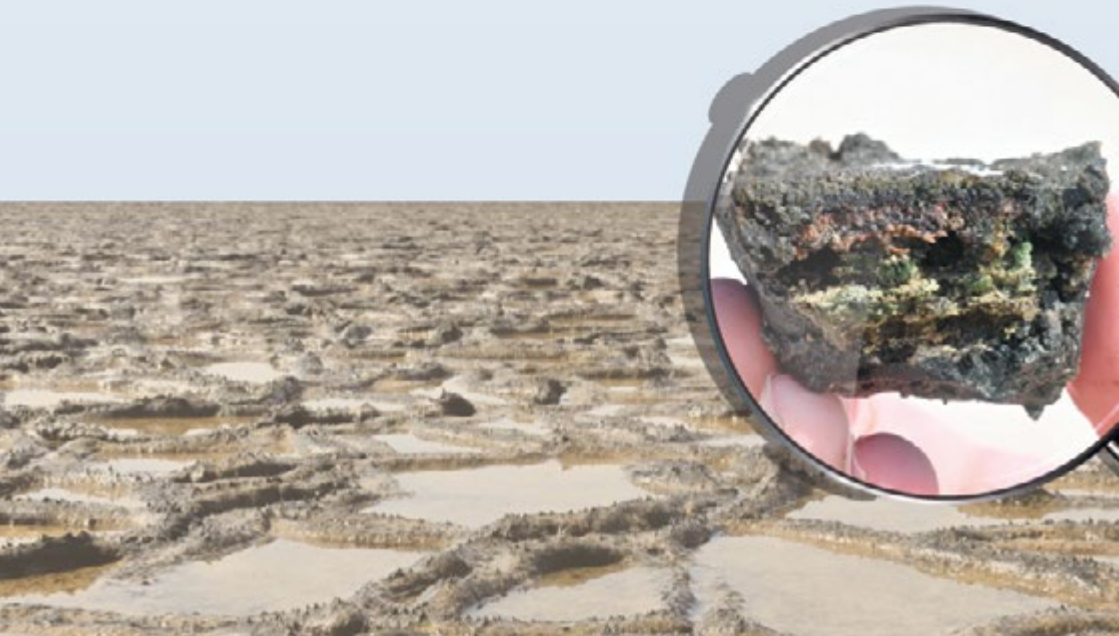
ExxonMobil

جامعة قطر
QATAR UNIVERSITY

The 2nd International Conference on Sabkha in Qatar

KEYNOTE AND INVITED SPEAKER'S BIOGRAPHY AND PRESENTATION SUMMARY

26-28 JANUARY, 2026



CONFERENCE AGENDA

DAY 1: MONDAY, 26 JANUARY, 2026

08:00 – 09:00	**Registration**
09:00 – 09:30	**Opening Session** • **Prof. Aiman Mahmood Erbad,** Vice President for Research and Graduate Studies, Qatar University • **ExxonMobil Representative** • **Prof. Hamad Al-Saad Al-Kuwari,** Director, Environmental Science Center
09:30 – 10:00	Coffee Break and photo exhibition
10:00 – 12:00	**Session 1: Biological and geological processes of the Sabkha system** **Keynote Speaker:** • **Fadhil Sadooni,** "Sabkha systems in space and time" **Speakers:** • **Raeid Abed,** "Limits of life: effects of saturation-level salinity on metabolic processes in microbial mats from coastal Sabkhas" • **Andre Antunes,** "Microbiology of Sabkhas of the Arabian Gulf and the Red Sea: From Biodiversity, to Biotechnology, and Astrobiology" • **Zulfa Al Disi,** "Microbial Controls on Carbonate and Sulfate Formation in Sabkha Environments"
12:00 – 13:00	Lunch
13:00 – 15:00	**Session 2: Modern Sabkha as analogs for ancient evaporate-carbonate systems** **Keynote Speaker:** • **Nora Noffke,** "The Sedimentary Record of Microbial Mats in Sabkhas – Archean to Modern" **Speakers:** • **Stefano Bernasconi,** "The preservation potential of the clumped isotope composition of poorly ordered dolomites to determine their origin in the sedimentary record" • **Martin Homann,** "Deciphering Archean Biosignatures: Modern Analogues Reveal the Role of Motile Bacteria in Tufted Microbial Mats" • **NAZAN YALÇIN ERIK,** "The Northern Extension of Arabian Plate Sabkha Systems: Evidence from the Cudi Group Evaporites, SE Türkiye"
19:00 – 21:00	Gala Dinner

CONFERENCE AGENDA

DAY 2: TUESDAY, 27 JANUARY, 2026

09:00 – 11:00	**Session 3: Dolomite problem advancement and challenges** **Speakers:** • **Daniel Petrash,** "Decoding dolomite: microbial mastery and abiotic alchemy across time" • **Mónica Sánchez-Román,** "Low-Temperature dolomite formation and biosignatures: Evidence from sabkha systems and laboratory experiments" • **Nereo Preto,** "Dolomites of the Dolomites and other Mesozoic sabkha depositional systems of Italy" • **Rajendran Sankaran** "Hyperspectral imaging and Spectroscopy of Carbonate minerals in the microbial mats of Arid Environment: Mapping Early Diagenesis and Dolomitization "
11:00 – 11:20	Coffee Break
11:20 – 13:30	**Session 4: Sabkhas as an analogue for extraterrestrial life** **Keynote Speaker:** • **Tomaso Bontognali,** "From the sabkhas of Qatar to Mars: modern analogs for biosignature formation and preservation" **Speakers:** • **Jorge Vago,** "Searching for Signs of Life with ExoMars Rosalind Franklin" • **Jean-Luc Josset,** "CLose-UP Imager (CLUPI) part of the science payload of the ExoMars Rover. First images results of Sabkhas Samples Observation using CLUPI Flight Model Representative" • **John Brucato,** "Sabkhas sulfates as analogues to preserve biomolecules on Mars" • **Nikolaus Kuhn,** "A Framwork for Tracking Sebkha Evolution With RPAV–Satellite Fusion for Environmental and Planetary Science"
13:55 – 14:40	Lunch
14:40 – 15:40	**Sabkha's future research trends –** panel discussion/closing session

CONFERENCE AGENDA

DAY 3: WEDNESDAY, 28 JANUARY, 2026

Full Day	**Field Trip to Khor Al Udeid Sabkha**

FADHIL SADOONI

Senior Energy Consultant,
Phoenix B+M, Auckland, New Zealand

PROFILE

Fadhil Sadooni is an independent senior energy consultant based in Auckland, New Zealand. Fadhil received a Ph.D. in petroleum geoscience from the University of Bristol, UK. He worked for 17 years in the petroleum industry in the Middle East and SE Asia. He started his career as a rig geologist drilling the Cretaceous carbonate reservoirs of northern Iraq. Fadhil also worked with Yarmouk University in Jordan and was the chairman of the Geology Department at the United Arab Emirates University between 2002 and 2006 and Qatar University between 1998-2001 and 2007-2025. He has published more than 90 papers in peer-reviewed journals and co-authored more than twelve books in Arabic and English on the different aspects of geology, including the Petroleum Geology of Iraq, published by the Scientific Press and the Geologic Evolution of Qatar and the Arabian Peninsula published by Springer Nature with more than 60 conference presentations. Fadhil has consulted many oil companies on hydrocarbon exploration in the Middle East. His present research focuses on geologic hydrogen, carbonate reservoir geomechanics, gas shale deposits of Eastern Arabia, microbial sediments, and life in extreme environments.

Web Link:
https://tinyurl.com/mvt5r82m

ABSTRACT

Sabkhas are significant cultural and ecological features in the Arabian Gulf region, forming an essential part of arid ecosystems such as those in the Arabian Peninsula. Historically, nomadic Bedouin communities relied on sabkhas as a source of salt for trade and used halophyte plants for food and medicine. Inland sabkhas mainly occur in the Interior Arabian Platform and are part of the Gypcrete Zone. Geological evidence shows sabkha-like environments dating back to the Proterozoic era, with microbial mats and evaporites forming under arid, hypersaline conditions. These environments reappeared throughout the Phanerozoic, often linked to greenhouse climates, and ancient carbonate-evaporite successions now serve as major hydrocarbon reservoirs, such as Qatar's Khuff Formation and Saudi Arabia's Arab Formation.

Modern sabkhas fringe the Arabian Gulf, Red Sea, Western Australia, and North Africa, providing excellent analogues for ancient evaporitic systems. Research has evolved from descriptive geomorphology in the 1960s–70s to multidisciplinary approaches involving stable isotope geochemistry, remote sensing, microbial genomics, and reactive transport modeling. These studies reveal sabkhas as active biogeochemical reactors where microbial activity drives carbonate and sulfate mineral formation, influencing global carbon and sulfur cycles.

Beyond sedimentology, sabkhas have gained importance in applied and planetary research. They are considered potential blue-carbon sinks due to organic trapping in hypersaline sediments and natural reactors for abiotic hydrogen generation. Their polygonal crusts and evaporitic minerals also serve as analogues for ancient Martian environments. Recent studies suggest sabkhas could generate white (geologic) hydrogen, while salinas are now used for green hydrogen production in Saudi Arabia, highlighting their role in sustainable energy and planetary science.

RAEID ABED

Head of the Department of Biology,
Sultan Qaboos University (SQU), Oman

PROFILE

Raeid M.M. Abed is a full Professor at and Head of the Department of Biology, Sultan Qaboos University (SQU), Oman. He completed his Ph.D. at the Max-Planck Institute for Marine Microbiology (MPIMM) in Bremen-Germany in 2001 on bioremediation of pollutants using cyanobacterial mats. After his Ph.D, he worked for 8 years at the Max-Planck Institute as a research scientist leading different international projects. He obtained several honors such as the Fellowship of Hanse Institute for Advanced studies in Germany, the Best Researcher and Best Teacher Awards at SQU, Oman and an award to establish his own "Research Study Group" in Germany. He was elected as an associate faculty member at the International Max-Planck Research School since 2015. Dr. Abed published more than 120 scientific papers in international peer-reviewed journals, 12 book chapters and edited a two-volumes book. He supervised 14 PhD and 40 MSc students. He serves as a reviewer for more than 40 international scientific journals.

Web Link:
https://tinyurl.com/yzsb3x57

LIMITS OF LIFE: EFFECTS OF SATURATION-LEVEL SALINITY ON METABOLIC PROCESSES IN MICROBIAL MATS FROM COASTAL SABKHAS

ABSTRACT

Hypersaline microbial mats are dense microbial ecosystems capable of performing complete element cycling and are considered analogs of early Earth and hypothetical extraterrestrial ecosystems. We studied the functionality and limits of key biogeochemical processes, such as photosynthesis, aerobic respiration, and sulfur cycling, in salt crust-covered microbial mats from a tidal flat at the coast of Oman. We measured light, oxygen, and sulfide microprofiles as well as sulfate reduction rates at salt saturation and in flood conditions and determined fine-scale stratification of pigments, biomass, and microbial taxa in the resident microbial community. The salt crust did not protect the mats against irradiation or evaporation. Although some oxygen production was measurable at salinities of #30% (wt/vol) in situ, at saturation-level salinity (40%), oxygenic photosynthesis was completely inhibited and only resumed 2 days after reducing the porewater salinity to 12%. Aerobic respiration and active sulfur cycling occurred at low rates under salt saturation and increased strongly upon salinity reduction. Apart from high relative abundances of Chloroflexi, photoheterotrophic Alphaproteobacteria, Bacteroidetes, and Archaea, the mat contained a distinct layer harboring filamentous Cyanobacteria, which is unusual for such high salinities. Our results show that the diverse microbial community inhabiting this salt flat mat ultimately depends on periodic salt dilution to be self-sustaining and is rather adapted to merely survive salt saturation than to thrive under the salt crust.

ANDRÉ ANTUNES

Dean of the Institute of Science and Environment,
University of Saint Joseph (Macau)

PROFILE

André Antunes is the Dean of the Institute of Science and Environment of the University of Saint Joseph (Macau). He is a leading expert in microbiology of marine and extreme environments, microbial diversity, and astrobiology, having specialized in deep-sea and high salinity locations.

His research career includes periods across Europe, Africa, Middle East, and Asia and extensive experience in international collaborations and sampling campaigns across the globe.

Web Link:
https://tinyurl.com/236e9vmk

Microbiology of Sabkhas of the Arabian Gulf and the Red Sea: From Biodiversity, to Biotechnology, and Astrobiology

ABSTRACT

This presentation will provide an overview on the microbiology of the Sabkhas of the Arabian Gulf and the Red Sea, centering on biodiversity, biotechnological potential and relevance for astrobiology.

Biodiversity: Sabkhas are very complex ecosystems with high concentrations of salts and heavy metals, high light intensity, low nutrient levels and fluctuations in temperature, pH and water. These environments are subject to an intricate interplay of physical, chemical and hydrodynamic factors, influencing the presence of organisms and their diversity. Sabkhas of the Arabian Peninsula have been the target of a few studies looking into their microbial diversity, mostly centered on coastal sabkhas and microbial mats. Representatives of Bacteria, Archaea and Eukarya can be found within the main layers of the mats. Eukaryotes and Archaea tend to be understudied.

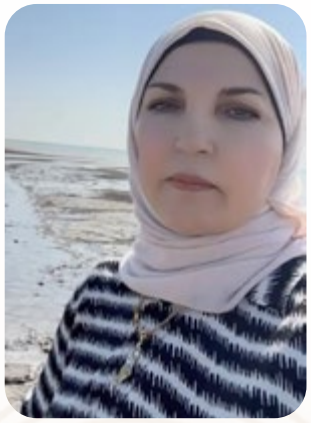
Biotechnology: Sabkhas on the Arabian Gulf and the Red Sea are a promising source of microbes for different applications but remain underexplored. Most bioprospection studies on these locations have been narrowly focused, looking at a specific application or a limited number of sites, yet they have provided some relevant results. It should be noted that bioprospection of sabkhas elsewhere points to an even wider biotechnological potential.

Astrobiology: Sabkhas are generally recognized as valuable terrestrial analogue sites, relevant for the study of evaporite-bearing Martian deposits and possible life on Mars. the study of such sites is seen as vital for 1) studying the limits of life, 2) retrieving new microbes for astrobiological exposure experiments, 3) analyzing long-term preservation and viability of biomolecules and microbes, 4) life-detection technology development and testing for space missions and 5) defining and refining planetary protection measures. Salt crusts in sabkhas can trap or cover and protect biological material, eventually preserving microbes, biomarkers or other evidence of life, making them particularly interesting to study.

ZULFA ALI AL DISI

Postdoctoral Researcher,
Environmental Science Center, Qatar University

PROFILE



Zulfa Ali Al Disi is a Postdoctoral Researcher at Qatar University's Environmental Science Center, specializing in geomicrobiology and mineral formation in extreme saline environments. Her research focuses on how halophilic bacteria and their extracellular polymeric substances (EPS) drive the formation of Mg-rich carbonates and low-temperature sulfate minerals in sabkha settings, with emerging work on microbial pigments as biomarkers. The outcomes of her research are published in high–impact factor peer-reviewed journals. Dr. Al Disi has co-supervised several undergraduate research projects, served as a judge in national school research competitions, and participated in numerous local and international scientific conferences. She is actively involved in QRDI-funded projects and collaborates with regional and global partners to advance the understanding of early diagenesis and microbial–mineral interactions in arid coastal systems.

Web Link:
https://tinyurl.com/58zrxz4k

Microbial Controls on Carbonate and Sulfate Formation in Sabkha Environments

ABSTRACT

Sabkhas are rare modern environments where we can still observe mineral processes that were likely common on early Earth. Extensive evaporation and high salinity create ideal conditions for the formation of carbonates, sulfates, and other evaporite minerals. These minerals—particularly dolomite and anhydrite—form in close association with microbial communities that survive in these extreme settings, often developing thick microbial mats that influence the surrounding sediments. This presentation offers an overview of how bacteria and their extracellular polymeric substances (EPS) contribute to two major mineral pathways in Qatar's sabkhas: the formation of Mg-rich carbonates and the low-temperature development of anhydrite. Our work shows that halophilic bacteria and their EPS generate microenvironments with chemical conditions that facilitate the formation and stabilization of high-Mg calcite and proto-dolomite—processes that naturally occur within sabkha environments. A comparable influence is evident in the sulfate system. Organic compounds and EPS appear capable of supporting gypsum-to-anhydrite transitions at temperatures much lower than the ~80 °C typically required for dehydration under purely thermal conditions. This provides new insight into how anhydrite may develop at or near the surface today, and how similar processes could have operated in ancient sabkha deposits. We also introduce early results on microbial pigments as potential sabkha biomarkers, which may help identify biological activity and environmental gradients in both modern and ancient settings—and even contribute to interpretations of evaporitic minerals detected on Mars.

NORA NOFFKE

Professor of Sedimentology and Paleontology,
Old Dominion University, Ocean and Earth Sciences, Norfolk, Virginia, USA,

PROFILE

Nora Noffke is a professor of sedimentology and paleontology at Old Dominion University, Virginia, USA. Her research is on microbially induced sedimentary structures in clastic sedimentary record, modern and fossil. Noffke has studied at the Geological-Paleontological Institute of the University Tübingen in Germany, where she worked with Dolf Seilacher on her Diploma thesis on Ordovician trace fossils. Her PhD thesis, supervised by Gisela Gerdes and Wolfgang Krumbein, University of Oldenburg, focused on the exploration of microbial mat structures in the North Sea tidal flats. Noffke became visiting professor at the Geological Department of the University of Frankfurt/M., where she described the first fossil structures of this type.

She continued her studies as guest researcher of Andrew Knoll, at Harvard University, before joining the faculty at Old Dominion University.

Web Link:
https://ww2.odu.edu/~nnoffke/

A Framwork for Tracking Sebkha Evolution With RPAV–Satellite Fusion for Environmental and Planetary Science

ABSTRACT

Sabkhas are shaped by unique sedimentary and hydrological dynamics, including erosion, deposition of detrital grains, and precipitation or dissolution of salts. Their hydrology is marked by subaerial exposure, desiccation, saline groundwater oscillation, and rare rainfall. Microbial mats dominated by cyanobacteria colonize large areas, forming structures that have existed since the Archean, as evidenced by fossil records.

Modern sabkhas feature microbial mats several centimeters thick, alternating with clastic layers from wind-blown sand during dry periods. These mats often display polygonal cracks caused by shrinkage and expansion under changing moisture conditions, and in prolonged arid phases, salt crystallization creates cauliflower-like petees. Extended desiccation can lead to mat fragmentation and redeposition by wind, while temporary water pooling produces tufted mats as a stress response to salinity or gas release.

Similar microbial mat structures are preserved in ancient formations such as the 2.8 Ga Sinqueni Formation and the 3.48 Ga Dresser Formation, which record environmental shifts from humid to semi-arid climates. These fossilized mats, along with associated features like mat chips and erosional remnants, serve as indicators of early shoreline sabkha environments and provide key insights into Paleoarchean ecosystems.

STEFANO BERNASCONI

Professor in the Department of Earth and Planetary Sciences,
ETH Zürich, Geologisches Institut, Zürich, Switzerland

PROFILE

Stefano Bernasconi is Professor in the Department of Earth and Planetary Sciences of ETH Zürich. His research focuses on the applications of stable and clumped isotopes to reconstruct past climate, diagenesis and tectonic evolution of mountain chains.

Over the years he has strongly promoted interdisciplinary research at the interface between geology and biology with numerous joint projects and students with environmental scientists, microbiologists, ecologists, plant- and soil scientists. Currently one of the major focuses is the application of carbonate clumped isotopes for paleoclimate reconstructions from foraminifera and coccoliths in marine sediments and from paleosols. In addition, he is using clumped isotopes to study diagenesis and burial history of sedimentary basins, tectonics and processes of dolomitisation.

Web Link:
https://tinyurl.com/dxrrmzvd

THE PRESERVATION POTENTIAL OF THE CLUMPED ISOTOPE COMPOSITION OF POORLY ORDERED DOLOMITES TO DETERMINE THEIR ORIGIN IN THE SEDIMENTARY RECORD

ABSTRACT

The clumped isotope composition of dolomite can be used to determine the temperature of formation and the isotopic composition of the fluids from which it precipitates. One of the natural samples used for the determination of the temperature dependence of the clumped isotope thermometer at low temperatures was from the the Dohat Faishakh Sabkha in Qatar. Modern early diagenetic sabkha dolomites, however, are generally poorly ordered, thus it is not clear if their original clumped isotope temperature is preserved in the geological record. In this contribution we will discuss heating experiments designed to determine the preservation potential of the clumped isotope composition of dolomite at higher temperatures. With these data we aim at improving the reconstruction of the precipitation conditions of evaporite-related dolomites in the geological record.

MARTIN HOMANN

Senior Geoscientist and Senior Research Fellow
Amentum, Harwell, England, United Kingdom

PROFILE

Martin Homann received his MSc in Geology from the University of Potsdam, Germany, in 2010 and his PhD in Geobiology from the Free University of Berlin, Germany, in 2016. After three years of postdoctoral research at the University of Western Brittany in France, he worked as an Assistant Professor in Sedimentology at University College London until the end of 2022. Following a brief appointment as a Visiting Associate at the California Institute of Technology from 2023 to 2024, he became a Research Investigator at the Blue Marble Space Institute of Science in 2025 and currently also works as Senior Consultant for Amentum Clean Energy Ltd.

His research focuses on the Archean biosphere—specifically, the environments where microbial life thrived billions of years ago and the morphological and geochemical traces it left behind in Earth's oldest sedimentary archives. He uses a multidisciplinary approach that combines field-generated data with lab-based observations, experiments, and geochemical analysis.

Web Link:
https://tinyurl.com/2j9fxyju

Deciphering Archean Biosignatures: Modern Analogues Reveal the Role of Motile Bacteria in Tufted Microbial Mats

ABSTRACT

Tufted microbial mats and reticulate ridges are among the earliest morphologically distinctive biosignatures in the Archean rock record. However, the mechanisms controlling their formation remain poorly understood. To address this, we combine observations of modern tufted microbial mats from hypersaline and sabkha environments of Tunisia with field data from tufted mats in the 3.22 Ga Moodies Group and stromatolites of the 3.42 Ga Witkop Formation (Kaapvaal Craton, South Africa). Our analysis demonstrates that the co-occurrence of these specific features is a robust indicator of the former presence of motile, filamentous bacteria. These findings provide a clearer model for the formation of some of Earth's earliest biosignatures and offer a new framework for identifying similar evidence of life in extraterrestrial sediments, such as those on Mars.

NAZAN YALÇIN ERIK

Professor and Head of Department,
Department of Geological Engineering, Sivas, Turkey

PROFILE

Prof. Dr. Nazan Yalçın Erik has been serving as a Professor at the Department of Geological Engineering, Sivas Cumhuriyet University (Türkiye), since 2021. She received her Ph.D. degree in 2002 from the same university, with a dissertation focused on evaporitic deposits and marine carbonate depositional systems within the Southeastern Anatolia petroleum province (Türkiye), located along the northern margin of the Arabian Plate. Building upon nearly two decades of accumulated scientific experience derived from this foundational research, she published the book Petroleum and Evaporites in 2022. In addition, she has authored six other scientific books addressing various aspects of energy and energy resources.

Throughout her 31-year academic career, Prof. Yalçın Erik has specialized in petroleum geology, organic geochemistry, sedimentary basin analysis, energy systems, and sustainable energy studies. She has participated in numerous national and international research projects focusing on both conventional and unconventional energy systems, including petroleum, natural gas, coal, and shale gas.

With over 130 peer-reviewed publications and conference papers, she actively supervises graduate and doctoral theses, engages in academia–industry collaborations, and regularly contributes to international scientific symposia.

Web Link:
https://avesis.cumhuriyet.edu.tr/nyalcin

THE NORTHERN EXTENSION OF ARABIAN PLATE SABKHA SYSTEMS: EVIDENCE FROM THE CUDI GROUP EVAPORITES, SE TÜRKIYE

ABSTRACT

Evaporitic successions across the Arabian Plate play a critical role in petroleum geology, acting both as regional seal formations and as diagenetically modified reservoir analogues. Although dolomite is the dominant reservoir lithology in eastern Arabia, the Triassic–Jurassic equivalents along the northern margin of the Arabian Plate have remained poorly understood. This study provides a detailed petrographic and sedimentological characterization of the Cudi Group evaporites in southeastern Turkey and demonstrates that this succession represents the northern extension of the Arabian sabkha–evaporitic system.

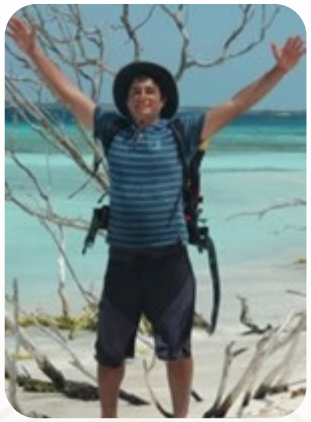
The Cudi Group consists of alternating dolomite and anhydrite beds. Petrographic thin-section and XRD analyses from six subsurface wells between Nusaybin and Cizre reveal typical sabkha-type facies, including dolomicrite, dolosparite, laminated anhydrite, algal laminations, fecal pellets, and stylolitic textures. High dolomite (60–85%) and anhydrite (10–35%) contents indicate intense evaporative dolomitization during early diagenesis.

These features show strong facies and diagenetic similarities with the Kurra Chine, Butmah, and Adaiyah formations in Iraq, the Mus Formation in Syria, the Mohilla Formation in the Levant, and the Khuff Formation in Qatar. Therefore, the Cudi Group can be regarded as the northern stratigraphic equivalent of the sabkha–evaporitic system that developed across the Arabian Plate since the Permian–Triassic. Furthermore, beyond the scope of the classical “sabkha sequence” model, the Cudi succession reveals more complex depositional and diagenetic processes. These results highlight the continuity of evaporitic environments across the Arabian Plate and emphasize the scientific and strategic importance of the Cudi Group for understanding the regional evolution of evaporitic basins and hydrocarbon systems.

DANIEL PETRASH

Research Scientist,
Czech Geological Survey, Prague, Czech Republic

PROFILE



Dr. Daniel Petrash is a geochemist specializing in sediment-water interface processes and microbial metal cycling. His research bridges the gap between modern biogeochemistry and deep-time sedimentary records, with a specific focus on carbonate authigenesis and redox dynamics. By integrating field studies of modern analogues with experimental modeling, he investigates how microbial metabolism drives mineral nucleation in aquatic environments. His current work explores sustainable metal recovery in post-mining landscapes and deciphers the cryptic geochemical mechanisms responsible for ancient dolomite formation.

Web Link:
https://cgs.gov.cz/en/personal/daniel-petras

DECODING DOLOMITE: MICROBIAL MASTERY AND ABIOTIC ALCHEMY ACROSS TIME

ABSTRACT

The massive abundance of dolomite in the Precambrian and Paleozoic rock record contrasts sharply with its scarcity in modern oceans—an enduring geological enigma known as the “Dolomite Problem.” While microbial activity is widely recognized as a prerequisite for low-temperature nucleation, the specific mechanisms that overcome the high kinetic barrier of magnesium hydration remain debated. This uncertainty obscures our ability to confidently link ancient platform dolomitization to planetary biogeochemical cycles. This presentation addresses this kinetic paradox by focusing on a mehcanisms that may be active in the Sabkha setting—Earth’s premier natural laboratory for episodic, low-temperature dolomite authigenesis. Moving beyond traditional evaporation-reflux models, we explore a cryptic biogeochemical “switch” that catalyzes mineralization: manganese (Mn) redox cycling. New experimental data demonstrates that coupling Mn-redox cycling with carboxyl functionalization (mimicking EPS-rich sabkha mats) creates a kinetically facile pathway for dolomite growth. We propose that a metastable Mn-rich template (pseudo-kutnohorite) forms during early diagenesis, circumventing the hydration barrier and facilitating the subsequent epitaxial growth of ordered dolomite. In the unique redox-stratified environment of the Sabkha, where microbial respiration constantly recycles metals, this mechanism acts as a biocatalyst, accelerating Mg uptake by over 60%. By deciphering these pathways, we can refine our interpretation of Sabkha-style dolostones and better understand the deep-time paragenesis of the fabric-retentive dolomites that dominate Earth’s history.

MÓNICA SÁNCHEZ-ROMÁN

Distinguished Professor at Department of Mineralogy and Petrology,
University of Granada, Granada, Spain

PROFILE

Mónica Sánchez-Román is a Distinguished Professor at the University of Granada (Spain) and Visiting Professor Fellow at Vrije Universiteit Amsterdam (The Netherlands), where she leads the Geobiology Group. Her research focuses on the geobiology and geochemistry of low-temperature carbonate formation, with particular emphasis on the long-standing "dolomite problem". She investigates how microbial activity, organic–inorganic interactions and geochemical conditions influence dolomite nucleation, crystal ordering and mineralogical transitions in modern and ancient environments, using an integrated approach that combines fieldwork with controlled laboratory experiments. Her work has provided new insights into the role of microorganisms in dolomite formation, the isotopic signatures of Mg-rich carbonates and their potential as biosignature archives on Earth and Mars.

Web Link:
https://www.ugr.es/en/staff/monica-sanchez-roman

Low-Temperature dolomite formation and biosignatures: Evidence from sabkha systems and laboratory experiments

ABSTRACT

Dolomite and other Mg-rich carbonates are widespread in the sedimentary record and have recently been identified on Mars, yet their low-temperature origin remains a long-standing problem in sedimentary geochemistry. At the same time, these minerals may preserve key biosignatures of early life and of extreme environments.

In this contribution, I will present an integrated approach that combines field studies in modern and ancient sabkha systems with carefully controlled laboratory experiments to investigate how microbial activity, inorganic–organic interactions and fluctuating geochemical conditions control the composition and ordering of low-temperature dolomites and related carbonates.
Using a combination of mineralogical and geochemical tools, we show that microorganisms can imprint distinctive geochemical signatures compared to purely inorganic precipitation. Mg- and Fe-rich carbonates emerge as robust proxies of biological activity and redox conditions, with important implications for constraining the environments in which terrestrial and martian carbonates may have formed.

These results help to narrow the "dolomite problem" by linking crystal chemistry, microbial processes and environmental parameters, while also framing low-temperature dolomites as promising archives for the detection of ancient life in both Earth and planetary contexts.

NEREO PRETO

Associate Professor,
Department of Geosciences, University of Padova, Italy

PROFILE

Web Link:
https://tinyurl.com/yc73bk8f

Nereo Preto is associate professor at the University of Padova, a more than 800 years old institution in Italy. His main research topics are the stratigraphy and sedimentology of carbonate platforms, the isotopic geochemistry, petrology and diagenesis of carbonates, and Triassic paleoclimatology. He has been studying the Dolomites since 1998.

ABSTRACT

The geology of Italy features abundant and well preserved Mesozoic carbonate platform successions, that make up the backbone of the Southern Alps, Apennines and Sicily. Dolomite is common throughout this pile of Mesozoic carbonates, and most importantly in the Triassic platform carbonates of north-eastern Italy that make up the UNESCO natural world heritage property of the Dolomites. The Dolomites got their name from the mineral dolomite, which was firstly identified in rocks from Southern Tyrol (former name of the Dolomites).

Despite the Dolomites are renown for being made of dolomite, properties of the different dolomites, and their relative processes of dolomitization or precipitation are severely understudied. Early work focused on the discordant dolomite bodies of the late Anisian Latemar Platform in the western Dolomites, and on the fabric-retaining fine grained dolomite of the Carnian-Raethian Dolomia Principale (Hauptdolomit) formation, but there is more to dolomite than this two case studies. In fact, many of the most iconic landscapes of the Dolomites, featuring breathtaking walls and peaks, are built on dolomite which origin has never been assessed adequately.

A review of the occurrence of dolomite in the Dolomites, and in the wider succession of Mesozoic platform carbonates of Italy, is presented here. It could be argued that in many instances, dolomite formed by mechanisms similar to the sabkha model of dolomitization, or at least should be associated to the establishment of sabkha depositional environments. The stratigraphic distribution of dolomite in Italian Mesozoic platform carbonates carry information about their paleogeographic position, and about the climate under which dolomite was precipitated.

RAJENDRAN SANKARAN

Research Associate,
Environmental Science Center, Qatar University

PROFILE

Rajendran Sankaran is a researcher at the Environmental Science Center, Qatar University. He has conducted several research projects in the applications of remote sensing and HSI techniques to earth and environmental resources in collaboration with international universities and research institutions. He published more research papers in peer-reviewed journals, edited volumes, organized seminars and workshops, and conducted training in remote sensing techniques. He is a reviewer of more than 15 journals of Elsevier and Springer in remote sensing applications. He is a Guest Editor of 'The Use of Hyperspectral Remote Sensing Data in Mineral Exploration' and 'New Approaches in High-Resolution SAR Imaging' Remote Sensing (IF 4.1) journal; and Geo-Spatial and AI Techniques: Advancements in Earth and Environmental Resource Applications. Sustainability (IF 3.3) journal. He is an Editorial Member of 'International Journal of Image and Data.

Web link:
https://tinyurl.com/mw64zub6

Hyperspectral Imaging Spectroscopy of Carbonate Minerals in the Microbial Mats of an Arid Environment: Mapping Early Diagenesis and Dolomitization

ABSTRACT

Hyperspectral imaging (HSI) spectroscopy is a non-destructive and high-resolution technique that can map minerals and organics in sabkhas at cm to mm scale. The technique detects spectral characteristics of pigments, minerals and organic carbon, differentiates between carbonate polymorphs, and identifies pigments (chlorophyll, carotenoids, and phycobiliproteins) present in the microbial mat layers. HSI maps the spatial distribution of precursor carbonates (aragonite, high-Mg calcite) and dolomite and helps model the fluid flow and conditions (evaporation, microbial sulfate reduction) that drive the important dolomitization process. In this study, 16 samples of microbial mats from two coastal sabkhas in Qatar—Khor Al Adaid and Dohat Faishakh were imaged in the VNIR wavelength region (400 to 1000 nm wavelengths at 1600 spatial pixels in 447 spectral bands with 1.9 spectral resolution) using a Pika XC2 HSI camera (Resonon, USA), and collected reflectance spectra in the SWIR wavelength region (1300 to 2500 nm at 7 nm spectral resolution) using a PIMA spectrometer (Spectronics, Japan). The interpretation of the HSI-derived spectral plot of mat layers showed the presence of chlorophyll-a (in blue region near ~430 nm), carotenoids and purple sulfur bacteria (Bacteriochlorophyll b) (absorptions at 550 nm and 850 nm), minerals anhydrite (absorptions near 1400 nm and 1940 nm), gypsum (absorptions near ~2130 and 2170 nm), and carbonates including calcites, aragonites, and dolomites (absorptions near ~2340 nm, ~2335 nm, and ~2320 nm respectively) and organic matter (absorption from 450 to 700 nm). Mapping of microbial mats was carried out by studying spectral band absorptions and determining endmember abundances using spectral unmixing algorithms and Spectral Angle Mapper (SAM) algorithm. SAM results showed the spatial distribution and interrelationship among minerals and pigments to understand early diagenesis and dolomitization in the microbial mats of arid environment. All the results of HSI are validated by Raman spectroscopy, X-ray diffraction (XRD), and total organic carbon (TOC) analyses. The laboratory and field HSI of sabkha samples can guide the interpretation of data from planetary spectrometers (e.g., on Mars rovers), looking for combined mineralogical (carbonates, evaporites) and potential biosignatures.

TOMASO BONTOGNALI

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PROFILE

Tomaso Bontognali is a geobiologist with extensive field experience in the sabkhas of Qatar, where he investigates microbe–mineral interactions and the formation of biosignatures relevant to early life on Earth and the search for life on Mars. He is primarily based at the Space Exploration Institute in Neuchâtel (Switzerland), and also holds positions as Lecturer at the University of Basel and Adjunct Professor at Qatar University. He obtained his PhD from ETH Zurich and conducted postdoctoral research at the California Institute of Technology. His work integrates field studies in modern and ancient analog environments, laboratory experiments on microbially induced mineralization, and geochemical analyses of Archean rocks. In particular, he is an expert in biomineralization processes catalyzed by microbial extracellular polymeric substances (EPS) and in the formation of dolomite at low temperatures. He is currently involved in the preparation of the ExoMars Rosalind Franklin Rover Mission led by ESA, whose primary goal is to search for evidence of past life on Mars.

Web Link:
https://tinyurl.com/2e5epemh

From the sabkhas of Qatar to Mars: modern analogs for biosignature formation and preservation

ABSTRACT

The aim of this contribution is to illustrate how the coastal sabkhas of Qatar are of major interest for the field of astrobiology, as they represent modern terrestrial analogs for investigating processes related to the origin, preservation, and detection of biosignatures on Mars. Although the surface of present-day Mars is considered inhospitable, results from orbital and rover-based missions suggest that liquid water was present on its surface in the past and that evaporitic minerals—similar to those forming in terrestrial sabkha systems—were widespread. Beyond the presence of mineralogical analogs, early Mars and sabkhas are also hypothesized to share biological similarities. Indeed, the ecological stress imposed by rapid and large fluctuations in salinity restricts life mainly to primitive microbial communities, resembling the type of hypothetical life forms that may have inhabited early Mars. The Qatari sabkhas therefore provide exceptional natural laboratories to investigate microbe–mineral interactions under extreme physicochemical conditions, where high salinity and intense evaporation dominate sedimentary processes.

An overview is presented of more than ten years of multidisciplinary research conducted in the Dohat Faishakh and Khor Al Adaid sabkhas in Qatar, focusing on microbially induced sedimentary structures (MISS), microbial biominerals whose formation is tightly linked to extracellular polymeric substances (EPS), and organic biomarkers preserved within evaporitic mineral phases. These findings provide critical insights into the types of biosignatures that may be detectable on Mars and directly support the scientific rationale and operational strategies of current and future robotic missions dedicated to the search for past life on the Red Planet.

In light of their scientific uniqueness and irreplaceable value as natural laboratories, Qatari sabkhas call for dedicated strategies of protection and long-term preservation.

JORGE VAGO

ExoMars Project Scientist,
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PROFILE

Jorge Vago was born in 1962 in Buenos Aires, Argentina. He obtained a Bachelor of Engineering and Electrical Engineering degrees at the Instituto Tecnológico de Buenos Aires (ITBA). In 1986 he enrolled in Cornell University (Ithaca NY, USA), where he completed a Master of Engineering in Applied Physics and a Ph.D. in Space Plasmas and Planetary Physics. Since 1992, he is with the European Space Agency in the Netherlands. Initially, he started working on multi-point plasma turbulence analysis in support of the Cluster mission. This was followed by a few years of project management, mainly developing physics experiment laboratories for Russian capsules (on fluid physics under microgravity) and for the International Space Station (on planet formation processes). Jorge is ESA's ExoMars Project Scientist. He is the interface for the investigator communities interested in the ExoMars Programme, particularly on the Rosalind Franklin rover mission, tasked with searching for signs of possible martian life. He also helps with other ESA activities in the international Mars exploration context, such as the Mars Sample Return mission. In addition, his work includes representing the ExoMars science objectives at programmatic level and contributing to science mission and payload definition.

Web Link:
https://tinyurl.com/c6nrs6mk

ABSTRACT

The search for life beyond Earth remains one of the most significant scientific pursuits of our time. Since its inception in 2002, the ExoMars program has been driven by a single question: Was there ever life on Mars? Every aspect of its design has been shaped to achieve this goal, particularly in the development of the Rosalind Franklin rover. To enable the detection of physical and chemical signs of past life, the mission incorporates a two-meter drill to access subsurface samples, a carefully selected scientific payload, strict criteria for choosing a landing site with high scientific potential, and a coordinated exploration strategy that ensures the rover and its instruments work together effectively. The Rosalind Franklin Mission (RFM) builds upon the ExoMars 2022 mission in collaboration with NASA. It is scheduled for launch in late 2028, with landing at Oxia Planum expected in 2030.

JEAN-LUC JOSSET

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PROFILE

Dr. Jean-Luc Josset is a planetary scientist and co-founder of the Space Exploration Institute (Neuchatel, Switzerland). He has contributed to missions including Rosetta, Huygens/Cassini, SMART-1, and JAXA's Kaguya, leading the AMIE camera on SMART-1 and developing micro-cameras for Rosetta's lander. Awarded by the International Astronomical Union in 2005, asteroid 18112 JeanlucJosset bears his name.

He currently serves on EANA's Executive Committee, chairs the 2026 European Astrobiology Conference, and is Principal Investigator of CLUPI on ESA's ExoMars rover, scheduled for launch in 2028.

Web Link:
https://www.researchgate.net/profile/Jean-Luc-Josset

SABKHAS SULFATES AS ANALOGUES TO PRESERVE BIOMOLECULES ON MARS

ABSTRACT

Mars 2020 and ExoMars missions aim to detect organic compounds, but harsh conditions—UV radiation, ionizing particles, and reactive minerals—threaten their stability. Minerals can both preserve and degrade organics, making subsurface environments the most promising for protection.

To support ESA's Rosalind Franklin rover, researchers study molecule-mineral interactions under simulated Martian conditions, testing the photostability of carboxylic acids, amino acids, and PAHs in sulfate-rich analog samples.

Investigations in Qatar's Khor Al Udeid Sabkha, a terrestrial analogue, assess whether sulfates offer photoprotection. These findings guide the search for life in ancient Martian environments, especially at Gale Crater, Jezero, and Oxia Planum.

JOHN BRUCATO

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PROFILE

John Robert Brucato is Research Director at the INAF Arcetri Astrophysical Observatory in Florence, Italy, and an Adjunct Professor of Astrobiology in the Department of Physics and Astronomy at the University of Florence. He specialises in astrobiology, focusing on the search for signs of life in the Solar System and the study of extraterrestrial material. He oversees the astrobiology laboratory at the Arcetri Observatory, where the chemical and physical interactions between mineral surfaces and biomolecules are examined under simulated space conditions. He is founder and Vice-President of the European Institute of Astrobiology and sits on several NASA and ESA scientific committees responsible for planning and evaluating space exploration programmes. He is involved in NASA's OSIRIS-REx mission, which aims to collect primitive, carbon-rich samples from asteroid 1999 RQ36 Bennu and return them to Earth, and in the ExoMars Rosalind Franklin rover mission, which is being carried out by the European Space Agency (ESA). He is also involved in NASA's Mars2020 – Perseverance mission, which aims to search for signs of life on Mars. In 2021, the International Astronomical Union named asteroid 2000 HP70 after him in recognition of his scientific achievements.

Web Link:
https://tinyurl.com/am6ruw7d

SABKHAS SULFATES AS ANALOGUES TO PRESERVE BIOMOLECULES ON MARS

ABSTRACT

The search for organic compounds is a central goal of the Mars 2020 and ExoMars missions. Minerals and salts on Mars play a dual role: they can preserve organic matter over geological timescales while also promoting its degradation. The planet's thin atmosphere exposes the surface to ionizing particles and UV radiation, which severely affects molecular stability. Evidence from Earth suggests that minerals such as sulphates, clays, and carbonates aid in preserving biosignatures, making the Martian subsurface—shielded from radiation—the most promising location for organic preservation.

To support the Rosalind Franklin rover's mission, researchers are studying how Martian-like minerals interact with organic molecules under radiation. These interactions depend on the specific molecules and mineral surfaces involved. Understanding these processes is essential for identifying the best targets on Mars. In this study, we tested the photostability of carboxylic acids, amino acids, and polycyclic aromatic hydrocarbons (PAHs) in simulated Martian conditions using sulphate-rich samples. Additionally, we examined salt deposits and microbial communities in Qatar's Khor Al Udeid Sabkha, a terrestrial analogue, to assess the role of sulphates in photoprotection. These findings will guide the search for life in ancient Martian environments, particularly in regions like Gale Crater, Jezero, and Oxia Planum.

NIKOLAUS KUHN

Professor of Physical Geography and Environmental Change,
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PROFILE

Prof. Nikolaus J. Kuhn is a Professor of Physical Geography and Environmental Change at the University of Basel, specializing in soil erosion, geomorphology, and planetary surface processes. He holds a PhD in Geography from the University of Toronto and a Diplom in Applied Physical Geography from the University of Trier. His career spans roles at leading institutions in Canada, the UK, USA, and Switzerland. He has authored around 100 peer-reviewed publications (h-index 41, over 5,300 citations) and secured approximately CHF 3 million in research funding, including projects with ESA, SNF, and international collaborations. Prof. Kuhn actively teaches at all academic levels, supervises numerous PhD students, and serves as editor for major journals such as Catena and Soil. He has chaired scientific societies, organized international conferences, and contributed to planetary exploration initiatives like ExoMars. His awards include the Government of Canada PhD research award and the Minerva Postdoctoral Fellowship.

Web Link:
https://tinyurl.com/mrxu454e

A Framwork for Tracking Sebkha Evolution With RPAV–Satellite Fusion for Environmental and Planetary Science

ABSTRACT

Sebkhas, both inland and coastal, are distinctive saline environments whose geomorphology, mineralogy, and surface textures make them valuable analogues for interpreting past aqueous processes on Mars. Features such as evaporitic mineral deposits, polygonal cracking, and desiccation-induced microtopography closely resemble landforms observed in Martian basins, positioning sebkhas as natural laboratories for planetary science. At the same time, these environments on Earth—especially coastal sebkhas—are increasingly vulnerable to climate-driven pressures including sea-level rise, shifting precipitation patterns, and more frequent extreme events. Such changes affect sedimentation dynamics, hydrological connectivity, and the development of salt crusts, underscoring the need for detailed, repeatable environmental monitoring.

Remotely Piloted Aerial Vehicles (RPAVs) offer high-resolution imagery and digital surface models capable of detecting fine-scale geomorphological and ecological variations within sebkhas. When merged with satellite data, which provide broader spatial context and long-term temporal records, a multi-resolution monitoring framework emerges. In this study, RPAV datasets are co-registered with satellite-derived indices and elevation products to validate surface classifications, quantify landscape transformation, and upscale localized observations to regional trends. This fusion enhances change detection and improves the interpretation of both modern and analogue-relevant surface processes.

By integrating RPAV and satellite remote sensing, the research establishes a generalizable approach for assessing environmental transformation in climate-sensitive coastal sebkhas while simultaneously refining our understanding of comparable Martian landscapes. The combined methodology supports improved environmental management on Earth and strengthens the interpretive frameworks used in planetary exploration.

Contact ESC

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