in order to obtain a single methodological procedure rather than individual geomorphological, sedimentological or engineering methods. In particular, the principal scope of this research is to propose a standard procedure that consider a quantitative and semi-quantitative approach for the monitoring of wave-dominated sandy beaches and their susceptibility to erosion. Moreover, the BERMS project seeks to overcome the long-standing conflicts between naturalistic requirements and the anthropic pressure on sandy beaches for social and economic purposes. The research focuses on three study area located in southern Italy along the Adriatic and Ionian Seas. In particular, the two sandy beaches of Torre Guaceto (TGU) and Porto Cesareo (PCE) are located in the Apulia Region, along the Adriatic Sea and the Gulf of Taranto respectively, while the Sibari beach (SIB) is located in Calabria along the Ionia Sea. These areas show different beach dynamics that can be considered as end members of the coastal variability within the central and northern Mediterranean, since sand composition, geomorphological characteristics, climatic and environmental factors, wind, wave, and general weather conditions are variables even in a short distance. For each area, the sedimentological and ecological studies will provide the principal source rocks supplying the detritus budget and define the physical/biological interactions within the beach. Moreover, the quantitative changes of sediment volume over time will be defined by topographic surveys using a Terrestrial Laser Scanner, Optical Total Station, and video-monitoring techniques. In addition, the volume estimation of the sand involved in the beach dynamics will be calculated by means of geophysical techniques, including Sub Bottom Profiler procedures, Ground Penetrating Radar investigation, and resistivity models. Finally, the Delft3d software will provide the effects of the dominant wave motion on the beach dynamics. The first year was dedicated to the data acquisition for the Apulian beaches (TGU and PCE) and, in the first months of the second year, for the Calabrian beach (SIB), with sand and bedrock sampling, biological data collection and mapping, geophysical, and geomorphological measurements. Next move concerns the data analysis and processing in order to provide a data base containing the results of the textural and petrographic analyses, the georeferencing of sedimentological and biological data, and the beach system elaboration, to reconstruct the sedimentary balance and to propose an overall sketch scheme of beach dynamics.

Assembling and dismantling the supercontinent Pangaea recorded from provenance relations of Phanerozoic sandstones of the circum-Mediterranean Region

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Keywords: Sandstone detrital modes; Foreland basins; circum-Mediterranean orogens; Paleotectonic evolution of western Mediterranean.

The composition and stratigraphic relations of clastic strata in diverse sedimentary basins of the circum-Mediterranean region reflect a complete record of provenance relations since break-up of Pangaea, neo-Tethyan rifting, and subsequent plate convergence between the two major plates of Europe and Africa, and other related microplates of Iberia, Adria and Mesomediterranean microplate.

Since the plate reorganization to the breakup of Pangea, at the end of Paleozoic-earliest Mesozoic, clastic wedges filled sedimentary basins within geodynamic settings evolving from continental rifts, rifted- continental margins, protoceanic basins, arc-trench systems, remnant ocean basins, proforeland basin systems and back-arc basins within the circum-Mediterranean region.

The changing nature of clastic particles in these clastic wedges reflect the provenance relations from different source rocks within the spatial and temporal evolving geo-puzzle terranes, including relations between ophiolite-bearing, uplifted continental crust (both shallow to deep crust terranes), volcanic and sedimentary (particularly carbonate strata) source rocks. Typical sand(stone) suites are quartzose, derived from flexured cratonal area, followed by quartzolithic and quartzofeldspathic derived from the growth fold- thrust belt. Mixed siliciclastic and carbonate shallow- to deep-marine clastic wedges are diffuse in manyfilled basin systems along the Circum-Mediterranean region, as such as volcanoclastic sand(stone) that may also occur interbedded with typical quartzolithic suites, in both remnant ocean basins and foreland basins.

The variable mosaic of source terranes within the Circum-Mediterranean region, representing striking examples of proforeland sandstone suites, offered the possibility to investigate provenance relations in sandstones with a new plane of precision and sophistication, discriminating grain particles in clastic wedges using spatial (extrabasinal versus intrabasinal), and temporal (coeval versus noncoeval) distinction of detrital signals.

The spatial/temporal approach in deciphering particles in clastic rocks has been widely used to detail the basinal dispersal pathways in different geotectonic settings, wherever mixed silicate and carbonate terranes act as the major source rocks, from rifted-continental margins to collisional orogens.

Marine Geology in the 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, ecological 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 indirect 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 data acquired with each instrument was processed and analyzed separately to obtain the different information needed for the interpretation phase:

- (a) Multibeam data have been processed to obtain the DTM (Digital Terrain Model) of the seafloor, obtaining the isobaths and information on the morphology of the seabed.
- (b) High-resolution mosaics obtained by Side Scan Sonar have been analyzed for the morphological classification of the seafloor, identifying the lithology of sediments and rocky outcrops and the distribution of habitats and evidence of anthropic activities.
- (c) the Sub-Bottom Profiler acquisitions and the ultra high resolution multichannel seismic imaging have been processed to obtain the seism-stratigraphic sections of the seafloor to recognize the main reflectors (top of carbonates, top of subappennine clays and the sea floor).

All the data were implemented in a Geographic Information System to produce undrafted and updated thematic maps of the offshore submerged sector that were integrated with the data and maps of the emerged part of the study area to produce the complete CARG Sheet 493 – 'Taranto'. The work done to produce the map contributed also to the creation of a large interdisciplinary database that will be used for in-depth future studies, such as the high-detail reconstruction of the geological evolution of the area from the Last Glacial Maximum to the present.

Palynological investigation on metamorphosed rocks of the inner Northern Apennines: new chronostratigraphical constrains of some Tuscan Palaeozoic units

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Keywords: palynomorphs, central Mediterranean, cryptospores, trilete spores.

The inner Northern Apennines is an alpine chain born from the dynamic convergence and collision between the Adria microplate and the Sardinia-Corsica Massif during the Jurassic to the early Miocene. This geological process crafted a complex mosaic of Palaeozoic metamorphosed successions, today exposed along the middle Tuscan Ridge and in the eastern portion of the Elba Island. These successions provide valuable insight into the stratigraphic evolution of the inner Northern Apennines. Unfortunately, most of them have been studied separately by different researchers, at different times and with different approaches, leading to discrepancies in dating. Moreover, in metamorphic rocks, fossils preservation is particularly challenging due to the intense pressure and temperature conditions that often destroy or significantly alter biomineralized fossils.

In the present study, we report palynological data from a total of seventeen samples deriving from the deepest portions of some of these Palaeozoic successions. Nine of them consist of phyllites and quartzites, four from Monte Pisano area and five from Punta Bianca area (Buti Formation). The remaining eight, cornubianites, were collected from the lowermost portion of the Palaeozoic succession on Elba Island, specifically within the thermometamorphic aureole of the Monte Calamita Complex.

Microflora yielded mainly consists of permanent tetrad as *Tetraedraletes medinensis*, dyad as *Dyadospora murusattenuata* and *D. murusdensa* and monad as *Gneudnaspora divellomedia* in assemblage with smooth and ornamented trilete spore as *Chelinospora poecilomorpha*, *Concentricosisporites sagittarius*, *Emphanisporites rotatus*, *Retusotriletes triangulatus* and others. Based on detailed comparisons with palynological records from Laurussia (e.g., UK, Ardenne-Rhenish region, Canada, and Nova Scotia) and Western Gondwana (e.g., Tunisia, Algeria, Spain, Brittany, Libya, Turkey, and Saudi Arabia), the assemblage has been attributed to the Wenlock (Homerian) to Ludlow stages of the Silurian. Microflora assemblage evidence a possible correlation between the Buti Formation and the lower portion of the Monte Calamita Complex. In the Alpi Apuane area, a similar age is reported for the Scisti neri e Dolomie ad *Orthoceras* Formation. Palynological study has proven to be an excellent tool helping to resolve stratigraphic and geodynamic problems even in rock deposits where different degrees of metamorphism are present.

A new customizable QGIS tool for data acquisition in geological survey (Practical applications in the CARG project)

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Keywords: CARG, GIS, Innovative Tools, QField.

Nowadays we are increasingly accustomed to using tools that allow us to acquire digital data in a precise and fast way. Data acquisition and analysis is essential in all fields of science and engineering, including geology. In the field of geological mapping, field data was acquired on a paper topographic map but in recent years there has been a great development of GIS software that can now be used also on smartphones and tablets.

The CARG project, coordinated by ISPRA*, aims to create and digitise 636 geological sheets at a scale of 1:50,000, covering the entire national territory. The geological data collected at a scale of 1:10,000 is stored in a complex database, following specific guidelines and dedicated vocabularies.

In the production of the Geological Sheet 575 “Catanzaro” and to speed up the process of data acquisition on the ground, a new innovative tool has been developed. Through the creation of a special GeoPackage on the QGIS platform which can be conveniently transferred to the QField application designed for smartphones and tablets, you can easily acquire a georeferenced geological point data.

This database, carefully built in the GIS environment, contains all the basic information related to the legend of the geological units of each study area. The interface of this tool is user-friendly and intuitive and was developed directly in the QGIS application to create a custom attribute form that facilitates the input of data collected in the field. The custom form consists of drop-down menus that are linked together with values already filled that can be selected to be associated with the point that will be placed on the map thanks to the geolocation of the mobile device used facilitating the necessary operations in the field. This new digital tool, together with the instruments already developed by ISPRA, represents a major breakthrough in data acquisition in geological survey. It is also a versatile tool, as it can be used in any geographical area by changing the entries in the legend.

Terrestrial analogues for planetary exploration: some examples from the African continent

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Keywords: Planetary Geology, Analogues, Astrobiology, Mars.

Field analogues for planetary exploration are terrestrial environments that share physical, chemical and/or geological similarities with modern or ancient extraterrestrial environments. Planetary field analogues provide a unique opportunity to perform in-situ measurements during field campaigns, allowing to test methodologies, protocols, and technologies that are part of the payloads of present and future missions and shed light on the interactions between geological processes and communities of extremophiles: organisms thriving under physical and chemical conditions that are considered extreme and potentially hostile for life as we know it. Terrestrial field analogues are generally considered ‘extreme environments’ as they are characterised by conditions that are unfavourable for life to thrive. As most of these terrestrial analogues occur in sedimentary environments, the trained eye and know-how of a sedimentologist become crucial for furthering our understanding in planetary geology.

The African continent presents exceptional examples of extreme environments, fossil and extant, that have been studied as planetary analogues. Here two of these sites, the Kess Kess mounds of Morocco and the Makgadikgadi pans of Botswana, will be presented and their ‘analogue’ characteristics placed under the spotlight.

Tectono-sedimentary evolution of Cretaceous-Neogene carbonate breccias of southwestern Sicily (Italy)

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Keywords: carbonate megabreccias, Meso-Cenozoic carbonates, matrix with planktonic fauna, from Cretaceous to Pliocene matrix.

The study area is located in southwestern Sicily, north of the town of Sciacca. In this area outcrops the outermost portion of the Sicilian Fold and Thrust Belt, consisting of units belonging to the Saccense Domain and related Neogene-Quaternary syntectonic cover.

Data collected on field, during the production of Sheet 628 “Sciacca” of the Geological Map of Italy, have provided new tools for understanding the geological evolution of this sector from a stratigraphic and structural point of view and to obtain information about the interaction between tectonics and sedimentation processes. The investigated area includes the ridge extending from west to east in the northern sector of the Sheet and consisting of thick bodies of carbonate megabreccias whose elements belong mostly to Meso-Cenozoic carbonate dispersed in a silty matrix. There are mainly three sectors in which these megabreccias outcrop: the Pizzo Telegrafo sector, the Rocca Ficuzza sector and the Coda di Volpe sector.

In the Pizzo Telegrafo sector, breccias with well-cemented reddish-yellow calcilutite matrix outcrop extensively. The elements of these breccias consist mostly of heterometric and angular fragments of limestone of Jurassic, while the matrix contains an association of radiolarian, planktonic foraminifera and calcareous microfossils that allow us to assign an age referable to Hauterivian-Albian (Lower Cretaceous).

In the Rocca Ficuzza sector, the succession consists of whitish limestones of Jurassic observable at the base of the southern slope. In the upper part the limestones pass, with a discontinuity surface, to megabreccia bodies consisting of fragments of Meso-Cenozoic carbonates in a reddish silty matrix. The matrix contains planktonic fauna and flora of the Piacenzian, interbedded with whitish marls of the Pliocene.

Finally, in the Coda di Volpe sector, the outcropping breccias unconformably lie above the carbonate platform of Jurassic. In this sector the breccia bodies consist of fragments belonging to the underlying Meso-Cenozoic carbonates and glauconitic sandstones dispersed in a reddish silty matrix containing a rich calcareous plankton assemblage. Biostratigraphic observations conducted on the matrix allowed us to tie the chronostratigraphic attribution of these bodies to the Miocene.

The deposits constituting the matrix of these breccias outcrop extensively at the adjacent areas of the investigated sectors and often, being located at the active fronts of the main thrusts, are involved in the deformation and evolution of these structures. The formation of such megabreccias has been interpreted as resulting from gravitational phenomena from the flanks of tectonically controlled escarpments developed initially during the Jurassic and reactivated during different tectonic phases from the Cretaceous until the Pliocene.

Submarine Mass Transport Deposits in the Southern Apennines and Sicily: distribution in space and time

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Keywords: (mega)turbidites, flysch, Miocene, biostratigraphy.

Submarine landslides and associated deposits are widely represented in the ancient and modern geological record alike. As part of the PRIN PNRR 2022 project (P2022T3A4E) TOOLS - “Testing the efficiency of submarine landslides On Organic carbon sequestration over geological timeS”, this research is focussing on submarine mass transport deposits (MTDs) and background successions cropping out in Southern Apennines and Sicily. The Cilento Group, which is exposed in the Southern Apennines, represents turbiditic deposits in a highly tectonized and fragmented foreland basin, active since the Miocene. In particular, the San Mauro Formation (Langhian-Tortonian) contains at least five major depositional events recorded as megaturbidites made of carbonate-siliciclastic facies, covering tens of kilometres across the basin. In central Sicily, along the Apenninic-Maghrebian Orogen, the almost coeval Reitano Flysch deposited in a thrust-top setting during Burdigalian-Langhian time. Here, several turbiditic bodies deposited on a deformed substratum. However, their depositional timing is not accurately constrained yet. Thus, this research aims at better defining the evolution and recurrence of these bodies through space and time at different scales. A detailed stratigraphic-sedimentological logging of San Mauro Formation and Reitano Flysch is still in progress, together with foraminiferal biostratigraphic analysis. These combined datasets will allow a better constraint to their depositional timing and basinal connections. The present study is based on a multidisciplinary approach, which also includes organic matter and petrographic-mineralogical analyses. It will help understanding biogeochemical cycles and natural carbon sequestration processes related to submarine mass transport processes and deposits through geological time.

The platform-to-basin transition record of the Matese-Frosolone Unit: (bio)stratigraphy of the Cretaceous to Miocene carbonate successions of Isernia sheet (Southern Apennines, Italy)

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Keywords: geological map, microfacies analysis, planktonic foraminifera, slope-basin deposits.

The Meso-Cenozoic carbonate succession exposed south of Isernia (Molise region, Italy), consists of juxtaposed carbonate platform, slope, and basinal facies. These carbonates, belonging to the Matese-Frosolone Tectonic Unit, were part of the platform-to-basin transition between the Matese Unit (Apennine Platform) and the adjacent Molise Basin.

The Upper Cretaceous to Miocene Montagnola di Frosolone Succession was studied as part of the geological mapping of Sheet 404 “Isernia” (1:50,000 - CARG Project). Field data were integrated with microfacies analysis and micropaleontology of about 80 samples. The stratigraphic study focused on the biostratigraphy of planktonic foraminifera and their assemblages, carried out using thin sections due to the lithified nature of the rocks.

Samples were categorized into five well-established formations of the Southern Apennines.

The oldest samples, labeled as Coste Chiavarine Formation (CCH), consist of fine-grained bioclastic limestones rich in rudist shell debris. Their Campanian age is documented by the presence of double-keeled *Globotruncana* specimens. The depositional environment (as for the overlying units) corresponds to a pelagic basin/toe-of-slope, characterized by prevailing low energy background sedimentation conditions, frequently interrupted by short-term higher-energy redeposition events (gravity flows).

The Middle Eocene-Oligocene Monaci Formation, which unconformably overlies the CCH Formation, consists of interlayered planktonic foraminiferal limestones, marlstones, and coarser bio-lithoclastic packages with reworked rudist shell fragments and alveolinids, nummulitids and orthophragminids. The Middle to Late Eocene age is well documented by the occurrence of planktonic foraminifera of the genera *Hantkenina*, *Acarinina*, *Morozovelloides*, *Globigerinatheka*.

The overlying Oligocene to Middle Miocene Macchiagodena Formation shows similar facies but the coarser limestones are characteristically made up of reworked *Amphistegina*, *Operculina*, and *Lepidocyclina*/*Miogypsina* specimens. The Miocene age is supported by the occurrence of specimens of *Catapsydrax*, together with numerous species of *Dentoglobigerina* and *Paragloborotalia*. The upper part is referred to the Langhian, given the occurrence of plankton of the *Trilobatus sicanus/bisphericus* group and the first specimens of *Orbulina universa*.

Major reworking occurred during the Langhian-Serravallian, as suggested by the recorded rudstone facies of the Polygenic Calcirudites and Monte Crivari Calcarenites. Relatively stable deep-water conditions characterized the Serravallian (up to the Early Tortonian) during the deposition of limestones and marlstones of the Longano Formation. The age (no older than Serravallian) is confirmed by the co-occurrence of *Orbulina universa* with specimens of the *Fohsella fohsi* lineage.

The study allowed better understanding the depositional complexity/variability and recording diachronies of the Cretaceous-Miocene carbonate platform-to-basin transition.

Sediment yield estimation using the EPM Model: critical analysis of key parameters

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Keywords: Coastal Erosion, Sediment Yield, EPM, Land-Cover Classification.

Coastal erosion and the sediment yield variation from river basins to coastal areas are expected to intensify due to climate change, posing an increasingly significant challenge for environmental and territorial management. In this context, soil erosion models play a crucial role as predictive tools for planning risk mitigation strategies and implementing environmental protection measures.

This study estimates the sediment production in the Aron River basin (Calabria, Italy) through advanced analysis of key parameters of the Erosion Potential Model (EPM). The EPM is a semi-quantitative model that integrates geological, geomorphological, climatic, and land-cover variables. This model enables the estimation of potential sediment production, transport within the river basin, and eventual deposition. Sensitivity analyses conducted in previous studies have identified the soil protection coefficient (related to land cover) and the erodibility coefficient (related to lithology) as the most influential parameters affecting final estimates. To improve the accuracy of sediment production estimates, new methodologies to evaluate these parameters were implemented.

Specifically, we focused on the implementation of the land-cover parameter through the advanced mapping of the main land-cover classes by a multispectral satellite analysis of Sentinel-2 images. The analysis of these images was performed using supervised classification algorithms based on machine learning techniques. The image processing was conducted using Random Forest (RF), a specific computational algorithm trained by several areas with specific land-cover types. This mapping, significantly more accurate than those available in the literature, allows us to reduce variability in the overall coefficient assignment.

The erodibility parameter was assessed by geomechanical analysis for each geo-lithological Unit. We have experimented with several applications in which GSI (*Geological Strength Index*) represents the best geomechanical parameter for the characterization of geo-lithological units. The erodibility coefficients derived from the original methodology were used to develop a linear correlation and generate new, specific values.

The critical analysis for both EPM's main sensitive parameters provides an estimate of sediment production and transport in the Aron Basin. The net volume of sediment (G) transported at the closure section of the basin was calculated both manually and semi-automatically using the YES (*Yield Erosion Sediment*) plug-in in the QGIS environment. The estimated average annual sediment volume produced in the basin is approximately 27,000 m³/year; this agrees with previous estimates for the same area. The proposed parameterization provides a solid basis for applying the model to other similar river basins within the same physiographic unit of the Tyrrhenian coastal stretch of Calabria.

Monitoring and conservation of marine-coastal environments: the role of the marine laboratory of the University of Calabria

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Keywords: Coastal monitoring, biodiversity, sediment transport modelling, environmental impact assessment

The Marine Laboratory (LaMar) of the University of Calabria is part of the SILA (*Sistema Integrato di Laboratori per l'Ambiente - Integrated Laboratories System for the Environment*) and plays a key role in the mapping, monitoring, control, protection and enhancement of marine, coastal and fluvial environments. LaMar supplies scientific and technological services to basic, applied and industrial research to academic Institutes and Companies with a focus on geo-bio-ecological and cultural marine resources, particularly on monitoring the impact of natural and anthropogenic risks on biodiversity. The LaMar dispose of advanced instruments and equipment able to furnish the following activities: i) single-beam, multi-beam, topographic, photogrammetric, multi and hyperspectral surveys, aimed at producing thematic cartography in the marine-coastal environment and investigate seabed deformation processes; ii) characterization and sampling of benthos, sediments, and marine waters for short, medium, and long-term monitoring of biotic and abiotic matrices; iii) estimating models aimed to the comprehension of production, transport, and sedimentation processes in fluvial, lacustrine, and marine-coastal environments; iv) geobiological and geochemical characterization of marine bioconstructions developing in both open and confined sectors, aimed to understanding formation processes and identifying ecological and environmental *proxies*.

Currently, LaMar is involved in several activities within national and international projects, including:

- Various Pilot Projects funded by the National Recovery and Resilience Plan (PNRR), focused on monitoring, protecting, and enhancing the benthic habitats and the physiographic units associated with the marine-coastal environment;
- CARG (Geological CARTography) project (Lamezia Terme, Villa San Giovanni, and Catanzaro sheets), especially in the acquisition, processing, post-processing and validation of morpho-bathymetric, sedimentological, and geophysical data from the seafloor;
- AZA project, aimed to protect and improve aquatic environments through the restoration of degraded ecosystems by implementing protective actions. Particularly the project is focused on developing flora and fauna introducing selective equipment for exploitation activities, and funding studies on the conservation and restoration of overexploited stocks, thus contributing to biodiversity protection;
- Eolic hybrid offshore project, with a total power of 540 MW, located on Rossano and Cariati Banks;
- Nourishment and monitoring project of the port and coastal areas in the municipality of Cetraro and Calopezzati.

In conclusion, the activities carried out and the results obtained highlight the potential of interdisciplinary infrastructures like the LaMar in the context of sustainable research and management of marine-coastal environments, providing crucial data for biodiversity conservation and marine resource enhancement.

Geological and Environmental Implications of Asbestos-Containing Serpentinites from Ophiolitic Sequences in Southern Italy

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Keywords: serpentinite, ophiolite, Natural Occurrences of asbestos, Southern Italy.

In southern Italy, the regions of Calabria and Basilicata are characterized by an extensive occurrence of serpentinite and metabasite rocks, occurring within the ophiolites of the Calabria-Peloritani Orogen and the southern Apennines. These serpentinites, specifically from the Gimigliano-Mount Reventino Unit (Calabria) and North-Calabrian Unit (Basilicata), derive from the metamorphism of ultramafic rocks, representing fragments of the Neotethyan Ocean that were uplifted during formation of the Apennine belt.

These serpentinite rocks have been traded and employed as building materials since prehistoric times, making detailed characterization crucial to understanding their performance and predicting their behaviour when used as construction materials, particularly in monuments.

These rocks contain serpentine-group polymorphs (chrysotile, lizardite, and antigorite) as the main constituents, which unfortunately can exhibit asbestiform habits, posing potential health risks. Additionally, minerals like chlorite, brucite, magnetite, talc, amphiboles, and carbonates are also present, along with remnants of the protolith, such as pyroxene and olivine, as accessory mineral phases. Available geochemical analyses reveal high concentrations of toxic elements, especially Cr and Ni.

The presence of Naturally Occurring Asbestos (NOA) and asbestiform minerals, alongside Potentially Toxic Elements (PTEs), poses significant health risks, as reported in literature. Human activities, such as quarrying, excavation, and infrastructure development, as well as natural processes like weathering, earthquakes, or hurricanes, can disturb these rocks and expose asbestos-containing fibres, releasing them into the environment, posing a potential hazard to human health, especially for populations living near the outcrops.

A detailed petrographic, mineralogical, petrophysical, and geochemical knowledge of these serpentinite rocks and derived soils is thus crucial, not only for predicting their behaviour when employed as building materials and for planning restoration interventions, but also for assessing health risk to populations living in these areas.

Ongoing research is redefining asbestos-containing geomaterials as georesources. Innovative processes (Patents No. 30653/2020 and No. EPA21425060/2021) aim to generate inert compounds from these materials. Moreover, serpentinites in the Southern Apennines are being considered for in-situ geological CO₂ sequestration, while abandoned quarries are being investigated as potential sources for Critical Raw Materials.

In conclusion, this contribution provides insights into the composition, behaviour, and potential health risks associated with southern Italy's serpentinites, supporting sustainable resource management and future applications.

Investigating microbial life preservation in gypsum: astrobiological implication for gypsum dune fields on Mars

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Keywords: gypsum, Mars, Organic Geochemistry, Astrobiology.

When gypsum crystal grows in the presence of a fluid phase, some of this fluid may be trapped as imperfections in the growing crystal to form 'fluid inclusions'. Fluid inclusions can be considered as time capsules storing information about ancient condition (*i.e.*, chemical composition, pressures, temperatures). Moreover, as observed in many evaporitic crystals (*i.e.*, halite, gypsum) these fluid inclusions can entrap microorganisms and biomaterials present in the surrounding fluid.

The potential for microorganisms to be preserved within the gypsum crystals suggests that similar colonization may have occurred on Mars if life ever existed there. Notably, extensive evaporite deposits have been identified on Mars through orbital measurements and in situ robotic exploration.

This project focuses on the origin of gypsum clasts that made up the dune of the Olympia Undae gypsum (Mars) and Cuatro Ciénegas Basin (Mexico) and, in particular, on the fluid phase and survival of microbes within gypsum-hosted fluid inclusions. Sampling will be conducted in the Cuatro Ciénegas Basin, a Martian gypsum dune field analogue site, which offers the opportunity to study microbial evolutionary processes on Earth and serves as a proxy for identifying biosignatures for extraterrestrial life.

The methodology is based on a morpho-sedimentological study of Olympia Undae and Cuatro Ciénegas Basin in Mexico gypsum dune fields by high resolution and multispectral remote sensing, followed by a petrographic analysis of the Cuatro Ciénegas Basin gypsum clasts and fluid inclusions trapped inside them, using optical microscopy, ultraviolet fluorescence, scanning electron microscopy, electron microprobe analysis, raman spectroscopy and microthermometry.

To ensure accuracy and avoid contamination, the sampling procedures will be tested on several Messinian gypsum facies of the deposits in the Catanzaro Trough (Italy), where fluid inclusions contain organic matter. In addition, the outcrops and samples will be investigated by field spectrometers. We will use a simulation chamber allowing to test the effect of low pressure, humidity, UV radiation and CO₂ atmosphere typical of the Martian surface on gypsum. Finally, the possibility to find entrapped or living organisms within the gypsum, will be investigated by assessing the feasibility of DNA extraction and metagenomic analysis of the gypsum-hosted fluid inclusions.

The expected outcome is to investigate gypsum as a promising target for the search for life on Mars and to develop a robust protocol for multiscale analysing and sampling of gypsum deposits, which can then be applied to Mars analogue sites. This research aims to not only deepen our understanding of microbial survival on Earth but also provide critical insights for future astrobiological missions to Mars, especially for detecting ancient biosignatures in Martian gypsum deposits like those at Olympia Undae.

Technological implementation for sampling and characterization of marine bioconstructions

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Keywords: bioconstructions, coralligenous, technological innovation.

Coralligenous is a hard biogenic substrate mainly produced by the superposition of several generation of calcareous red algae, living in dim light condition. Among the bioconstructed habitats of the Mediterranean Sea, it is undoubtedly the most important ecosystem due to its extent, complexity and heterogeneity, which supports very high levels of biodiversity. 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 European Union.

Consistently with principles of the Europe Blue Growth Strategy, an innovative ROV-based technology for minimally invasive sampling of marine bioconstructions has been developed. This underwater coring device, driven via a specifically designed control interface which contains information such as core rotation speed, drilling depth and tool magazine positioning, is characterized by three main modules: i) core drilling head, containing an innovative quick release system that engages core bits with a custom chuck; ii) anchoring system, enabling the stable connection between ROV and bioconstruction during sampling operations; iii) tool change mechanism, an automatic rotating turret that provides the storage of the core samples after every coring operation.

In the new project “*Tech4You PP2.3.1: Development of tools and applications for integrated marine communities and substrates monitoring*”, the system is being enhanced through integration of robotic and AI-based computer vision technologies in order to carry out accurately the following activities: (i) more accurate sampling of bioconstruction through several technological upgrades; (ii) detailed mapping of the sea floor carried out using an optical module consisting of a stereo-camera and high resolution camera installed on a ROV; (iii) high resolution 3D reconstruction of specific target using photogrammetric techniques.

In this work, 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 “*tal quale*” build-ups revealed no significant differences in term of abundance and relationship between skeletal frame-builders and non-skeletal carbonate components, despite the much smaller size of the core sample. These results allow to consider the ROV-based system as a powerful tool to obtain representative samples of bioconstructions for geobiological, environmental and paleoenvironmental studies without making invasive sampling, which would damage these fragile and delicate ecosystems.

New protocol for marine bioconstructions mapping: a powerful tool for natural and/or anthropogenic changes

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

Coralligenous is a biocenotic complex mainly produced by the accumulation of calcareous encrusting algae growing in dim light conditions, able to form 3D biogenic build-ups. It contributes to seascape formation and demise through geological times, producing various morphotypes and causing geomorphological changes of the seafloor.

Although coralligenous bioconstructions are present along almost all Mediterranean continental shelf, their distribution is still underestimated and sparsely mapped. In addition, due to its importance

as a hot spot of biodiversity, the European Community considers the Coralligenous to be among the most important habitats to monitor and protect, also considering its low accretion rate and its high sensitivity to natural and anthropic impacts, including climate change. For all these reasons, seabed mapping using acoustic instruments, such as MBES and acoustic profiling can provide a very useful tool for seascape characterization and habitat mapping without making mechanical samples.

In this work, a semi-automated GIS-based protocol for benthic habitat mapping were proposed and tested in shallow coastal water of Capo Bianco (Calabria, Italy). The method combined high resolution bathymetric and backscatter data obtained by MBES surveys with geomorphological and geomorphometric indices to develop innovative approaches for eco-geomorphological and geobiological studies. In particular, the entire spatial dataset was integrated into QGIS and geomorphometric analysis was performed with SAGA and GDAL. To discriminate the areas covered by coralligenous bioconstructions, backscatter values, together with water depth, slope, seafloor roughness and profile curvature, were imported and queried into PostgreSQL. The extraction of Coralligenous build-ups was subsequently performed using the Topographic Position Index (TPI) at the finest possible scale and using a threshold value in order to maintain the high resolution of the extraction and reduce the occurrences of artifacts. Resulting raster were re-classified and polygonised and the remaining artifacts were manually detected. For each coralligenous polygon, the Shape Index (SI) was calculated in order to distinguish between banks and discrete relief. Height’s estimation involved complex DEM filtering operations performed with SAGA. These algorithms aimed to derive a “reference surface” from which the depth of each build-up could be subtracted. Area and volume of each polygon was calculated using vector field operations implemented in QGIS.

In conclusion, the protocol proposed has proven capable not only of identifying marine bioconstructions, but also of quantitatively defining their three-dimensional distribution. For these reasons, it represents a powerful tool for accurately delineating their spatial extent and evaluating their evolution over time in response to natural or anthropogenic changes.

Astronomical forcing in coeval marine and continental deposits of the Piacenzian of the Valdelsa Basin (Southern Tuscany, Italy). A cyclostratigraphic application through portable-XRF proxy data

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Keywords: cyclostratigraphy, Upper Pliocene, Southern Tuscany.

Portable X-ray fluorescence (p-XRF) is a powerful tool for cyclostratigraphy investigations and for detecting paleoclimate indicators in the sedimentary record. This contribution presents a case study of p-XRF cyclostratigraphy applied to shallow-water marine and coeval continental Pliocene deposits located in the central-eastern sector of Valdelsa Basin (Southern Tuscany, Italy), one of the wider and most important Neogene basins of the hinterland of the Northern Apennines. The p-XRF data acquisition has been performed on selected sections, mainly composed of mudstone, deposited during the Piacenzian, including the mid-Pliocene Warm Period (from 3.3 to 2.9 Ma). Geochemical data, acquired with equal spacing samplings on cleaned sediment surface, have been integrated with paleomagnetic and calcareous plankton biostratigraphic data. To identify orbital frequencies recorded by geochemical data series, power spectral analysis has been performed first in the space domain. The astrochronological tuning has been realised considering a preliminary age model of the studied section based on correlation between geochemical data and insolation curve. The studied successions respond to the precession periodicity as for other Southern Tuscany Pliocene sections. Geochemical, facies and micropaleontological data, all combined together, allow us to define changes in the depositional environment and their relationship to climate forcing driven by the orbital configuration. The high-resolution calibration of the studied successions, allowed to outline of an evolutive paleoclimatic, paleoenvironmental and paleogeographical model of the studied area. The results show the high potential of the p-XRF analysis for the cyclostratigraphical application integrated with other paleoclimatic and paleoecological proxy data and the efficacy in detecting changes in depositional conditions.

Portraits of an Ancient Sea: Paleoecology and Paleoclimate of the Pleistocene Marine Deposits in the Hyblean Area

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Keywords: Pleistocene, climate changes, Palaeobiodiversity, Mediterranean Sea.

Several Pleistocene marine deposits crop out in the Hyblean area, shedding light on the geological, paleontological, and climatic history of the south-eastern Sicily. During the Quaternary, subsequent environmental changes happened which shaped local marine biota and influenced marine sediment deposition. Consequently, the resulting successions can tell us the story they registered about climatic phases, past sea level variations, and the replacing of marine species and habitats, a model for the Mediterranean Sea basin.

In the present instance, we present some case studies, comprising benthic invertebrate associations that include thermophilic species alternating with others exhibiting cold-temperate distribution and boreal guests. 1) The early Pleistocene Megara Section (SR), located in the north-eastern part of the Hyblean area, consists of organogenic sands interbedded in a clayey-silty succession. The benthic communities include several species which testify a cold climate phase. 2) The Capo Massolivieri Section (SR), in the Maddalena Peninsula in the eastern side of the Hyblean plateau, includes fossil-rich sediments, dating back to the Plio-Pleistocene, highlighting paleoecological and paleoclimatic shifts during the Piacenzian-Gelasian and Gelasian-Calabrian transition periods. 3) The marine deposits of the Catallarga Hill (CT) are located in the north-western margin of the Hyblean Plateau. They contain a particularly rich association whose high paleo-biodiversity (with several taxa of different palaeoecological affinities) points to a marine paleo-environment including several contiguous habitats and a complex history of possible palaeoclimatic adaptation of several species in the early to the middle Pleistocene. These fossil-bearing marine deposits of south-eastern Sicily provide fundamental information on paleoecology, marine species distribution and changes in marine habitats over time, as well as on the impact of abrupt climatic variations during glacial-interglacial cycles on Pleistocene benthic communities, serving as a record and archive of the geological and paleontological history of the Mediterranean Sea.

Analysis of alluvial sediments along eastern Sicily (Italy) hydrographic basins

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Keywords: sediments, hydrographic basins, watercourses.

The evolution of watercourses involves changes in path, in sediments transport and water energy. The characterisation and analysis of sediment sources and their dynamics along slopes and be carried out through various approaches and methodologies, which can be combined depending upon the purposes and detail of the study. Sediment source can be defined as the basin area whose sediments are subsequently conveyed to the hydrographic network. The processes of sediment production and transport are multiple and can be traced back to different geomorphological contexts.

The studied hydrographyc basins, namely Alcantara, Simeto and Hyblean, are located in eastern Sicily (Italy). This research aims to carry out a balance of sediments in various river stretches to define a classification of possible trends (propensity to sedimentation or erosion) and to quantify the volumes of sediment in sedimentation or erosion, in order to evaluate their mutual interaction. In other words, the purpose of this study is to identify the main sediment sources along the slopes, assessing their degree of activity and connection with the hydrographic network and the possible estimation of the related volumes of sediment conveyed into watercourses. The methodology is based on IDRAIM (2016), a procedure supporting the management of watercourses and geomorphological processes. With respect to sediment balance, the IDRAIM procedure requires the use of RUSLE, an empirical model that calculates long-term average annual soil loss due to sheet and rill erosion. This model considers six main factors controlling soil erosion: the erosivity of the eroding agents (water), the erodibility of the soil (including stoniness), the slope length and steepness, the land cover and management (or human practices designed against erosion). After the identification of sediments accumulation points through RUSLE model, in-situ sampling was carried out. To evaluate the finest fraction, a grain size analysis was carried out using sieves in laboratory. To study the coarser fraction, instead, it was used Basegrain, an automatic object detection software for grain size analysis based on photographs of river beds. Initial results show that along the Alcantara most of the sediments sampled correspond to gravels. In addition, it was observed the presence of landslides interfering with the river course; in this regard, further investigations are being conducted in order to complete the study.

This study paves the way to a complete sedimentological analysis at the hydrographic basin scale, especially in regions characterized by complex geological settings, where landslide and anthropogenic works strongly affect the morphological quality of watercourses.

Insights into the recent erosive-depositional processes affecting the submerged portion of La Fossa Caldera (Vulcano Island, Tyrrhenian Sea, Italy)

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Keywords: volcano, caldera, ROV exploration, Multibeam bathymetry.

Vulcano Island, part of the Aeolian archipelago, is the upper part of a large and active insular volcano, with its most recent eruption occurred in 1888-1890. Its morphology is shaped by the intersection of two main calderas: Il Piano Caldera in the southern part of the island and La Fossa Caldera in the northern part. The study area is the north-eastern, submerged portion of La Fossa caldera, which is the result of multiple collapses occurred between 80- 8 ka years ago. The NE part of the caldera extends over 300 m water depth, being bordered by two very steep submarine scarps with slope gradients reaching up to 80°. In this work, we present an integrated analysis of high-resolution multi-temporal bathymetric and backscatter data collected from 2003 to 2023, along with video footage obtained from a Remotely Operated Vehicle (June 2022, March 2023, and May 2024) and the research submersible JAGO (February 2020). This analysis enabled us to conduct a morphometric and morphological characterization of the main erosive-depositional features of the submerged portion of La Fossa Caldera. We identified over 200 erosional-depositional elements, including a) landslide scars affecting the edge of the coastal platform and submarine depositional terrace here present, b) a network of small gullies and channels, which have dismantled the caldera fill, c) trains of coaxial crescent-shaped bedforms within the main channel's floor. In addition, the comparison of repeated bathymetric surveys together with evidence of recent erosive processes through the analysis of ROV images point out for an active morphological evolution that may create hazards for local coastal communities.

Analysis of layered deposits of Arabia Terra, Mars: example from a crater and surrounding plateau nearby Schiaparelli Crater

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Keywords: Mars, ELDs, groundwater upwelling

The Equatorial Layered Deposits (ELDs) consists of light-toned layered deposits found in many places in the equatorial region of Mars and especially widespread in Arabia Terra, a densely cratered and ancient region characterized by a gradual transition between the lowlands and the highlands (no dichotomy).

The ELDs textural characters, geographic distribution, the frequent association with hydrated mineral sand the proposed control by groundwater upwelling make them an ideal target to understand Martian past climate. Still, many authors have proposed different scenarios (i.e., aeolian processes, groundwater upwelling). The purpose of this study is to analyze the ELDs located in an unnamed crater (lat. 1°37’24.48 “N and long. 8°48’17.80 “E) and the surrounding plateau.

The study was based on remote observations supported by the available datasets (i.e., CTX etc), processed using ISIS, ENVI and the NASA AMES Stereo Pipeline.

The goal is to infer the depositional environment of the ELDs formation, and the stratigraphic relationships between them and the surrounding deposits. Using Garvin et al. (2003) equations, we inferred the geometry of the ELDs in the main crater and in a smaller, more recent one located in the intercratered plains.

Mineralogical analysis of the study area allows us to state the presence of a terrain with a composition that may be very similar to that of ferruginous sandstones on Earth (with the prevalence of iron/ iron oxides).

A geologic map and geological sections were realized, and followed by a chronostratigraphic scheme. Thus a depositional model of the area is proposed. This model suggests the presence of at least two different depositional environments. The playa environment dominated the main crater and the aeolian environment dominated the plateau, except for the small recent crater (playa environment).

The model is thus characterized by a control of groundwater upwelling and its fluctuations, leading to evaporite precipitation and aeolian dunes preservation. The presence of such an evolution in the study area has potential astrobiological and habitability implications.

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High-resolution 3D model of Plio-Pleistocene stratigraphy succession in Southwestern Sicily's foreland-basin system

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Keywords: 3D geological modeling, Sicilian Fold and Thrust Belt (FTB), Late Pliocene Pleistocene successions.

The southwestern Sicily represents a key sector for studying the Late Pliocene-Pleistocene stratigraphic evolution of the Sicilian foreland-basin system. The data collected during the realization of the sheets n.628 “Sciacca” and n.618 “Castelvetrano” (CARG project) revealed important sedimentological, stratigraphic, and tectonic features, enabling the accurate geological reconstruction of two sedimentary basins (Menfi and Ribera basin) set on different sectors of the Sicilian Fold and Thrust Belt (FTB). Both are located in the outer sector of the FTB, but the Menfi succession accumulated on a deformed carbonate substrate constituted by the Saccense Domain, while the Ribera succession covers the deformed substrate constituted by the Gela Thrust wedge.

One of the most innovative aspects of this study is represented by the 3D geological model reconstruction. By integrating data from geological mapping, seismic reflection profiles, well logs, geophysical surveys, geological cross-sections a detailed three-dimensional model was produced, greatly improving the understanding of the sedimentary and structural dynamics of the southwestern Sicily.

In the Menfi basin, the Late Pliocene-Pleistocene succession includes the marnoso-arenacea del Belice formation (Piacenzian-Gelasian), constituted by hemipelagic clayey marls, turbiditic sandy silts, and breccias, transitioning to resedimented arenites and calcarenites. This unit passes upward to the Agrigento formation (Calabrian), consisting of hemipelagic clays and marls with intercalated sands and bio-calcarenites.

In the south-eastern sector, the Ribera basin succession includes the Monte Narbone formation (Middle Piacenzian-Early Calabrian), composed of marls and silty clays alternating with sapropelitic layers. Upward, this latter unit is overlain by the Agrigento formation, here featured by thick bio-calcarenites, with cross-lamination and prograding geometries, alternated with sandy marls and clays.

The 3D geo-structural model of the study area well shows as the Monte San Calogero, a ramp anticline with double vergence and left-lateral transpressive kinematics, acts as a structural high separating these two basins. Data revealed that the Menfi sedimentary basin thickens from west to east, reaching about 1250 meters, while the Ribera basin reaches the thickness of 2200 meters, in the offshore sector.

The realization of 3D geological model and the creation of thickness maps for the Plio-Pleistocene sedimentary sequence provided crucial insights into sedimentary and tectonic processes, significantly enhancing the understanding of the Sicilian FTB evolution.

Palynostratigraphical characterization of the OAE1b and OAE1c in the Umbria-Marche Basin (Northern Apennines, Italy)

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Keywords: Cretaceous, OAEs, Marne a Fucoidi Formation, Bottaccione section.

The Early Cretaceous of Umbria-Marche Basin is marked by 3 Oceanic Anoxic Events (OAEs) belonging to the Marne a Fucoidi Formation (early Aptian-late Albian). This formation consists of multicolor marlstones and marly limestones, interbedded by organic-rich black shale levels. Anoxic events are associated with the widespread deposition of dark-colored, laminated, organic-carbon-rich shales due to the development of dysoxic to anoxic condition at the sea bottom. These events may be on a global scale such as the early Aptian OAE1a, or on a regional scale such as the late Aptian-early Albian OAE1b and the late Albian OAE1c. In the present study was analyzed the microfloristic content, from Fiume Bosso, Roccaccia and Bottaccione sections, for the first time and from Poggio le Guaine section. The Bottaccione section became worldwide famous for the detected presence of Cretaceous-Paleogene boundary and the GSSP for the base of the Campanian stage. After undergoing standard palynological treatment, it has been mounted a total number of 175 slides from 39 samples. The OAE1b palynological assemblage is characterized by the occurrence of sporomorphs, such as *Cyathidites* spp. and *Afropollis* spp., and dinocysts, such as *Florentinia mantellii* and *Spiniferites* spp. The overlaying OAE1c consists of sporomorphs, such as *Cicatricosisporites* spp. and *Callialasporites trilobatus* and dinocysts, such as *Litosphaeridium conispinum* and *L. siphoniphorum*. These assemblages show close similarities with other areas of the Tethyan domain such as France and northern Egypt. The key species *L. conispinum* was recorded in all studied sections. Its first occurrence marks the late Albian in the Tethyan domain and allows to refer the black shale levels in which it was recorded to the OAE1c. The occurrence of *Elaterosporites klaszii* and *Elaterosporites verrucatus*, which are typical of the Albian to Cenomanian Elaterates Province, was also recorded in this study, in association with *L. conispinum* and *L. siphoniphorum* in the Fiume Bosso section, and just below the first occurrence of *L. conispinum* in the Bottaccione section.

Pollen and Spore Records as Proxies for Past Solar UV-B Irradiance: Preliminary Insights from an Ongoing Study in the Central Mediterranean

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Keywords: Pollen, UV-B, FTIR, Mediterranean.

This work focuses on investigating paleoclimatic changes and their underlying mechanisms in the Central Mediterranean region, using sedimentary records collected from Corvani pond in Corsica, France. The geographic location of this area makes it particularly vulnerable and sensitive to both modern and past climate changes during the Quaternary due to its position at the crossroads of subtropical, mid-latitude, and Atlantic climate systems. A chemo-palynological proxy is employed to reconstruct paleo-solar irradiance, specifically ultraviolet B (UV-B) radiation, which affects climate by heating the Earth's surface, influencing temperature and atmospheric circulation, and also impacts ozone production and depletion through the Chapman cycle.

Plants carrying pollen and exposed to harmful UV-B radiation during photosynthesis can suffer damage to proteins, lipids, and other chemical components. To protect themselves, they produce UV-B absorbing compounds (UACs) like ferulic acid (FA) and para-coumaric acid (pCA), which absorb UV-B radiation, and protect pollen. The methodological part of the work focuses on assessing the reliability of *Quercus* pollen as an indicator species for tracking UV-B fluctuations by studying the expected increase in aromatic compounds in response to UV-B exposure. Fresh pollen from the Lazio region in Italy are analyzed and compared to *Quercus* pollen collected from mosses (pollen traps) at the same site. Attenuated Total Reflection Fourier Transform Infrared (ATR micro-FTIR) spectroscopy is employed to evaluate the pollen's sensitivity to solar irradiance and the impact of chemical treatments on its chemical signature, while in the second part of the work, this methodology will be applied to the sedimentary core, sampled at centennial intervals, to detect solar maxima and minima and UV-B fluctuations over the study period. Additionally, the project will analyze the relationship between solar activity, ozone changes (which are directly influenced by incoming solar energy), and paleoclimatic events that occurred during this time.

Sentinel 2 multispectral imagery analysis: determining the age of lava flows

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Keywords: Satellite, Sentinel, Multispectral.

Here we propose the use of multispectral satellite imagery to discriminate lava flows of different ages on Mount Etna region. We elaborate a procedure consisting of comparison of different treatments such as iron oxide, sulphur and argillification as proxies of the time duration of exposure to weathering. We tested the method taking advantage from the well constrained chronostratigraphy of volcanic products of Mount Etna, is freely available as a WMS service. We tested the procedure using freely accessible Sentinel 2B images with a return period of 2-3 days sufficient for our purposes. Firstly, the satellite images have been cleaned from all the vegetation, in ArcGIS Pro software, realising a mask starting from the NDVI to exclude every pixel of vegetation or moisture. On cleaned images, different band ratios are elaborated to extrapolate the values of FeO, Fe²⁺, Fe³⁺, FeSi, coarse grained iron, FeS, sulphur, illite and clay. The attempt is to extrapolate some trend from these parameters that allow to calculate the age of the lava flows. Comparison with existing chronostratigraphic age of every lava flow on Etna volcano allow us to calibrate and validate the method. The future goal is to calibrate the method more accurately by considering the impact of variety of lava composition to minimize the error of multispectral analysis.

Instability processes of coastal rocky cliffs and associated retreat trends in relation to the evolution of extreme meteo-marine events: an advanced methodological approach

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Keywords: Syracuse, coastal instability, cliff erosion, calcarenites, Latomie.

The PRIN PNRR project P202227R77 focuses on studying coastal instability in southeastern Sicily and the Apulia region, specifically targeting the carbonate rock cliffs. Its main objective is to understand the factors contributing to instability and to develop strategies to mitigate collapse risks, preserving this geologically and culturally significant area. The Siracusa coastline in Sicily is characterized by steep limestone and calcarenite cliffs dating back to Miocene and Pliocene, affected by marine erosion, tectonic activity, karst phenomena, and human impact. The main formations are: Monti Climiti (Lower Miocene): calcarenites and algal calcirudites with karst erosions and a network of fractures; Monte Carrubba (Upper Miocene): soft stratified calcarenites with fossils of bivalves; Pliocene calcarenites: composed of breccias, sands, marls and silts, with thicknesses of up to 20 metres; Pleistocene sands and calcarenites: coarse and yellowish. Tectonic structures, such as the Ibleo-Maltese escarpment and the Siracusa fault, significantly affect coastal stability, leading to fractures and collapses exacerbated by erosion. Cliffs can reach heights of 50 meters, particularly at the Maddalena peninsula and Capo Santa Panagia. Wave action erodes the base of these cliffs, forming sea caves and grooves, while the presence of karst and man-made cavities, like ancient stone quarries, further weakens the rock structure. The combined effects of sea waves, rainfall, and local seismicity primarily drive the erosion processes, increasing the likelihood of rockfall. A key part of the project is the aerophotogrammetric and thermal surveys, carried out by drones equipped with high-resolution optical and thermal sensors. These drones, equipped with RTK (Real Time Kinematic) technology, allowed collecting extremely precise georeferenced data, reducing position error and guaranteeing complete coverage of the study areas. The surveys were carried out following manual flight plans, given the complexity of the terrain, with the aim of obtaining detailed images of the crags. Collected data were subsequently processed to create three-dimensional models of the rock cliff, using Structure from Motion (SfM) and Multi Vision Stereo techniques. These models were used to analyse the main discontinuities in the rock mass and to identify potentially unstable rock volumes. The discontinuity spatial data extracted from the digital models showed a good correspondence with the direction of the active faults in the area, confirming the influence of tectonic activity on the cliff retreat. Furthermore, during the drone flights, thermal images were taken that will be processed to identify temperature differences along the cliffs, suggesting the likely presence of structural anomalies or water infiltration.

The ichnofossil-Lagerstätte of Val d'Ambria (SO): an exceptional paleoecological window on the lower Permian of the Italian Southern Alps

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Keywords: Syracuse, coastal instability, cliff erosion, calcarenites, Latomie.

Recent research in upper Val d'Ambria (Sondrio, Italy) has uncovered an exceptional richness from a paleontological point of view, revealing a site of significant scientific interest. The studied area is located in the central portion of the Orobic Basin, more precisely in the Trabuchello-Cabianca anticline, on the Valtellina side of the Pizzo del Diavolo di Tenda, Pizzo dell'Omo, Pizzo Rondenino and Monte Aga watershed. This sedimentary basin is known for its geological complexity and for preserving a thick stratigraphic sequence dating back to the early Permian.

The fossils found at the site belong to the Kungurian Pizzo del Diavolo Formation and are characterized by a remarkable variety, primarily consisting of tetrapod footprints, invertebrate traces and sparse macroflora remains. The vertebrate footprints are representative of a diverse fauna, with the presence of 8 different ichnogenera, including *Amphisauropus*, *Batrachichnus*, *Dimetropus*, *Dromopus*, *Erpetopus*, *Hyloidichnus*, *Limnopus*, and *Varanopus*. The ichnogenera *Dromopus* and *Erpetopus* appear to be the most common, while footprints assigned to *Dimetropus* are the rarest and, therefore, of particular interest. The trace fossils indicate that the area was frequented by a community of terrestrial animals, including reptiles, amphibians and rare synapsids.

In addition to tetrapod footprints, the discovery of invertebrate traces and macroflora remains provides further key- data for interpreting the depositional environments and the climatic and ecological conditions of the early Permian. The combination of these paleontological elements with stratigraphic logs and the detailed description of sedimentary facies will allow for a more precise reconstruction of the paleoenvironmental and palaeoecological evolution of the Orobic Basin in the time interval in which these biotas flourished. A preliminary analysis of the site suggests that the area may have hosted a varied environment, with probable alternance between semi-humid and dry climatic conditions. These frequent alternations are typical of the observed fluvial-lacustrine landscape, featuring extensive alluvial sand- to mudflats and ephemeral lakes, not far from the basin margins.

The planned research at this site could provide increasingly detailed information about the biodiversity of the area during the early Permian, thereby enriching our understanding of the dynamics of life and climate change at the end of the Palaeozoic Era.

Marine geohazards in the Hyblean offshore (SE Sicily, Italy)

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Keywords: Syracuse, coastal instability, cliff erosion, calcarenites, Latomie.

The Sicilian Channel holds a position of strategic prominence within the Italian economic context. More than one-third of Italy's offshore oil is extracted in this area. Explorations carried out by ENI between 2006 and 2008 along the southern coasts of Sicily led to the discovery of two natural gas fields, which are expected to contribute significantly to supplying Italy with more than 2 billion cubic meters of gas per year. However, the importance of the Sicilian Channel extends beyond the potential discovery of non-renewable energy resources. With winds reaching average annual speeds of 7 to 8 m/s, the area is one of the windiest regions in Italy and, consequently, a site of interest for wind energy development. Structures such as oil platforms and wind farms are susceptible to natural risks (submarine landslides, earthquakes, tsunamis, extreme marine weather events), potentially resulting in the loss of structural elements, human lives, and environmental disasters. Consequently, characterizing geohazards to provide reliable, updated and updatable information over time is crucial to support governmental decision-making, to monitor existing structures, to ensure proper planning and to promote a more efficient and advantageous exploitation of resources.

The present research project aims to integrate seismic data with biostratigraphic data from cores to enhance understanding of the intensity and recurrence rates of cyclical events driving geohazard. The research will primarily focus on past/geological marine landslides from offshore Sicily to chart their occurrence in space and time and the causative mechanisms.

The use of PETREL software will allow for the creation of 3D models capable of providing a visualization of seismic data, and detailed biostratigraphic analyses will permit dating of main events and recurrence periods. The development of a reliable, queryable, updated, and updatable GIS infrastructure, allowing space for *Volunteered Geographic Information* from citizens, will offer a comprehensive overview of the geohazards in the study area and would provide valuable support for land-use planning and emergency management. Furthermore, a marine geology and multi-hazard analysis of the offshore area of the Hyblean Plateau would also be a good starting point for future and planned cartography in the frame of CARG project.

The influence of fine sediment aggregation on microplastic transport mechanisms in riverine systems

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Keywords: Microplastics, Rivers, Flocculation.

Rivers serve as primary pathways for conveying microplastics from land to oceans, yet they also have the capacity to retain these tiny particles within their sedimentary deposits. A key factor in this process is the role of fine cohesive sediments, which can adhere to microplastic particles and form aggregates. These aggregates are capable of being transported as part of the bedload, leading to enhanced accumulation of both microplastics and sediments. This study investigates the mechanisms of microplastic-sediment aggregation and their effects on the transport and deposition of microplastics in rivers through laboratory experiments. A rotating wheel apparatus (34 cm diameter, 7 cm depth) was used to keep mud in suspension and promote aggregation, while FLOCCAM, a settling column with a high-resolution camera, was employed to analyse floc properties. Five experiments were conducted, analysing ~4,000 flocs per experiment. Four experiments included mixtures of water, sediment (1 g/L), and 500 µm long fibres as microplastics (MPs-sediment ratio of 1:25), using four different plastic polymers: Polypropylene (PP, $\rho=0.9$ g/cm³), Polyamide (PA, $\rho=1.14$ g/cm³), Polyester (PES, $\rho=1.38$ g/cm³), and Aramid (AR, $\rho=1.44$ g/cm³). The fifth experiment, a control, was conducted to observe flocs formation without microplastics. Arno River mud with a d_{50} of 40 µm was used as sediment. The mixtures were placed in the rotating wheel at a shear rate of 10 s⁻¹ for 2 hours. After the complete settling, flocs were collected and released into the FLOCCAM. The recorded videos were analyzed using the SAFAS software to determine floc size, morphology, and settling velocity. Results indicated that the inclusion of microplastic fibres within flocs formed larger and more elongated aggregates that settle faster than sediment-only flocs.

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