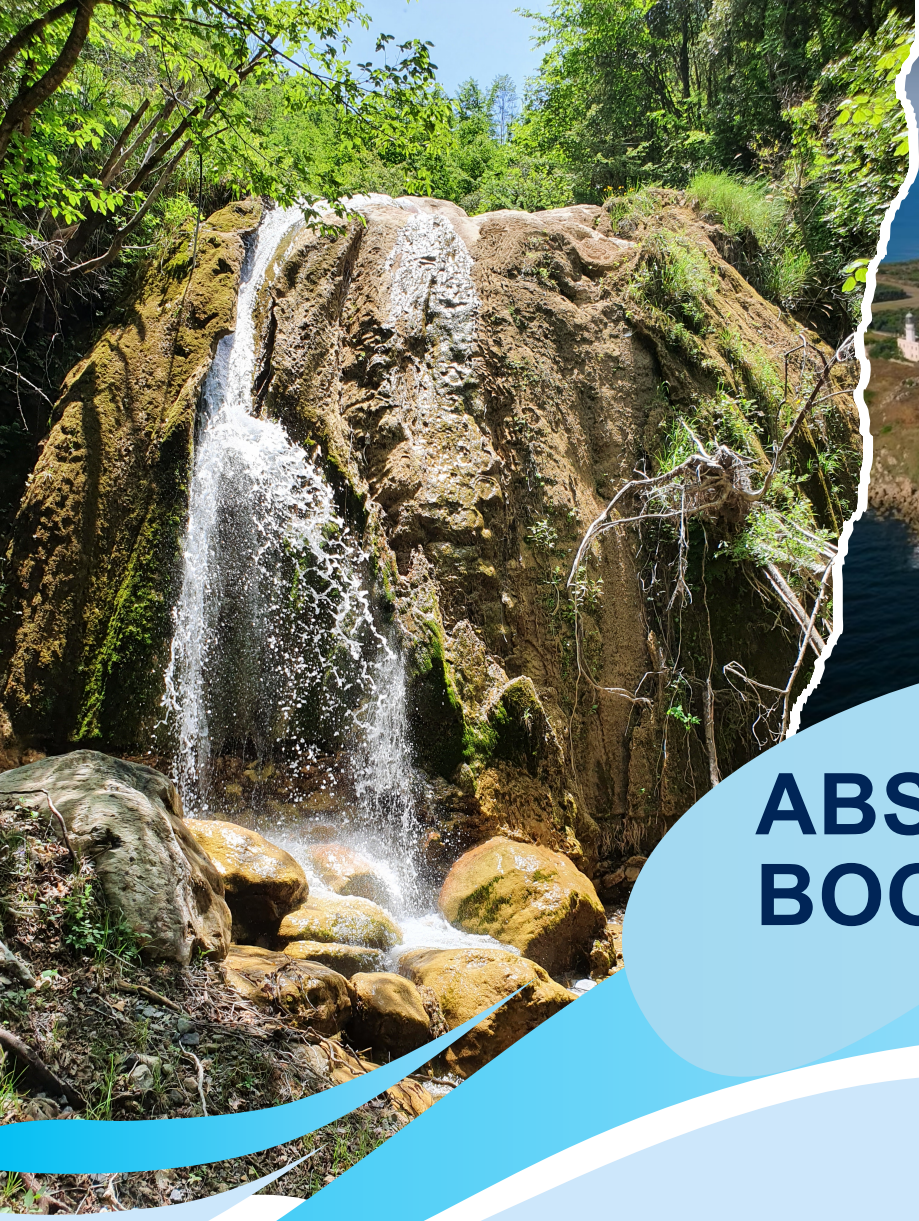

ABSTRACT BOOK

UNIVERSITÀ DELLA CALABRIA
DIPARTIMENTO DI INGEGNERIA DELL'AMBIENTE
DIAM
ORDINE DEI GEOLOGI DELLA CALABRIA
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COVER IMAGES:

Left: A small waterfall along the Parmenta Stream (Buonvicino, Calabria) typified by microbial-mediated calcite precipitation forming tufa (Photo courtesy of M. Borrelli).

Right: An aerial view of Capo Colonna (Crotone, Calabria) where the MIS 5a deposits outcrop in contact with the underlying Cutro Formation.

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New biostratigraphic constraints on the Torrice sandstones (Valle Latina, central Apennines)

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During the Neogene, the central Apennines experienced the eastward migration of the foredeep system due to the convergence between the European plate and the Adria microplate. In the Ernici Mts., along the southeastern margin of Valle Latina, syn-orogenic deposits record the involvement of this area in the orogenic system. In Monte San Giovanni Campano, bituminous sandstones unconformably overlie the carbonate ramp deposits of the Calcare a briozoi e litotamni Fm. They represent the infill of a wedge-top basin. These deposits belong to the "Sintema delle Arenarie di Torrice," part of the "Supersintema di Monte San Giovanni Campano". According to their stratigraphic position, an early Messinian age has been proposed for the depositional onset of the Torrice sandstones, but no finding of any biostratigraphic marker has been reported. Recent fieldwork has been carried out as part of the geological survey for the CARG Project 390-Frosinone. In the study area, we analyzed a stratigraphic succession of whitish-grey clays intercalated with occasional very thin siltstones passing upward to medium-grained bituminous massive sandstones with conglomerate lags and marine mollusks. The calcareous nannofossil biostratigraphical analysis performed on the clays shows the presence of Amaurolithus primus from the base of the study section. The First Occurrence of this marker species in the Mediterranean is fixed at 7.42 Ma. This age represents therefore the maximum age for the Torrice sandstones.

New insights in the tectonic and sedimentary evolution of north-western sector of Calabrian Arc

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The study area is located in the northwestern sector of Calabria, where the Calabrian Arc Units, composed of metamorphic and crystalline Hercynian to Alpine rocks, over-thrust the southernmost part of the Apennine fold-thrust belt. In the latter, the Mesozoic-Tertiary carbonate and subordinately siliciclastic deposits, show a stratigraphic vertical and lateral continuity with lateral facies variation, along the whole sector, despite the intense tectonism and metamorphism. Two not coaxial fold-and-thrust systems was identified, which affect all the sedimentary units, up to the Pliocene deposits. The oldest structures are linked with a contractional phase with both NE and SW vergences, post Eocene in age and active until the Tortonian. The subsequent compressive phase, orthogonal to the previous one, shows SE vergence in the carbonate platform units, and towards NW in the terrains of the Messinian-lower Pliocene cycle. A strike-slip tectonic phase along NW-SE oriented regional shear zones was then active during the Pleistocene; followed by a final regional extensional regime along NE-SW, both low-angle and high-angle fault systems, that produced tectonic inversion of the previous contractional structure, and the Crati Valley opening, thanks to the clockwise rotation of the Sila Massif.

Sedimentary evolution of Plio-Quaternary foreland-basin successions developed at the front of the Sicilian-Maghrebian fold and thrust belt (south-western Sicily)

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We present preliminary results coming from stratigraphic and sedimentological analyses carried out on Plio-Quaternary sedimentary successions outcropping in south-western Sicily. In the area between Ribera and Castelvetrano villages, Plio-Quaternary successions filled foreland-basins related to the frontal accretion of the Sicilian fold and thrust belt (FTB). During the Early Pliocene, pelagic sedimentation characterized the investigated successions, but starting from the Late Pliocene, they developed with different features influenced by local tectonics and sediment supply. Throughout the area, the Piacenzian-Gelasian interval is characterized by progressively more abundant terrigenous input, including scattered mass transport deposits. During the Calabrian, hybrid sedimentation of neritic domain (from infralittoral to circalittoral zones) set in the eastern sector, while the western area hosted a sedimentation typical of deeper environments. Lastly, since Middle Pleistocene, scattered, terraced, littoral sediments deposited. During the Early Pliocene the deep paleo-bathymetry (several hundreds of meters) of the pelagic deposits indicate that successions accumulated in a subsiding foredeep basin. Subsequently, the compressional tectonic deformation incorporated these areas in thrust-top basins where marine sedimentation lasted with a general regressive sedimentary trend. Local uplift of the orogenic wedge owing to crustal thickening, combined with structural damming by growth of anticlines, deeply influenced the development of these regressive sequences. Since the Calabrian lasting tectonic uplift forced the forward migration of coastal depositional systems that accounted for the progressively shallower character of the Middle-Upper Pleistocene sedimentary successions. Furthermore, both tectonic uplift and glacio-eustatic oscillations controlled the sedimentary evolution during this latter time interval.

Late Quaternary evolution of Fondi alluvial-coastal plain by means of new chronostratigraphic constraints

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The Fondi Plain, is a low-lying alluvial-coastal area along the Tyrrhenian flank of the Central Apennines (Italy). It represents a natural laboratory for investigating the interplay among glacio-eustatic fluctuations, sedimentary inputs and tectonics, and is part of the PRIN 2022 GAIA project. The latter applies for understanding the evolution of coastal plains in order to evaluate natural dynamics and assessing future coastal vulnerabilities. New borehole and field investigations were acquired and analyzed by high-resolution stratigraphic, sedimentological, and palaeoecological approaches, combined with reinterpreted data from previous studies. Different chronological constraints were adopted: radiocarbon, OSL and amino acid racemization (AAR) datings to provide a robust age control on the morphostratigraphic evolution of the plain and relative sea-level (RSL) changes. The Late Pleistocene marine infralittoral sands at the base of the SF2 core at −21.5 m and -19 MSL, progressively covered by backshore and aeolian sands, suggest, by AAR dating, ages ranging from MIS 5 to MIS 3. New radiocarbon data from semi-enclosed lagoonal deposits, located in the upper part of the SF2 core, indicate that RSL ranged between about −5.6 MSL at 7.2 ka BP and about −2.8 m MSL at 4.2 ka BP. These values suggest that the plain underwent tectonic subsidence at least up to the Late Pleistocene, whereas experienced a mid-Holocene coastal stability phase between 7 and 4 ka BP, soon after an initial rapid rise of RSL between 9 and 7 ka BP. These findings aligned with other regional paleo sea-level indicators as well as with Glacial Isostatic Adjustment (GIA) models.

An integrated stratigraphic approach to constrain phosphogenetic events in Southeastern Sicily

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An integrated stratigraphic study of the Oligocene-Miocene sedimentary succession, exposed in the western sector of the Hyblean Foreland (SE Sicily) and traditionally described as continuous, revealed several stratigraphic hiatuses, marked by hardgrounds or omission-grounds, in some cases followed by phosphatic layers. Similar levels, represented by both in situ crusts and/or reworked phosphatic pebbles, are also found in other Oligo-Miocene carbonate successions of the Mediterranean region, such as the Maltese archipelago or the Apulian foreland. Five outcrops bearing phosphatic levels, referable to three different stratigraphic horizons, have been investigated, four of which yielded isolated shark teeth. Detailed integrated biostratigraphy allowed to constrain the stratigraphic intervals in which these levels fall. The analysis of the strontium isotope provided detailed ages for two of the three phosphatic layers. The phosphatic horizon located between the Leonardo and Irminio fms yielded several shark teeth with mean ages of 23.8, 22.8, 22.4 Ma, thus revealing a hiatus between the Chattian and the Aquitanian stages, ranging from a minimum of 2 to a maximum of about 3 My. The second layer falls within the Irminio fm and has a mean age of 20.6 Ma Burdigalian). These intervals figured out within the framework of global climatic changes and regional paleoceanography and are interpreted as the result of the upwelling of nutrient-rich deep waters, increased weathering and phosphorus availability triggered by global cooling and enhanced circulation in the Mediterranean basin.

The Mascheroni Fountain in the rupestrian town of Laterza (Puglia, southern Italy): linking geology to cultural heritage

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Water resource allow us to trace the history of many of our towns. In settings with limited surface water, a very interesting study case is represented by the presence/preservation of water in the rupestrian towns located along the rocky walls of canyons (locally named “gravine”) southward cutting the Murge karstic area (Puglia, southern Italy). In some sections of their valleys, soft-rocks, easy to be dug, are exposed, allowing the development of rupestrian towns. Here, before the construction of aqueducts that now bring water from the “distant” Apennines, the building of historic fountains, in addition to the collection of rainwater in cisterns, testifies to the presence of an aquifer now undervalued as an important local water resource useful for the anthropization of a predominantly karst territory. Our study regards an aquifer feeding the Mascheroni Fountain (Great Masks Fountain) through a short qanat that allowed the development of the old town of Laterza, in Puglia (southern Italy). Starting from the attractiveness of the ancient fountain, the connection between geological features of the area and the ancestral origin of the city could be proposed to a large audience, representing an intriguing opportunity to develop themes useful for geotouristic purposes. This topic is of paramount importance since the town of Laterza is located at the boundary between the UNESCO MurGEoparkand the “Terra delle Gravine” Regional Park, making it the ideal starting point for both parks.

Microbial Architects of alkaline extreme environments: Bacterial and Diatom-Driven Biomineralization in Lake Salda (SW Turkey)

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Lake Salda, located in southwestern Turkey, is an alkaline (pH 9.0–9.3), magnesium-rich lacustrine system. Along its shallow shoreline, actively growing stromatolites are continuously eroded by nearshore currents, resulting in the formation of pebble accumulations. Both stromatolites and associated pebbles exhibit similar macro- and microfabrics, characterized by a framework of brownish, thrombolitic microcrystalline hydromagnesite forming irregular clumps, surrounded by pale-yellow, crystalline hydromagnesite, and rimmed on their outer surfaces by laminated crystalline hydromagnesite. The microcrystalline hydromagnesite consists of aggregates of nanospheres (200–400 nm), often arranged into unbranched, curved filaments. In contrast, the crystalline hydromagnesite displays a platy crystal morphology (10–20 μm), frequently forming rosette-like structures. Additional acicular calcite crystals are also present. These mineral fabrics are intimately associated with filamentous and sheet-like organic matter, which appears to play an active role in the biomineralization process. Notably, diatoms also contribute to hydromagnesite precipitation. Under alkaline stress conditions, they produce an external organic sheath analogous to microbial extracellular polymeric substances (EPS), providing a structured substrate for mineral nucleation and growth. This suggests a cooperative role between microbial and eukaryotic communities in facilitating mineralization. Altogether, these findings highlight the complex biogeochemical interactions that drive carbonate biomineralization in extreme alkaline environments. The processes observed in Lake Salda offer valuable insights into biologically mediated mineral formation on Earth and contribute to our understanding of similar mechanisms that may have operated in ancient lacustrine environments on Mars, reinforcing the relevance of Lake Salda as a planetary analog site.

Palaeoclimatic changes during the Middle Miocene: Evidence from the sedimentary record of South-eastern Sicily

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The Middle Miocene climate is marked by a changeover from a warm period (Miocene Climatic Optimum, ~17-14.7 Ma), to a transitional phase (Middle Miocene Climatic Transition), culminating in a cold stage (Icehouse Mode, ~13.8 Ma). This period is associated with a global positive excursion of $\delta^{13}C$ (“Monterey Excursion”), showing a series of $\delta^{13}C$ maxima (CM events) highlighted by cooling peaks in the $\delta^{18}O$ values (Mi events).

The Middle Miocene, in the South-East of Sicily, is represented by the marly clays of the Tellaro Fm.. The latter crops out with an excellent exposure in the San Biagio section, which has been chosen for this work since it is rich in calcareous plankton content. An integrated stratigraphic study, involving high resolution plankton biostratigraphy and stable isotopes analysis (O and C) on foraminifera tests, has been carried out.

The calcareous plankton biostratigraphy provides a well constrained age-model for the studied succession, which ranges from the middle Langhian (~14 Ma) to the basal Serravallian (~13.6 Ma) stages.

Oxygen and carbon isotope analyses were conducted separately on *T. trilobus* and *T. quadrilobatus*. foraminiferal tests. The $\delta^{18}O$ record shows that the succession falls within the Middle Miocene Climate Transition and is characterized by a relatively warm but dynamic climate phase. Furthermore, the preliminary $\delta^{13}C$ curve shows several positive peaks that correspond to different carbon maxima of the Monterey Event.

Tectono-stratigraphic features of the foreland–foredeep transition in Southern Italy: insights from the Bradanic Trough–Murge boundary

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In Southern Italy, the Apulia Foreland and Bradanic Trough represent the foreland and foredeep, respectively, of the Southern Apennines orogenic system. The Apulia Foreland is mainly composed of Cretaceous carbonates of the Mesozoic Apulia Carbonate Platform. These units, distributed west-southwest along fault systems and buried beneath a Plio-Pleistocene sedimentary wedge, form the bedrock of the foredeep. One of the most uplifted portions of the Apulia Foreland is the Murge area, whose western margin is marked by a prominent escarpment. At the foreland–foredeep transition, the foredeep bedrock crops out in few localities, providing a rare opportunity to directly observe features typically inferred from subsurface data. One of these localities is Gravina in Puglia town area, where the only available reflection seismic data include the CD-3-84 profile, from the ViDEPI project, and two lines provided by Eni S.p.A. This study presents the first detailed interpretation of these data and was carried out within the “GeoSciences: un’infrastruttura di ricerca per la Rete Italiana dei Servizi Geologici – GeoSciences IR” project, as part of ongoing investigations into the Quaternary tectono-sedimentary evolution of Apulia.

Sandstone diagenesis in the Southern Apennines and other geotectonic settings

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The assessment of diagenetic processes in sandstone is essential for understanding reservoir evolution and subsurface resource potential. Key regions including southern Italy (Southern Apennines, Northern Calabria), Central California (USA), and the Sub-Himalayas (Pakistan) offer diverse tectonostratigraphic contexts of different ages of sandstone suites to evaluate how burial-related processes such as compaction, cementation, dissolution, and replacement shaped the sandstones petrophysical properties. In the southern Italy foreland basin systems, Miocene turbiditic sandstones exhibit complex diagenetic signatures reflecting shifts in provenance and tectonic setting. The Eocene Butano Sandstone in California documents the diagenetic dissolution of feldspar induced by hydrothermal activity due to the fault-related deformation of the La Honda Basin. In the Sub-Himalayas, the Cambrian Khewra Sandstone demonstrates the critical role of early diagenetic processes and their impact on porosity evolution and reservoir quality. Petrographic and petrophysical data integration highlights the strong interplay between depositional environments, tectonic regimes, and diagenesis in controlling porosity, permeability, and mechanical behavior. These findings provide insights for future studies on sandstones diagenesis, and may contribute to predictive models of reservoir quality for global sedimentary systems and future energy strategies.

The Central Mediterranean during Late Miocene: hints of progressive isolation from hemipelagic deposits (Central Italy)

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The Messinian Salinity Crisis (MSC), associated with the complete isolation of the Mediterranean, is one of the most studied phenomena since its first discovery in the 1970s. Recent literature shows evidence of progressive isolation and detrimental conditions for benthic fauna before the MSC. This work aims to identify the consequences of the progressive closure on Central Mediterranean seawater chemistry, nutrient contents and trophic conditions, as well as the oxygen levels of deep waters. To achieve that, we analysed $\delta^{18}O$ and $\delta^{13}C$ on separated *Orbulina* specimens of two Tortonian-Messinian marly successions belonging to the different domains of the Central Apennines: the Latium-Abruzzi and the Apulian Domain (Central Italy). Stratigraphic constraints are provided by calcareous nannofossil biostratigraphy.

Preliminary results indicate a stratification of the water column in the Latium-Abruzzi Domain, where planktonic foraminifera thrive in surface waters while low-oxygen levels are recorded at the bottom of the water column. Carbon isotope ratios attest changes in the productivity of surface waters, correlated to the regional and global Late Miocene carbon isotope signature. Conversely, the Latium-Abruzzi oxygen isotope trend decreases, deviating from other Mediterranean and Atlantic records, due to decreased salinity of surface waters linked to increased riverine input.

Holocene vertical movements in Calabria and southern Anatolia as revealed by geological and archaeological records

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Calabria and southern Anatolia are both placed on subducting system overriding plates: the Calabrian Arc and the Cyprus Arc. In terms of seismicity, volcanic activity, and lateral and vertical movements, they are the most active sectors in the Mediterranean area. Coastline markers displaced from the present mean sea level are, generally, used to recognize past vertical movements. The Mediterranean area is particularly rich in Holocene coastline markers, which are both geological (notches, wave-cut platforms, beach deposits, etc.) and archaeological (fish-tanks, coastal wells, harbour installations, etc.). New ^{14}C AMS datings of late Holocene sea-level markers along the Ionian coast of Calabria and from southern Anatolia, compared with the elevation of the coeval sea-levels as reconstructed by Glacial Isostatic Adjustment models, document positive vertical movements in both regions, with values from 0.4 to 0.8 mm/yr and from 0.9 to 1.5 mm/yr, respectively.

Since both uplifting areas are a part of the overriding plate of an active subduction zone, we can conclude that in the late Holocene the subduction zone beneath southern Anatolia was more efficient in inducing uplift with respect to that beneath the Calabrian Arc. The double late Holocene uplift rate of southern Anatolia points to consider that the effects of the late Middle Pleistocene slab break-off of the Cyprus Arc subducting plate were still acting.

Composition and diagenesis of deep-buried siliciclastic sandstones from the Puglia1 Well, Italy

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The Carboniferous-Permian time within the Mediterranean region is still a matter of strong debate for its abrupt evolution that dramatically changed the configuration of Pangaea. Numerous tectonic events shaped the Permian to Middle Triassic paleogeography and significantly influenced sedimentation patterns in Permian basins of the future Mediterranean region. This work investigates an Upper Permian siliciclastic succession recorded in the Puglia 1 well (Southern Italy), drilled by ENI, which intersects approximately 1000 m of siliciclastic deposits between 6110 m and 7070 m depth, underlying a thick Triassic-to-Pleistocene carbonate platform. Petrographic analysis reveals a quartzolithic composition dominated by quartz and metasedimentary lithic fragments, with interstitial components mainly consisting of clay matrix and Fe-dolomite/ankerite cements. Compaction is the main porosity-reducing diagenetic process, with thin-section porosity ranging from 0.3% to 5.2%. The provenance of the clastics is linked to the erosion of the Devonian-Carboniferous Variscan belt, sourcing from areas such as Calabria-Peloritani, the Southern Alps, and internal domains of Circum-Mediterranean orogenic belts. These findings contribute to a better understanding of post-Variscan sedimentary processes offering compositional insights into Mediterranean deep siliciclastic successions, supporting ongoing geological interpretations of the Southern Apennine foreland system.

Mineralogical and Geochemical Signatures of the Late Carboniferous Culm facies in the Ghomaride and Malaguide Complexes (Betic-Rif Chains: Western Mediterranean)

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The Betic-Rif Chains share a similar tectono-stratigraphic architecture of Alpine nappes with decreasing metamorphic grade upwards. The Malaguide Complex (Betics) and Ghomarides (Rif), emplaced during the late Oligocene - lower Miocene, represent the uppermost tectonostratigraphic units of the Internal Zones of these mountain chains. Despite tectonic similarities, the mineralogical and geochemical features of their Carboniferous Culm successions provide key insights into diagenetic maturity, provenance, paleoclimate weathering, unroofing and tectonic processes. Mineralogical analysis reveals assemblages dominated by quartz, feldspars, goethite, calcite, hematite, anatase, and phyllosilicates, primarily illite-muscovite (Il-Ms), mixed-layer illite-smectite (I/S), chlorite, trioctahedral mixed-layers (TML), and subordinately paragonite, and kaolinite. The Kubler Index, b_0 parameter of illite- muscovite and mineralogical assemblage show low metamorphic grade conditions under low pressure. Higher temperatures are recorded in the lower portions of the Culm lithofacies in the Spanish sector, with a decreasing trend upward, while Culm lithofacies in the Moroccan sector record the intermediate temperatures. Petrographic and geochemical data indicate protoliths derived from pelites. High Il-Ms content and K_2O, Al_2O_3, SiO_2 abundances reflect a felsic source, while chlorite and TML phases suggest contributions from mafic sources. Oxidising conditions prevailed during deposition, with CIA values indicating moderate weathering in the source-area. Provenance shifts from mafic to felsic upwards in both sectors, supporting a common geological history. These results contribute to the paleotectonic and paleogeographic setting linked to the final closure of the Paleotethyan ocean and the onset of the Paleotethysian (Pre-Alpine) orogenesis, as well as the overprint of later Alpine metamorphism, during Cenozoic.

Paleozoic Sandstone Signatures of the Circum-Mediterranean Region: Implications for Orogenic and Paleogeographic Evolution

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The Carboniferous to Permian sandstones from the Paleozoic Circum-Mediterranean region (Spain, Morocco, Sardinia, Puglia, and Sicily) provide crucial detrital evidence for the sedimentary processes during the Paleotethys closure. The Culm sandstones are synorogenic deep-marine turbidites marking the final stages of the Variscan orogeny in the western Paleotethys, between the Iberian-French Massifs and the African Atlas. Middle Carboniferous sandstones in the Malaguide (Spain) and Ghomaride (Morocco) complexes show a quartzolithic composition with significant high- to medium-grade metamorphic content. The detritus likely originated from a deformed, lithic, and transitional orogen, enriched with volcanic and ophiolitic materials from Cambrian to Lower Carboniferous terranes. In Sardinia, Late Pennsylvanian-Permian sandstones show a compositional shift from quartzolithic to feldspatholithic, indicating a transition from Variscan to volcaniclastic sediment sources due to coeval volcanic activity in pull-a-part sub-basins. In contrast, the Kungurian sediments in Sicily, with quartzolithic petrofacies, suggest a deeper, more protected depositional environment. The Upper Permian siliciclastic deposits in Puglia, preserved in the Puglia 1 well, reflect erosion of the Variscan orogen. These sandstones offer insights into paleogeographic reconstruction, tectonic processes, and sediment dispersal, helping refine regional provenance relations and their role in the global fragmentation of Pangaea.

New Stratigraphic Data on the Oligo-Miocene succession of the western Hyblean Plateau (SE Sicily)

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The sedimentary succession outcropping in the western sector of the Hyblean Plateau, south-eastern Sicily, mainly consists of carbonate deposits of Oligocene and Miocene age. It has been recently deeply investigated, through a detailed field work, carried out in the framework of the CARG Project for the realization of the Ragusa geological sheet nr. 648.
Field evidence combined with an integrated stratigraphy approach revealed the presence of several unconformities associated with significant stratigraphic hiatuses, whose duration has been carefully constrained.
The biostratigraphic analysis also enabled a chronostratigraphic reassessment of the lithostratigraphic units considering the recent redefinition of the GSSPs for Miocene stages.
The analyses carried out proved to be particularly useful for distinguishing among very similar lithostratigraphic units and for establishing their mutual relationships, resulting in a new, more suitable and effective litostratigraphic subdivision of the considered succession.
The strong influence of global paleoclimatic events on the stratigraphic architecture and tectono-sedimentary evolution of the area was also highlighted.

The Mediterranean salinity crisis: more than 50 years of research between land and sea

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The salinity crisis that occurred in the Messinian in the Mediterranean represents one of the most unique geological events, which after many decades still provides numerous research insights and still leaves numerous question marks.
The incredible discovery of salts in the Mediterranean seafloor have given rise to a revision of the original hypothesis on the formation of Messinian evaporites, paving the way for numerous and sometimes conflicting schools of thought.
This talk aims to provide an overview of “deep” evaporites in light of recent discoveries during the IODP 402 expedition in Tyrrhenian.

Aphotic Microbial-Induced Calcite Precipitation: a novel Drainage-Pipe Limescale?

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Limescale is a common calcite mineral deposit that accumulates on surfaces in contact with hard water, particularly in heating and plumbing systems, creating significant operational inefficiencies, increased energy consumption, and equipment degradation. In this study a limescale deposit formed inside a drainage pipe -installed about 30 years ago near the city of Cosenza (Italy) and collecting surface and spring water- is analyzed. Draining water shows pH ca 8.1 and total dissolved salts (TDS) around 300 ppm. The precipitate, composed of low-Mg calcite, appears like an isopachous crust, ca 3 cm thick, along the entire inner surface of a pvc pipe of 15 cm in diameter. The crust is characterized by an alternation of pale white and dark yellowish concentric laminae that, at the microscale, respectively are formed by micrite and sparite layers. The micrite layers, 800 μm thick in average, are composed by mineral nanospheres with a diameter of ~100 nm, that hierarchical aggregates to form polyhedral crystal structures. The sparite layers, ca 5 mm in thickness, are composed of 0.1 - 3 mm elongated tetrahedral crystals showing concentric discontinuous growth surfaces. The surface of the limescale in contact with the water, shows a rough yellowish patina, possibly an oligotypic biofilm, as it consists of sheet-like mucus-like material hosting abundant clusters of microbial filaments, up to hundreds of μm long and less than 1 μm in diameter. The strict association of the biofilm and the mineral nucleation points, together with a strong similitude of crystal habit and structure with Ca-carbonate microbialites, could suggests a microbial mediation in the precipitation of both calcite laminae types forming the limescale, within an aphotic environment.

A resilient rhodolith bed habitat in the Mar Piccolo basin of Taranto (Southern Italy)

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The city of Taranto is known for the numerous anthropic activities that develop along its coastal sector, such as the metallurgical industry, the oil refinery, the cement factory, the Navy port, intensive fishing and mussel-farming activities in the Mar Piccolo and Mar Grande of Taranto, two basins connected to the Ionian Sea. The land and sea sectors are both part of the Taranto Site of National Interest. In this context, a shallow Rhodolith Bed (RB) has developed in the north-eastern sector of the Mar Piccolo, between 0.5 and 3 metres deep, considering that in the Mediterranean Sea RBs are usually found between 30 and 100 m deep and that only three other very shallow marine RB sites have also been discovered here so far. In general, RBs have an important ecological role, as they host a high diversity of organisms and different species of flora; but they are also able to sequester carbon dioxide and, on the other hand, are regulators of water filtration, water pH and sediments. The relationship between this ecosystem and human activities has been studied using a multidisciplinary approach. The environment was described and characterised through geomorphological reconstruction and sedimentological analysis. The individual rhodoliths collected were described through image analysis and each nucleus on which they developed was interpreted through microscopy and SEM analysis. Three main classes of nuclei were distinguished: bioclastic nucleus, lithic nucleus and anthropic nucleus.

New constraints for the Permian-Triassic boundary identification in Botswana

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The Kalahari Karoo Basin (KKB) in Botswana hosts the volcano-sedimentary units of the Karoo Supergroup spanning from the Late Carboniferous glacial deposits of the Dwyka Group to the Early Jurassic basalts of the Stormberg Lava Group. The Karoo Supergroup includes the shallow marine to continental deposits of the Lower Triassic Beaufort Group (Tlhabala Formation in Botswana). This unit has probably recorded the mass extinction event occurred at the Permian-Triassic (P-T) transition, corresponding to global climatic and environmental shifts. Despite its central role in the evolution of Gondwana, our understanding of KKB's geological evolution in Botswana remains incomplete due to limited exposures and comprehensive databases on lithostratigraphy.

The focus of this work is to identify the P-T boundary in the mudrocks that characterise the Tlhabala Formation in Botswana using multiple proxies including geochemical, mineralogical and lithological variations and carbon stable isotopes composition of organic matter.

Sedimentological data were collected from three (3) drill cores from the eastern KKB of Botswana. Core logging was followed by petrographic, mineralogical and geochemical (major elements) analyses on selected samples across the Tlhabala Formation in order to refine the lithofacies description.

These analyses revealed an abrupt facies change in the mudrocks of the Tlhabala Formation that was associated, at least in one core, with a negative carbon isotopes ratio shift. We interpret this abrupt change as the possible PT- transition.

Ultimately, this research aspires to contribute to a deeper understanding of the paleoclimatic evolution of southern Gondwana, including a better lithological and geochemical characterization of the P-T boundary in Botswana, advancing our knowledge of this crucial geological time interval.

New advances in the stratigraphy of the Cretaceous Oceanic Anoxic Events of the *argilliti* e *radiolariti di Campomaggiore* (Southern Apennines, Italy)

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The Cretaceous sedimentary succession of the "*argilliti e radiolariti di Campomaggiore*" (Late Valanginian? – Turonian) developed in the Lagonegro-Molise Basin. This succession belongs to the "*membro diasprigno del Flysch Rosso*" and outcrops along the eastern margin of the Southern Apennines, in Basilicata region. The facies analysis demonstrates that this unit deposited in a well-oxygenated deep-sea basin which experienced severe anoxic conditions in discrete, relatively short time intervals, as in particular testified by five laminated organic carbon-rich horizons yielding high Total Organic Carbon content and good kerogen quality. These horizons named Calanche Anoxic Events (CAE1-5) could be correlated to Cretaceous worldwide Oceanic Anoxic Events. The radiolarian biostratigraphy allowed to correlate CAE5 to the well-known Bonarelli Level (OAE2) from the Umbria-Marche Basin but did not provide sufficient data for the identification of CAE1-4 levels preventing a precise correlation with other Cretaceous anoxic events known at regional or global scale.

New studies, based on detailed lithostratigraphy and Cretaceous microflora from CAE1-5 horizons give rigorous chronostratigraphic constrains, providing to assign the CAE1 horizon to the Weissert Oceanic Anoxic Event (Valanginian), the CAE2 to the Selli Level-equivalent (early Aptian), the CAE3 and CAE4 to the late Albian and to confirm the late Cenomanian for the CAE5 horizon (the Bonarelli Level-equivalent).

Plunge pools, canyons and fans: the influence of slope breaks in deep-sea sedimentary processes (Tyrrhenian Sea, Italy)

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In the submarine environment, abrupt gradient variations alter gravity-flow behaviour, resulting in distinctive geomorphologic and sedimentary features. In this paper, through the analysis of bathymetric and seismic data, we examine the products of the interaction between submarine-gravity flows and topographic features in the Tyrrhenian Sea. Plunge pool depressions are the most frequent elements indicative of abrupt gradient reductions. Type 1 plunge pools form in connection with a hydraulic jump and net erosional scours and cyclic steps at canyon mouths. They are isolated features or form a row, possibly representing the initial phase of canyon excavation. Type 2 plunge pools are associated to canyon/channel backfilling due to high sedimentation downstream of an abrupt slope break. They are confined features combined with mouth-bar deposition and pass downslope to leveed channels or downslope flaring, low-relief channels. Finally, type 3 plunge pools are parts of scour-mouth bar couples and form through density dominated flows. They pass downslope to supercritical fans with abundant bedforms or erosional areas with downslope converging channels and landslides. Our analysis shows that, in small basins in active margins, plunge-pool formation has pervasive effects, which guide the sedimentary evolution of large parts of the adjacent seafloor areas. Hence, this reveals important details for understanding canyon and channel inception and infill, and deep-sea fan evolution.

Microbial mediated As-schwertmannite in an extreme acidic system (San Blasio Mine, Calabria, Southern Italy)

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Iron and arsenic extraction occurred at the San Blasio mine (Caulonia, Southern Italy), until it was finally abandoned in the XX century. A whitish/reddish muddy precipitate was identified on the floor of an acid sulphate-calcic creek (pH ca. +3) outflowing from the mine. The precipitate primarily consists of amorphous As-schwertmannite, with a composition of 69% FeO, 14% SO_4, and 11% As_2O_5 (Wt%). The basic mineral structure is represented by <1nm amorphous As-schwertmannite nanoparticles. These typically aggregate into relatively homogeneous clusters or, more frequently, form subspherical nanospheres with diameters ranging from ca. 100 to 300 nm. These nanospheres are generally hollow, featuring a solid mineral wall ca. 30 nm thick, and can be observed either as individual particles or coalescing into more complex clusters. Furthermore, mineral nanofibers (100-300 nm long and 5-30 nm wide) can bulge from the nanospheres with a radial orientation. The precipitate is strictly associated with microbial cells, possibly archaea, actinobacteria, fungi or other acidophiles prokaryotes that are commonly covered by extracellular polymers. Abundant spheroidal bodies with a diameter of ca. 100-200 nm, characterized by a bilayer membrane, are widespread, probably referable to bacterial membranous vesicles or spores. All these organic structures are partially to totally mineralized by As-schwertmannite; among these the spheroidal bodies (vesicles and/or spores) are the most diffuse. Finally, the understanding of the microbial communities and the biochemical pathway that mediate this precipitation system, could drive to the possible development of a sustainable water treatment plant, finalized to avoid toxic elements dispersion in the environment and to recover an As-enriched precipitate.

Grain-size distribution and sand composition of barrier spit between Capo Suvero and Gizzeria village (Calabria, southern Italy)

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The study analyses the sand composition and grain-size distribution of the backshore beach sediments forming a barrier spit between Capo Suvero promontory and Gizzeria village (Calabria, South Italy) on the Calabria Tyrrhenian coast. Previous studies mainly discussed the mineralogy composition of the offshore and backshore beach sands and the historical shoreline evolution of this coast stretch. The present study extends the previous works because it is based on a detailed composition and granulometric analysis of the beach sediments that built a spit in 2005 and dismantled a few years later. Twenty-seven beach samples were collected in 2005 within the backshore zone along three transects and analysed in this work. The achieved goals indicate that the granulometric analysis of the backshore sediment samples exhibits different peaks among the grain-size fraction ranging from pebble to coarse sediments, and the majority contain more than 60% (in weight) of the very coarse sand fraction, showing a high-energy environment. The sediment mineralogy consists of an assemblage dominated by Schist+Phyllite+Serpentinite lithic fragments. Therefore, metamorphic rock fragments are the dominant grain type in the backshore environment. Serpentinite lithic fragments testify its provenance from a small high-pressure and low temperature complex of blue schists outcropping in the Calabria Coastal Range. The detrital modes indicate a predominant source represented by the Savuto River flowing across the intermediate-lower crustal rocks forming the Coastal Range on the study area's north side. Therefore, the achieved goals testify that Capo Suvero promontory does not obstruct longshore sand transport as was recognised in previous work.

Estimation of soil erosion and sediment yield integration with RUSLE and SDR models in the Mesima basin, Calabria, southern Italy

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Water-induced soil erosion is a significant contributor to land degradation, posing a threat to both environmental and socioeconomic sustainability. The present study aimed to evaluate the mean annual soil loss in the Mesima river basin (area: 806.41 km²) located in the middle-southern sector of the Calabria region, southern Italy. Additionally, the study calculated the mean sediment yield and identified the primary sediment sources within the basin. A spatially distributed approach was employed, integrating the Revised Universal Soil Loss Equation (RUSLE) and Sediment Delivery Ratio (SDR) models with Geographic Information Systems (GIS) and remote sensing techniques. The results showed that annual soil loss within the basin varied from 0 to 258.35 t/ha/yr with a mean of 3.37 t/ha/yr. The computed yearly soil loss was approximately 271.76 × 10^3 tonnes. Additionally, the estimated sediment yield within the basin ranges from 0 to 95.75 t/ha/yr, with a mean of 1.07 t/ha/yr; consequently, the yearly sediment yield will realistically amount to 86.64 × 10^3 tonnes. These results indicate that approximately 31.9% of eroded soil is transferred to streams, while 68.1% remains and is deposited without reaching the streams. Our results show that the Mesima basin is highly diverse in terms of erosion and sediment yield, owing to the variable topographic, geomorphic, and land-use/cover characteristics of its sub-basins. Topographic steepness (LS factor) contributes the most to soil erosion, followed by crop and management (CP) factors in most sub-basins. The current investigation effectively identified erosion-prone areas and critical sediment sources, offering valuable support for sustainable land management and soil conservation planning.

Transport controls on modern siliciclastic sand

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Transport mechanisms control siliciclastic sedimentation, segregating different grain sizes, influencing grains shapes, and leading to more stable end-products even in absence of multicycle reworking. For modern first cycle sand, shed by igneous source rocks, transport mechanisms, produce two “grain breakage styles”, marking changes such as liberation of free monocrystals, grain-size reduction and roundness variability. Interfacial boundaries of sand rock fragments, exert a relevant role on the two breakage styles, mainly through abrasion or percussion deformations. Data of glacial plutoniclastic sand, suggest that the 2 φ class interval can be considered a “threshold” from which new textures originate. Abrasion microfeatures relate to the very coarse and medium sand whereas percussion produces angular and chipped grains in the finer sand grade. This latter process is triggered by breakdown along isomineralic straight interfaces. For volcaniclastic beach sand, abrasion acts to increase roundness of glass-rich grains, such as those with vitric and microlitic textures, whereas percussion disrupts glass-poor particles, along isomineralic interfaces of lathwork grains, creating splinters of monocrystals and reducing original grain. Siliciclastic sand(stone) texture is transport-sensitive and facies-independent, thus failure to considerate the value provided by the textural descriptors can generate incomplete or biased information of compositional data and provenance.

Classic and 3D stratigraphic approach for the study and valorisation of a geosite: the Cretaceos inner-platform succession of “Cava Porcili” (UNESCO MurGEopark, southern Italy)

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In the Murge area (Apulia Foreland, southern Italy) many quarries are opened to use the Cretaceous limestones of the Apulian Platform as building stones. “Cava Porcili” is one of the biggest and abandoned quarries located south of Minervino Murge town. The quarry falls within the UNESCO MurGEopark and offers great scientific, educational and geotouristic potential. As far as scientific topics are concerned, one of the most important is stratigraphy and sedimentology of the outcropping 80m thick Cretaceous succession, belonging to the Calcare di Bari Fm and consisting of well-bedded peritidal and shallow subtidal carbonate lithofacies associations (inner-platform domain). Facies analysis suggests protected shallow-water environments with frequent exposures testified by thin interbedded layers of continental silty clays. This succession has been preliminary referred to Middle-Late Cenomanian, based on the benthic foraminifer assemblage (*Chrysalidina gradata, Pseudorhapydionina dubia, Nezzazatinella picardi,* and *Cuneolina pavonia*).
The stratigraphic-sedimentologic study was mainly performed by climbing activity and supported using 2 different 3D techniques of photogrammetry. 3D models allowed: i) to propose a detailed lateral coverage of the whole quarry, ii) to study geology in three dimensions and iii) to make virtually accessible the succession, waiting and hoping for full future geotouristic fruition of this geosite in the UNESCO MurGEopark.

Tracking Microplastics in Coastal Environments: A Case Study from Pino di Lenne, Taranto (Southern Italy)

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Pino di Lenne, located within the Stornara Nature Reserve in southern Italy, is a protected coastal area designated as both a Site of Community Interest (SCI) and a Special Protection Area (SPA). The beach remains largely untouched by anthropogenic activity, with no bathing facilities or mechanical cleaning, making it an optimal site for monitoring microplastics (MPs). Potential sources of MPs include the Lenne River and minimal seasonal human presence. The area is characterized by well-preserved dune systems and high biodiversity.

The Lenne River, which originates from a karst spring at 23 meters above sea level, runs for 24 kilometers before discharging into the Gulf of Taranto. Fed by surface aquifers, it plays a key role in shaping the landscape by transporting sediments. A unique ecological feature of the site is the presence of Sabellaria worm reefs, which trap both sand and anthropogenic debris, thereby influencing sediment dynamics.

This study investigated the distribution of MPs across various beach zones, with sampling points spanning from the backshore to the submerged areas. MPs were extracted using an olive oil-based separation method. Results indicate that MPs tend to degrade in the backshore before being deposited on the seabed. Four types of MPs were identified—fibers, films, fragments, and pellets—with black and blue being the predominant colors. Concentrations were relatively high, though varied between different sectors of the beach.

Overall, the findings offer a detailed assessment of microplastic dispersion at Pino di Lenne, suggesting accumulation through gradual sedimentation, entrapment in biological structures like worm reefs, and redistribution driven by high-energy events.

The role of global and local factors in the deposition of methane-derived carbonates: the Tortonian-Messinian succession of the Majella Area (Abruzzo, central Italy)

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Carbonate deposits represent a crucial archive of geological events. Their study offers valuable insights into the processes controlling their deposition at global and local scales, including climate and environmental changes. In the Majella area (Abruzzo, Central Italy), a succession of carbonate deposits associated with evidences of microbial activity developed during the Tortonian-Messinian. Such carbonates record the progressive establishment of critical conditions for marine ecosystems in the Mediterranean Basin during the Messinian Salinity Crisis. In particular, the studied section features thick (more than 15 m) carbonate deposits developed on top of a marlstone layer, within a relatively shallow marine environment. These carbonates are predominantly composed of bioclastic packstones containing ostracods, recrystallized peloidal packstones, microbial boundstones, and breccia deposits. Stable isotope analysis shows $\delta^{13}C$ values ranging from -29.9 to -5.4‰, and $\delta^{18}O$ values from -1.3 to 3.0‰. The negative $\delta^{13}C$ values suggest a methane source, indicating that the extensive carbonate precipitation in the studied section may have been influenced by microbial processes. The Tortonian-Messinian interval was marked by significant palaeoceanographic and climatic shifts but the rise of methane-rich fluids, likely thermogenic, was probably controlled by local factors. These data and the ongoing analyses provide new evidence on the pre-Messinian Salinity Crisis period in the Majella area, offering a detailed account of a relatively shallow-water succession with sedimentological features that distinguish it from other Mediterranean carbonate successions.

Strike-slip in the Crotone Basin: impacts on tectonic deformation, geohazards and economic significance

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The Neogene–Quaternary evolution of the Crotone Basin (southern Italy) was driven by the Rossano–San Nicola (RSFZ) and Petilia–Sosti (PSFZ) fault zones, which profoundly influenced regional physiography, slope stability and economic potential. Seismic and borehole data reveal a positive flower structure along the RSFZ, which concomitanlty uplifted and subsided the northern and southern sectors, through dextral transpression and thrust expulsion. Subsequent tectonic phases include Late Messinian and Early–Late Pliocene reverse-oblique strike-slip events, forming offshore structural highs and the emergence of Messinian units. In contrast, extensional/transtensional tectonics during the Messinian to Pleistocene affected both fault zones, shaping local depocenters and tectonic troughs. These dynamics led to the formation of two large-scale gravitational complexes: the Crotone Megalandslide and the Squillace Complex. The first comprises a SE-dipping listric fault set linked, via a buried basal detachment surface, to a compressional toe (Crotone Swell), which in turn promoted hydrocarbon expulsion and trapping in the Luna Field — the largest offshore gas reservoir in Italy. The second features NE-trending headwalls transitioning to W–E toe domains. These active collapses initiated in the Early Pliocene and experienced phases of temporary pause or slowdown, and reflect the interaction between slab rollback, regional convergence, and Tyrrhenian back-arc extension during Calabrian Arc migration.

A borehole database (VOL-BO DB) for 3D Subsurface Stratigraphic Modeling in the Coastal Plain of the Volturno River, Italy

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In the Mediterranean area, many coastal plains are affected by subsidence and other natural hazards due to several natural and anthropogenic factors. The Volturno River coastal plain (Campania, southern Italy) represents a highly dynamic area where geological processes are influenced by fluvial, coastal, tectonic, volcanic and anthropogenic activities. Despite the accessible data being poor and fragmented, this study created a detailed, spatially referenced database of borehole logs excavated across the Volturno River plain, in order to define a 3D geological modeling of the area's stratigraphy, also aimed at defining the geometry of aquifers. A hierarchical coding system was adopted to harmonize the different lithological classifications, enabling the conversion of descriptive narratives into standardized lithostratigraphic units. GIS technology was employed to spatially reference each survey, allowing for easy visualization and integration with other spatial datasets, such as digital elevation models, land use maps, and orthophoto. Furthermore, inconsistencies in stratigraphic interpretations between adjacent surveys were solved employing cross-correlation techniques and expert geological review. The resulting database currently comprises over 500 borehole logs distributed throughout the plain, covering an area of approximately 300 km². Preliminary analyses reveal a complex stratigraphic architecture that will be integrated in the development of a high-fidelity 3D geological model of the Volturno coastal plain, offering also a replicable workflow for similar studies in other coastal and fluvial environments. This approach supports more informed decision-making in fields ranging from civil engineering and environmental protection to cultural heritage preservation and climate change adaptation.

Open issues in the geology of the CARG Sheet 420 “Troia” in the framework of the geology of southern Apennines

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The external Irpinia-Daunia sector, at the northwestern edge of the Southern Apennines, is a geologically complex region where several key issues remain unresolved. Classical thin-skinned tectonic models describe the area as a Neogene thrust stack of allochthonous units overlying the Apulian foreland. However, new structural and stratigraphic data challenge this view, revealing inconsistencies in unit attribution and tectonic architecture.
Ambiguities persist in distinguishing formations linked to the Lagonegro Basin units, the Sannio unit, the “Argille Varicolori” Complex, and the Apulian Margin. Moreover, the influence of inherited Mesozoic extensional faults on thrust propagation, and the potential role of basement-involved structures, remain poorly constrained.
Recent studies integrating field mapping, seismic reinterpretation, and syn-orogenic stratigraphy suggest a more intricate evolution, combining thin- and thick-skinned tectonics. Reactivated rift-related faults appear to have guided deformation, leading to local uplift, out-of-sequence thrusting, and strong lateral variability in structural style.
New geological surveys that are ongoing for the CARG sheet 420 “Troia" could support a polyphase tectonic history with significant stratigraphic and structural heterogeneity. These insights propose the Irpinia-Daunia area as a key site for refining geodynamic models of the Apennine front and understanding active tectonics in a historically seismogenic region.

Petrographic Insights into Coastal Sediment Dynamics: A Multidisciplinary Study from the Sibari Site (BERMS Project)

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As part of the BERMS project, the Sibari coastal area (northern Ionian Sea, Calabria) serves as a key study site for investigating sandy beach dynamics under the influence of natural and anthropogenic factors. Characterized by a wave-dominated regime and a complex sedimentary environment, Sibari offers an ideal setting to examine the relationships between sediment provenance, transport pathways, and beach morphological evolution.

The core of the research focuses on petrographic and compositional analyses of beach and nearshore sediments, aimed at identifying primary detrital sources and reconstructing sedimentary inputs from surrounding geological units. Detailed grain-size characterization, heavy mineral assemblage studies, and thin-section petrography were conducted to trace lithological contributions and infer sediment transport processes.

These data were integrated with geomorphological mapping, topographic profiling, and geophysical surveys (including Ground Penetrating Radar and resistivity models) to contextualize sediment dynamics in relation to coastal morphology and subsurface structure. The multi-scale approach allows a refined understanding of sediment budgets, depositional patterns, and erosional susceptibility specific to the Sibari site.

By combining petrographic precision with broader environmental datasets, this site-specific study contributes to the overarching goal of BERMS: developing transferable methodologies for beach monitoring and management across Mediterranean coastal systems.

Integrating Multidisciplinary Approaches to Assess Beach Dynamics and Erosion Susceptibility: The BERMS Project

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The BERMS project explores the complexity of wave-dominated sandy beach systems through a multidisciplinary framework that integrates sedimentological, geomorphological, geophysical, compositional, and ecological analyses. Its primary goal is to develop a standardized methodology to monitor and assess erosion susceptibility in Mediterranean beach environments, particularly in the face of increasing anthropogenic pressure and climate-related changes.

Field activities focus on three representative coastal sites in Southern Italy—Torre Guaceto and Porto Cesareo (Apulia), and Sibari (Calabria)—each characterized by distinct sediment dynamics, geomorphological settings, and ecological sensitivities. The study combines high-resolution topographic surveys with subsurface imaging techniques (Sub Bottom Profilers, Ground Penetrating Radar, resistivity models), supported by numerical simulations using the Delft3D software.

A key innovation of the project lies in its methodological integration: by combining traditional field-based approaches with advanced modeling and ecological indicators, BERMS aims to balance environmental conservation with socio-economic development needs. Special attention is given to identifying primary sediment sources and understanding sediment–ecosystem interactions, which are essential for sustainable coastal management.

The results of the BERMS project are expected to provide scalable tools and protocols for long-term beach monitoring across the Mediterranean, contributing to more informed decision-making processes in coastal planning and climate resilience strategies.

Geological mapping for the resolution of environmental issues: Sheet 1:50.000 493 "Taranto" (CARG)

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The Geological Map 1:50,000 - Sheet 493 “Taranto” constitutes a scientific and cartographic product resulting from extensive collaboration among various institutions and comprehensive field investigations. The information provided outlines new geological features pertaining to both the emerged and submerged sectors of the area. Taranto area is located between the Apulian Foreland and the outer margins of both the Bradanic Trough and the Taranto Trench, the latter being the sector of the Apennine foredeep that extends into the Gulf of Taranto (Ionian Sea).

The area of Taranto has been designated as a Site of National Interest (SIN) for the presence of serious environmental problems related to industrial activity. Due to strong contamination and environmental risk, it requires remediation, requalification and environmental restoration. We show how an accurate survey of the continental and marine areas can provide a solid basis for the analysis and resolution of numerous environmental issues (authorized and unauthorized landfills, various anthropogenic impacts in marine areas, etc.).

The role of regolith in the determination of Radon-222 concentration: first results from a study area in Calabria (Italia)

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In addition to the Uranium-238 content in the bedrock and the presence of faults, fractures and cavities, the observed concentrations of Radon-222 (Rn) in the regolith are highly dependent on soil characteristics, which influence the upward migration of the gas and its release into the atmosphere. Grain size, intercalations of finer material, permeability, and moisture - among other factors - strongly control the diffusion of Rn: wet soils, including layers with low permeability and significant clay/silt amounts, can hinder the uptake of gas from the ground, whereas dry, coarser materials facilitate the movement of fluids. Similarly, other factors (e.g., soil thickness, slope concavity and exposure, season of measure) may appreciably influence the measurements.

The main controlling factors influencing Rn concentration in the soil are briefly reviewed, and first results from the Gioia Plain (Southern Calabria, Italia) are described. The study area is characterized by regional, active fault systems, and Tertiary/Quaternary sediments overlying Palaeozoic magmatic and metamorphic rocks. Observed amounts of Rn in the soil testify how these factors cannot be neglected in the identification of ‘priority areas’, where higher Rn concentrations are expected in soil and buildings. All these geological factors must be considered when planning a measurement campaign, or carrying out monitoring and data analysis, aiming at understanding the Rn distribution in the soil.

Assessment of the Geothermal Potential of Miocene-Pliocene Clastic Successions in the Subsurface of Lombardy (N Italy)

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In the Po Basin (N Italy), stratigraphic units of considerable interest as targets for low-enthalpy geothermal exploration include continental to shallow-marine siliciclastic successions of late Miocene (Messinian) to early Pliocene age. However, these stratigraphic intervals exhibit rather complex sedimentary architectures and lithological heterogeneity, which affect their potential for geothermal use. To assess quantitatively the suitability of these units for geothermal heating, a detailed geological model of the subsurface has been produced for a ca. 100 km^2 area in the Bergamo province (Lombardy region), based on the integration of well and seismic-reflection datasets.

The Sergnano Gravel Formation (SGF) is considered a primary focus of the model. This unit is of special interest because it occurs across the basin over attractive subsurface temperature ranges (at depths reaching 1500 m below sea level) and exhibits attractive reservoir properties. However, the SGF is characterized by a stratigraphic architecture that varies markedly in space across the area, in relation to the effect of basin tectonics and base-level changes; three-dimensional geometries and spatial distribution of conglomeratic units assigned to this formation reflect complex erosional and depositional dynamics across Messinian to Zanclean times. The generated stratigraphic model served as the basis for producing stochastic geocellular models of the lithological and petrophysical heterogeneity of the conglomeratic targets. The static models were then used for constraining simulations of subsurface fluid flow and heat transport through a geothermal well doublet, via a finite-difference method (TOUGH2).

The results highlight significant variability in heat-transport behaviour across portions of the SGF stratigraphy that developed during the Messinian falling stage – locally preserved on morphological palaeohighs – and lowstand to early transgressive stratigraphic units restricted to the lower part of the infill of palaeovalleys carved by the fall in base level. This outcome underscores the need for a robust characterization of sedimentary architectures and related lithological heterogeneity in this type of low-enthalpy geothermal reservoirs.

The turbidites of the middle Valle Latina (Sacco River; central Apennines, Italy): towards a new facies map and depositional model

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The Latium-Abruzzi "turbidite complex" extends along a NW-SE band around 50 km wide and over 150 km long in the central Apennines, from the Salto Lake to the northern part of the Campania region. In the NW it outcrops widely, while the outcrops become more discontinuous to the SE, where they occur mostly within the Valle Latina (Sacco River valley) and Valle Roveto (upper Liri River valley). They are interpreted, respectively, as the Tortonian and Messinian fill of the NE-migrating foredeep related to the Apennine chain, with palaeoflow overall from NW to SE. Compared to other foredeep sectors such as those of the Marnoso-Arenacea and Laga turbidite systems, very limited large-scale sedimentological studies have been undertaken, with none in the last forty years.

The turbidites of the middle Valle Latina represent the medial part of the eastern-most and oldest system. New fieldwork has been undertaken as part of the geological mapping of the CARG 1:50,000 Frosinone sheet. This has been combined with bibliographic research aimed at identifying previously studied outcrops from the years 1960s-80s – mostly quarry faces and motorway cuts – which do not exist any longer or are now covered by vegetation. The results are summarised in a new facies map whose compilation is in progress and that includes key differences in the geometry of the sedimentary bodies relative to previously published maps, building the framework for a revaluation of the foredeep basin geometry and evolution.

New insights on the Early Miocene siliceous event in the Northern Mediterranean region

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A significant increase of the siliceous deposition occurred in the Mediterranean region during the Early Miocene. The paleoceanographic and sedimentological meaning of this event, as well as its relationships with the geodynamic evolution of the Mediterranean basin, are debated. We present preliminary results deriving from the sedimentological study of siliceous deposits belonging to the Marne a Pteropodi Inferiori Fm. (MPI) which crop out in the Monferrato area (Tertiary Piedmont Basin). The MPI are distinguished into a diatomaceous and a marly-siliceous member. The diatomaceous member consists of the following lithologies: i) diatomaceous marls; ii) clastic sediments; iii) dolomitic beds; iv) cherts. A more monotonous lithologic assemblage is observed in the marly-siliceous member, typified by the rhythmic alternation of silty and silicified marls interrupted by fine-grained clastic beds. A striking feature of the diatomaceous marls is the high content of mm-sized diatoms; their presence is a matter of contrasting paleoenvironmental and sedimentological interpretations. Scarcely preserved diatom remains can also be observed in the silicified marls, otherwise characterized by chalcedony, sulfides and scattered dolomite. This reinforces the hypothesis of the biotic origin of Early Miocene siliceous deposits. At the same time, the occurrence of authigenic minerals suggest a hitherto underexplored link between the microbial degradation of organic matter and silica diagenesis.

Anatomy of a turbidite system along the shelf break-upper slope transition: stratigraphy, geometries, and facies distribution (Taza-Guercif Basin, Late Tortonian, NE Morocco)

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Submarine channels act as a link for sediment delivery from coastal systems to the basin floor. Despite extensive research, field studies on the downstream evolution of channelized sandstones in upper slope settings remain limited. During the late Tortonian, a marine transgression drowned a mixed carbonate-siliciclastic coastal system, depositing marls in the Taza-Guercif Basin. This study focuses on the initiation of the Tachrift Turbidite System, which incised these marls. The exceptionally exposed outcrops offer a rare opportunity to study the 3D architecture from the shelf break to the downstream slope stratigraphy. The studied ~250 m thick succession is documented by field mapping, sedimentary logging, and facies analysis, recording >50 channel fills separated by meters-thick marlstones. The mostly fine- to medium-grained channel fills vary in width from 5 to 200 m, while the thickness of channel axis deposits ranges from 0.5 m to 8 m. Paleocurrent analysis and channel geometries distinguished five main flow pathways, enabling the reconstruction of upper-slope complex physiography. Four end-member depositional styles have been identified: 1) erosional channel fills, without overbank deposits; 2) laterally migrating channel fills, with overbank deposits; 3) vertically offset stacked channel fills, with poorly developed overbank deposits; 4) mixed vertically and laterally offset channel fills, with overbank deposits. Variability in depositional style is interpreted as a result of distance from the shelf break, suggesting that slope morphology influenced channel architecture and fill. These results could assist in the characterization of analogous channel fills in upper-slope settings in the subsurface.

Deformation patterns of late Quaternary paleosols from the central Po Plain (Mirandola area)

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A thorough knowledge of shallow subsurface stratigraphy is essential for land-use planning and geological hazard assessment, and the CARG project (1:50,000 Geological Mapping of Italy) has played a key role in improving our understanding of the stratigraphy of modern alluvial and coastal plains. This study focused on the epicentral area of the 2012 Emilia earthquake, in the central Po Plain (sheets 183 and 184). Recent studies have shown that late Quaternary sedimentary successions may be affected by tectonic deformation but this aspect remains poorly investigated. In this work, we used new continuous cores and cone penetration tests (CPTUs) to reconstruct the shallow subsurface architecture through 12 geological cross-sections. This high-resolution approach revealed a southern domain made up of well-drained floodplain, with six laterally extensive paleosols, and a northern sector dominated by a set of correlative fluvial channel-belt. The paleosol marking the Pleistocene-Holocene boundary and Holocene poorly-drained and swamp deposits were mapped to evaluate near-surface deformation. The deformation of Holocene markers is spatially consistent with the geometry of the underlying, thrust-related structures and with the recent seismic activity of the Mirandola Anticline. Our results show that paleosol-based mapping, supported by CPTU analysis, can be effective in detecting near-surface deformation, offering insights into the late Quaternary evolution of seismically active lowlands.

Upper Miocene foredeep sedimentation in the Alburni Mts, S. Apennines: the Tempa del Prato Formation

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The synorogenic succession of the Alburni Mts does not conform to the classical one characterising the Alburni-Cervati-Pollino tectonic unit elsewhere in the Southern Apennines. A foredeep-like siliciclastic sedimentary succession unconformably overlies the upper Cretaceous carbonate platform deposits, cropping out in discontinuous patches (outliers). The Lower Miocene Roccadaspide and Bifurto formations are missing, and their stratigraphic position is instead occupied by an upper Miocene polymictic, rudite with a yellowish calcareous matrix, successively blanketed by sandstone deposits. These sandstones embed coarser-grained lenses containing large crystalline rounded blocks, sub-rounded to sub-angular metamorphic and sedimentary clasts arranged into a matrix-supported fabric. The unconformable boundary between the Alburno-Cervati carbonate platform and these Miocene siliciclastic deposits is and often highlighted by the occurrence of a diagenetic overprint consisting of cherty nodules and oxidized crusts. This succession, here informally named as “Tempa del Prato Formation”, preserves channel-like facies followed by thick finer grained intervals with sporadic coarser-grained inputs, developed during the Tortonian. These deposits seem to infill a complex depositional setting carved atop the dismantling Cretaceous carbonate platform, characterized by the structural confinement of steep extensional fault systems that also guided the localized development of elevated, erosional to bypass areas adjacent to relatively deep depocenters. The present contribution is framed as part of the CARG mapping project (sheet 487 “Roccadaspide”)

Chronologies of the Earth: communicating Deep Time in contemporary contexts

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The concept of deep time, central to geological understanding, did not emerge fully formed within the scientific domain. Its roots lie in the eighteenth-century foundational contributions of James Hutton, who, observing the unconformity at Siccar Point, first grasped the inconceivable age of the Earth, a revelation that overturned biblical chronologies and redefined the temporal scale of natural processes. And yet, it was not until 1981 that the evocative expression “deep time” was coined by writer John McPhee, a striking indication of the enduring rift between scientific knowledge and its cultural assimilation. This contribution explores the historical evolution of the idea of deep time, from Hutton’s empirical insight to its cultural codification, and reflects on the persistent challenges of rendering it intelligible to non-specialists. Drawing on our current outreach efforts in schools and public programmes, we reflect on how the concept of deep time itself can become a compelling narrative tool: one that both engages curiosity and lays bare the persistent challenges of reconciling geological time with human perception. By confronting the epistemological dissonance between human temporality and Earth’s immensity, this study aims to transform abstract chronology into narrative experience, laying the groundwork for a more conscious engagement with our planet’s deep past, and its long future.

What if Geoscience had listened to Zonia Baber?

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At the turn of the twentieth century, as the geosciences increasingly served the interests of empire, industry, and extraction, the American teacher of geology and geography Zonia Baber (1862–1956) envisioned a radically different role for the discipline. Rejecting dominant scientific narratives rooted in conquest and exploitation, she pioneered an approach to geoscience education grounded in ethical responsibility, intercultural dialogue, and environmental care. Through her work at the University of Chicago and her leadership in peace and civil rights movements, Baber merged field-based scientific inquiry with civic engagement, promoting experiential learning as a tool for fostering equity and cooperation. This study repositions Baber as a forerunner of modern geoethics, highlighting how her interdisciplinary and justice-driven vision anticipated today's calls for socially responsive geoscience. Long marginalised by structural biases, her legacy offers a compelling model for reimagining the discipline as an instrument of planetary stewardship and collective wellbeing. Revisiting Baber's contributions not only recovers a vibrant chapter in the history of geosciences, but also urges a critical reflection on the values that continue to shape its future.

Fossil root hairs of *Posidonia oceanica* preserved in MIS 5e coastal deposits (Taranto, Apulia, Southern Italy)

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The seagrass *Posidonia oceanica* forms one of the most complex coastal ecosystems of the Mediterranean. Its identification in the fossil record, necessary to trace the evolution of this habitat, is rarely based on plant fossils due to their rarity and more often relies on indirect indicators. In this study, we show the first fossil evidence of seagrass root hairs, preserved in Marine Isotope Stage 5e bioclastic deposits suggesting a detrital bottom that hosted patchy *Posidonia* meadows. Microscopy analyses revealed mineralized filaments identified as *P. oceanica* root hairs, along with epidermal root fragments displaying the typical cellular structure of this seagrass. Mineralized root hairs appear as a network enveloping and linking the sediment clasts, mirroring their modern counterpart. The mineralized root hairs are composed of nano- to micro-crystalline calcium carbonate still preserving their original tubular structure. Fossilization was probably favoured by two conditions: the presence of a microbial community through the sediments and on the root hairs, which mediated the early carbonate precipitation, and the root physiology. The molluscan assemblage, dominated by infaunal species accompanied by plant-related forms, indicates a sandy and gravelly infralittoral environment with vegetated patches. Moreover, the general fossil assemblage, also rich in calcareous red algae and benthic foraminifera, implies a strong bioclastic production deriving from the *Posidonia* meadow.

A New perspective on the depositional environment of the Montefino succession (Abruzzo Pliocene foredeep, central Italy)

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The Montefino succession (MoS) consists of a lower Pliocene 300 m-thick stack of sandstones with minor pelitic intercalations, mappable over tens of km between the Vomano and Tavo valleys, in north-eastern Abruzzo. Since it was first described, the MoS was defined as a turbiditic channel-lobe transition deposit, usually considered as the top of the Cellino Formation. The ongoing field mapping carried out in the context of the CARG Project (350 - Penne Sheet), provides new evidence not relatable to the above interpretation. Particularly, the lenticular geometry of some arenaceous beds of the MoS, showing clear pinch-out closures, the occurrence of intervals with heterolithic bedding and the diffuse bioturbation traces referable to *skolithos* association, indicate littoral/paralic facies in the frame of a siliciclastic continental shelf. All these observations, together with the recognition of an unconformity in the pelites just below the lowermost sandstone beds, suggest that the studied succession should be separated from the underlying Cellino Fm, whose facies are clearly referred to a deep foredeep basin. We propose to define the Montefino Fm as a new informal unit ascribing its depositional environment to a deltaic system. If confirmed by further biostratigraphic and petrostratigraphic analyses, this hypothesis could open new tectono-stratigraphic constrains concerning the position of the leading edge of the Apennine compressional front, at the time of MoS deposition.

Sediment transport mechanisms inferred from deposits of an outburst flood, Northern Patagonian Icefield, Chile

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Unusual fluid dynamics arising from variable sediment concentrations in catastrophic events such as glacial lake outburst floods (GLOFs) present unpredictable patterns of sediment deposition. We explore a breached moraine GLOF originating in the Soler Valley adjacent to the Northern Patagonian Icefield in Chile that discharged a proglacial lake. Flood volumes exceeding 140 x 10^6 m^3 and peak discharges of up to 20,000 m^3/s stripped the valley of its vegetation and left an apron of GLOF sediment mantling the valley floor. Field observations and UAV imagery are coupled with the GrainID algorithm to create grain size distributions along the path of the flood, and 3-D models from remote sensing data constrain the mass of mobilized moraine material. Using these insights, we perform a mass balance "chi transformation" of the deposits from geometric to mass space to evaluate scale-independent sediment dispersal behaviors. Our results indicate 1.) grain sizes shift from downstream coarsening to fining, and 2.) the bulk deposit transitions from boulders to cobbles at a chi distance of ~0.7. Downstream coarsening in the upper reaches is likely a consequence of a slurry-like fluid near the breach, which evolved to a Newtonian fluid as mass was lost to deposition. The boulder-cobble transition at a chi distance of 0.7 is consistent with experimental and field cases of downstream fining from other settings around the world. These results suggest that local variability in fluid dynamics across sediment/fluid mixture types is partially offset by a form of scale-independent self-similarity in sediment dispersal patterns, regardless of the rate or mode of sediment transport.

3D stratigraphic and tectonic modelling of the Neogene succession of the Crotone Basin

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The Neogene succession of the Crotone Basin, a marginal basin of the Calabrian terranes (Ionian sector), is characterized by a thick stratigraphic succession controlled by the occurrence of syn sedimentary (since Serravallian) and still active tectonics. This latter also affected the Messinian Salinity Crisis deposition that, in itself, constitutes one of the most intricate and widely discussed events in Mediterranean geological history. This work integrated multiple surface geological data (geological mapping and stratigraphic log reconstruction), together with a wide spectrum of subsurface data such as well logs and seismic lines, acquired during 60-80s for hydrocarbon explorations. The analysis testified significant tectonic deformations, including thrust faults that locally influence the continuity of the successions. GIS-based methodologies and Python modelling techniques were used to generate 3D models of the Neogene sedimentary infill of the basin, based on linear interpolations and KNN algorithms. The dataset, derived from ENI databases, includes 63 lithological records (onshore and offshore), integrated with 43 check points extracted from 9 previously interpreted seismic sections. Data were classified into three main stratigraphic units: Pre-Messinian, Messinian, and Post-Messinian, and organized in a database containing well locations, seismic profile locations, and depth values of the identified units. The resulting 3D models enabled the reconstruction of both the stratigraphic architecture and structural setting of the basin, identifying the stratigraphic relationships between the three units and the main fault systems confirming the efficiency of the proposed methodology.

Tectonics, Sedimentation and Climate change in the Evolution of Continental Margins: Case Studies in the Central Mediterranean

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The dynamic interaction between tectonics, sedimentation and climate change plays a key role in the evolution of the sedimentary systems on continental margins.
The presented studies illustrate some complex geological domains of the Central Mediterranean, where the convergence of the African and Eurasian plates drove the formation of collisional/subduction systems and sedimentary basins.
Active tectonics controlled uplift and subsidence, creating or limiting accommodation space and influencing depositional architecture in terms of facies sequence and stratal pattern. At the same time, sea level fluctuations, driven by global climate change, regulate sedimentary processes, alternating phases of progradation and retrogradation, accretion and erosion of depositional systems. The integrated analysis of stratigraphic, structural and paleoclimatic data reveals how these factors interact, leading to the variable morpho-structural evolution of continental margins and to the formation of depositional sequences with different characteristics.
This study provides important insights into the mechanisms of interaction between internal and external forcing factors in shaping geological sceneries and controlling environmental features through time.

Sandstone petrography of the Marnoso-arenacea Formation (Umbria, central Italy): implication for provenance and tectonic setting

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Sandstones petrography is widely used to infer paleogeographic and tectonic settings, source rocks composition, transport and depositional environment. We investigated 39 sandstones samples from the Marnoso-arenacea Formation (Umbria, Central Italy). The Marnoso- arenacea Formation, up to a maximum thickness of 3500 m-clastic wedge, is deposited in a ~300 km-long foreland basin, subparallel to the Miocene front of the Northern Apennines orogenic prism. Samples were mainly collected from the Marnoso arenacea Umbra Formation (MUM) and the Marnoso arenacea Umbro-Romagnola Formation (FMA). Sandstone detrital modes have been determined by applying the Gazzi-Dickinson point counting method. The modal composition of sandstones revealed three petrofacies with a dominant litho-feldpatho-quartzose and a less diffuse feldspatho-litho-quartzose petrofacies mainly for FMA samples and a feldspatho-quartzose composition for FMA8 and MUM Formation. Phaneritic rock fragments indicate a plutonic/gneissic provenance for MUM formation suggesting an alpine clastic supply, transferring first cycle detritus to the basin. In contrast the sandstones of the FMA show a sedimentaclastic detrital mode suggesting a contribution of terrigenous detritus shed by the paleo-Apennine orogenic wedge. Moreover, for these latter sandstones, rounded to subrounded quartz and ultrastable heavy minerals grains, such as zircon and rutile, have been revealed useful indicators of sedimentary recycling from older siliciclastic successions. From the sandstone detrital modes, it has been confirmed that the Marnoso Arenacea formation is multiple-sourced in response to possible both intensive reworking and first-cycle provenance.

What opportunities for dissemination of sedimentary geology topics in the MurGEopark (Puglia, Southern Italy)?

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On 17 April 2025 UNESCO named 16 new Global Geoparks including the MurGEopark (Puglia, Southern Italy). “The worldwide geological uniqueness of the MurGEopark is that the area is the only in situ remnant of the Adria Plate, the old continental plate almost entirely squeezed between the Africa and Eurasia Plates” and the area could be defined as “the last piece of Adria, the (almost) lost continent”. A long history of researches, mainly stratigraphic/sedimentologic, were performed in the MurGEopark territory, corresponding to part of the Murge Alte region, where a Cretaceous succession of the Apulia Carbonate Platform (one of the largest peri-Tethys carbonate platforms) crops out, and to part of the adjacent Premurge territory, where the southwestward lateral continuation of the same platform (being flexed toward the Southern Apennines Chain) is covered by a thin Plio-Quaternary foredeep succession, i.e., the Bradanic Trough deposits. An “anomalous” regional middle-late Quaternary uplift led to expose both kind of successions recording part of the ancient evolution of the continent and the more recent Southern Apennines foredeep development. The presence of several geosites of stratigraphic/sedimentological importance has been highlighted but significant problems of dissemination remain on any geological subject.

The rupestrian towns in the “Terra delle Gravine” regional park (Puglia, Southern Italy): examples of ancient urban development in the geological features of the “Gravine” canyons

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In the western sector of the Murge area (Puglia, Southern Italy) several canyons locally known as “Gravine” characterize the karstic landscape, exposing tens of meters of Cretaceous limestones overlain by Plio-Pleistocene calcarenites. The latter are soft-rocks that allowed to develop urban settlements characterized by houses with rooms, arcs, pillars, ornaments and friezes directly dug in the same rocks. The presence of suspended aquifers in the upper part of the flanks of the “Gravine” was managed by a system of channels and tanks, even collecting rainwater. The architectural structures of the settlements are based on such systems, resulting integrated with the natural resources given by the geological and geomorphological context. Therefore, “Gravine” canyon and rupestrian towns give us a glimpse on the man-environment relationships particularly explicative for educational and geotouristic purposes. In addition, along the flanks of the Gravine and into the rooms of the caved settlements, it is possible to find beautiful specimens of fossils, allowing the visitors to journey through the culture and the geological history of the area. Several examples of human settlements located in the “Terra delle Gravine” regional park will be shown, giving us a unique point of view of how the anthropization and geological context express a kind of culture spread all over a wide territory being a worldwide important geoheritage feature to be preserved for future generations.

The record of the Monterey Event in the Northern Mediterranean: New insights from the carbonate ramp deposits of the Pietra da Cantoni Formation (Tertiary Piedmont Basin, NW Italy)

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The Monterey Event has garnered renewed interest in recent years due to the significant relevance of the Miocene as a case study epoch for addressing past climate and oceanographic perturbations. The Monterey Event was a major anomaly in the global carbon cycle, marked by a positive carbon isotope shift (from +0.02 ‰ to +2.65 ‰) that occurred during the "Middle Miocene Climate Optimum" between 16.9 and 14.7 Ma. During this period, atmospheric pCO2 was near or moderately higher than modern values, while global mean temperatures ranged from 3 to 6°C higher than today. The Monterey Event has been globally recognized in both shallow and deep marine environments, while in the Mediterranean region, it has now been identified in the carbonate ramp deposits of the Central Apennines and Malta. This work focuses on Aquitanian to Serravallian carbonate deposits (Pietra da Cantoni Formation, PdC Fm.) exposed in the Tertiary Piedmont Basin (NW Italy). The PdC Fm. consists of shallow to deep marine sediments, ranging from inner ramp rodalgal calcarenites and calcirudites to outer ramp planktic foraminifer-rich calcareous marls. We have carried out sedimentological, petrographical, and biostratigraphical analyses of six stratigraphic sections, along with a detailed chemostratigraphic study of one section through bulk rock analysis of the carbon and oxygen stable isotope composition of 68 samples. The main goal is to identify the Monterey Event and its impact on biogenic sedimentation in the Northern Mediterranean.
The preliminary results show that the Monterey Event is recorded in the studied succession. These results will allow comparisons with similar deposits in other areas of the Mediterranean region.

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