جامعة قطر
QATAR UNIVERSITY

International Conference on Sabkha in Qatar

Keynote and Invited Speaker's Biography and Presentation Summary

16-18 January, 2023

Qatar University,
Research Complex (H10), Auditorium

Qatar National Research Fund
Member of Qatar Foundation

ExxonMobil

QATAR AIRWAYS القطرية

DAY 1
CONFERENCE AGENDA

DAY 1: MONDAY, 16 JANUARY, 2023

08:00 – 09:00	Registration
09:00 – 09:30	Opening Session • **Dr. Hassan Al-Derham,** President, Qatar University • **Mr. Jagir Baxi,** Vice President and Ventures Manager at ExxonMobil • **Prof. Hamad Al-Saad Al-Kuwari,** Environmental Science Center Director
09:30 – 10:00	Coffee Break and picture exhibition
10:00 – 12:00	**Session I: General overview of the Sabkha in Qatar** **Moderator:** Saeed Al Meer **Keynote Speaker:** • **Tomaso Bontognali,** "The sabkhas of Qatar: a treasure for scientific research" **Speakers:** • **Zulfa Al-Disi,** "Exploring the role of microbially-produced organic molecules in formation of Mg-rich carbonate minerals" • **Rajendran Sankaran,** "Salinity and temporal stability of an inland sabkha of the State of Qatar" • **Judith McKenzie,** "Coastal Sabkhas of Qatar: Nature's Laboratory for the Study of Biogeochemical Processes in Hypersaline Environments"
12:00 – 13:00	Lunch
13:00 – 15:00	**Session 2: The dolomite problem** **Moderator:** PJ Moore **Keynote Speaker:** • **Maurice Tucker,** "Dolomite: is it still a problem? Still some issues but microbes part of the answer " **Speakers:** • **Adrian Immerhauser,** "The 'Dolomite Problem' - A personal view" • **Maria Mutti,** "Strata-bound dolomite and stratigraphic patterns" • **Peter Swart,** "Hypersaline Origins of Bahamian Dolomites: Evidence from New Geochemical Proxies"
15:00 – 16:00	Coffee break and Poster competition

DAY 2
CONFERENCE AGENDA

DAY 2: TUESDAY, 17 JANUARY, 2023

08:00 – 10:00	**Session 3: Microbial ecology in extreme evaporitic environments** **Moderator:** Radhouane Ben Hamadou **Keynote Speaker:** • **Dimtri Meier,** "Thriving or surviving? Survival strategies and limitation of physiological processes in a microbial mat at salt saturation" **Speakers**: • **Nabil Zouari,** "Understanding the biodiversity of bacterial adaptation in hypersaline evaporitic environments of Qatar Sabkhas" • **Raeid Abed,** "Structural-Functional analysis of extremely hypersaline microbial mats from the Arabian Peninsula" • **Samir Jaoua,** "Investigation and Application of Local Qatari Microbial resources for the Biological Control of pathogenic Bacteria, Insects and Mycotoxigenic Fungi"
10:00 – 10:20	Coffee Break
10:20 – 11:55	**Session 4: The sabkha as a natural laboratory to understand the formation of hydrocarbon reservoirs** **Moderator:** Sophia Ghanimeh **Keynote Speaker:** • **Fadhil Sadooni,** "Dolomites from the Carbonate-Evaporite strata of the Permian – Jurassic of Eastern Arabia" **Speakers:** • **Mahmoud Ashour,** "Sabkhas in Qatar Peninsula" • **Crisogono Vasconcelos,** "Coupled silica and carbon cycles in hypersaline Environment, possible phage processes to mineralization"

DAY 3
CONFERENCE AGENDA

DAY 3: WEDNESDAY, 18 JANUARY, 2023

08:00 – 10:00	**Session 5: The sabkhas of Qatar as a modern analogue for the study of early life** **Moderator:** Fadhil Sadooni **Keynote Speaker:** • **Martin Van Kranendonk,** "The sabkhas of Qatar as a modern analogue for the study of early life in the 3.4 billion-year-old Strelley Pool Formation of the Pilbara Craton, Australia and the search for life on Mars" **Speakers:** • **Maria Dittirch,** "Biomineralization within microbial mats during a transition from anoxygenic to oxygenic photosynthesis" • **Jassim Al-Khayat,** "Exploring the potentiality of Qatar coastal sabkhas to store organic carbon" • **Kirstin Bergmann,** "Sabkhas in the Neoproterozoic: Records of dolomite formation, climate, and microbial life"
10:00 – 10:20	Coffee Break
10:20 – 12:20	**Session 6: The sabkhas of Qatar as Terrestrial analogues for the search of life on Mars** **Moderator:** Tomaso Bontognali **Keynote Speaker:** • **Jean-Luc Josset,** "The ExoMars Mission, the search of life on Mars using CLUPI the CLose-UP Imager part of the science payload" **Speakers:** • **Zach Diloreto,** "Hybrid Genomic and Spectroscopic Analyses of Gypsum from the Dohat Faishakh Sabkha in Qatar: Biomarkers and their Astrobiological Implications" • **Franziska Blattmann,** "Microbial polygons: defining a morphological biosignatures for the search for life on Mars" • **Tomaso Bontognali,** "Concluding remarks"
12:20 – 13:20	Sabkha protection plan – round table/closing session and announcement of poster competition results
13:20 – 14:20	Lunch

TOMASO BONTOGNALI

SPACE EXPLORATION INSTITUTE OF NEUCHÂTEL AND
UNIVERSITY OF BASEL, SWITZERLAND

PROFILE

Tomaso Bontognali is a research scientist in geobiology at the Space Exploration Institute of Neuchâtel and at the University of Basel, Switzerland. He is currently dedicating most of his time to the preparation of the ESA ExoMars mission, which foresee the launch of a rover that will look for signs of life on Mars. In parallel, he is adjunct professor at Qatar University. Since a decade, he is regularly conducting projects and field campaigns to explore the sabkhas of Qatar. His research focuses on microbe-mineral interactions that lead to the formation of morphological and geochemical biosignatures (e.g., stromatolites, microbial dolomite) relevant for the study of early life on Earth and the search for life on other planets.

The sabkhas of Qatar: a treasure for scientific research

ABSTRACT

The modern sabkhas (salt flats) of Qatar are among the few environments on Earth where it is possible to study geological and microbiological processes that nowadays are rare, but that were likely dominant during some past periods of the history of our planet. The strong evaporation characterizing the arid sabkha environments lead to the formation of carbonates, sulfates and other evaporite minerals. Their precipitation occurs in the presence of microbes, which are able to survive in these extremely inhospitable places. In the absence of competition with more evolved eukaryotic life, such primitive microbial communities can grow producing thick microbial mats, which in turn influence sedimentary processes. The minerals and sedimentary structures forming in the sabkhas are commonly found in ancient sedimentary sequences: they constitute economically important gas and oil reservoir rocks, they record past climatic conditions, they preserve some of the oldest evidence for the existence of life on Earth, and they have even been detected on the surface of Mars by rovers that are looking for signs of extraterrestrial life. For these reasons, the sabkhas of Qatar represent unique "natural laboratories" or "modern analogs" where it is possible to test hypotheses and implement new proxies useful to conduct multidisciplinary research with an enormous potential. Hopefully, these scientific activities will also increase the general awareness about the importance of preserving these delicate ecosystems, which should be considered as a natural heritage of the country.

ZULFA ALI AL DISI

POST-DOCTORAL FELLOW,
QATAR UNIVERSITY

PROFILE

Zulfa Ali Al Disi is Post-Doctoral Fellow at Qatar University. She received her B.Sc. in Chemistry from UAE University, Master of Business Administration (MBA) from Manchester Business School, Masters & PhD in Biological and Environment Sciences from Qatar University University. Her PhD thesis was on the Role of Aerobic in Dolomite Formation in The Evaporitic Environments of Qatar Sabkhas. Zulfa started her career as laboratory technician then as quality assurance manager. When she pursued her academic career, she worked as research assistant and as post doc in the frame of NPRP and PDRA grants. Her main research interests focus on bioremediation and biomineralization using local bacterial strains isolated from Qatar Sabkhas and soils. The outcomes of her research are published in high impact factor peer-reviewed journals.

She co-supervised several undergraduate research projects, acted as a judge in the annual school research competitions and participated in many local and international scientific conferences.

Exploring the role of microbially-produced organic molecules in formation of Mg-rich carbonate minerals

ABSTRACT

Dolomite (Ca,MgCO3) - a Mg-rich carbonate mineral - is a common constituent of ancient sedimentary sequences that does not frequently form in modern environment. Studies conducted in the field of geobiology have shown that microbial activity facilitates the formation of Mg-rich carbonates at low temperature, which implies that some occurrences of such minerals in the geological record may represent a biosignature. This hypothesis is of great interest for understanding the evolution of early life on Earth and for the search of life on other planets. We carried out a large number of laboratory experiments using bacterial strains isolated from sabkhas of Qatar. The bacterial cells, their exerted extracellular substances (EPS), or specific organic molecules that are constituents of EPS (i.e. amino acids & xanthan) were applied in a systematic approach to explore their role of in the formation of high magnesium carbonate phases that are considered as potential precursor for dolomite formation. These organic molecules are characterized with the presence of specific that functional groups that influence the incorporation of Mg into the carbonate minerals that form through evaporation of seawater. The highest Mg incorporation (45 mol% Mg) was achieved in the experiments performed in the presence of bacterial cells or EPS compared with control experiments (37 mol% Mg) performed under identical conditions but in the absence of any organic molecules. These results provide further understanding and allows for better linking Mg-rich carbonates and the extremophilic microorganisms.

RAJENDRAN SANKARAN

ENVIRONMENTAL SCIENCE CENTER,
QATAR UNIVERSITY

PROFILE

Rajendran Sankaran is a researcher at Environmental Science Center, Qatar University conducted several research projects in the applications of remote sensing technique to earth and environmental resources in collaboration with international universities and research institutions. He published several research papers in peer-reviewed journals, edited volume, organized seminar and workshops, and conducted trainings.

He is a reviewer of more than 10 journals of Elsevier and Springer in remote sensing applications

Salinity and temporal stability of an inland sabkha of the State of Qatar

ABSTRACT

Sabkha (salt flat) extends intermittently with different extensions along the Arabian Gulf coasts. Large fluctuations in the daily and seasonal temperature and humidity conditions in the sabkha regions form various salts of chloride and sulfate in the capillary “vadose” zones. The concentration of salts in the coastal sabkha is about 4 to 5 times higher than in the Arabian Gulf’s water. The salt content of the sabkha water varies between 37 and 60 % and the region is to be studied for sustainable development of agriculture and utilization of land resources of the region. But, the limited accessibility of the sabkha environment makes them hard to study by conventional field mapping. Remote sensing techniques have the potential to detect evaporite minerals, discriminate sabkha, and map salt crust and saline soils. This study maps salt crusts, gypsiferous soil flats and soil salinity, and studies temporal stability of an inland sabkha that occurred near Dukhan in northwest coastal region of the State of Qatar using satellite data of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) of Terra satellite and MultiSpectral Instrument (MSI) of Sentinel-2 satellite. Mapping of siliceous sand deposits, saline gypsiferous sand and silt flats, salt crust and carbonate formation in the region are carried out using ASTER data. The salinity of the area is mapped using the monthly data of MSI for the years 2018 to 2020 by Normalized Difference Salinity Index (NDSI) (band11-band12) / (band11+band12). The moisture of the area is studied by using the Normalized Difference Moisture Index (NDMI) (b8-b11) / (b8+b11) to describe the temporal stability of the Sabkha. The interpretation of NDSI and NDMI images showed variations in the occurrence and distribution of salinity and moisture in the sabkha, which depended on the changes in the climate over the region. The results are validated through field studies and measurements of salinity, Ec, TDS and pH parameters over samples that were collected from salt crusts and salt flats.

JUDITH A. MCKENZIE

GEOLOGICAL INSTITUTE, SWISS FEDERAL INSTITUTE OF TECHNOLOGY, ETH, ZURICH, SWITZERLAND

PROFILE

Judith A. McKenzie is Professor em. of Geology, Geological Institute, Department of Earth Sciences, Swiss Federal Institute of Technology, ETHZ, Zurich, Switzerland. Her ETHZ doctoral thesis, entitled "Isotope study of the hydrology and the co-existing carbonate phases from site of Recent dolomitization, the coastal sabkha of Abu Dhabi, Persian Gulf" was successfully submitted in 1976. Afterwards, she proceeded with her research in geochemical (carbonate) sedimentology with a continued focus on dolomite as an ETH research associate and established a stable isotope laboratory in the Geological Institute. After a short tenure as Associate Professor at the University of Florida, she returned to ETHZ as a tenured Research Professor in 1987 and was promoted to Professor of Geology (Earth System Sciences) in 1996. Her continued research interests in modern dolomite forming environments led to the development of a Geomicrobiology Laboratory and subsequently participation in new sabkha projects in Abu Dhabi and Qatar with an emphasis on geomicrobial processes. Throughout her career, she has been very active in the international ocean drilling programs sailing on 5 cruises as ship-board scientist or co-chief scientist. She is an elected fellow of a number of societies including AGU and GSA, as well being a jointly elected GS & EAG geochemical fellow. She has received a number of scientific awards, including the EGU Lamarck Medal, the Gustav Steinmann Medal of Geologische Vereinigung e.V., the IUGS Argand Award and the SEPM Twenhofel Medal. Her current research interests include a focus on geomicrobiology with emphasis on microbial dolomite precipitation and modern and ancient carbonate/evaporite sedimentation in hypersaline environments.

Coastal Sabkhas of Qatar: Nature's Laboratory for the Study of Biogeochemical Processes in Hypersaline Environments

ABSTRACT

In 1791, Déodat de Dolomieu published a paper wherein he recognized dolomite to be a distinct carbonate mineral [CaMgCO3)2] found in the Sud-Tyrolian Mountains, now known as the Dolomite Mountains. Both the mineral and the mountains were named after Monsieur Dolomieu to honor his fundamental discovery. His observation that this unique mineral did not react with weak acids continues to serve as a field method for carbonate identification. Eventually, his discovery of this exceptional carbonate mineral led to the long-standing dolomite problem, which refers to the lack of modern analogues to explain the abundance of dolomite versus limestone in the geologic record. For example, the ratio of dolomite to limestone in the Proterozoic is 3:1, but dolomite is rarely found in Holocene sediments and does not precipitate from modern normal seawater.

However, in the second half of the 20th century, the discovery of low-temperature dolomite precipitating in some rare modern environments produced significant scientific breakthroughs towards solving the dolomite problem. In particular, in the mid-1960's, dolomite was found to precipitate from the highly evaporated waters beneath the Sabkha Dohat Faishakh on the north-west coast of Qatar (Illing et al., 1965) and was subsequently discovered forming, together with gypsum and massive anhydrite deposits, beneath the coastal sabkhas of Abu Dhabi. Early studies of these two coastal sabkha systems during the following decades focused on the hydrology and geochemistry of these very unique hypersaline environments.

More recently, with the development of new imaging and biogeochemical technologies, scientific discoveries have progressed using a geomicrobiological approach including microbial studies of the associated microbial mats living on and buried beneath the modern sabkhas, as well as high-resolution imaging of the crystal structures of the precipitates. Significant new discoveries continue to be made, for example at the sabkhas of Khor Al-Adaid, southeast Qatar (Diloreto et al., 2019, 2021).

MAURICE TUCKER

VISITING PROFESSOR UNIVERSITY OF BRISTOL;
EMERITUS PROFESSOR DURHAM UNIVERSITY

PROFILE

Maurice Tucker: After degrees at the universities of Durham (BSc) and Reading (PhD), then positions at the universities of Sierra Leone, Cardiff, Newcastle on Tyne and Durham, with sabbaticals at UC Berkeley and UWA Perth. Fascinated by limestones since age 7, has worked on carbonates from around the world and all parts of the geological record. Limestones: the love of my life.

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Dolomite: is it still a problem? Still some issues but microbes part of the answer

ABSTRACT

Dolomite has been a conundrum for decades but issues remain in spite of extensive research. Of course, there are different types of dolomite and not all are a problem, and there is protodolomite, or is there ? Several of the dolomite issues are related to its precise crystal structure and chemistry, and when is CaMg(CO3)2 actually dolomite. Dolomite nucleation is a factor, but once nuclei are formed, off it goes, subject to Mg2+ availability and fluid flow. Experimental studies are proving useful in terms of dolomite precipitation as well as dolomitisation of CaCO3, but as always, do the lab conditions really reflect natural environments? And then there is the possibility of viruses being involved….. they are still unappreciated in Earth Sciences !

ADRIAN IMMENSHAUSER

RUHR-UNIVERSITY, BOCHUM, GERMANY
adrian.immenhauser@rub.de

PROFILE

Adrian Immenhauser is a carbonate sedimentologist and sedimentary geochemist. He was born in 1965 in New Mexico (USA) but holds the Swiss citizenship. He studied geology and mineralogy at the University of Berne (Switzerland). His PhD research dealt with topics such as ophiolites, plate tectonics of the Indian Ocean and stratigraphy of Oman. Following his PhD and a short postdoc project in Berne, he accepted a position as an assistant professor at the Free University Amsterdam (The Netherlands), where he was active until 2005. In January 2006, he moved to Germany (Bochum; Chair for Sediment and Isotope Geology). In collaboration with his colleagues and students, he focuses on the improved understanding of carbonates and their geochemical (isotopes of C, O, Mg and Ca), crystallographic and petrographic properties as archives of their palaeoenvironment and in their function as reservoir units. The department combines detailed fieldwork, experimental approaches and analytical laboratory work to understand carbonate precipitation, diagenesis and biomineralization.New Mexico (USA) but holds the Swiss citizenship. He studied geology and mineralogy at the University of Berne (Switzerland). His PhD research dealt with topics such as ophiolites, plate tectonics of the Indian Ocean and stratigraphy of Oman. Following his PhD and a short postdoc project in Berne, he accepted a position as an assistant professor at the Free University Amsterdam (The Netherlands), where he was active until 2005. In January 2006, he moved to Germany (Bochum; Chair for Sediment and Isotope Geology). In collaboration with his colleagues and students, he focuses on the improved understanding of carbonates and their geochemical (isotopes of C, O, Mg and Ca), crystallographic and petrographic properties as archives of their palaeoenvironment and in their function as reservoir units. The department combines detailed fieldwork, experimental approaches and analytical laboratory work to understand carbonate precipitation, diagenesis and biomineralization.

The 'Dolomite Problem' - A personal view

ABSTRACT

The mineral dolomite and the uncertainties surrounding its origin have attracted the attention of geoscientists for over two centuries. Déodat de Dolomieu published his classic paper in 1791, and today, the Web of Science lists 160,000 papers when entering the search term `dolomite problem', and 537,000 papers are listed for `dolomite'. Depending on the definition used, the core of the Dolomite Problem is the apparent paradox posed by the paucity of dolomite in modern marine depositional environments versus its relative abundance in the sedimentary rock record. This presentation reviews field and laboratory (geochemical, petrographical, experimental) work by the author, colleagues and students, and data from the published record. The main message is that the term `dolomite´ (and `dolostone') is oversimplifying when used in an unspecific manner. Dolomite and related Ca/Mg carbonates belong to a diverse group of minerals that are secreted from bodily fluids, are induced by microbial activity, or precipitated from various aqueous solutions with different geochemistries and temperatures ranging from Earth's surface conditions to the metamorphic realm at 300°C. This diversity in precipitation environments, mineralogy, crystallography and geochemical properties may result in confusion and controversy.

MARIA MUTTI

CHAIR OF SEDIMENTOLOGY AT
THE UNIVERSITY OF POTSDAM, GERMANY

PROFILE

Maria Mutti is Professor and Chair of Sedimentology at the University of Potsdam (Germany) since 2002 and has previously held academic positions at ETH Zürich, Woods Hole Oceanographic Institution, and the University of Southern California, Los Angeles.

Her research interests revolve around carbonate sedimentary systems, the interplay between the biosphere, the climate system and Earth History, and applications of sedimentary geology for subsurface studies. Current research approaches include multiscale outcrop studies, subsurface data analysis, and modelling of properties at different scales, to predict lateral and vertical variability in carbonate reservoirs. Maria has a long track record in academic-industry collaborations, both for research and for training. As a past President of SEPM, as well in other capacities, Maria has organized meetings and chaired technical sessions at annual meetings for both AAPG and SEPM and several other conferences and will become AAPG Europe President in summer 2023.

ABSTRACT

The spatial distribution and geometry of dolomite is considered an important criterion to discriminate dolomitization mechanisms. Relatively much importance has been given in past years to structurally-controlled dolostone-limestone transitions, or dolomitization fronts, but comparatively little attention has been given to the stratigraphic control over the occurrence and distribution of dolomite. Strata-bound dolomite is commonly related to specific properties of the sedimentary rocks, such as porosity and permeability, which being specific to individual sedimentary layers can act as preferential conduits for dolomitization fluids. In some cases, strata-bound dolomite is facies specific and can be related to a syn-depositional or very early post-depositional dolomite precipitation mechanism.
Here we will review different occurrences of strata-bound dolomite and will analyze cases of dolomitized strata which formed in ancient sabkha-type environments.

Earlier studies linking dolomite occurrence to sequence stratigraphy (Montañez and Read, 1992; Mutti and Simo, 1994) have identified patterns of dolomite distribution in ancient coastal sabkhas. More have followed, for example highlighting the role of dolomitic beds in reservoir modelling (e.g., Groetsch et al., 2003), or the overprinting of the regressive cycles by gypsum and anhydrite (Strohmenger et al., 2010). Our current understanding of the dolomite forming processes in these environments reflects the huge leap in knowledge achieved during the past decades, nevertheless, the information regarding the distribution of dolomite remains unaffected. In these cases, dolomite occurrence is linked to short-term relative sea-level fall and tidal flat progradation within individual high-frequency cycles. When analyzed in a basin-scale context, observing relationship platform location and dolomitization, the distribution of early dolomite is clearly confined to shallow water lithofacies. Even at higher order of cyclicity, it seems to track relative sea-level fluctuations in the basin fill, moving through time as a response to episodes of regression- transgression along the basin margin, reflecting processes such as rates of sea-level rise and differential subsidence along the shelf margin.

PETER SWART

DEPARTMENT OF MARINE GEOSCIENCES, UNIVERSITY OF MIAMI
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PROFILE

Peter Swart was raised in the Netherlands, US, and UK where he obtained his PhD in Geochemistry from the University of London in 1980. Subsequently he completed a postdoctoral fellowship at the University of Cambridge where he conducted research on the stable C isotopic composition of moon rocks and meteorites. In 1983 he moved to the University of Miami to work on the geochemistry of dolomite with Dr. Robert Ginsburg and served as departmental chair between 1989 and 2015. He is currently the Lewis G. Weeks Professor in the Department of Marine Geosciences at the University of Miami, Florida. Dr Swart is also Head of the Stable Isotope Laboratory where he supervises six mass stable isotope mass spectrometers. His research interests include stable isotope geochemistry, carbonate diagenesis, sedimentology and petrology, and cosmochemistry.

Between 2008 and 2014 he served as editor of the journal Sedimentology and in 2015 he started the open access journal The Depositional Record. Previously he served as an associate editor for the journals of Corals Reefs, Palaeo 3x, and Sedimentary Petrology. He is the author of over 230 papers in the peer reviewed literature and a fellow of the American Geophysical Union, Geological Society of America, and American Association for the Advancement of Science.

Hypersaline Origins of Bahamian Dolomites: Evidence from New Geochemical Proxies

ABSTRACT

Although dolomite is found as an early diagenetic mineral in Holocene and Pleistocene sediments throughout the world, there has been a distinction between those dolomites found in arid environments, such as the Arabian Gulf in association with evaporite minerals, and those present in less extreme climates with higher amounts of meteoric precipitation such as in the Bahamas. Although the precise formation mechanisms of dolomite formation in both locations are still not precisely known, it is generally believed that fundamental different mechanisms of dolomitization may be involved, one associated with fluids of higher salinity and one associated with normal seawater. In this presentation we present new evidence that contrary to previous proposed mechanisms, that some of the Bahamian dolomites are formed under the influence of brines elevated in salinity, perhaps similar to those formed in Arabian Gulf, albeit perhaps not under as extreme salinity.

In the Bahamas, rocks of Pliocene and older age have frequently been subjected to massive dolomitization with the principal hypothesis being that the dolomitization was induced by normal seawater being circulated through the carbonate precursors. However, several lines of evidence derived from changes in petrography, sedimentology, and geochemistry suggest that the dolomites are related to repeated small changes in sea level. We suggest that during periods of lower sea level, hypersaline ponds develop upon islands, similar to those observed throughout the Bahamas today. The warm dense fluids which are present in the hypersaline ponds contain high amounts of organic material that degrade through aerobic and anaerobic oxidation thus elevating alkalinity and are thus producing a solution highly conducive to the formation of dolomite. The fluids reflux through the underlying sediments and interact with underlying seawater causing the precipitation of dolomite as well as dolomitization of the precursor sediments. Repeated small oscillations of sea level produced a number of sequences of dolomite, each overlain by sedimentological evidence of the presence of shallow hypersaline ponds.

DIMITRI V. MEIER

ETH ZÜRICH (SWITZERLAND)

PROFILE

Dimitri V. Meier, coming from a molecular biology educational background, I consider myself an environmental microbiologist and microbial ecologist since my PhD at the Max Planck Institute for Marine Microbiology, where I studied the ecological niches of co-occurring sulfur-oxidizing bacteria in hydrothermal environments.

During my postdoc at University of Vienna I switched my focus towards microbial activity and dormancy in water-limited surface environments such as biological soil crust and hypersaline microbial mats in coastal sabkhas. In 2021, I obtained a Marie Skłodowska-Curie fellowship to work on microbial survival in deep buried oligotrophic lake sediment at ETH Zürich where I am currently located.

My research interests focuses on:

- Microbial ecology: interactions, differentiation and niche partitioning of microorganisms
- Microbial dormancy and microbial activity patterns in complex environments with fluctuating conditions such as soils and sediments
- Limits of microbial life and survival strategies in extreme environments
- Extracellular electron transfer in microbial interactions with metals and syntrophic partners
- Big data analysis ("omics") in environmental microbiology, its advantages and shortcomings
- Linking culture-independent data-based approaches to cultivation work and geochemical measurements

Thriving or surviving? Survival strategies and limitation of physiological processes in a microbial mat at salt saturation

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 limits of key microbial processes, such as photosynthesis, aerobic respiration, and sulfur cycling in salt crust-covered microbial mats from the coast of Oman. Although some oxygen production was measurable in situ at salinity 30% (w/v), at saturation-level salinity (40%), oxygenic photosynthesis was completely inhibited and only resumed two days after reducing the salinity to 12%. Aerobic respiration and sulfur cycling occurred at low rates under salt saturation and increased strongly upon salinity reduction. Microscopic observations showed that the mat contained filamentous Cyanobacteria unusual for such high salinities. Analysis of metagenome-assembled genomes revealed that nearly all cyanobacteria encoded genes for phototrophic sulfide oxidation. Sulfide-oxidation and CO_2-fixation genes were also found in Rhodovibrio populations, previously not known to oxidize sulfide. Anoxygenic sulfur-based photosynthesis thus might be a key energy-generating process enabling survival when oxygenic photosynthesis is inhibited by salt saturation. Looking for further hypersalinity adaptations, we found genetic signatures of archaea-like potassium-based osmoregulation in bacterial populations other than Salinibacter. Comparisons to related genomes from arid soil crusts, another cyanobacteria-rich surface community exposed to UV-radiation and heat, indicated genetic differences between adaptations to hypersalinity and desiccation.

Our results highlight important microbial hypersalinity survival strategies and show that such communities ultimately depend on periodic salt dilution to be self-sustaining. Thus, they are rather adapted to survive salt saturation than to thrive under the salt crust.

NABIL ZOUARI

DEPARTMENT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES,
COLLEGE OF ARTS AND SCIENCES, QATAR UNIVERSITY

PROFILE

Nabil Zouari is Full-Professor of Biotechnology and Environmental Microbiology at the Department of Biologicala and Environmental Sciences, College of Arts and Sciences, Qatar University. He obtained his PhD degree in Microbiology, Enzyme Engineering & Bioconversion from the University of Technology of Compiègne (UTC, France). Prof Nabil is also engineer in biological engineering. He has 35 years of experience in Teaching and Research & Development in the fields of Environmental Technology, Enzyme Engineering, Industrial Microbiology and transfer of technology in France, Tunisia and Qatar. Prof Nabil published more than 90 papers in international indexed journals, covering all his fields of specialization. He developed 6 industrial applications in the field of agro-industry. He has an experience of ten years in the field of results development and valorization and incubation of innovations (in France and Tunisia) and created one start-up in the field of biotechnology. He has experience in leading and directing research projects, UG and graduate research supervision (dozens of theses) and graduate studies coordination as well. He is occupying actually the position of Coordinator of Graduate programs (PhD, MSc and Graduate Certificate).

Understanding the biodiversity of bacterial adaptation in hypersaline evaporitic environments of Qatar Sabkhas

ABSTRACT

Little is known about the roles of extremophiles and of bacteria tolerating hash conditions in ecosystems, including climate regulation. Recent works showed that their contribution to the production of greenhouse gases, as well as to the major carbon, nitrogen and nitrate cycles is far from negligible. Often, the genome contains more than 90% of genes coding for proteins with unknown functions in extremophiles. Some tolerant bacteria are also abundant at harsh conditions. For what reasons? Their biological macromolecules known to be extracellular must necessarily adapt to the physico-chemical conditions, to the particular nutritional and energy resources of these extreme environments. Their stability and functionality are crucial to the survival of such microorganisms. These constraints can lead to the emergence of new metabolic pathways using substrates and cofactors different from those used by “conventional” organisms. Over the past 30 years, we have witnessed the discovery of an extraordinary diversity of microorganisms inhabiting environments previously thought to be hostile to life. Today, we know that microbial life extends on Earth wherever we find water in a liquid state (appropriate water activity (aw)), from the polar ice caps to underwater hydrothermal springs, in deserts, in hypersaline lakes or soda, in acidic waters, inside the earth’s crust, and also Sabkhas. In all types of adaptations associated with microbial life in “extreme” conditions, changes in protein structures profoundly alter the biochemistry and physiology of biological systems. At the geological scale, large-scale climatic variations have established extreme conditions on the surface of the planet. It is also for this reason that the notion of extremophilia must be put into perspective.

In the frame of our research projects, halophilic bacteria (moderate and extreme) have been isolated from hypersaline evaporitic environments of Qatar Sabkhas. The taxonomic biodiversity of microorganisms found in these environments is essentially linked to their characteristics: bacteria which are aerobic, halophilic and heterotrophic. We showed, using proteins profiles analyses, that they are endowed with metabolic and physiological activity involved in transformation and degradation of organic pollutants but in forming many types of minerals.

Microbial mats al Khor Al Udaid Sabkha, Qatar
(Photo Credit: Fadhil Sadooni)

Microbial mats at Mesaieed Sabkha, Qatar
(Photo Credit: Maurice Tucker)

RAEID ABED

DEPARTMENT OF BIOLOGY,
SULTAN QABOOS UNIVERSITY (SQU), OMAN

PROFILE

Raeid Abed is a full Professor at 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 95 scientific papers in international peer-reviewed journals, 12 book chapters and edited a two-volumes book.

He supervised 9 PhD and 30 MSc students. He serves as a reviewer for more than 40 international scientific journals.

Structural-Functional analysis of extremely hypersaline microbial mats from the Arabian Peninsula

ABSTRACT

Microbial mats in most extreme settings, as found at the coastline of the subtropical-arid Arabian Peninsula (Sabkhas), have been rarely studied. We used molecular toos (illumina MiSeq sequencing, metagenomic analysis, FISH-fluorescence in situ hybridization), microsensors, stable isotopes and qPCR to study the diversity, adaptation and carbon and nitrogen cycling in hypersaline microbial mats from Oman and UAE. Highly adapted bacterial specialists were mainly found at the most extreme, upper tidal sites and less specialized organisms with wide tolerance ranges in intermediate and lower sites of the transect. Up to 40% of the archaeal sequences represented so far unknown phyla. Microscopic observations of mats under salt crusts from Oman showed that the mat contained filamentous Cyanobacteria unusual for such high salinities. Analysis of metagenome-assembled genomes revealed that nearly all cyanobacteria encoded genes for phototrophic sulfide oxidation. Sulfide-oxidation and CO2-fixation genes were also found in Rhodovibrio populations, previously not known to oxidize sulfide. Anoxygenic sulfur-based photosynthesis thus might be a key energy-generating process enabling survival when oxygenic photosynthesis is inhibited by salt saturation. Looking for further hypersalinity adaptations, we found genetic signatures of archaea-like potassium-based osmoregulation in bacterial populations other than Salinibacter.

In mats from Oman where salinity reaches 40% (saturation), sulfate reduction, aerobic respiration and anoxygenic photosynthesis were active but not oxygenic photosynthesis. With respect to nitrogen cycle, mats from UAE had potential rates of ammonia oxidation and denitrification of 0.8±0.4 and 2.0±1.0 nmol N g-1 h-1, respectively, whereas anammox was not detectable. The rate of N2O production under anoxic conditions accounted for ca. 5% of total denitrification. Using qPCR, amoA genes had the highest copy number while narG and nirS genes exhibited comparable estimates. Sequences of nirS gene were novel whereas nirK sequences were related to sequences from the Rhizobiales group. We conclude that the mats in the Arabian Peninsula have adjusted the diversity and function of their microbial communities to cope with the extreme conditions.

SAMIR JAOUA

BIOLOGICAL AND ENVIRONMENTAL SCIENCES,
COLLEGE OF ARTS AND SCIENCES, QATAR UNIVERSITY

PROFILE

Samir Jaoua is working as a Full Professor at the Department of Biological and Environmental Sciences, at the College of Arts and Sciences at Qatar University. He obtained his PhD from the University of Technology of Compiegne (France). He is also a qualified Professor in France universities, a Professor at the University of Sfax (Tunisia), and an official member of the Committee of Professors at the University of Sassari (Italy). Samir Jaoua is Microbiologist and molecular and microbial Biotechnologist, having more than 34 years of experience in microbiology and molecular & microbial Biotechnology in France, Switzerland, Belgium, Germany, Tunisia, and Qatar. I have been teaching BSc, MSc and PhD courses of Microbiology, Molecular and Cell Biology, Biotechnology, Genetic engineering and DNA Technology, Environmental genomics and bioengineering, and many others. He has been supervising 19 successfully defended PhDs, in addition to many BSc senior projects and MSc theses. Prof. Samir Jaoua is mainly a senior author in more than 148 international original research articles published in international peer-reviewed Scopus and web of Sc. Journals with Google Scholar H-index: 40; Scopus-H-index: 33; i-10-index: 119; Citations: 5078.

- http://qufaculty.qu.edu.qa/samirjaoua
- https://scholar.google.com/citations?user=dH0g1coAAAAJ&hl=en&cstart=40&pagesize=20
- https://www.researchgate.net/profile/Samir_Jaoua/scores

Investigation and Application of Local Qatari Microbial resources for the Biological Control of pathogenic Bacteria, Insects and Mycotoxigenic Fungi

ABSTRACT

Pathogenic fungi and insects affect both crops' yield and human health and safety. Toxigenic fungi accumulate toxic metabolites and contaminate the food chain directly or indirectly through the animal products because of feed-to-food carry-over phenomena. Many pathogenic insects are destroying one fifth of the world's total crop production and putting millions of people and cattle at risk due to the transmission of many diseases. Today, the main controlling measures used worldwide are based on chemical pesticides that are harmful to humans and polluting the environment and food chains.

Bacillus thuringiensis (Bt) based insecticidal formulations are considered as one of the most successful, environmentally safe and sustainable method of controlling insect pests. Bacillus thuringiensis (Bt) is a Gram positive bacterium producing various insecticidal proteins, among which the delta-endotoxins Cry and the vegetative insecticidal proteins Vip.

In the present study, we developed and set up:

- A gene bank of more than 600 B. thuringiensis strains: a source of many types of biopesticides and antimicrobial agents useful in agriculture and for the control of disease vectors.
- Yeast strains including the low-fermenting yeast Lachancea thermotolerans and a local novel yeast Kluyveromyces marxianus having a volatilome and binding potentialities for the biocontrol of toxigenic fungi and their mycotoxins.
- Bacterial antifungal compounds and Volatile organic compounds, including local bacterial strains of Bacillus pumilus in the control of Aspergillus carbonarius and ochratoxin A contamination and Bacillus licheniformis volatile compounds for the biological control of toxigenic Aspergillus and Penicillium spp..

FADHIL SADOONI

RESEARCH PROFESSOR,
ENVIRONMENTAL SCIENCE CENTER, QATAR UNIVERSITY

PROFILE

Fadhil Sadooni is currently a research professor with the Environmental Science Center at Qatar University. Fadhil received a Ph.D. in petroleum geoscience from the University of Bristol, UK. Before joining Qatar University, he worked for 20 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 to 2006. He has published more than 70 papers in peer-reviewed journals and co-authored more than ten books in Arabic and English on the different aspects of geology, including the Petroleum Geology of Iraq, published by the Scientific Press with more than 60 conference presentations.

Fadhil has worked as a consultant for many oil companies on hydrocarbon exploration in the Middle East. His present research focuses on carbonate reservoir characterization, shale deposits of Eastern Arabia, microbial sediments, and life in extreme environments.

Dolomites from the Carbonate-Evaporite strata of the Permian – Jurassic of Eastern Arabia

ABSTRACT

Dolomite is a major reservoir rock in most of the hydrocarbon fields of eastern Arabia. The newly discovered oil and gas reserves in the Triassic strata of the northern Arabian Plate are located in the Upper Triassic Kurra Chine Formation in northern Iraq and Syria and the late Triassic Mohilla Formation in the Levant. These dolomites are interbedded with evaporites and closely associated with microbial materials. The Kurdish term Kurra Chine means black mud, an indication of the high microbial contents of these sediments. The main gas reservoir in the North Field of Qatar is the Permian-Triassic Khuff Formation. This formation has also a considerable amount of evaporites, and recovered cores from the wells show traces of microbial mats. The Jurassic Arab Formation is the main reservoir in Saudi Arabia, and it hosts the largest oil reserve in the world. The Formation consists of four members A-D, and each member is formed of alternation of limestone, dolomite, and anhydrite.

Many early workers attempted to interpret these evaporite-carbonate sequences as ancient mega sabkhas that extended over larger areas under arid climatic conditions. Similar work has been done on correlating the Upper Triassic Hith Anhydrite Formation with the modern sabkhas of Abu Dhabi. There are, however, some problems facing the direct application of the so-called sabkha sequence to interpret the ancient carbonate-evaporite association. Detailed works on these strata have indicated that they were formed under more complex depositional conditions. However, it is still of interest to pursue such a possibility by investigating the general characteristics of the sabkha system on larger temporal and spatial scales.

MAHMOUD ASHOUR

COORDINATOR OF THE MEDITERRANEAN RENAISSANCE PROGRAM
AND THE CHAIRMAN OF THE NATURAL HAZARD COMMITTEE

PROFILE

Mahmoud Ashour is professor and holds a Ph.D. in Geomorphology from Ain Shams University, Egypt. He worked with the University of Sheffield, UK, Qatar University, and Sultan Qaboos University, Oman. He published 53 papers in peer-reviewed journals, co-authored seven books, including one on the sabkhas and sand dunes of Qatar, and contributed to more than 50 international and regional meetings.

He published monumental pioneering papers on the geology and geomorphology of Qatar that provided foundation stones for later research. He is the Coordinator of the Mediterranean Renaissance Program and the Chairman of the Natural Hazard Committee.

Sabkhas in Qatar Peninsula

ABSTRACT

Sabkhas represent a very distinctive geomorphologic feature in the Qatar peninsula. They cover about 7% of the land surface. Investigations recognized two main types of sabkhas; the first is the Inland Sabkhas which is more mature. The second is the coastal sabkhas or supratidal flats which are more wide spread. Both types are characteristically flat containing a shallow water table, with highly saline ground water. This ground water may be either directly connected with the sea or with continental groundwater. Also surface water from tidal flooding and rainfall and run-off partially recharge the system. Sediments are mainly evaporates, quartz grains and mud, sodium chloride is very frequent on the surface. Beside the two main types a subsidiary type, not very well known are anthropogenic sabkhas near the inhabited areas and cultivated depressions.

Detailed investigation revealed that the origin and evolution of sabkhas in Qatar are greatly influenced by: The low lying topography of the country, the shallow to very shallow coasts, the hot to very hot climate, sea level changes, ground water, geological setting, and anthropogenic interference.

CRISOGONO VASCONCELOS

SCIENTIFIC ADVISOR TO THE PRESIDENCY OF THE
BRAZILIAN GEOLOGICAL SURVEY

PROFILE

Crisogono Vasconcelos is a geomicrobiologist and sedimentary geochemist. He was born in Brazil but holds the Swiss citizenship. He completed his undergraduate studies in geology at the University Rural Rio de Janeiro (Brazil) followed by a master degree in geochemistry at Universidade Federal Fluminense, Niterói (Brazil). In 1994 he concluded his PhD at Swiss Federal Institute of Technology (ETH) Zurich, Switzerland in the geochemistry of microbial dolomite. In 1995, he assumed an academic position, European Community and Federal Office for Education and Science at ETH Zurich, and conducted research in a consortium involving a drilling project on the Great Barrier Reef, Australia. In 1996, he moved to Brazil as research scientist, and meanwhile he received a grant to attend a post-graduate advance course in microbial diversity at the Marine Biological Laboratory Woods Hole (USA), plus PIB/NASA Scholarship to study microbial fossil from Precambrian rock (Pilbara Craton). From 1997 to 2018, he was a Senior Research Scientist, head and co-founder of the Geomicrobiology Laboratory, Geological Institute, ETH Zürich. In 2019, he was a visiting professor at Federal University of Paraná Brazil. From 2020 until the present, he is employed as a scientific advisor to the presidency of the Brazilian Geological Survey. His main research focus at moment is the study of the role of microbes, including viruses, on petrophysical properties and metal accumulations

Coupled silica and carbon cycles in hypersaline Environment, possible phage processes to mineralization

ABSTRACT

Microbial mats are biologically complex and have been considered to be important but basic ecosystems, which are related to the development of the biosphere conditions on Earth through geological time. They can be found globally in a wide range of environments, but most specifically they are abundant in hypersaline conditions, including in sabkha environments. The processes of mineral precipitation, as the result of interactions between biological activity and the environment, is often referred to as being biologically-induced and controlled mineralization. In contrast, biologically-influenced is related to extracellular polymeric substances (EPS) because this organic matrix provides physical protection and electrostatic interaction enabling specific ions to accumulate, for example, sulfate reduction metabolisms can result in the incorporation of Mg2+ ions into the mineral lattice .

In this study, we report an important diagenetic process related with silica and carbon cycles, which can occur in modern hypersaline environments. For instance, sabkha sediments can develop into potentially very important oil and gas reservoirs. However, the biological formation of Mg-carbonates and Mg-clays can ultimately influence the petrophysical properties of the host rock. For example, the transformation of Mg-carbonates into Mg-clays is an ongoing process in modern environments, as well as in the geological record. Indeed, newly observed biological processes involving the mineralization of carbonate and clay minerals have been associated with viruses, (bacteriophage) which can, in turn, have an influence on organic mineralization. Thus, hypersaline environments, such as modern sabkhas, can provide an excellent template to test important implications of viruses for the global biogeochemical cycles, which are coupled with the silica and carbon cycles.

MARTIN VAN KRANENDONK

PROFESSOR OF GEOLOGY AT
THE UNIVERSITY OF NEW SOUTH WALES SYDNEY

PROFILE

Martin Van Kranendonk was born and trained in Canada, receiving his PhD in 1992 and then undertaking a post-doc position at the Geological Survey of Canada from 1992-1994. In 1994, Martin moved to Australia as an ARC post-doctoral fellow at the University of Newcastle, where he commenced research on the Pilbara. He then joined the Geological Survey of Western Australia in 1997, where he worked for 15 years until the start of 2012 when he accepted a position as Professor of Geology at the University of New South Wales Sydney.

Martin is a leading world expert on the early history of the Earth, including the habitats and metabolisms of the earliest traces of life, mechanisms of crust formation, and Archean tectonics, and he is the Director of the Australian Centre for Astrobiology.

Martin has appeared on numerous television and radio documentaries on early Earth and has been involved in educational outreach programs for school children and the general public.

The sabkhas of Qatar as a modern analogue for the study of early life in the 3.4 billion-year-old Strelley Pool Formation of the Pilbara Craton, Australia and the search for life on Mars

ABSTRACT

The >3 billion-year-old (Ga) rocks of the Pilbara Craton in northwestern Australia contain the best-preserved evidence of ancient life on Earth in low-strain rocks that retain abundant primary features. Previous work has shown that this ancient life occupied a variety of habitats, including the shorelines of a shallow water volcanic caldera lake, terrestrial hot springs, and a shallow marine shelf environment.
A recent new addition to the habitats of ancient Pilbara life is based on research on the sabkhas of Qatar and applies to a 1 m thick succession with stromatolites and well-preserved microfossils in the 3.35 Ga Strelley Pool Formation . This succession consists of organic-rich cherts with evidence for deposition under very shallow quiet-water conditions, grading up from cross-bedded carbonate sandstones, to centimetre-bedded black chert with beds of low amplitude domical stromatolites, to very finely bedded black chert that locally contains bedding planes with wind-blown crescentic ripples and highly irregular fine-scale lamination. Locally, this unit also contains a 5 cm-thick layer with distinctive white quartz lenses 1 x 3-4 cm in size that are interpreted as silica-replaced evaporative gypsum crystals, as also found in 3.2 Ga terrestrial sandstones from South Africa.

The centimetre-high stromatolite horizons within this succession consist of finely laminated, low-amplitude domes that accreted within planar beds and, locally, on surfaces with irregular, 10-cm high, topographic relief. Stromatolites show sharp growth margins and internal truncations of lamination, and their growth was terminated by deposition of thin sandstones. Stromatolite lamination on surface outcrops is defined by rusty red-black Fe-oxyhydroxides, indicating an origin as highly sulfidized carbonates. Sulfur isotopes indicate that at least part of the microbial community, and likely well-preserved, large lenticular microfossils discovered in this unit, were sulfate-reducing bacteria.

MARIA DITTRICH

UNIVERSITY OF TORONTO, CANADA

PROFILE

Maria Dittrich is a Full Professor at the University of Toronto, Canada. She received a master's degree in physics with distinction from Moscow State University, Russia, Ph.D. in aquatic ecology from, Institute for Freshwater Ecology and Fisheries, Berlin, Germany and Habilitation in Biogeochemistry from ETH Zurich, Switzerland. Over the past years, Professor Dittrich initiated and collaborated on several projects focused on carbonate formation in extreme environments, phosphorus and carbon cycling in lakes and natural nanoparticles, and the catchments. Professor Dittrich's research approach involves a combination of a wide range of field studies, modelling and laboratory experiments, analytical techniques, including Atomic Force and electron microscopy, and conventional and synchrotron-based spectroscopy (infra-red, electron energy loss; EELS, near-edge x-ray absorption fine-structure; NEXAFS). She teaches various Geomicrobiology and Aquatic Biogeochemistry courses at the University of Toronto and trained eleven postdoctoral fellows in Canada and Switzerland, ten Ph.D. students, twenty-four master students, and thirty-seven undergraduate students.

Biomineralization within microbial mats during a transition from anoxygenic to oxygenic photosynthesis

ABSTRACT

Fossil evidence from 3,5000 Mio years ago showed that microbial mats are the earliest life form on Earth. Exploring microbial mats contributes to understanding how microbes and associated biogeochemical processes have adapted to rising oxygen during Earth's evolution. This study reveals how microbes can be involved in dolomite formation during fluctuating environmental conditions, especially in oxygen and salinity levels. The hypersaline microbial mats within the sabkhas of Qatar were chosen due to the well-documented presence of both microbial mats and currently forming low-temperature dolomite. Observations collected over three seasons indicated that the molecular composition of extracellular polymeric substances (EPS) of microbial origin was affected dramatically by salinity fluctuations and can be linked to associated dynamics in a microbial community.

The presented data on environmental conditions, the molecular composition of EPS, and microbial communities deliver evidence that the coexistence between cyanobacteria and anoxygenic phototrophs is a critical factor for dolomite formation. Interpolating this finding over geological time scales and combining it with known data, we suggest that the increase of oxygen during the evolution of the Earth has reduced the concurrence of oxygenic and anoxygenic phototrophs, which in turn affected the deposition of dolomite. Our findings indicate that geochemical-driven cycles of growth and decay within specific microbial communities, such as oxygenic and anoxygenic phototrophs, promote low-temperature dolomite formation.

JASSIM AL-KHAYAT

PROFESSOR OF MARINE BIOLOGY AND ECOLOGY,
QATAR UNIVERSITY

PROFILE

Jassim Al-Khayat is a professor of marine biology and ecology at Qatar University. He received his B.Sc. in Marine Sciences & Geology from Qatar University, P.G. Diploma North Wales University. M.Sc. in Fishery and marine Sciences from Aberdeen University (UK) and Ph.D. in Marine Biology from North Wales University. Jassim has been as faculty member for more than 21 years teaching marine sciences courses at Qatar University. In addition, he served in several positions including Head of the Marine Sciences Department, and coordinator of marine sciences programs and previous research vessel "Lab of the Seas". Dr. Jassim currently serves on the ESC-QU as a manager of the new research vessel "Janan", and marine biological principle investigator.

His research interests lie in the area of marine biota and its habitats, ranging from intertidal zone to subtidal zone (e.g. seagrass beds & coral reefs). He has collaborated actively with researchers in several other disciplines of marine sciences, particularly benthic invertebrates and their habitats.

Jassim is the author & co-author of several papers (~ 45 papers) and three books. Supervised a number of research theses for postgraduate students. He provided a services and consultation for a several communities, local schools, & Ministry of Municipal Affair and Environment. He has participated as a principal investigator and field manager in more than 40 projects. He currently manages and involves as a leader in two project and executive manager and senior marine biologist in two projects.

Exploring the potentiality of Qatar coastal sabkhas to store organic carbon

ABSTRACT

Sabkhas are evaporitic environments that are often associated with the occurrence of microbial mats. Sabkhas are considered a suitable model to study life signatures preserved through evaporitic disposition as well as understanding and interpretation of geological record. Sabkhas of Qatar are recognized as rare environments on Earth representing modern analogue for ancient sedimentary sequences. The growing concerns and challenges due to global warming issues require great attention to explore ecosystems that can serve in carbon sequestering and preservation.

Marine ecosystems can contribute to climate change mitigation by sequestering excess carbon from the atmosphere are known as "Blue Carbon" ecosystems. Evolving recent research works are focusing on the capacity of coastal sabkha systems as blue carbon for sequestering and storage of organic carbon. The study on coastal sabkhas of contrasting geological backgrounds for their capacity of organic carbon retention, revealed that coastal sabkhas have high potential to store blue carbon despite significant differences in their carbon storage capacity.

KRISTIN BERGMANN

ASSISTANT PROFESSOR AT MIT

PROFILE

Kristin Bergmann from the landscape to the atomic scale, she is reconstructing Earth's ancient environmental conditions to explore the co-evolution of life and the Earth system. Her focus is on understanding climate dynamics during the radiation of complex life, in order to understand why it emerged on Earth—and to grasp how rare it may be in the Universe.

She got her academic start at Carleton College in Minnesota, taught middle school in New Jersey, went on to get a PhD at Caltech, and was a part of the Harvard Society of Fellows before starting as an assistant professor at MIT in 2015. She was named a 2018 Packard Fellow and a 2020 MIT 'Committed to Caring' honoree

Sabkhas in the Neoproterozoic: Records of dolomite formation, climate, and microbial life

ABSTRACT

Neoproterozoic carbonate platforms often include thick successions of dolomitic Sabkha-like peritidal carbonates. Here we present a combination of field observations, petrography, and carbon, oxygen, and clumped isotopic measurements to add constraints on their environment of formation and diagenetic alteration. Specifically we will focus on results from the Neoproterozoic stratigraphy preserved in the Sultanate of Oman, Australia, and Svalbard. In Svalbard, these carbonate facies can also include early black chert rip up clasts preserving a range of early diverse microscopic eukaryotes living within microbial mats. Through our combination of observations we provide insights into the climate and water composition of these ancient Sabkha environments, the range of microbially-influenced fabrics preserved, and why these settings are often dolomite in the Neoproterozoic rock record.

JEAN-LUC JOSSET

INSTITUTE OF EARTH SURFACE DYNAMICS,
UNIVERSITY OF LAUSANNNE, SWITZERLAND

PROFILE

Jean-Luc Josset is a planetary scientist, co-founder and director of the Space Exploration Institute, a public research institute based in Neuchatel, Switzerland. After an academic education at the University Pierre et Marie Curie, Paris VI, DEA Astronomy and a PhD in Physics, he joined the Space Science Dpt of the European Space Agency (ESA). Involved in several space mission definitions such as MarsNet, Rosetta, Huygens/Cassini. He was the project manager of the micro-cameras development for Rosetta Lander (ESA Mission to a comet nucleus, CIVA Instrument/IAS F, landing on the comet 12 Nov. 2014.

He was the principal investigator (PI) of the AMIE camera on board the first European mission to the Moon SMART-1 launched in 2003. The successful mission with the AMIE instrument, returned the first image of the far side of the moon and allowed dedicated science investigation on the South Pole (Shackleton Crater). Invited scientist by the JAXA for the Kaguya Moon mission, he published results as co-author in Science and Nature papers.

In 2005, he receives an Award from the International Astronomical Union for outstanding contribution for Space Science & Exploration. As recognition: Asteroid 2000 NX17 named “18112 JeanlucJosset” Elected Member of the Executive committee of the European Astrobiology Network Association (EANA), he is currently the principal investigator of the science instrument CLUPI on board the ExoMars rover mission to be launched in 2028.

The ExoMars Mission, the search of life on Mars using CLUPI the CLose-UP Imager part of the science payload

ABSTRACT

The main goal of the ExoMars rover mission is the search of life on Mars. The Mission was planned to be launched in September 2022 before to be postponed (in 2028) due to the suspension of collaboration with Russia.

The scientific objectives of the ESA ExoMars rover mission are to search for traces of past or present life and to characterise the near-sub surface. Both objectives require study of the rock/regolith materials in terms of structure, textures, mineralogy, and elemental and organic composition. The key point of the ExoMars rover is the capability to drill the surface of Mars up to 2m under the surface and to collect samples to be in-situ analysed.

The ExoMars rover payload consists of a suite of complementary instruments designed to reach these objectives.

CLUPI, the high-performance colour close up imager, part of the science payload on board the ExoMars Rover plays an important role in attaining the mission objectives: it is the equivalent of the hand lens that no geologist is without when undertaking field work. CLUPI is a powerful, highly integrated miniaturized (<900g) low-power robust imaging system, able to sustain very low temperatures (–120°C). CLUPI has a working distance from 11.5cm to infinite providing outstanding pictures with a color detector of 2652x1768x3. At 11.5cm, the spatial resolution is 8 micrometer/pixel in color. The optical-mechanical interface is a smart assembly that can sustain a wide temperature range.

The ExoMars 2028 rover mission will be briefly described together with the overall science payload on board. A detailed focus on the CLUPI instrument will be presented showing its capabilities to provide important information significantly contributing to the understanding of the geological environment and could identify outstanding potential biofabrics of past life on Mars.

ZACH DILORETO

DEPARTMENT OF PHYSICAL AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF TORONTO SCARBOROUGH

PROFILE

Zach Diloreto is a postdoctoral fellow at the University of Toronto, where he studies microbe-mineral interactions and biotechnology development. His past work has focused on "the dolomite problem" using sabkhas as a study site to investigate biomineralization mechanisms occurring within these unique environments. He has also contributed to research focused on searching for life on Mars using sabkhas as Earth analogues of the red planet to delineate potential biomarkers and their interactions with mineralogical matrixes. His current projects also aim the leverage microbial processes delineated from hypersaline sabkhas to develop novel biotechnology to mitigate the impacts on climate change.

Hybrid Genomic and Spectroscopic Analyses of Gypsum from the Dohat Faishakh Sabkha in Qatar: Biomarkers and their Astrobiological Implications

ABSTRACT

Data obtained from NASA's Mars Exploration Rovers (e.g., Spirit, and Opportunity), as well as orbiter missions (Mars Express, Reconnaissance Orbiter) have revealed the unambiguous existence of gypsum on the planet's surface. Such gypsum likely formed early in the planet's history, in a period for which multiple evidence suggests that conditions at the surface of the planet may have been less inhospitable than today, and compatible with the existence of microbial life. Because gypsum mostly forms in the presence of liquid water as an essential element for sustaining microbial life and has a low porosity which is ideal for preserving organic material, it is a promising target to look for signs of past microbial life. To better understand the interactions of pigments and other biomarkers possibly encapsulated in a gypsum matrix we studied organic matter preservation within gypsum that precipitates in a salt flat or so called coastal sabkha located in Qatar. Sabkha's ecosystem are considered a modern analogue to evaporitic environments that may have existed on early Mars. Using a combination of genomic analysis and Raman spectroscopy we observed that gypsum formed in a layer heavily dominated by halophilic archaea (>50% total ZOTUS) and that organic material produced by microorganisms consisted of several types of organic material such as carotenoids, chlorphylls, scytonemin and phycobiliproteins. These organic molecules are precursors to geologic biomarkers that may have formed on Mars and providing a reference for a signals that may be detected on future Mars missions.

FRANZISKA R. BLATTMANN

INSTITUTE OF EARTH SURFACE DYNAMICS,
UNIVERSITY OF LAUSANNNE, SWITZERLAND

PROFILE

Franziska R. Blattmann is an early career researcher working on obtaining her PhD at the University of Lausanne in Switzerland. She received her Bachelor and Master of Science in Earth Sciences from ETH Zürich. During her time at ETH and under the supervision of Tomaso Bontognali her master thesis was focused on the microbialites of Qatar. The aim of her work was to gain a better understanding of the formation of microbially influenced sedimentary structures (MISS) in the intertidal zone of the sabkha. Her main research interests are focused on early life, extinction events, organic carbon and nutrient cycling and stable isotope geochemistry.

MICROBIAL POLYGONS: DEFINING A MORPHOLOGICAL BIOSIGNATURES FOR THE SEARCH FOR LIFE ON MARS

ABSTRACT

Microbially influenced sedimentary structures (MISS) form due to an interplay between microbes, extracellular polymeric substance (EPS), authigenic minerals, autochthonous detrital clasts and the dynamics of an overlying waterbody. Defining MISS morphologies are important in the search for early life on Mars and Earth. Particularly on Mars as exploration is being conducted by means of camera-equipped rovers. These do not have the resolution for identifying single microfossils but could easily spot a cm-size morphological biosignature. To be able to consider MISS as biosignatures, it is essential to exclude that an identical sedimentary structure can form through purely abiotic processes. Here, we discuss the formation and preservation of a type of MISS we named microbial polygon. The microbial polygon is defined as a polygonal structure with a doming rim. The morphology and formation mechanisms of MISS were analyzed in two modern Qatari sabkhas. We have also analyzed lithified polygonal structures found in Al-Ruwais, Qatar. Key features identified in modern microbial polygons not found in desiccation cracks are the rounded and doming rim, folded laminae as well as overlapping laminae within the rim area of the mat. Our sedimentological, mineralogical and radiocarbon analysis allow us to conclude that these polygonal structures result from the presence of EPS stabilizing detrital clasts and precipitating micrite. Their biogenicity can easily be overseen due to their similarity to desiccation cracks. Through the study of an approximately 2800 yBP outcrop in Al-Ruwais, we can show that some key features of the microbial polygons are present and preserved. Hence, microbial polygons can be preserved in the geological record on Earth and Mars, providing evidence for the existence of early/extraterrestrial life.

CONTACT ESC

Environmental Science Center (ESC), at Qatar University, is the first of its kind in Qatar, and it was established in 1980.

If you need more information about the laboratories and the major research facilities in the ESC, please contact us:

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