

The plain between the mountains – report of the second season of MASPAG's survey in the Sultanate of Oman

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Abstract: Missione Archeologica della Sapienza nella Penisola Arabica e nel Golfo (MASPAG) concluded its second season of extensive survey in the al-Batinah South governorate, within Nakhal, al-Awabi and Wadi al Ma'awil provinces (Sultanate of Oman). The landscape near Wadi al Ma'awil was investigated during the last season (2022-2023). This is an intricate context from an environmental and landscape point of view: the mountain ranges of the Jebel Akhdar delimit an alluvial plain dominated by at least three seasonal wadis. These converge into one another at Wadi al Ma'awil, where an area with abundant surface material (pottery, metal slag, malacofauna, stone tools), oasis relicts, and several burial areas extending from the jebels of the plain up the rocky slopes have been identified. The evident traces of frequentation, in some cases dating back to the Bronze Age, allow us to reflect on the human-environment relationship and the processes of domestication of the oases. The aim of this contribution is to outline the framework of the research activities conducted in the field, and to share some reflections formulated at the end of the second survey campaign.

Emergence and evolution of date palm cultivation in Northwestern Arabia

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Abstract: The history of Human occupation in the al-‘Ulā area, in northwestern Saudi Arabia, is currently under study, including the iconic sites of Dedan and Madâ’in Sâlih. Oasis agriculture, with the date palm (*Phoenix dactylifera*) as the key species, is attested since at least the Nabatean period, in Madâ’in Sâlih. The production of dates is still one of the main resource of the oasis today. However, the origins of these palms, when phoeniculture began in western Arabia and how it evolved over the past two millennia remain puzzling.

In this study, we analyze the genomes of more than 500 date palm sampled in the al-‘Ulā region in order to reconstruct the emergence and evolution of phoeniculture within this desert environment. Our preliminary analyses indicate that those palms constitute a mix between the well-defined North African and West Asian populations, corroborating the role of crossroads of civilizations of this oasis. Several archaeological artefacts, including a date necklace from a Nabatean-Roman tomb are also currently analyzed through ancient DNA and morphometrics analyses. Together, those analyses will not only inform the history of oasis agriculture in northwestern Arabia, but the history of diffusion of date palm cultivation from its cradle in the Gulf.

The late development of Central Arabian oases – Al-Kharj as a case study

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Abstract: While the oasis systems emerge as early as the Bronze Age in Eastern and Northwestern Arabia, they do not seem to reach central Arabia until much later. The archaeological and environmental studies carried out at al-Yamâma, the main ancient settlement of the oasis of al-Kharj (Riyadh Province, Saudi Arabia), show that the latter did not emerge before the second half of the 1st millennium BCE. This late appearance is most likely not a local epiphenomenon as it was also observed in Laylâ-Aflaj and Qaryat al-Faw oases. The zooarchaeological and archaeobotanical studies conducted at al-Yamâma show another specificity.

During its long occupation (5th cent. BCE – 18th cent. CE), despite active caravan trade and pilgrim routes, the area remained marginal, showing little or no diversification of the archaeobiological assemblage, and few archaeological imports or external innovation. This is reflected in the bone remains which unsurprisingly show a clear dominance of caprine and camel, followed by gazelle and spiny tailed lizard. The combined presence of date palms, barley and wheats throughout this period highlights the continuity of the crops locally grown. It is only from the late Islamic period that new crops are recorded with the introduction of subtropical crops, namely sorghum and cotton, which indicate a stronger integration of al- Kharj into regional trade networks.

Reconstructing the history of al-‘Ulā oasis (kingdom of Saudi Arabia): first insights from the al-‘Ulā Cultural Oasis Project (2019-2023)

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Abstract: Funded and steered by the French Agency for AIUla Development (AFALULA), on behalf of the Royal Commission for AIUla (RCU), the al-‘Ulā Cultural Oasis Project (UCOP), carried out by Archaïos, aims at understanding the history of this well-known oasis located in the northern Hejaz region (Kingdom of Saudi Arabia). The project’s multidisciplinary methodology combines a systematic pedestrian survey of past and present cultivated spaces, in order to map them, with detailed studies of water systems, vernacular architecture and archaeological material, as well as the photo-interpretation of archive imagery and spatial analyses at different scales.

In this presentation, we aim at filling the gaps in our knowledge of the understudied Islamic and pre-modern Arabian oases by presenting and proposing a preliminary interpretation of the archaeological map of al-‘Ulā oasis, the first of this kind in Saudi Arabia. An analysis of the oasis’ spatial organization will be provided, as well as hypotheses regarding its spatial development during the last 800 years. Our purpose is in particular to understand how environmental constraints have helped shape the oasis space and how it has been impacted by the modernization of Saudi economy in the late 20th century.

Past vegetation and impact of human activities in Southeast Arabia during the medieval period: First regional charcoal synthesis.

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Abstract: Until recently, the medieval Islamic period was poorly investigated from an archaeobotanical point of view in Southeast Arabia. Analyses of charcoal assemblages from three archaeological sites (Kush, Fulayj, Qalhât) give the unique opportunity to reconstruct the evolution of past vegetation and the impact of human activities on throughout the whole medieval Islamic period (7th-15th c. CE). They highlight the exploitation of various plant formations including mangroves from the shoreline (*Avicennia marina*, Rhizophoraceae), pseudo-savannah of the foothill areas (*Vachellia* sp., *Prosopis* sp., *Ziziphus* sp.), hygrophilous taxa growing on the borders of wadis and alluvial fans (*Ficus* cf. *salicifolia*, *Nerium oleander*, *Moringa peregrina*) and mountainous formations (*Dodonaea viscosa*, *Euphorbia* cf. *larica*, *Periploca* sp.). The part of the oasis agroecosystem in the fuel economy could be appreciated with the proportions of date palm (*Phoenix dactylifera*) in the assemblage. This diversity of taxa (some of them from remote areas), the evidence of plants now absents in the surroundings as well as the importance of date palm may imply a possible degradation of the nearby vegetation cover during the occupation of the sites. The effects of over-grazing practices on the natural vegetation might be also evaluated though the development of specific taxa (e.g., *Dodonaea viscosa*).

Landscape evolution and environmental dynamics of Nafūn (al-Wuṣṭā Governorate, central Oman)

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Abstract: The coastal alluvial plain of Wadi Nafūn and the wider surrounding area north of Duqm represent a unique landscape with a high concentration of archaeological sites mostly associated with the Early and Late Iron Age. The shell-midden coastal settlement, trilith monuments, petroglyph sites, cairn tombs and circular stone structures provide a unique insight into Early and Late Iron Age communities of central Oman, still little known archaeologically. The archaeological evidence now records more than 155 sites. Surprisingly, apart from a large Middle Neolithic collective grave, no evidence of earlier occupation was discovered. The seasonal presence of possibly nomadic or semi-nomadic Iron Age communities was connected to social gatherings with links to maritime routes due to the visual connection with a distinct navigation landmark—al Hamr rock-island. Shell midden settlement, dated to Early Iron Age, proves these assumptions with finds of copper-alloy objects with provenance in northern and central Oman, and carnelian beads potentially suggesting links with India, Persia, or Yemen. The first petroglyph site in central Oman at Aṣ Ṣufayyah shows multiple engravings of camels, camel-riders, and inscriptions in Omani Musnad. These discoveries provide important data for better understanding the role of south-central Oman during the Late Iron Age, which in Wadi Nafūn is further represented by numerous triliths and Samad burials. Our goals are a precise spatio-temporal and environmental analysis which can contribute to understanding the tribal migrations across the South-Eastern Arabia in the Iron Age period.

Facing Early Bronze Age climate change in South East Arabia: new data from Salūt-ST1, Central Oman

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Abstract: During the 3rd millennium BC, a series of oases placed along the western foothills of the al-Hajar Mountains saw the establishment of intensive human occupation, associated with the construction of large buildings (the so-called “towers”) and residential structures. This kind of settlements was supported by the onset of a cultivation land use in the area of the oases. The development of such settlements was often associated with and supported by the introduction of substantial water management systems, including simple wells and complex, large ditches.

The oasis of Salūt, in the central Sultanate of Oman, is one of such Early Bronze Age centres. There, extensive excavation exposed the whole layout of the huge ditch surrounding the tower of Salūt-ST1. Large portions thereof were fully excavated, allowing the documentation of the sediments infilling the impressive hydraulic structure. The results of their geoarchaeological study will be presented here and compared with other archaeological data available for South East Arabia and local evidence for environmental changes.

Evidence from Salūt-ST1 illustrates various phases in the use of the ditch, including the original presence of standing water and later, gradual backfilling with colluvial episodes alternated with phases of human activity inside the ditch. Besides, excavations led to the discovery of several wells excavated through the marl bedrock of the ditch, witnessing the attempt to reach a deeper water table in the moment when overexploitation and/or the onset of a more arid climate made the former supply insufficient. The quest for deeper water resources is archaeologically dated around the beginning of the 2nd millennium. Human activity in the oasis continued for centuries and new ways to cope with the arid climate and support cultivations were experimented, including the introduction of underground water galleries (*aflaj*) in the Iron Age.

Malacological assemblages in oases environment, a way to recount human activities through time

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Abstract: Oases are anthropogenic landscapes which have been occupied and exploited for millennia in the Arabic Peninsula. On the long-term, these landscapes have been subject to both environmental variations and anthropic activities. Malacological analysis can provide information to question the nature and effects of these changes on oasis landscapes. Within the framework of recent projects dedicated to the integrated study of oasian landscape in Arabia (ArcAgr-AU and ANR OASIWAT, Dir. L. Purdue), we developed a systemic field and laboratory approach to study malacological assemblages, in order to help reconstruct the evolution of these agro-ecosystems, the associated agrarian practices and to measure the impact of water and soil management on malacological biocenoses.

Our observations were applied to the study of stratigraphic sequences (AlUla oasis-Saudi Arabia, Masafi oasis-U.A.E and Rustaq oasis-Oman) covering the last 4 millennia. Our data were confronted with sedimentary, pedological and physico-chemical analyses conducted in parallel. These results suggest that the anthropization of oasis spaces (e.g., agriculture, circulation) favors the spatial dispersion of species. Moreover, agricultural communities, through their management of resources (irrigation, amendment, reorganization of plots, abandonment) influence the edaphic factors of biotopes that condition the maintenance and development of malacological populations. The composition of the assemblages is therefore linked to the structuring and organization of the oases studied as seen in Iron Age (\approx 800. BCE) and Islamic Period.

Early- to mid-Holocene lake formation in NW Arabia was driven by the West African Monsoon

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Abstract: Due to the scarcity of precise climate archives on the Arabian Peninsula, the duration and impact of the early- to mid-Holocene humid period (HHP) as well as the impact on the landscape and regional cultural evolution are not fully resolved and remain under debate. Here, we present taphonomic analyses of a new Holocene shoreline record in the oasis of Tayma (NW Arabia) mainly consisting of bioclastic deposits (gastropods, barnacles, foraminifera, ostracods) and indicating the presence of a >17 m deep and >22 km² palaeo- lake. Sub-decadally resolved proxy data from the varved lake sediments inside the basin (microfacies, pollen, TOC, stable isotopes) and varve and radiocarbon dating point to five phases of lake development between 8,800 and 7,900 cal yr BP, corresponding to the mapped shoreline deposit. A transient simulation conducted in the Earth System Model MPI-ESM for the last 8000 years indicates stronger late-summer rainfall during the HHP embedded in the intensified West African monsoon (WAM) circulation. Tayma is located at the distal fringes of increased monsoonal influence. This may explain the very short existence of the perennial lake compared to the HHP's millennial-scale impact in areas closer to the core domains of the WAM and the South Asian Monsoon.

An overview of the interactions between human societies and natural hazards in Arabia since the Late Pleistocene

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Abstract: Since Homo Erectus, then Homo Sapiens, first left Africa, man has inhabited the different territories of the Arabian Peninsula as a hunter-gatherer. This long occupation, affected by sea level variations and significant climatic fluctuations, allowed the sedentary farmers, fishermen and nomads to benefit from a precise knowledge of the ecosystems and their resources during the Neolithic period. With diverse vulnerabilities, all those societies have been confronted to the same natural hazards, extreme climatic events and epidemics with varying intensity over time. After introducing a typology of natural hazards and their unequal distribution throughout the Arabian Peninsula, we will study the links between environmental hazards and societies from the Paleolithic to the Iron Age in order to determine which were most instrumental in the development of lifestyles and agricultural techniques. Among the natural hazards, those that had the greatest impact are without context the aridification crises. Paradoxically, it is at the end of unfavorable aridification cycles that technical innovations linked to the use of water, such as the falaj system, allowed the creation of oases and an increase in productivity.

First results from the UmWeltWandel project in Al-Khashbah (Oman)

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Abstract: The aridity of Eastern Arabia makes the reconstruction of its ancient environment extremely challenging. Many proxies do not survive in these conditions. Nevertheless, climate, landscape and vegetation of the past are essential to understanding long-term patterns of human occupation and socio-political developments. Therefore, the UmWeltWandel project employs a variety of different methods from the fields of geochemistry, paleoclimatology, geomorphology, archaeobotany and palynology to gain insight into the environment of Central Oman in the Neolithic and Early Bronze Age. The results of the first two years of this project will be presented in this paper, focussing on how the area of Al-Khashbah in the governorate of Ash Sharqiyah North has developed from humid conditions in the Neolithic to dryer conditions in the Bronze Age.

Grass, Water and Sand: Exploring the Environmental Parameters and Practicalities of Cattle Herding in the Neolithic of Northern Arabia.

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Abstract: Environmental and archaeological records relating to Holocene climatic changes can at present not be linked beyond broad-scale correlations between wet and dry phases, and the impact of vegetation changes on wildlife and livestock remains unknown. Rock art analyses have documented a rich wildlife in northern Arabia, as well as the symbolic and economic importance of livestock. However, the archaeological record suggests that at least part of the adaptation to these marginal environments was characterised by extremely high mobility. This raises questions of how much livestock could be supported by the landscape, on the practicalities of sustaining cattle herds through dry phases and sand dunes, as well as on the impact livestock grazing would have had on the local vegetation, and thus on wildlife.

Sustainable, modern cattle farming is dependent on rainfall and on the corresponding growth rates of vegetation, factors that are highly susceptible to climatic fluctuations. These modern parameters can be adjusted to prehistoric environmental conditions and animal breeds. Using the Jubbah oasis as a case study we can model the capacity of the prehistoric landscape to support livestock herds and provide a better understanding of the impact Holocene environmental changes had on prehistoric human and animal populations.

The Nexus of Cult and Pastoralism in Neolithic Northwest Arabia: Contextualising the Mustatil Phenomenon.

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Abstract: At present more than 1600 mustatil have been recorded across northern Arabia. These monumental ritual structures have been interpreted as markers of territoriality and a key component in constructing and consolidating kinship ties and communal social identities in the Late Neolithic of northern Arabia. Perhaps most strikingly, these structures are marked by a homogeneity of architectural form, over a vast geographic area, some 300,000 km². In AIUla County, seven mustatil have currently been excavated, four by the AAKSA project. These excavations have revealed chronologically contemporaneous ritual deposits of faunal remains, specifically the horns and upper cranial elements of domesticated sheep, goat, and cattle, as well as wild taxa, such as gazelle and ibex. Despite the overall similarity of architectural form across these examples, the faunal composition of these deposits varies, with some structures marked by higher proportions of wild taxa, whilst others are predominantly composed of cattle and/or caprids. In this paper, we explore the possibility that these assemblages represent the pastoral economies of the group(s) who constructed the mustatil, shedding new light on the various lifeways and herding practices of northwest Arabia during the Neolithic.

The Second Millennium in Southeast Arabia

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Abstract: The advent of the 2nd millennium saw marked changes in settlement in Southeast Arabia (= Northern Oman and the UAE). Many Umm an-Nar sites were either abandoned (e.g. Unar Island), declined notably in size (e.g. al-Tikha) or were markedly reconfigured (e.g. Bat). In Northern Oman these developments led on to an almost complete absence of settlement during the Late Bronze Age (c. 1650 – 1300 BC). During this period very little evidence is available, mostly consisting of limited finds from tombs and occasional pottery sherds. However, in the northernmost extent of Southeast Arabia, in particular in the area encompassed by the Sir and Jiri plains of Northern Ras al-Khaimah, the situation was radically different. In this area settlement continued – or indeed increased in density, and this continued right through the Late Bronze Age. The tradition of large, surface-built collective tombs, reminiscent of – though markedly different from - the Umm an-Nar tradition continued into the Wadi Suq period. The location of at least 16 major cemeteries of this type is known and these give a key insight into the location and nature of sedentary occupation at this time.

This paper will examine this pattern of evidence and consider what it tells us about the changing nature of early second millennium settlement in the face of the marked climatic shifts at the time of the 4.2ky BP event. It will argue that a unique configuration of sub-surface aquifers as well as access to the ‘Dilmun-facing coast’ of the NW Emirates, along with other factors, explain the unique development of Northern Ras al-Khaimah area at this time.

Millennial-scale transformations of landscapes and land use in the canyon of Southeast Arabia. Insights from the archaeological investigations in Tanuf, North-Central Oman

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Abstract: In the piedmont areas of arid Southeast Arabia, canyons played a fundamental role in human- ecological history by providing rich water resources and transportation routes. Humans utilised these resources and transformed the canyon landscapes at a millennial timescale. Thus, archaeological investigations can contribute to reconstructing the long-term human activity in canyons. To reconstruct this relationship, we have investigated the canyon of Wadi Tanuf in North-Central Oman. The identified 13 sites indicated that the canyon had been utilised from prehistory and that human activity has intermittently transformed. The earliest records date back to the Hafit period, and the canyon was used as a transportation route. Cairns are clustered from the wadi bed to the edge of high cliffs. The radiometric dates from the excavations at Mugharat al-Kahf cave also support the possible temporal shelter use. Canyons continued to be used as transportation routes in the Middle Bronze and Early Iron Ages, as indicated by much mortuary and temporal occupational evidence. However, a possible settlement was also confirmed in the Early Iron Age. After Islamisation, the canyon has been used as cemeteries and fortifications during conflicts. Thus, the canyon provided effective roles and land use potential for transforming human activity through millennia.

Industrial periodicity of copper smelting: new research in Wadi al-Raki (Oman)

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Abstract: Industrial periodicity is a hallmark of modern and ancient extractive economies. In southeast Arabia, current evidence demonstrates that intensive periods of copper production are bracketed by century to millennia scale periods of little to no production. Explanations for this periodicity range from environmental degradation (e.g., deforestation related to unsustainable fuelwood provisioning) to shifts in local and distant trade networks to internal sociocultural factors. In this paper, we give an overview of current understanding of this problem and introduce new data from the Archaeological Water Histories of Oman (ArWHO) project's work at Wadi al-Raki, one of the largest and better preserved ancient industrial landscapes in southeast Arabia. Methods used to generate this data include pedestrian survey and remote sensing, targeted excavations, and laboratory analyses of production debris and wood charcoal to examine the periodicity of copper production. Our work provides a new baseline understanding of factors that drove changes in the tempo of industrial copper production in southeast Arabia.

Environmental dynamics in northwestern Arabia during the Holocene: fluvial, wetland and dune archives in the AIUla oasis

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Abstract: The oasis of AIUla (NW Saudi Arabia) provides a unique research background for paleoenvironmental studies. Located at the foot of the Harrat al-Uwayrid formation which separates the sandy deserts of northern Arabia (Hamra Desert) from the Red Sea, AIUla is characterized by the development of emblematic archaeological sites such as the Iron Age site of Dadan, the Nabataean site of Hegra, or the Islamic city of AIUla. To better understand the environmental, hydrological and climatic background in which the oasis developed, alluvial and eolian sedimentary archives were studied in the oasis and its surroundings. Geophysical investigations and stratigraphic description of exposed sedimentary archives, test pits and core drillings were conducted in the field and samples collected for sedimentological, geochemical and chronological analyses (OSL and 14C). Based on 130 radiocarbon and OSL dates, our results provide the opportunity to propose a first chronostratigraphic overview of Late Quaternary deposition in the AIUla, with 11 distinct sedimentary phases. Our results highlight a long-term tendency towards aridification since the second part of the Holocene, as well as short-term climatic oscillations. This allows us to draw first hypotheses on the impact of hydroclimatic dynamics on ancient societies for the last 10 millennia.

Caprines in Prehistoric South-Eastern Arabia: Variations in Animal Exploitation Through Zooarchaeological Data.

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Abstract: The Al-Hajar Mountains, which run parallel to the Sea of Oman in both the Sultanate of Oman and the United Arab Emirates, form the spine of the land that hosted the easternmost human communities of the Arabian Peninsula from the Prehistory. Numerous archaeological sites, located in different geographical and environmental conditions, have been discovered and explored in this region over the last three decades. The impact humans already had on the landscape from the Neolithic/Early Bronze Age to the Late Iron Age is demonstrated by the discovery of settlements and graveyards of great complexity. Within the time span covered by the present study, it is possible to observe diachronic and geographical variations in the composition of the zooarchaeological assemblages, reflecting different strategies in the exploitation of domestic animals, namely sheep and goats. Over time, domestic animals became increasingly important to both the inland communities on the fringes of the Al-Hajar Mountains and the fisherfolks settled along the Arabian Sea coast. This contribution aims to provide a broad overview of the newly available zooarchaeological data necessary to highlight synchronous regional patterns and diachronic evolutionary trends in breeding strategies and animal exploitation, considering them in the context of climatic changes, social-economic transformations, and trade routes.

Southeastern Arabia population patterns and intensity of cultural exchanges across the Holocene Humid Period

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Abstract: The Early and Middle Holocene in Southeastern Arabia is characterised by substantial climate change as well as change in material culture, with differences across space and time. The main drivers of social development and technological innovation are 1) the shift in population density and 2) climatic fluctuation. Here we present preliminary results of tests aimed at identifying long-term relationship patterns between human population dynamics and climate from the Early Holocene to the end of the Middle Holocene (12000 - 5000 cal. BP). The main goal is to assess to what extent climate change impacted human societies and their know-how -exemplified in this case by lithic technology. Our tests are based on a first comprehensive collection of all the available radiocarbon dates from surveyed or excavated sites (n 325), the distribution of projectile points (n 1200), and paleoclimatic records from cave speleothems and lake sediments. Archaeological data and paleoclimatic records will be compared across four regional case studies (Oman, UAE, Qatar, and Yemen), allowing the identification of regionalised patterns in population and climate trends. Long-term trends in the frequency of lithic technological traits in Southeastern Arabia will be obtained through aoristic analysis. The resulting patterns will be compared against demographic proxies (e.g., sum of radiocarbon dates) and paleoclimatic proxies obtained for the region of interest. Correlation between these different sources of information will be measured to assess potential links between population dynamics, technological change, cultural exchange, and environmental change from the Early to the end of the Middle Holocene in Southeastern Arabia.

How Bone Connects Life's Past to the Present. Zooarchaeology at Dadan (AlUla, Saudi Arabia).

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Abstract: The excavations undertaken on the site of Dadan have recovered a very important bone assemblage (more than 75,000 remains), allowing us to reconstruct and better understand the subsistence strategies of the inhabitants in a central part of the al-‘Ula (AlUla) oasis for at least three thousand years. The city of Dadan was the capital of important Iron Age regional powers, the Dadan and later the Lihyan Kingdoms, which controlled the caravan routes across the oasis between the Levant and Mesopotamia and the south of the Arabian Peninsula, and later the Red Sea. Subsequently, the site of Dadan continued to be occupied in the Late Antique and Islamic periods. From these different chronological periods and excavation areas, the bone remains, representing meal leftovers, shows a clear dominance of caprine (sheep/goat) followed by the Arabian camel. Wild species, such as gazelle, oryx and hare, signs of hunting activities, are very rare, as also is birdlife. These domestic species are certainly the result of local breeding and underline the great autonomy of the inhabitants of the oasis. Only fish or seashell come from a more distant horizon, the Red Sea via the trade routes. The absence of pig and the lack of chicken or cattle raise many questions, as does the small presence of camel in the area occupied/developed in the Late Antique.

Persistent Pastoralism in a Dynamic Dhofar Landscape: Results from the ASOM Project

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Abstract: The cloud forest escarpment, grassy plateau and sharp geographic transition to inland deserts makes the Dhofar mountains a unique environment in Arabia. Throughout prehistory, pastoral communities have shaped and adapted this environment while adjusting pastoral strategies to suit its dynamic conditions. The Ancient Socioecological systems in OMan (ASOM) Project examines under what environmental conditions territoriality emerges in pastoral ecosystems and how territoriality in turn shapes the environment. Recognizing the roles of human movements, population growth, and the state of rangelands in long-term dynamics of pastoralism, we studied how four variables--mobility, demography, territoriality, and vegetation dynamics can cause cycling or push the pastoral ecosystem from one state to another, as in an adaptive cycle switching between open and closed (territorial) access to resources. We hypothesized that coupling in the human systems (mobility, social rules of territorial and open property) and natural systems (vegetation, demography) explains long-term patterns. The research engaged methods from paleoecology, archaeology, and interdisciplinary computational modeling study to study human landscapes and historical changes in vegetation over 6000 years in Dhofar (Southern Oman). We found changes in vegetation consistent with climate shifts and human presence, which we compare to the archaeological evidence of human social dynamics. Using agent- based modeling that represents the climate, ecology, and social system of pre-historic pastoralists in Dhofar, the project team examines the dynamic feedbacks between climate change, pastoral populations, and rangeland ecology in simulations that run for over hundreds and thousands of years.

Late prehistoric environments and human adaptations at Saruq al-Hadid, Dubai: the archaeobotanical evidence

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Abstract: This paper presents and contextualises the archaeobotanical remains from the late prehistoric site of Saruq al-Hadid in the United Arab Emirates. The approach incorporates systematic studies of plant macroremains (seeds and fruits), wood, and charcoal, and preliminary analyses of phytoliths and pollen, and assesses these remains against modern botanical assemblages collected at the site and from the wider region and archaeobotanical datasets from contemporary Bronze and Iron Age sites in southeastern Arabia. Alongside studies of animal bones recovered from the site, the archaeobotanical evidence offers a key window into the past environment of Saruq al-Hadid, as well as human practices related to subsistence, mobility, exchange and craft production. The results are significant for understanding the human exploitation of the site, and more generally of the desert and desert fringes of the region, which are emerging as critical but poorly understood components of ancient settlement systems in southeastern Arabia.

Between Mountains and the Sea. Archaeological Survey and Landscape Studies at Al-Tikha/Rustaq, Oman

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Abstract: Al Tikha is an archaeological site located in the Al Bathina region of Oman, and mostly dated to the Early Bronze Age culture of Umm an Nar (2700-200 BCE). The site extends for more than 70 hectares along the western bank of the Wadi Far, approximately 5 kms North of the city centre of Rustaq. Al Tikha presents an impressive number of stone-built structures clearly visible on the surface, as well as the remains of several tower tombs, and other archaeological features, making it a primary settlement for the Umm an Nar culture of Oman.

In Winter 2022 the first Italian-Omani field season was carried out at the site, thanks to the collaboration between the University of Pisa and the Sultan Qaboos University. This paper discusses the results of the intensive, field-walking survey of the site, along with some drone-based landscape studies. The aim is to present the settlement's history and its relationship with the surrounding environment through time.

New evidence of Late Pleistocene and Holocene sedimentary processes and eolian dynamics in the northern al-Hajar Range (UAE, Oasis of Masafi)

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Abstract: In arid environments, continental records of climate change are rare. In southeast Arabia, where most of the landscape is dominated by the ophiolitic al-Hajar range, paleoclimatic data is mainly derived from sedimentary records on the western piedmonts. In the mountains, where human occupation could have prevailed during periods of climatic stress, climatic data are lacking, mainly as a result of weakly-preserved sedimentary archives. Recent studies have revealed the existence of thick but under-explored sedimentary archives in these environments: sedimentary sequences in oases. In order to evaluate their potentiality as hydro-climatic archives, we develop a geomorphic and geoarchaeological approach in the oasis of Masafi (UAE). Results allow us to identify and decipher sediment sources and deposition modes over the last 18 ka years, which include local sediment and eolian inputs remobilized by runoff processes, wind powdering, and anthropogenic processes linked to agricultural practices. The results obtained reveal the complexity of hydro-sedimentary processes and sediment connectivity but the high potential of oases archives if studied with caution.

Fluvial investigations in the context of paleoenvironmental change over the last 330,000 years and its influence on human occupation in SE Arabia

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Abstract: Over the last 20 years an increased number of palaeoenvironmental studies has permitted the reconstruction of palaeoenvironmental change in SE Arabia. To date work has focussed primarily on aeolian deposits like dune systems, while further geoproxy records indicating wet periods including speleothems, lake sediments, alluvial fan and fluvial deposits remain studied less. In this context the Hajar Mountains and the interplay of the mid-latitude Westerlies, Indian Ocean Monsoon and tropical cyclones has played a crucial role in the activation of hydrological systems. Our recent multi-proxy investigations of two ephemeral river systems (Wadi Dhaid and Wadi Iddayyah) in the northern United Arab Emirates highlight the need to reconsider the traditional division of the climate in SE Arabia into distinct wet or dry phases aligned with glacial/interglacial MIS stages. Instead of distinct phases that allowed human occupation we advocate for a continuity of possibilities with varying conditions. In order to further develop this discussion, we give an overview of the environmental change in SE Arabia over the last 330,000 years on the basis of our recent investigations. Finally, these findings will be set in the context of the multiple phases of Palaeolithic and Neolithic human occupation in the region and the debates around human dispersals.

Towers and settlement in the Bisya region (ad-Dakhiliyah, Oman) during the Early Bronze Age: adaptation strategy of human occupation in a semi-arid environment

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Abstract: The Bisya region is one of the main settlement areas of the Early Bronze Age in the southern foothills of the Hajar mountains in Oman. Since 2021, the FAMCO mission has undertaken a multi-scalar analysis of human occupation at Bisya. This study integrates an archaeological survey (sites and tombs) combined with targeted surveys by remote sensing (GPA, lidar and thermal imagery), which make it possible to document architecture and installations in and around the towers; environmental studies (geomorphology, palaeobotany); targeted excavations (settlement, tower and tombs), and the analysis of food supply through isotopic analyses. The site of al-Dhabi 2, in particular, presents a hill tower associated with a settlement area (Umm an-Nar period) and tombs (Hafit and Umm an-Nar types). The botanical samples (charcoal) from the dwellings document the exploitation of vegetal resources and fuel, tackling the issue of date palm cultivation. The study of the site's geomorphological context allows us to question the water management and the establishment of food crops. All in all, this study documents the conditions of the installation of the first oases in a semi-arid environment, integrating the problems of water management, the beginnings of irrigated agriculture/horticulture, and the relations between sedentary and nomadic life.

Meat, milk and ‘invisible’ organic products in pottery: results of ceramic lipid residue analysis of vessels from Bronze Age sites in SE Arabia

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Abstract: Populations in the Bronze Age in SE Arabia had intimate knowledge of their environments and engaged in complex knowledge-, technological and production systems, and also maintained exchange networks involving both organic and material culture across long distances. This study presents the results of lipid residue analysis from pottery from locally- produced pottery such as Fine Red Omani Ware and Sandy Ware, as well as imported pottery such as Mesopotamian pottery and Indus Black-Slipped Jars from the sites of Hili 8, Salut ST1, Bat (Settlement Slope), Mukhtru and Kalba 4 to explore what kinds of organic products were used and/or consumed in daily subsistence activities, as well as what products may have been moved from afar. Lipids were extracted from pottery and analysed via Gas Chromatography-Mass Spectrometry (GC-MS). A subset of the samples were analysed via Gas Chromatography-combustion-Isotopic Ratio Mass Spectrometry (GC-c-IRMS) to distinguish between terrestrial and marine sources and dairy and ruminant carcass fats. The results highlight the importance of pastoral products, such as meat and milk, but also suggest the presence of plant oils and other plant products in different vessels, indicative of diverse culinary and vessel-use practices. The direct identification of foodstuffs and characterisation of archaeologically ‘invisible’ products (cf. Crawford 1973) that were contained or processed in ceramic vessels using sensitive chemical techniques provide a new means to interrogate the relationship between people and their environment in ancient SE Arabia.

Cultural and Environmental Resiliency at Bat, Oman: Early Bronze Age and Today

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Abstract: The Bat landscape of northwestern Oman is one of dense archaeological remains and diverse ecological conditions. The site has been a centre for human activity since the Palaeolithic, most famously attested by the Early Bronze Age tombs, towers, and settlement of the UNESCO World Heritage zone. With the support of the US National Endowment for the Humanities, ongoing work by the Bat Archaeological Project aims to reconstruct the site's Umm an-Nar period (ca. 2700-2000 BC) cultural landscape and the human-environment interactions that led to its creation and resilience. The concept of resilience, or the ability of a system to persist and thrive even in the face of perturbations, can be applied to both natural ecosystems and human communities in ancient and modern times. A program of interdisciplinary collaborations integrating geomorphological, archaeobotanical, and phytolith analysis with remote sensing and traditional excavation of domestic spaces on the Bat landscape allows us to trace the arc of Umm an-Nar period activity at Bat alongside its changing environment. A parallel program of ecological survey assessing modern biological (floral and faunal) and hydrological resiliency provides a framework for understanding Bat's history as a centre for human-environment interaction in the Umm an-Nar period. This paper presents the methodology and preliminary results of two seasons of resiliency studies at Bat.

Hayl (pl. *huyul*), a specific landscape form in the Al-Hajar Mts (SE Arabia)

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Abstract: The paper serves as an introduction to a promising, yet understudied landscape form of the southeastern Arabian Peninsula: the small-sized sediment-filled karst depressions (locally called *huyul*, sg. *hayl*) found in various parts of the Al-Hajar Mts (Oman, UAE).

With their “coating” of fine, aeolian sediment, *huyul* can hold back humidity on the surface of fissured limestone/dolomite formations. They appear to be a specific feature of the immature karst of arid countries. (Conversely, in areas with copious rainfall and mature karst, analogous deposits are washed from the rock surface, as is observable in some areas of the Balkans).

These episodically moisturized sediment flats must have been vital footholds for lifeforms in the erosional landscape of the Al-Hajar Mts, and no less so, for prehistoric visitors (stone artefacts at the intermountain site Hayl Ajah at ca. 1000 m a.s.l.).

Although *open-air* features, the *huyul* of northern Oman offer unique opportunities for palaeoenvironmental and palaeoclimatic research, as proven by the case of a karst depression in Eastern Al-Hajar Mts (Maqta). Additionally, the preliminary archaeological research at Hayl Ajah shows that good evidence of prehistoric occupation may also be found in a *hayl*. The paper will refer mainly sedimentological and geoarchaeological information.