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ABSTRACT BOOK

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COVER IMAGE:

Bologna vista verso Ovest dal Dipartimento di Matematica (Foto L. Gemignani).

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Insights on Tidal channel Initiations from Sinuous Creeks in the Venice Lagoon

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Keywords: tidal channels, initiation, salt marsh.

Tidal networks are a ubiquitous element of tidal systems and exert control on water and sediment distribution and nutrient fluxes in coastal environments. Recently, significant attention has been devoted to understanding the hydrodynamics and morphodynamic evolution of tidal channels. However, a substantial knowledge gap remains regarding the initiation of channels draining salt marshes and forming the most capillary part of tidal networks. Specifically, it is not clear whether these minor channels have the capability to develop on marshes or can be directly inherited from tidal flats once these evolve into salt marshes.

The present work investigates tidal creeks draining the salt marshes of the Venice Lagoon, North-Eastern Italy, and aims at understanding whether they are more likely to be initiated on the marshes, or if they are instead inherited from tidal flats. The Venice Lagoon is the largest Mediterranean brackish water body with an average tidal range of about 1 m. It's a tide dominated environment characterized by next to zero sediment of riverine input. Marshes of the Venice Lagoon host a dense network of tidal channels, that shows a well-defined meandering pattern also in its smaller elements. The study investigates point-bar deposits associated with channels ranging in width between 0.5 m and 3 m, aiming to determine in which sedimentary environment the bar nucleated by recovering sedimentary cores along a transect aligned with the meander bend axis. Across 36 study transects, facies analysis allowed the identification of five main types of deposits: salt marsh, point-bar, channel-lag, early salt marsh and tidal flat deposits. The type of deposits (i.e. salt marsh, early salt marsh and tidal flat) hosting the nucleation point of the study bars provides insights about the depositional environment where related channel started to develop.

Our results show that most of the channel's bars originate at the transition between salt marsh and tidal flat, indicating that the erosive processes began to carve the active surface when there was development of an early stage marsh vegetation. That vegetation is able to stabilize the sediment enough to allow efficient channel incision and development of an incipient point-bar but is also too sparse to effectively provide enough erosion resistance to significantly impede channel incision.

Martian salts everywhere. An astrobiological perspective for salt-bearing environments

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Keywords: Martian salts, Astrobiology, Salt-rich environments.

The presence of salts on the Martian surface, identified through orbital spectroscopy and rover analyses, indicates past interactions between water and rock, and provides key evidence for the planet's aqueous history. Chlorides, sulphates and perchlorates found in various regions suggest that Mars once hosted liquid water under varying pH and redox conditions. These salts help reconstruct past climate scenarios and point to episodes of evaporation and brine activity, possibly extending the window for past habitability.

On Earth, salt-rich environments – such as hypersaline lakes, salt flats, and subsurface brines – host diverse microbial communities, including extremophiles that thrive in high-salinity and low-water activity conditions. These analogs inform our understanding of how life might persist under similarly harsh conditions on Mars. Moreover, salts have the capacity to preserve organic molecules and microbial biosignatures over geological timescales, making them valuable targets in the search for past life. While some Martian salts may present chemical challenges to life, their role in stabilizing biomolecules, and preserving evidence of habitability mirrors similar processes observed in extreme Earth environments. Comparing these terrestrial analogs with Martian salt deposits enhances our ability to assess the chance for life on Mars and guides the selection of astrobiologically relevant exploration sites.

Unraveling marine phosphogenesis along the Miocene coast of Peru: Origin and sedimentological significance of the Pisco Formation phosphorites

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Keywords: Unconformity, Sedimentary condensation, Apatite, Pisco Basin, Upwelling.

Phosphorite deposits form through phosphogenesis, a mechanism of diffusion and concentration of interstitial phosphate in sediments leading to Ca-phosphate mineral precipitation in a favorable sedimentary regime at the seafloor. The Miocene deposits of the Pisco Formation (East Pisco Basin, Peru) record complex early diagenetic processes leading to the formation of phosphorite deposits. These layers consist of phosphatic clasts and nodules along with dolomite clasts, basement boulders, shark teeth, mollusk molds and vertebrate bone fragments. The P-rich clasts are mainly composed of phosphatic intraclasts and small phosphatic nodules. They occur associated with minor amounts of dolomite clasts coated by Fe-oxyhydroxides and laminites. Petrographic, mineralogical, and geochemical data suggest that the Pisco phosphorite deposits are transgressive lags laying on ravinement surfaces. They formed just below the sediment-water boundary during the early transgression phases, when the porewaters were enriched in phosphorus due to the abundance of organic-rich sediments and the microbial activity, as typical of upwelling settings. These deposits formed in shallow marine conditions, characterized by high biological productivity and low net sedimentation rates, with suboxic conditions at and beneath the sediment-water interface. The concentration of phosphate coated clasts was then favored by a sedimentary condensation mechanism of dynamic bypassing.

High-resolution pollen and multi-proxy analyses for the reconstruction of Holocene environmental dynamics and depositional processes in a stratigraphically expanded Po Delta succession (Italy)

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Keywords: multi-proxy analysis, pollen, depositional processes, Po Delta, Holocene.

The S1P borehole, drilled into the Po della Pila lobe, preserves an expanded chronostratigraphic record of Holocene environmental and paleoclimatic evolution. A multi-proxy approach was applied: palynological analyses (97 samples) provided vegetation reconstructions for both environmental and climatic interpretation. Sedimentological (e.g. SEM and XRF-scanning) and paleontological (e.g. meiofauna) analyses helped to distinguish between marine and terrestrial sedimentary facies and related depositional processes. The chronology was based on the combination of radiocarbon dating (seven AMS ^{14}C dates) and radionuclide analyses (^{210}Pb and ^{137}Cs). The lower part of the core (40 m–36 m) documents the Early Holocene evolution and is composed of organic-rich, fine-grained deposits formed under low fluvial influence, as indicated by high pollen concentrations and an infralittoral meiofaunal assemblage. Early Holocene spectra document the transition from an open grassland environment to a fully developed mixed deciduous forest during the HCO. Between ~36 and ~31 m, a progressive increase in river input is recorded, marked by a decrease in pollen concentration and an increase in the abundance of opportunistic foraminifera. This interval covers the Middle Holocene, characterized by meso-hygrophilous woodlands interspersed with cool episodes corresponding to well-known climatic events (e.g., 9.3 ka, Bronze–Iron Age transition). Above ~30 m, a 25-m-thick coarsening-upward succession of muds intercalated with fine sands documents the rapid Late Holocene delta-lobe progradation. Poor pollen preservation and scarce meiofauna indicate a high-energy, river-dominated system. Besides, pollen assemblages reveal the emergence of anthropic signals, particularly during the Roman period, with vegetation responding both to cultivation and to major phases of climate instability (e.g. LALIA and LIA), with peaks in montane taxa chronologically consistent with documented Solar Minima. Over the last two millennia, deforestation (Anthony et al., 2024) and hydraulic interventions further enhanced sediment supply, which resulted in finer temporal resolution, allowing the detection of short-lived climatic fluctuations. The uppermost 6 m record the onset of the modern delta plain with organic-rich muds containing wetland pollen species and brackish ostracods. Furthermore, the integration of sedimentological and geochemical indicators, such as the nature of organic matter and the Ni/Ca ratio coupled with micropaleontological and palynological data, make it possible to discriminate between marine- and river-dominated layers, revealing short-lived events linked to storms and river floods. Overall, this study demonstrates the potential of deltaic successions as reliable archives for the reconstruction of Late Holocene environmental and climatic evolution.

Anthony E. et al. (2024) - Delta sustainability from the Holocene to the Anthropocene and envisioning the future. *Nature Sustainability*, 7(10), 1235-1246.

Multiscale Lineament Identification through Manual Extraction from Multiple Visualizations of DTMs: the eastern Lessini Mountains (CARG, Verona Est, Italy)

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Keywords: Digital Terrain Model, Remote Sensing, CARG, Lineaments, Lessini Mountain.

Remote sensing and Digital Terrain Models (DTMs) analysis are now well-established tools for landform mapping, especially given the increasing availability of national and global datasets. Within the framework of the Italian CARG Project for producing the Geological Map of Italy at a 1:50000 scale, DTMs play a key role in improving geological interpretation by enhancing the understanding of surface structures and landscape evolution, supporting and improving field geological mapping.

However, lineament identification on remotely sensed data is often influenced by a high degree of subjectivity. As noted in previous studies, factors such as the operator's experience, observation scale, and DTM visualization method (e.g., artificial illumination azimuth) significantly affect the number, orientation, and length of extracted lineaments (Rutzinger et al., 2007). Building on the methodologies of Scheiber et al. (2015) and Smith & Clark (2005), this study proposes a multiscale approach that employs multiple DTM visualizations to establish a reproducible workflow, aiming to minimize such subjectivity.

The study area is located in the eastern Lessini Mountains (Verona, Italy), characterized by Mesozoic and Cenozoic limestones in the west, Paleogene volcanic rocks (mainly basalts) in the east, and Quaternary fluvioglacial deposits to the south. This area has undergone complex tectonic evolution, driven by the pre-Alpine extensional phase, which led to the development of normal faults bounding graben and half-grabens. The most significant structure in the area is the Castelvero Fault, which act as a major structural boundary between the carbonate and volcanic units.

Lineaments were extracted from a 6-meter resolution DTM provided by the Veneto Region using GIS software at four scales (1:200,000, 1:100,000, 1:50,000, and 1:25,000) and through three visualization techniques (Ambient Occlusion, Hillshade with azimuth at 315°, and at 45°), resulting in twelve lineament maps. Rose diagram analysis of the lineament trends revealed two dominant orientations: NNW–SSE and WSW–ENE, with notable differences between volcanic and carbonate lithologies.

Comparison with existing geological maps (Servizio Geologico d'Italia, 1967) revealed significant discrepancies, suggesting that the tectonic features of the area have not a clear motphological expression detectable in DTMs. This highlights the need for further fieldwork to verify the actual orientation and nature of geological structures.

In conclusion, the multiscale identification and analysis of lineaments using DTMs significantly enhance geological interpretation in the Lessini Mountains. The study underscores the differences with previous surveys and points to lithology-dependent variations in lineament orientation, emphasizing the value of this approach for guiding future geological investigations.

Rutzinger M. et al. (2007) - Development of algorithms for the extraction of linear patterns (lineaments) from airborne laser scanning data (pp. 1-8). Proc. of the Conference 'Geomorphology for the Future'.

Shceiber T. et al. (2015) - Manual extraction of bedrock lineaments from high-resolution LiDAR data: methodological bias and human perception. GFF, 137(4), 362-372. https://doi.org/10.1080/11035897.2015.1085434.

Servizio Geologico d'Italia (1967) - Carta Geologica d'Italia, alla scala 1:100.000). F. 49. Verona. ISPRA, Roma

Smith M.J. & Clark C.D. (2005) - Methods for the visualization of digital elevation models for landform mapping. Earth Surf. Process. Landforms, 30, 885-900. https://doi.org/10.1002/esp.1210.

The life cycle of extensional back-arc basins, with examples from the Black Sea region

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Keywords: basin inversion, far-field deformation, backarc basin, detrital thermochronology.

Extensional back-arc basins are important elements of global tectonics and make up a significant proportion of the sedimentary milieu of convergent plate boundaries. They are transitory features as temporal/spatial variations of the interplay between the convergence of tectonic plates and the velocity of subduction typically lead to their structural inversion. The remnants of back-arc basins visible on land customarily result from accretion/collision tectonics, are highly deformed and deeply eroded, and thus provide a fragmentary picture of their original characteristics. As a result, most of the current knowledge on back-arc basins is based on the study of present-day offshore examples, with limited understanding of the details of their sediment dispersal pattern and stratigraphic architecture.

This talk focuses on two back-arc basins well exposed on land: Srednogorie (Bulgaria; Cretaceous) and Adjara-Trialeti (Georgia; Eocene). Such basins are the westward and eastward continental prolongations of the Black Sea, a Cretaceous-to-Eocene extensional domain located along the southern margin of the Eurasian plate. Their peculiar position between the rheologically resistant lithosphere of the Black Sea and the polydeformed and structurally weak Balkan and Caucasian continental lithosphere protected them from total inversion during the Alpine orogenic cycle, making them easily accessible without dismembering their internal stratigraphic architecture and obscuring their structural relationships with the adjacent orogens.

Geomicrobiology of terrestrial hydrothermal carbonates: assessing the role of extracellular polymeric substances (EPS) in travertine precipitation

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Keywords: travertine; microbial mat; EPS Extracellular Polymeric Substances; central Italy.

Carbonate mineral precipitation is driven by a continuum of abiotic, biologically controlled (skeletal), biologically induced (microbial metabolism) and biologically influenced (organomineralization mediated by biofilm EPS extracellular polymeric substances) processes. Various terrestrial aquatic settings may constitute favourable environments for the formation of authigenic carbonate and silicate minerals, under specific physico-chemical properties of the precipitating fluid. Distinctive fabrics and mineralogy are often associated with microorganisms and microbial mats, particularly in extreme environmental conditions (e.g., high temperature, alkalinity, salinity, turbulence), unfavourable to multicellular life.

Terrestrial hydrothermal environments thrive with thermophilic microorganisms and are among the discussed candidate sites for the origin of life. Travertines, i.e. carbonate deposits precipitated by fluids of geothermal origin outflowing from subaerial springs, potentially store valuable information on the interaction between microbial communities, their biofilms and authigenic mineral formation.

This study investigates the geomicrobiological processes in three meso-thermal springs (54-34°C), actively precipitating travertines in Central Italy. Travertines were analysed through sedimentological, mineralogical, geochemical and geomicrobiological techniques: polarized light and fluorescence microscopy, SEM-EDS (Scanning Electron Microscopy-Energy Dispersive x-rays Spectrometry), XRD (X-ray diffraction), ATR-FTIR (Attenuated Total Reflectance Fourier Transform Infrared), C and O isotopes, and DNA sequencing.

The results confirm that microbial communities vary as a function of thermal water temperature with sulphide oxidizing bacteria and *Chloroflexi* being dominant at temperatures > 45°C and filamentous cyanobacteria prevailing below 40°C. Despite facies diversity, microscale carbonate precipitates similarly consist of calcite and aragonite crystals arranged in radial rosettes (30-500 μm in diameter), which nucleate on the biofilm EPS (extracellular polymeric substances) and are spatially distributed following the EPS structure, despite different temperatures and associated microbial communities.

These findings suggest that travertine precipitation, driven primarily by physico-chemical parameters (temperature, alkalinity, CO_2 degassing), is influenced by EPS acting as substrates for crystal nucleation (EPS-mediated mineralization) and affecting the resultant fabric types, regardless of specific microorganism composition and metabolism.

Gypsum Alabaster: Geological and Mineralogical Characterization of Gabriele Brunelli's *Salvator Mundi* statue (Bologna, 1615–1682) and the Specific Importance of this Stone Material in Cultural Heritage.

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Keywords: gypsum alabaster, Cultural Heritage, diagnostics, stone provenance.

This study presents the results of a diagnostic investigation conducted during the conservation and restoration work on a seventeenth-century statue called *Salvator Mundi* made by Gabriele Brunelli (Bologna, 1615-1682) (Favale, 2024).

Some samples of the statue were collected and examined by macroscopic observation, stereomicroscopy, polarised light microscopy on thin and polished sections and fundamentally through a multi-analytical approach, including X-Ray Powder Diffraction (XRPD), Field Emission Environmental Scanning Electron Microscopy (FE-ESEM) with Energy-Dispersive Spectroscopy (EDS) and confocal Raman Microspectrometry. This study scientifically refuted the long-standing historical assumption that the statue was made of marble, demonstrating instead that it is composed of gypsum alabaster ($CaSO_4 \cdot 2H_2O$) (Riccomini, 1972).

Petrographic analyses revealed a microcrystalline, felted texture composed of very fine gypsum crystals (0.1-0.2 mm) with occasional semitransparent selenitic porphyroblasts reaching about 0.5 mm in size. Polished sections displayed an orange-brown surface alteration, extending to roughly 200 μm, associated with iron oxides (limonite) and organic residues. Indeed, FE-ESEM and EDS confirmed Ca and S as the main elements, with traces of C as the main component of the organic substance (Del Curto et al., 2012).

The research expanded also into a geological and historical survey to identify potential origin areas of the material. While alabaster is typically associated with the Volterra district in Tuscany, this study highlighted the availability of high-quality microcrystalline gypsum in the Emilia-Romagna region. The investigation pointed to local outcrops in the Bolognese "Vena del Gesso" (such as the Sassatello and Spipola areas) and the Romagna gypsum veins near Rimini as probable quarries by analysing historical sources and documents on geological formations (Gulli et al., 2018).

These findings suggested a deliberate choice by the artist to utilize locally available, yet aesthetically sophisticated, stone varieties, reassessing the role of Emilian gypsum in monumental sculptures.

Favale C. (2024) - Il restauro della scultura in alabastro gessoso raffigurante il Santissimo Salvatore presso il chiostro dell'ex convento di San Salvatore a Bologna. Con un'appendice storico-documentaria sullo scultore Gabriele Brunelli (1615-1682). [Tesi]. Accademia di Belle Arti di Bologna.

Del Curto D. et al. (2012) - La conservazione del "degrado" di superfici lapidee all'esterno: un contributo sperimentale sulla formazione delle pellicole a ossalato di calcio da materiale organico naturale. In: Alessandrini G., Benedetti D., Del Curto D., Grilletto A., La conservazione del patrimonio architettonico all'aperto: superfici, strutture, finiture e contesti, Arcadia Ricerche, 513-523, ISBN: 9788895409160.

Gulli D. et al. (2018) - Georcheogypsum. Geologia e archeologia del gesso: dal lapis specularis alla scagliola. Palermo: Regione siciliana, Assessorato dei beni culturali e dell'identità siciliana, Dipartimento dei beni culturali e dell'identità siciliana. 513 pp., SBN Pal0311409.

Riccomini E. (1972) - Ordine e vaghezza. Scultura in Emilia nell'età barocca. Zanichelli. 377 pp.

The BERMS Project and the Integrated Characterisation of Southern Italian Beaches

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Keywords: sandy beach, holistic approach.

The wave-dominated sandy beach are complex systems that require a structured approach to monitoring and assessing susceptibility to erosion, particularly within Mediterranean environments. The innovative aspect of the BERMS project is its multidisciplinary methodology, which integrates sedimentological, geomorphological, geophysical, petrographic and biological analyses in order to characterise these systems. The locations where this new approach has been improved are three beaches in southern Italy: Torre Guaceto (Adriatic Sea) and Porto Cesareo (Ionian Sea) in Puglia, and Sibari (Ionian Sea) in Calabria. The choice of locations is linked to their status as Marine Protected Areas (Porto Cesareo and Torre Guaceto) and Regional Natural Reserve (Sibari), with the aim of mitigating human impact and preserving local habitats. All three sites are economically, socially, and environmentally significant, serving as popular tourist destinations and generating substantial revenue. On the other hand, however, these locations present significant differences in beach dynamics, particularly in terms of sediment composition, morphology and wave climate. Considering the growing anthropogenic impact and climate change, it is necessary to develop new methodological techniques for monitoring sandy beaches. Starting from sediment characterisation, beach profile equilibrium and morphodynamic assessment, biological, ecological and innovative technologies have been added, such as terrestrial laser scanners, marine geophysical instruments and remote-controlled vehicles, for a holistic study capable of improving a unified study approach. BERMS seeks to overcome the limitations of previous studies that were often sectoral or thematic by integrating the majority of active physical and biological processes that influence beach dynamics. It aims to harmonize the needs of environmental conservation with the requirements for socio-economic development. The project pays particular attention to identifying primary sediment sources and understanding sediment–ecosystem interactions, which are considered essential elements for sustainable coastal zone management and promoting responsible use of marine areas.

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Tectono-thermal evolution of the eastern Balkan: constraints from low-temperature thermochronometry

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Keywords: Intraplate deformation; fission-track analysis; (U-Th-Sm)/He analysis; synorogenic sedimentary record.

In this work, we present the first low-temperature thermochronologic data [fission track and (U-Th-Sm)/He analyses on apatite] on the eastern Balkan, an intraplate fold-and-thrust belt marking the boundary between the Moesian Platform to the north and a series of accreted lithospheric terranes to the south. This boundary has undergone a complex evolution, with multiple reactivations and contrasting kinematics.

The analytical dataset and its statistical inverse modelling point to the shallow burial (~2–2.5 km) of syn-orogenic sediments in the frontal portion of the orogenic wedge followed by cooling/exhumation starting in the middle Eocene coeval with orogenic collapse. Moreover, our data indicate Late Cretaceous unroofing of the Srednogorie Zone to the south. In contrast, the flexed and partly deformed lower (Moesian) plate and the associated foredeep sediments north of the belt have remained thermally unreset, retaining the Late Cretaceous provenance signature of the eroded hinterland.

These results suggest that Cenozoic shortening and exhumation have been relatively limited in the eastern Balkan. Instead, the tectonic evolution is characterized by a significant strike-slip deformation focused along inherited structural discontinuities related to a buried Triassic–Jurassic rift system. We propose a causative link between strike-slip deformation in the eastern Balkan and far-field stress transmission related to the oblique closure of the Vardar Ocean to the west.

Deltaic Deposition on a Hangingwall Dipslope: Tectono-Sedimentary Insights from the Crati Basin (Calabrian Arc)

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Keywords: Basin analysis, Fault-controlled systems, Gilbert-type deltas.

Sedimentation in extensional basins is strongly influenced by tectonic activity, which controls basin geometry, accommodation, and depositional *loci* and architectural style. In basins where the structural framework is poorly exposed, the sedimentology and stratigraphic architecture of syn-rift deltaic deposits could provide a powerful tool to reconstruct the evolution of basin-margin fault systems and understand how sedimentation is modulated by tectonics. The Crati Basin represents an ideal example: although Pleistocene deltaic successions have been documented in several sectors of the basin, the western margin has received less interest leaving unresolved the nature and tectono-sedimentary significance of its deposits in relation to the Pleistocene evolution of the Crati Graben.

Here, we characterize the facies, depositional architecture, and along-strike variability of the deltaic successions exposed in the central Crati Basin, where the geometry and activity of the controlling fault systems remain only partially constrained. The studied strata record the development of eastward and northward-prograding Gilbert-type deltas arranged in a forward-stepping pattern, with well-developed topset–foreset geometries and facies assemblages indicative of tractional, gravity-driven, and episodic debris-flow processes. Compositional changes reflect shifts in sediment sources linked to relative sea-level fluctuations and the structural evolution of the basin. The resulting stratigraphic architecture documents sustained accommodation generation and progressive eastward migration of depocenters, primarily governed by fault-controlled subsidence along the hangingwall dipslope of the western margin of the basin.

Results indicate that detailed sedimentological and stratigraphic analysis of deltaic systems could provide key constraints on normal-fault system growth and the spatial variability of accommodation.

The Impact of Ocean Depths on Earth's Dynamics

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Keywords: Ocean Geology, Plate Tectonics, Mid-Ocean Ridges, Seafloor Processes, Hydrothermal Alteration.

Advances in Ocean Geology, a field with limited tradition in the Italian scientific community, underscore its crucial role in understanding Earth's dynamics. Since the mid-20th century, seafloor exploration has revealed how plate tectonics shapes oceanic lithosphere, from the fragmentation of Pangea to the evolution of mid-ocean ridges. Variations in ridge spreading rates have influenced plate boundary evolution, crustal production, ridge morphology, deep-ocean circulation, sedimentation, and hydrothermal alteration, with significant implications for ocean chemistry, climate, and the potential for abiotic organic synthesis. Changes in plate motion particularly affect the evolution of triple junctions, such as the Macquarie junction in the southwestern Pacific, where unstable configurations, through local deformations, control the geometry and dynamics of plate boundaries over long timescales. Studies of slow and ultra-slow ridges, including transform faults and Oceanic Core Complexes, show how mantle rocks can be exposed at the seafloor and interact with seawater, releasing chemical elements that influence seawater composition and shape seafloor mineralogy. All together, these findings provide an integrated view of seafloor processes, geochemical cycles, and the deep-ocean environment as a natural laboratory for Earth and life sciences.

Microbial diversity and biosignatures in extreme environments: the Alalobad geothermal field (Afar, Ethiopia) as a planetary analogue

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Keywords: Astrobiology, Extreme environments, Planetary field analogue, Early Mars.

Understanding microbial life in extreme environments is fundamental to astrobiology and planetary exploration. Hydrothermal systems serve as natural laboratories to study how life adapts to extreme conditions, the early stages of biomineralization, and the preservation of biosignatures.

This study addresses a critical gap in microbiological data from the Alalobad site, an active geothermal field located within the Tendaho Rift of the Afar Depression in Ethiopia. Notably, the site hosts high-temperature pools (up to 99 °C), alkaline pH conditions, and extensive silica- and carbonate-rich sinter terraces.

Rock samples and microbial mats were collected from different pools within the geothermal field using sterile swabs (SRK FLOQSwabs®, Copan, Italy). The swab eluates were plated onto different growth media and incubated at a range of temperatures to optimize cultivation conditions for extremophiles. The resulting isolates were identified using MALDI Biotyper® System (Bruker Daltonik GmbH, Bremen, Germany), a matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) platform , enabling rapid identification of culturable strains.

The percentage of isolates identified/site was calculated to evaluate the discriminatory power of MALDI Biotyper® for environmental isolates, revealing the presence of both well-characterized taxa and a substantial fraction of putatively novel or underrepresented organisms in existing reference databases. To complement culture-dependent analyses, shotgun metagenomic sequencing was performed on a selected subset of samples, enabling comprehensive profiling of the taxonomic and functional diversity within the uncultivable microbial fraction.

To assess how microbial diversity was influenced by both environmental and experimental factors, we compared species composition across hydrothermal pools with distinct physicochemical profiles and under different cultivation settings (media and temperatures).

This study presents the first microbiological characterization of the Alalobad geothermal site, using a new sampling approach, and reinforcing the utility of MALDI Biotyper® as a high-throughput tool for rapid microbial identification in extremophile cultivation workflows. The results underscore the need to expand spectral reference database of the instrument to encompass the unidentified or low identification level obtained of environmental taxa, including potentially novel lineages relevant to life detection strategies. Overall, this approach and results will contribute to the development of biosignature-oriented research in planetary analogue environments.

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Normal fault-controlled deltaic systems along-strike architectural variability (Crati Basin, Italy): preliminary results

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Keywrds: Crati Basin, Fault-controlled deposits, Along-strike variability, Shelf-delta, Gilbert-delta.

Deltaic systems can be classified into: (i) base-of-scarp, (ii) Gilbert-, and (iii) shelf-type based on the depth of water in the receiving basin and the gradient of the depositional slope, which in turn control the stratal architecture and facies types distribution within each delta type. When these types of deltas develop in tectonically active settings, related to faulted margins, their stratigraphic architecture is also controlled by temporal and spatial variability in fault slip rate, relative sea-level changes and sedimentation rates.

This study aims to address the along-strike architectural variability of Pliocene-Pleistocene deltaic systems deposited in the eastern margin of the Crati Basin (southern Italy), which is characterised by an array of major N-S striking normal faults, and a secondary fault network composed of NE-SW and NW-SE-striking faults, developed since the Pliocene-Early Pleistocene. To assess it we had the following objectives: (i) construct strike and dip logs along the basin margin to determine facies and sourcing areas, (ii) establish outcrop-based internal geometry and architectural variability, and (iii) build correlation panels to assess lateral geometry and facies changes. We divided the eastern margin into three sectors (i.e., southern, central, and northern), with throw greatest in the northern sector and decreasing southwards. Petrographic composition (i.e., crystalline-metamorphic basement clasts) and large-scale architectures indicates that sediments were mainly sourced from the uplifted eastern basin margin, where the basement outcrops, with the bodies prograding towards the depozone in the west. Sediments were eroded from the uplifted footwall areas, and deposited in the hangingwall, with their bioclastic content indicating relatively shallow marine conditions. Log correlation shows dominance of coarse-grained material (i.e., conglomerates) near the faulted margin, thinning and fining westwards into siltstone. Preliminary results indicate that in the early phase shelf-type deltas developed above the basement along the entire length of the subsided hangingwall. Stratigraphically above, the northern and central sectors are characterised by the formation of Gilbert-type deltas, whereas in the southern area, shelf-type deltas continued to develop. Our results suggest that the growth of the margin was characterised by initial low gradient depositional slopes and the formation of shelf-type deltas. Continued syn-sedimentary growth of the margin resulted in steeper depositional slopes along the central and northern sectors and the related development of Gilbert-type deltas.

Mars and Moon geology in light of Riccardo's legacy

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Keywords: Mars, Moon, feeding systems, lava tubes, planetary maps.

Riccardo Pozzobon was a planetary researcher who tragically disappeared during field research on the Mendenhall glacier in Alaska in September of this year. Riccardo was renowned for his expertise in digital remote sensing and ground surveying, with over 60 scientific publications to his credit. His research focused on various aspects of planetary geology, including Martian volcanoes, Lunar and Martian lava tubes, bulged Martian craters and planetary geological mapping. This presentation will highlight his key findings on the feeding system of major Tharsis Volcanoes and Arabia Terra mud volcanoes which he investigated though fractal analyses of vents and fractures distribution. I will then discuss his long-term research on lunar and Martian skylights and terrestrial lava tubes, which culminated in his contribution to the first direct evidence of lunar underground caves—one of the most impactful recent findings for future robotic and human lunar exploration. Finally, the differences between terrestrial and planetary geological maps will be explained as well as the data integration methods that Riccardo explored to enhance the informative potential of extraterrestrial geological maps.

Comparative Spatial Analysis of Carbonaceous Materials in Proterozoic & Neoproterozoic Stromatolites as Planetary Analogs

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Keywords: biosignatures, planetary analogs, stromatolites, carbon, early life.

Ancient stromatolites, such as those from the Precambrian (> ~540 Ma), provide records of early Earth's biosphere, revealing interactions between microbial communities and environments at both local and global scales (Bosak et al., 2013), and can serve as vital planetary analogs in developing approaches to biosignature detection and interpretation. Our previous work has examined stromatolites from the Mbuji-Mayi Supergroup (DR Congo) with the aim of exploring the spatial distribution of light element chemical distribution and speciation, particularly carbon–oxygen bonding, to aid in identification of organic molecule characteristics and preservation in diagenetically mature stromatolite fossils. Analyses using optical and electron microscopy, including SEM and STEM coupled with electron energy loss spectroscopy (STEM–EELS), provided insights into the mineralogical composition and spatial distribution of organic materials within these stromatolites, including kerogen-rich regions. Notably, EELS spectra of kerogen show well-developed C K-edge structure, including features at the pi prime transition (~285 eV) and sigma prime transition (~291 eV), collectively indicate of relatively poorly ordered amorphous carbon, as well as a small peak around 286.3 eV, which may be indicative of carbon–oxygen bonding. We aim to further spatially resolve the molecular composition of functional group signatures within kerogenous regions of stromatolites. Specifically, STXM has been used for spatial resolution of carbon–oxygen bonding within kerogenous material within organosedimentary samples, while investigating the potential presence of other organic groups that were not identifiable using EELS, such as signals from aliphatic, amide and ester bonds as evidence of diagenetic transformation of lipid fatty acids, with the aim of resolving hydrocarbon lipid moieties, such as carboxyl groups (Finkel et al., 2023), within ~1 billion year old material, which would represent a significant advancement in our understanding of deep-time organic preservation. A similar methodological approach will be applied to a set of younger Tambien Group Adwa stromatolites (~>613 Ma) with the aim of conducting a comparative analysis of carbonaceous material in kerogen-rich regions. These findings will enhance our understanding of how early microbial ecosystems were preserved during the Precambrian, which may offer clues about environmental factors that influenced the stability of these microbial communities and their role in early Earth's biogeochemical cycles. The results have astro-geobiological implications, particularly in reconstructing early biospheres, could provide data for broader models of Precambrian carbon cycling, and can aid in the development of biosignature detection techniques.

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Bosak T. et al. (2013) - The meaning of stromatolites. Annu. Rev. Earth Planet. Sci., 41, 21-44, https://doi.org/10.1146/annurev-earth-042711-105327

Finkel PL. et al. (2023) – An overview of lipid biomarkers in terrestrial extreme environments with relevance for Mars exploration. Astrobio., 23(5), 563-604, https://doi.org/10.1089/ast.2022.008.

Stratigraphy and eruptive history of the Pietre Cotte volcanic succession and the 1888-90 activity, Vulcano (Italy)

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Keywords: La Fossa Cone, Stratigraphy, Geochemistry, Petrography and SEM analyses, Eruptive dynamics.

The recent evolution (last 1000 years) of La Fossa cone (Vulcano island) has long intrigued scientists and sparked debates regarding the origin and timing of products belonging to its various eruptive units. In the present work, we aim to reconstruct in detail the stratigraphy of Pietre Cotte pyroclastic succession, representing the result of the activities from the XIV century up to the latest AD 1888-90 eruptive cycle.

Although very recent stratigraphy of these products, the timing of the main eruptions and their characters, and the identification of the source area(s) still remain partly unclear. Stratigraphic fieldwork, lithofacies analysis and volcanological interpretation have been carried out, together with laboratory analyses of representative sample components, volcanic-glass geochemistry, thin-section petrography, and morphoscopic SEM analyses. These studies have led to the definition of an updated volcanic succession result of recurring hydromagmatic to magmatic eruptions, with vent-opening phreatic phases, that produced multiple depositional units from fallout and pyroclastic density currents. The Pietre Cotte succession includes distinctive pumice-fallout layers and the well-known rhyolitic lava flow, reflecting a complex eruptive evolution. Based on our stratigraghic data and the re-interpretation of the available historical reports, combined with the available paleomagnetic ages, the rhyolitic lava flow is most likely dated to AD 1739, whereas the pumice fallout layers were likely emitted slightly after in AD 1771.

Constraining the precise timing of the main explosive and effusive events is crucial to better understand the dynamics of La Fossa's shallow magmatic–hydrothermal system and the evolution of its most recent eruptive activity, thus providing key insights for volcanic hazard assessment on Vulcano Island.

Source-to-sink propagation of marine litter: the role of seafloor morphology and sedimentary transport processes

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Keywords: marine litter, microplastics, litter transport, sedimentary gravity flows, litter hotspots.

Marine litter is nowadays ubiquitous in all environmental compartments of the world's oceans and sequestration in sediments is considered its ultimate sink. However, a significant gap of knowledge remains regarding the processes driving the dispersal and accumulation of litter in the marine environment. Marine litter encompasses a wide spectrum of materials ranging in size from macro- to microparticles, each possessing different properties and shapes that largely influence its transport, deposition and impacts. Understanding litter distribution is challenging as it is driven by a complex interplay of a multitude of anthropogenic and natural factors; the former are linked to litter sources, while the latter reflect geomorphological characteristics and physical transport dynamics.

This talk will present an assessment of seafloor litter across different settings, from submarine canyons to prodelta environments, using a geological process-based approach. The integrated analysis of litter data with morphobathymetric, geo-acoustic and sedimentological contextual information aims to relate litter distribution to transport and depositional processes, in order to reconstruct the source-to-sink patterns of debris coming from land sources and identify accumulation hotspots. The study of litter as a novel anthropogenic tracer offers valuable insights into sediment transport dynamics and dispersal patterns in the marine environment, potentially aiding a better understanding of the behaviour and long-term fate of this pollutant at sea.

Reconstructing the 3D facies architecture of the Pescara paleovalley fill (Central Italy) using new core analyses and legacy data

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Keywords: Paleovalley System, stratigraphic architecture, facies analysis.

Buried paleovalleys (PVs) in coastal lowlands exhibit abrupt lateral changes in sediment thickness and physical properties. Beneath the Pescara coastal plain, a late Holocene paleovalley (PV) is incised into the Mutignano Formation (Fm) and filled with fluvial gravels, soft estuarine mud and younger fluvio-deltaic deposits. Defining its geometry and facies architecture is essential for paleoenvironmental reconstructions and seismic-hazard assessment. The dataset includes 137 core descriptions and 10 cone penetration tests (CPTu) from the Pescara Municipality. A new 55-m-deep sediment core ("Magellano") was recovered to refine facies analysis and chronological framework. The core was described for texture, grain-size, colour and accessory materials. Pocket penetration measurements (i.e., compressive strength) acquired in fine-grained intervals supported facies interpretation (Amorosi et al., 2015). Ten stratigraphic cross-sections, both longitudinal and transversal to the valley axis, were realized and integrated to construct a 3D facies model of the PV fill. Results highlight a basal erosional surface dated to the onset of the Last Glacial Maximum (LGM, about 30 ky BP), separating the Mutignano Fm from the PV fill. The latter consists of basal fluvial gravels, up to 14 m thick, likely deposited during the LGM, overlain by >20 m of soft estuarine muds accumulated during the Holocene transgression. This succession is capped by ~11 m of fluvio-deltaic strata reflecting late Holocene coastal progradation. The 3D model delineates PV geometry and facies relationships, improving sequence-stratigraphic framework, and providing a robust basis for future geotechnical, geophysical and hydrogeological analyses.

Amorosi A. et al. (2015) - The value of pocket penetration tests for the high-resolution palaeosol stratigraphy of late Quaternary deposits. Geological Journal, 50(5), pp.670-682.

A multi-methodological experimental and theoretical analysis of the physico-chemical properties of dolomite

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Keywords: Dolomite, Analytical methods, Elastic constants, Equation of State, Density Functional Theory.

Carbonate minerals play a fundamental role in Earth's carbon cycle, transporting and recycling carbon at the mantle's depth (Martin, 2017). Understanding their mineralogical structure and its dependent properties is essential for interpreting their behavior in Earth environments (Reeder, 1983).

The present research provided a physicochemical profile of dolomite [$CaMg(CO_3)_2$], using a multi-methodological approach that integrates *ab initio* simulations with experimental analyses. Natural samples collected from Traversella's mountains were characterized by XRD, low-vacuum ESEM-EDS, and vibrational spectroscopy (FTIR and Raman) to ensure accurate identification. Theoretical modeling was performed using the CRYSTAL code within the Density Functional Theory (DFT) framework. The study evaluates the influence of the Hamiltonian by testing 11 functionals (including LDA, GGA, meta-GGA, and hybrids) and D3 dispersion corrections on the structural and electronic properties of dolomite at 0 K (Dovesi et al., 2020).

Comparison between experimental and theoretical datasets revealed strong consistency between the results. Calculated crystal structures aligned well with XRD findings, and simulated IR and Raman spectra (at Γ point) accurately reproduced vibrational frequencies (including LO-TO splitting). While all simulated spectra display some frequency shifting, LDA functionals tend to produce blue-shifted bands, whereas GGA functionals lean towards red-shifts. The effect of the corrections for the long-range dispersive forces (D3) is strongly dependent on both the chosen functional and the nature of the mode. Electronic property calculations, specifically band structures and density of states (DOS), indicated a band gap of 5.0 eV, highlighting the non-conductive nature of the mineral. The elastic properties, derived from both second-order elastic moduli, incorporating nuclear relaxation via the internal-strain tensor, and a third-order isothermal Birch-Murnaghan equation of state (EOS), confirmed the strongly anisotropic nature of dolomite arising from its heterodesmic, mixed covalent-ionic bonding. Bulk moduli calculated from the stiffness tensor and EOS approaches showed excellent internal consistency, differing by approximately 1%. Although the athermal nature of the simulations leads to an overestimation of structural stiffness compared to ambient experimental conditions, the data provided robust constraints on dolomite stability.

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New challenges in delta research

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Keywords: Nature-based solutions; Po River Delta; double clinoform delta; subaqueous platform

Deltas are very important environments, as their deposits host natural resources, from freshwater aquifers to hydrocarbons, and their delta plains are areas of significant socio-economic and ecosystem value. At the same time, deltaic environments are very vulnerable, chiefly due to their low elevation, occurrence of highly dynamic depositional processes, high population density and anthropogenic pressure, as well as threats coming from climate change.

The first part of this talk focuses on the challenges facing low lying deltaic plains, as anthropic activities and interventions have significantly modified the hydro-morphodynamic behavior of fluvio-deltaic environments, making the reclaimed lands hydrologically disconnected from the river and starving natural wetlands. In river deltas, nature-based solutions based on levee breaching have become an increasingly common approach for restoring coastal wetlands and reestablishing natural depositional dynamics on previously reclaimed deltaic plains, as seen in the Isola della Batteria area in the Po River Delta.

However, there is more to a delta than just its delta plain. Another challenge is related to understanding their overall stratigraphic architecture, which recent research has shown to be much more complex than previously thought, in particular where double clinoforms are developed. Delta bathymetry, seismic data and near-surface sediment sampling on modern deltas with significant wave, tidal or marine current influence show a double clinoform architecture with a bridging subaqueous platform. Much of the muddy portion of river-sediment discharge that reaches the coastline bypasses the mouth bar/shoreline clinoform and is deposited, eroded, re-suspended and stored in the distant subaqueous portion of deltas. However, architectural reconstruction from outcrop or well-log data is less simple. As the subaerial delta progrades on top of its coeval subaqueous delta, a continuous or discontinuous erosion surface can form. Importantly, the resulting architecture is the expression of one single prograding deltaic system, and not caused by unsteady allogenic forcing.

Unveiling the Bobbio Tectonic Window: thermo-tectonic insights into the Alps-Apennines junction

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Keywords: Northern Apennines, low-temperature thermochronology, buried thrust front.

The dynamic relationships between the S-verging Southern Alps and the N-verging Northern Apennines fold-and-thrust belts—and their shared Po Plain foreland basin, including their kinematic interactions —represent a classic yet still debated geological problem. In this context, the regional transect extending from the Bobbio Tectonic Window (BTW) in the Emilian Apennines, where Miocene foredeep turbidites crop out, to the central subsurface of the Po Plain, where the Northern Apennines thrust front along the Emilian Arc interacts with the Southern Alps orogenic front, provides a key setting for investigating these relationships. Previous studies have mainly focused on reconstructing fault slip-rates based on the interpretation of seismic profiles across the Emilian Arc, but a comprehensive tectonic reconstruction that includes thermochronological analysis of the BTW turbiditic sequence is still missing. In this work, we aim to clarify the relationship between the evolution of the BTW and the propagation of the buried thrust fronts of both the Northern Apennines and the Southern Alps. Specifically, we investigated the cooling and exhumation history of rocks exposed in the core of the BTW and compared it with the tectonic history of the Northern Apennines thrust front along the Emilian Arc.

To achieve this, we applied apatite fission-track (AFT) and (U-Th)/He low-temperature thermochronology to samples from the Bobbio Fm. in the BTW, which range in age from 20 to 16 Ma (Lower–Middle Miocene). Our preliminary thermochronological results indicate a Pliocene cooling phase with a maximum temperature of about 90°C. We interpret this signal as evidence of out-of-sequence thrust reactivation within the inner Northern Apennine fold-and-thrust belt, triggered by the interaction between the frontal sector of the Emilian Arc and the Southern Alps.

This study illustrates how far-field geological structures can influence the kinematics of thrust systems and provides new insights into the generally decreasing Pliocene–Pleistocene tectonic activity of the buried Northern Apennines thrust front.

Microbially influenced evaporitic textures and microbiota of the Makgadikgadi Pan (Botswana): analogues for Martian biosignature formation

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Keywords: astrobiology, extremophiles, evaporitc crusts, terrestrial analogues.

Evaporitic playa systems provide valuable terrestrial analogues for investigating the formation and preservation of biosignature under environmental conditions similar to those proposed for early Mars. The Makgadikgadi Pan in Botswana—among the largest evaporitic basins on Earth—combine hypersaline, alkaline, and seasonally dynamic conditions, making it an ideal natural laboratory for studying microbe–mineral interactions of astrobiology relevance (Franchi et al., 2025).

This study focuses on the surface salt crusts of Ntwetwe Pan, part of the Makgadikgadi Pan in Botswana, with the aim of characterizing their mineralogy, microtextures, and microbial structures, and evaluating their astrobiological relevance. Samples were collected along a ~280-meter transect across salinity and moisture gradients. X-ray diffraction revealed halite as the dominant mineral, accompanied by widespread calcite and quartz, and by thenardite and trona in zones of elevated salinity. SEM-EDS analyses identified complex microfabrics—mineralized filaments, EPS-like matrices, and fine-grained coatings— indicative of microbial mediation in mineral precipitation and entrapment. A clear spatial pattern trend emerged: crusts from the margins were enriched in carbonates and exhibited well-preserved filament mineralization, while central samples, dominated by halite and trona, displayed poorer EPS preservation and weaker biosignature encapsulation. These findings underscore the role of environmental gradients in shaping the preservation potential of biosignatures. Along the transect, several features resembling potential biosignatures—such as spheroidal aggregates, acicular crystals, and vermicular cavities—were documented. Although some of them initially suggested a biogenic origin, their regular morphologies, lack of associated carbon, and mineralogical composition pointed instead to an abiotic origin likely due to rapid crystallization and dissolution–reprecipitation cycles under intense evaporative conditions.

The Makgadikgadi Pan represents a valuable natural laboratory for refining biosignature detection strategies in Martian evaporitic environments such as Jezero Crater and Meridiani Planum (Schmidt et al., 2023). While rapid mineral precipitation in these systems may enhance microbial preservation, it can also generate abiotic features that closely resemble biogenic structures. This study reinforces the importance of a multidisciplinary approach—combining morphology, geochemistry, and mineralogy—in distinguishing true biosignatures, and provides critical insights for shaping the scientific goals of future astrobiology missions.

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Franchi F. et al. (2025) - Microbial abundance across a salinity and mineralogical transect in the Ntwetwe Pan of Botswana: A terrestrial analogue for playa deposits on Mars. Planetary and Space Science, 255, 106028.

Schmidt G. et al. (2023) - Structural influences on groundwater circulation in the Makgadikgadi salt pans of Botswana? Implications for martian playa environments. Frontiers in Astronomy and Space Sciences, 10, 1108386.

Effects of bioturbation on porosity and permeability in shallow-water carbonates: A case study from the Appenine Carbonate Platform (Italy)

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Keywords: bioturbated carbonates, Thalassinoides, petrophysical analysis, reservoir characterization.

Bioturbated carbonate sequences pose significant challenges for reservoir characterization in both hydrocarbon exploration, exploitation and underground CO_2 storage. Bioturbation can strongly influence the petrophysical properties of host rocks, generating sedimentary heterogeneities and often modifying the original porosity and permeability. This study investigates a 75-meter-thick Upper Cenomanian–Lower Turonian bioturbated carbonate succession from the Apennine Carbonate Platform in Southern Italy.

A comprehensive, multidisciplinary approach was employed, integrating facies, ichnological and petrophysical analyses, supported by non-destructive imaging techniques such as CT and Micro-CT scanning. Porosity was measured using mercury intrusion and resaturation methods, while permeability data were obtained using a probe permeameter and through software-based simulations, allowing for direct comparison between burrow structures and the surrounding matrix. To evaluate rock-fluid interactions under CO_2-rich conditions, batch experiments were also conducted on selected samples. CT imaging was used to quantify burrow geometry, connectivity, and tortuosity, assessing their influence on fluid flow properties. High-resolution Micro-CT data enabled detailed modelling of porosity and permeability, which was subsequently cross-validated against the laboratory results.

The examined sequence exhibits a boxwork pattern of burrows organized with a preferential horizontal network featuring vertical shafts exhibiting Y- or T-shaped morphologies typical of the *Thalassinoides* ichnotaxa. Bioturbation intensity and porosity increase upwards in the section. CT imaging reveals low-tortuosity burrow pathways with circular to elliptical cross-sections. In the most bioturbated intervals, burrows occupy approximately 39% of the rock volume and are predominantly dolomitized, with porosity ranging from 1.8% to 17.7%. In contrast, matrix porosity ranges from 1% to 4.8%. Permeability measured values (~101.8 mD) are consistent with those modelled from micro-CT-based simulations (~117 mD).

The findings of this study emphasize the substantial impact of bioturbation on the distribution and quality of porosity and permeability in complex carbonate reservoirs providing valuable implications for understanding fluid migration, rock-fluid interactions, and diagenetic processes.

Tracing Holocene dynamics of lagoon's ecological quality: a stratigraphic-based, benthic foraminiferal approach from the Po Plain (N Adriatic Sea)

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Lagoonal environments are highly biodiverse coastal ecosystems, extremely susceptible to multiple anthropogenic and natural stressors (eutrophication, contaminants, storms and floods, relative sea-level rise among others). Given their ecological importance, effective monitoring and restoration strategies are essential to safeguard their integrity. The quantitative assessment of the Ecological Quality Status (EcoQS) represents a fundamental step in designing action plans through an ecosystem-based approach that incorporates biological indicators, as mandated by the EU Water Framework Directive (2000) and the Marine Strategy Framework Directive (2008/56/EC).

This study aims to contextualize the EcoQS of a modern lagoon (Bellocchio Lagoon) belonging to the Po coastal plain (N Adriatic Sea), by comparing current values with pristine reference conditions from the past. To achieve this purpose, we integrated analyses of benthic foraminiferal assemblages from sediment cores and modern samples to reconstruct environmental changes and EcoQS temporal trends mainly applying the Foram-AMBI index, which is based on species sensitivity to organic-matter enrichment.

Reference conditions (PaleoEcoQS) were reconstructed analyzing the foraminiferal assemblages encased within the well-dated sedimentary successions of a near-site humid area, whose Holocene record reflects depositional environments comparable, though on a different scale, to the Bellocchio Lagoon.

A reliable comparison of past and present environments was based on the identification of three distinct biofacies within the Bellocchio Lagoon, by means of cluster analyses based on the benthic foraminiferal thanatocoenoses. Each biofacies corresponds to a sub environment (i.e. inner lagoon, outer lagoon, and salt marsh - channels) characterized by a typifying foraminiferal content and a set of environmental parameters (i.e. sand, calcium carbonate and total organic matter content). Using the Modern Analogue Matching technique, cores assemblages were compared to the biofacies, enabling the identification of modern analogues for past depositional settings. The reconstruction of long-term ecosystems' dynamics and the assessment of the Ecological Quality Ratio, calculated comparing the EcoQS derived from core samples with the EcoQS of modern biocoenoses, allow to evaluate the present-day ecological conditions in the context of the natural and human forcing factors that have affected lagoonal environments over time.

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