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Guest Editorial

Green Arabia: Human prehistory at the Crossroads of Continents

The Arabian Peninsula should play a central role in understanding the biological and cultural legacy of humanity, as the region is at the crossroads between Africa and Asia, thereby linking the landmasses of Northeast Africa and the Sinai in the northwest, the plains and river valleys of Jordan and Iraq to the north, and the uplands of the Iranian plateau in the northeast. Yet, many accounts concerning the geographic spread and biogeography of hominins continue to marginalize Arabia in favour of the Levant and regions to the north and west (e.g. Stewart and Stringer, 2012). Even if some migration models allow for a movement of human populations across southern Asia, most publications illustrate Arabia as a transit zone only to be side-stepped and briefly utilized along its southernmost periphery or coastal margin (e.g. Mellars et al., 2013). A set of new scholarly publications have attempted to rectify this situation, drawing attention to the entirety of the Arabian Peninsula as a key geographic zone where significant demographic processes unfolded (e.g. Petraglia and Rose, 2009; Magee, 2014). Although mainly concentrating on the Holocene record, the travelling "Roads of Arabia" exhibit and its accompanying book (Al-Ghabban et al., 2010) have also engendered greater scholarly and public awareness of the region's natural and cultural heritage and the place of Arabia in the wider world.

The Arabian Peninsula is a virtual natural history library for understanding the relationships between climate change, environmental variability and the evolution of human populations through time. Indeed, environmental change in the Saharo-Arabian belt is recognized to be vital for understanding the expansion, contraction and extinction of human populations through time (e.g. Foley and Lahr, 1998; Scerri et al., 2014a). The amelioration of environments across the middle latitude belt promoted the development of savannahs, thereby contributing to the movement of early humans out of Africa (Dennell, 2009). These ameliorated environments, with plentiful freshwater sources and a diverse and abundant array of animal resources, have been considered as optimal life zones of Pleistocene hominins (Finlayson, 2013). In Finlayson's view, Arabia was not only a key corridor for movement of humans between other regions, as indicated by the environmental and archaeological evidence (Boivin et al., 2013), but also a 'crucible' for human evolution (see also Finlayson, 2014). As will be demonstrated below, ongoing research supports this notion and confirms that Arabia contains plentiful evidence for the existence of palaeorivers, lakes and wetlands (Breeze et al., 2015) and stratified Palaeolithic sites (Groucutt and Petraglia, 2012).

On the basis of mitochondrial DNA coalescence ages, genetic studies indicate that human populations were present in Arabia for at least 60,000 years (Fernandes et al., 2015), if not before (Scally and Durbin, 2012). Little is known, however, about what happened to people between the initial human colonization of the region and the onset of the Neolithic at ~10,000 years ago. Nevertheless, as will be reviewed below, during the Early to Middle Holocene humid phase, between ~11 and 6,000 years ago, it appears that Arabia experienced a demographic growth in human populations, evidenced by the wide distribution of archaeological sites across the peninsula (Groucutt and Petraglia, 2012). Despite the fact that most archaeological research in Arabia has concentrated on the Holocene record, significant gaps still remain about cultural developments and the influence of climate change on hunter-gatherers, pastoral communities, and oasis settlements (Magee, 2014).

To address the role of Arabia in world prehistory, an international conference was held at St John's College, University of Oxford, on April 2–4, 2014. The conference, entitled: "Green Arabia: Human Prehistory at the Crossroads of Continents", was sponsored by the Saudi Commission for Tourism and Antiquities (SCTA) and the European Research Council (ERC). The conference was co-organised by Michael Petraglia, Abdullah Alsharekh, Ash Parton and Huw Groucutt, representing a key aspect of joint archaeological research being undertaken by King Saud University and the University of Oxford. The main aim of the "Green Arabia" conference was to explore the relationship between climate change and human occupation history of the Arabian Peninsula and in surrounding geographic regions. The conference began with extensive media coverage by the international press, eventually resulting in an in-depth feature article in *Science*, "In Search of Green Arabia" (Lawler, 2014).

As an opening to the "Green Arabia" conference on the evening of April 2nd, and before an over-capacity audience of more than 200 invited guests, scholars and students, Professor Nicholas Rawlins, Pro-Vice Chancellor of the University of Oxford, welcomed the attendees to Oxford. An introductory speech was delivered by HRH the Prince of Wales, who stressed the importance of international partnerships for evaluating the impact of climate change on human societies both past and present. The introductory speeches were followed by the launching of the "Palaeodeserts" website (www.palaeodeserts.com) in Arabic, in an attempt to engage the people of Arabia and the Middle East with ongoing archaeological and palaeoenvironmental research. The first keynote talk of the evening was by HRH Prince Sultan Bin Salman Bin Abdulaziz Al-Saud, Chairman of the Board and President of the Saudi Commission for Tourism and Antiquities. Prince Sultan Bin Salman discussed the

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cultural heritage of Saudi Arabia, while noting his intent to form the "Green Arabia Research Centre" in Riyadh. Michael Petraglia, University of Oxford, delivered the second keynote of the evening, centring on climate change and its relation to the discovery of new archaeological sites in the Kingdom of Saudi Arabia by the Palaeodeserts team. Rick Potts of the Human Origins Program, Smithsonian Institution, capped the evening off with a wide-ranging talk on the relationship between environmental variability and the evolution and dispersal of humans out of Africa.

After a welcoming speech by Professor Ali bin Ibrahim Al-Ghabban, a total of 28 papers was presented during the following two days of the conference, on April 3rd and 4th. The papers were organized around four main themes of the conference: Climate Change and Demography; Behavioural Responses to Environmental Change; Recording the Past: New Models, Methods, Discoveries; and, Bridges, Barriers and Habitats: Arabia and Beyond. Alongside the conference papers, a total of 20 posters were displayed. Three temporary exhibits were also developed with palaeontological and archaeological finds from Saudi Arabia, together with a special exhibit on the research contributions of Professor Norman Whalen, featuring his personal notebooks and archives that were generously donated to Oxford by his former department at Texas State University.

Given the quality of the presentations and the amount of newly generated data on the environments and archaeology of Arabia and surrounding regions, the co-organisers of the Green Arabia conference felt that publication would be appropriate, thereby resulting in this special issue of *Quaternary International*. Though the conference was geographically and topically wide-ranging, covering records from other regions and disciplines, the co-editors of this volume felt that a more focused set of papers would be more desirable, concentrating on climate change and the human occupation history of the Arabian Peninsula. A total of 19 articles have therefore been published for this special issue of *Quaternary International* (Fig. 1).

On the basis of fossil and genetic information, the speciation of *Homo sapiens* is believed to have occurred in Africa, although considerable debate concerns the timing of out of Africa dispersals and the relative success of colonizing populations to adapt to new conditions. Groucutt et al. (2015a) summarise the stone tool assemblages present in Africa and Eurasia, in an explicit attempt to test two distinct out of Africa models; one centred on the repeated expansion of human populations using Middle Palaeolithic technologies beginning by Marine Isotope Stage 5 (MIS 5), and another that hypothesizes that humans moved as part of a single successful wave at ca. 60–50 ka, using geometric/microlithic industries. In their comprehensive analysis of the temporal and spatial variability of lithic industries, the authors conclude that Middle Palaeolithic assemblages across Africa and many regions of southern Asia, including Arabia and India, share technological features, suggesting that the onset of human dispersals was earlier and more geographically expansive than previously assumed. In contrast, the authors demonstrate that geometric/microlithic industries, which were previously assumed to be technologically and stylistically similar (e.g. Mellars et al., 2013), in fact show significant temporal and spatial variability, calling into question the utility of these tool forms as markers of human movements outside Africa.

The geographic expansion of human populations towards Australasia has traditionally been portrayed as a "coastal" route (e.g. Stringer, 2000; Macaulay et al., 2005; Oppenheimer, 2009). Yet, some have critiqued the coastal "super-highway" characterization based upon the absence of marine-oriented archaeological sites anywhere along the Indian Ocean rim, in contrast to the presence of abundant terrestrial archaeological sites (e.g. Boivin et al., 2013). Two articles in this special issue make significant headway in addressing these polorized viewpoints. Erlandson and Braje (2015) make the persuasive case that the coastline along the Indian Ocean rim would have had highly productive habitats that would have offered a rich and diverse array of aquatic and terrestrial resources for dispersing humans. Similar to the "kelp highway" hypothesis developed for the Americas (Erlandson et al., 2007), the authors suggest that a "mangrove highway" would have facilitated the dispersal of groups from Africa and towards Southeast Asia. Erlandson and Braje argue, however, that the coastlines were not universally productive over the large expanse of the Indian Ocean rim, thus promoting the utilization of both coastal and terrestrial resources as opportunities arose for prehistoric groups. In their view, humans utilizing the Indian Ocean rim would have paused and taken advantage of productive areas along the coastal and interior zones while exploring areas further along the marine ecosystems. Though Erlandson and Braje recognize that the large majority of potential coastal sites may be underwater, the authors identify several areas characterized by a narrow continental shelf that might yield land-based evidence for coastal dispersals, including parts of the southern margin of Arabia and Iran, the south and eastern zones of India and Sri Lanka, and the western coast of the Andaman Islands. Following on from Erlandson and Braje, and under the umbrella of their clever title, "Blue Arabia", Bailey et al. (2015) discuss the implications of their long-term underwater and terrestrial surveys along the Red Sea margin of southwestern Saudi Arabia. Bailey et al. demonstrate that this fertile region contains archaeological sites representative of many time periods, suggesting a prolonged hominin presence possibly extending back a million years or more. The surveys have produced evidence of an extensive distribution of sites both along the coast and in the hinterland, with at least one Palaeolithic site that is associated with an ancient shoreline. In summing up the current situation, and echoing a key point made by Erlandson and Braje, Bailey et al. (2015) state: "We suspect that patterns of dispersal in, through and around the Arabian Peninsula will turn out to be neither solely 'green' – following well-watered environments wherever they may occur – nor solely 'blue' in following the coastline, but a combination of the two".

Climate change, and the remodelling of environments and landscapes, has been linked with hominin speciation and extinction, dispersals and behavioural innovations (e.g. Potts, 2013; Maslin et al., 2015). Oscillations of the Saharan environment, fluctuating from arid to humid, are likewise thought to have both attracted and repelled human populations through time (e.g. Larrasoaña et al., 2013; Scerri et al., 2014a), and moreover, the development of rivers and lakes is thought to have contributed to the movement of humans out of Africa (e.g. Drake et al., 2011). Changes in climate, particularly in rainfall regimes, are examined by Jennings et al. (2015a) who utilize five global models to examine fluctuating environments of the Arabian Peninsula. All five climate models demonstrated that the Arabian Peninsula at ca. 130–125 ka was significantly wetter than today. Most significantly, the authors highlight the strong influence of the North African summer monsoon for contributing rainfall to Arabia; a climatic system that has been underplayed relative to the better-known Indian Ocean monsoon and Mediterranean climate regimes. Additional pluvial phases were recorded in the global models at 104 ka (MIS 5c), 56 ka (early MIS 3) and 21 ka (LGM), suggesting that archaeologists should expect to see evidence for multiple dispersals and a complex demographic scenario. Parton et al. (2015) examine a wide variety of palaeoclimatic records for humid periods in and around the Arabian Peninsula utilising both terrestrial and marine core data. The authors indicate that significant evidence for humid periods are present, implying that there were "multiple windows" for demographic expansion of hominins across Arabia at the

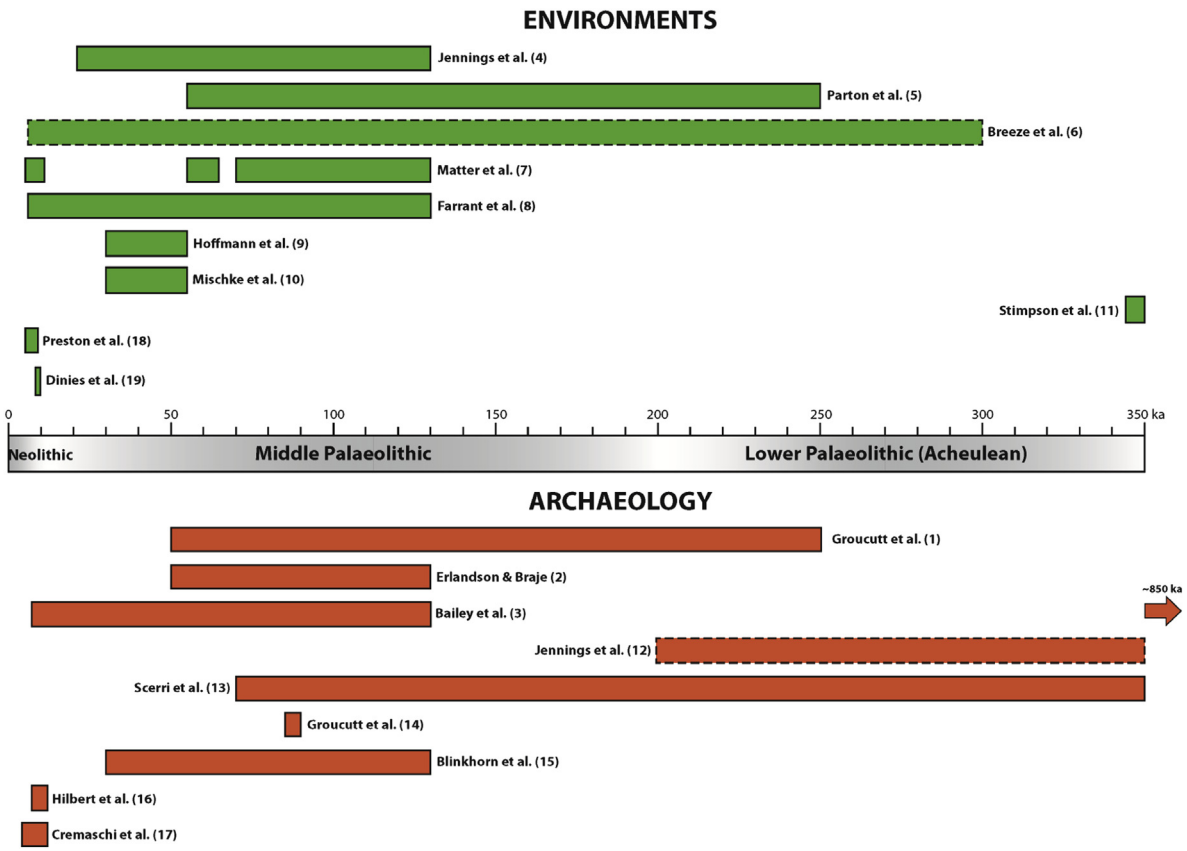

Fig. 1. Schematic timeline for articles covered in this special issue. (1) Groucutt et al. (2015a); (2) Erlandson and Braje (2015); (3) Bailey et al. (2015); (4) Jennings et al. (2015a); (5) Parton et al. (2015); (6) Breeze et al. (2015); (7) Matter et al. (2015); (8) Farrant et al. (2015); (9) Hoffmann et al. (2015); (10) Mischke et al. (2015); (11) Stimpson et al. (2015); (12) Jennings et al. (2015b); (13) Scerri et al. (2015); (14) Groucutt et al. (2015c); (15) Blinkhorn et al. (2015); (16) Hilbert et al. (2015); (17) Cremaschi et al. (2015); (18) Preston et al. (2015); (19) Dinies et al. (2015).

intervals of 200–190 ka (MIS 7), 170 ka (MIS 6), 155 ka (MIS 6), 130–120 ka (MIS 5e), 105–95 ka (MIS 5c), 85–75 ka (MIS 5a), and 60–55 ka (MIS 3). Most importantly, the authors indicate that humid periods show temporal and geographic differences as a consequence of fluctuations in Arabia's climatic systems, thus implying that archaeologists should expect to see variations in the location of favourable environments for human occupation.

Ancient rivers, lakes and marshes are now known to be common hydrological features across the Arabian Peninsula, owing to the use and analysis of satellite imagery to locate potential freshwater sources (Breeze et al., 2015). The results of this remote sensing work have been rather dramatic, demonstrating the high frequency of palaeodrainage channels and lakes across the region, many of which correspond with previously identified archaeological sites spanning from the Acheulean to the Neolithic. Field survey in several areas of Saudi Arabia has verified the accuracy of this novel desktop method; 96% of the identified lake or marsh basins contained confirmatory deposits, and 86% of the mapped palaeodrainage matched visible channels. Field investigations have also indicated the predictive power of the mapping project, as 76% of the surveyed palaeolake basins contained archaeological sites.

The Empty Quarter, or the Rub' al-Khali, is the largest sand sea on Earth, measuring ~640,000 km^2, and covering a third of the Arabian Peninsula. This large, hyper-arid desert is one of the most impenetrable places on Earth today, but this was not always the case, given its rather impressive Quaternary deposits which show evidence for humid phases. Matter et al. (2015) review the findings of four expeditions into the Empty Quarter, resulting in one of the most comprehensive compilations of the Late Pleistocene environmental history of the region. A number of palaeolakes across the Empty Quarter are reported, many of which were dated to humid intervals in MIS 5, i.e, between ca. 130–70 ka. Palaeolakes were also dated to the Early/Mid Holocene (ca. 11–5.5 ka) and in one instance, palaeolake deposits were present in MIS 4/3 (ca. 65–55 ka). Most remarkably, the presence of the mussel *Unio* provides indirect evidence for the presence of fish in the lakes, thereby indicating the presence of both freshwater and aquatic resources for humans who travelled into the desert interior (Groucutt et al., 2015b). The complementary article by Farrant et al. (2015) zeros in on the northeastern part of the Empty Quarter, with the aim to examine dune accumulation during the Late Pleistocene. On the basis of a comprehensive database of optically stimulated luminescence (OSL) samples, the authors demonstrate that dune stabilisation occurs during humid periods (i.e., MIS 5e, 5c, 5a; MIS 4/MIS 3 transition; Early Holocene) and that conversely, aridity is indicated by the lack of dates during most of MIS 2–4 and at intervals during MIS 5. The independent studies by Matter et al. and Farrant et al. are on the whole consistent, showing that there were significant fluctuations in aridity and humidity in the Empty Quarter, clearly of considerable importance for understanding the prehistory of human expansions and withdrawals in this vast region.

Human expansions out of Africa and across Eurasia have been discussed relative to MIS 3 environments ranging between ca. 55–30 ka; however, the environmental and cultural record of Arabia during this critical time period is generally poorly known.

Hoffmann et al. (2015) report on key fluvial and lacustrine deposits and sequences in the Oman Mountains. Through close scrutiny of the Wadi Mistal sediments, Hoffman et al. conclude that MIS 3 is characterized by strong, but short lived precipitation events rather than continuous monsoonal rainfall. Further north, Mischke et al. (2015) report on MIS 3 deposits in the Al Jafr Basin of Jordan, previously considered to represent a large lake body. On the basis of sedimentological, palaeontological and mineralogical analyses, Mischke and colleagues find that the area was a heterogeneous wetland setting, consisting of shallow ponds and rich aquatic resources, slow flowing streams, and swamps. The Al Jafr Basin and its wetlands experienced significant alterations in MIS 2, the deposits mostly recording aeolian and sheetwash events. Such detailed sedimentary archives of MIS 3 conditions from Oman and Jordan have significant implications for human prehistory, suggesting that humid intervals were present for expansion and occupation, although according to Hoffman et al. and Mischke et al., these ecological settings were temporary and fragile, suggesting humans may have had to cope with significant climatic changes.

Though the Quaternary history of Arabia is becoming better known on account of the investigation of terrestrial sedimentary archives, little is known about the palaeontological record with the exception of rare reports of fossil finds in the Nefud Desert and the Empty Quarter (McClure, 1984; Thomas et al., 1998). Stimpson et al. (2015) report the results of the first test excavations of a palaeontological site, at the Ti's al Ghadah locality, which was independently estimated by OSL to date to approximately 325 ka (MIS 9) (Rosenberg et al., 2013). A range of fauna were identified from the locality during investigations by Thomas et al. and Stimpson et al., and included oryx, elephant, horse, fox, jaguar, grebe, fish and reptiles, indicative of a freshwater lake and savannah ecosystem. Stimpson et al. place particular attention on the identification of the Eurasian jaguar (*Panthera* cf. *gombaszogensis*). The presence of the jaguar at Ti's al Ghadah clearly implies that the Nefud Desert biomass was great enough to attract large carnivores. These findings demonstrate the abundant fossil record of Arabia, which should be a key target of future research.

Mammalian dispersals into Arabia appear to broadly coincide with the colonization of the region by early humans. Jennings et al. (2015b) have followed up on previous research at Dawadmi, in the central part of Saudi Arabia, where Whalen et al. (1983) established the presence of a rich Acheulean record. Systematic surveys by Jennings and colleagues identified a number of new Acheulean localities, which were shown to be strongly associated with fine-grained andesite dykes for the manufacture of distinctive large cutting tools (e.g. handaxes, cleavers). The distribution of andesite dykes, found across an area measuring 100 × 55 km, is predicted to contain numerous additional sites, thereby representing one of the largest-scale spatial distributions of Acheulean localities in the world. The Dawadmi evidence, taken together with the presence of Acheulean sites in the Nefud (Shipton et al., 2014), indicates that early humans spread across many areas of the peninsula, as did mammals. Key future research foci here include understanding the chronology of the Arabian Lower Palaeolithic and conducting comparative studies with surrounding regions.

In addition to the central province of Saudi Arabia, early human populations were also present in the Nefud Desert in the north. Archaeological survey in the western portion of the Nefud Desert was recently conducted by Scerri et al. (2015), resulting in the identification of a range of Lower and Middle Palaeolithic sites. Consistent with the identification of vertebrate animals near lakeshores in the Nefud, the archaeological sites are primarily associated with lacustrine settings. The authors speculate that evidence for larger and more stable lakes may have led to a more sustained hominin presence in the Middle Pleistocene, leading to the development of a rather unique Late Acheulean technology found at some sites. In contrast, Late Pleistocene lakes may not be as sizeable and permanent, thus accounting for the smaller size of the Middle Palaeolithic sites, which may represent briefer forays of groups during humid intervals. The additional archaeological evidence from the Nefud supports the contention that the region was a critically important part of southwest Asia, in which climatic ameliorations witnessed hominin expansions, thereby acting as a nexus between the Saharo-Arabian belt, the Levant and areas eastwards of the peninsula (see also Scerri et al., 2014b).

The Jubbah palaeolake, located in the Nefud desert, has produced a number of Middle Palaeolithic sites dating to wet periods such as MIS 5 (Petraglia et al., 2012). One of the key site areas identified in the basin concentrates around Jebel Katefeh, where a quartzite source occurs 800 m distant from a lakeshore site. In their article, Groucutt et al. (2015c) conduct one of the first detailed technological studies of a Middle Palaeolithic site in Saudi Arabia. The authors report on stone tool reduction, raw material influences, and mobility strategies, situating the Jebel Katefeh sites in relation to others in the basin and in surrounding areas. Consistent with the findings reported by Scerri et al. (2015), the analysis of lithic assemblages from Jebel Katefeh suggest a limited occupation span by a highly mobile population. The technological traits of the Jebel Katefeh sites are considered to reflect situational adaptions and perhaps cultural influences from both the Levant and North Africa.

Given the abundance of Middle Palaeolithic sites in Arabia, the question naturally arises as to whether assemblages found further eastwards are part of a wider dispersal. The Thar Desert of India, as part of the mid-latitude belt, is of particular interest in examining wider demographic movements. Blinkhorn et al. (2015) have conducted one of the most comprehensive reviews of point technologies in India, suggesting that these forms are a key component of Middle Palaeolithic industries. Moreover, the authors assert that the point technologies share similarities with contemporaneous assemblages in North Africa and Arabia, implying the possibility for dispersals and adaptations to these arid zones (see also Blinkhorn et al., 2013).

Major temporal gaps remain in the archaeological record of Arabia between ca. 70–12 ka, with the exception of a few Middle Palaeolithic sites dated to ca. 55 ka (Delagnes et al., 2012) and ca. 40 ka (Armitage et al., 2011). The reporting of Terminal Pleistocene and Early Holocene sites in Oman by Hilbert et al. (2015) from excavations of three rockshelters is therefore of significance, and accompanies recent information for transitional hunter-gatherer sites in the Nefud (Hilbert et al., 2014). In their article, Hilbert et al. (2015) describe the “Nejd Leptolithic tradition” of Oman, comprised of lithic assemblages with blade technology, burins, endscrapers, and pedunculated points. Fluvial and colluvial evidence from the rockshelter settings indicate a humid landscape during site occupations. Most importantly, the investigators identify an archaeological horizon dated to ca. 13 ka, suggesting continuity of hunting and gathering populations at the transition between the Terminal Pleistocene and Early Holocene. In an upland area south of the Dhofar plateau, in Oman, Cremaschi et al. (2015) conducted interdisciplinary archaeological investigations demonstrating the presence of hunter-gatherers in caves and rockshelters situated at Jebel Qara. Interestingly, the onset of Early Holocene humidity, owing to increased monsoon intensity, promoted the development of a large community of land snails that was exploited by human groups for subsistence, as indicated by anthropogenic accumulations in the caves and rockshelters. After ca. 9 ka, increased humidity led to the abandonment of the caves and rockshelters, and as suggested by Cremaschi et al., groups may have moved to the coastal zone, leading to Neolithic settlements near mangrove settings.

Fig. 2. HRH Prince Sultan Bin Salman Bin Abdulaziz Al-Saud, Chairman and President, Saudi Commission for Tourism and Antiquities (left) and Professor Ali bin Ibrahim Al-Ghabban, Vice President (right). Photo: Abdossalam Madkhali.

As we have seen for the Dhofar region of Oman, the onset of humid conditions in the Early Holocene is significant for understanding the population history in southern Arabia. The article by Preston et al. (2015) builds on this research by examining the Early-Middle Holocene record in southeastern Arabia, while emphasising the need to examine the heterogeneity of regional records in order to accurately assess how human populations responded to changes in local ecosystems. A lake and dune record from Wahalah, UAE, indicates that dune emplacement continued into the Early Holocene, with the onset of lacustrine conditions beginning at ca. 8.5 ka, slightly later than other Arabian palaeolake records. A shift towards more arid conditions occurred between ca. 7.8 and 5.9 ka, with peak instability and dune emplacement between ca. 5.9 and 5.3 ka. Preston et al. (2015) compare the Wahalah record to other archives in southeast Arabia, examining interactions between regional climate and humans during the Neolithic. Though the expansion of Neolithic populations during the Early to Middle Holocene is widely recognised, the palaeoclimate data from Wahalah adds to the growing evidence that the period was characterized by a series of abrupt, short-term phases of aridity. Such environmental variability would have had a profound impact on Neolithic populations, perhaps corresponding with the limited evidence for archaeological sites in many areas and changes in technological traditions and economies. After the general, though geographically variable, increase in archaeological sites in southeast Arabia by ca. 7 ka, the Wahalah environmental record supports evidence for increased aridity at 5.9 ka, reinforcing the "Dark Millennium" hypothesis which links climate change to a decline of human populations in the interior and an increase of settlement along the coast (e.g. Uerpmann, 2003; Preston et al., 2012).

Though a large amount of information is available about Early to Middle Holocene environments of southern Arabia, much less is known about the ecological settings of large areas of the central and northern zones of Arabia. The palynological data presented by Dinies et al. (2015) from the oasis of Tayma, in northwestern Saudi Arabia, is thus an important contribution, and joins new environmental data emerging from the Jubbah Oasis (Hilbert et al., 2014). Dinies and colleagues focus on the Early Holocene record, which provides important background information for the later cultural development of Tayma by the fourth millennium BC (Engel et al., 2012). The authors demonstrate the dominance of goosefoot throughout the sequence, demonstrative of desert vegetation and coinciding with the development of a brackish water body by 9.2 ka. Dinies and colleagues show distinct vegetation changes in the Early Holocene, with the spread of grasslands at ca. 9 ka, reaching their maximum at ca. 8.6–8 ka, suggesting that Neolithic populations could have expanded during this time. At 8 ka, the grasslands declined and drought-resistant dwarf-shrublands expanded, consistent with changes in environmental conditions recorded in southeastern Arabia (Preston et al., 2015).

In sum, the 19 articles in this special issue of *Quaternary International* cover a wide range of geographical areas and time periods of the Arabian Peninsula (Fig. 1). As can be seen in Fig. 1, much ground is covered, with new insights on environmental and cultural events in MIS 5, MIS 3, and the Early and Middle phases of the Holocene. Fig. 1 also, however, demonstrates that there are many gaps in our knowledge about the environmental and cultural history of Arabia that require further field studies. We hope that interdisciplinary, international collaboration continues to develop, rightly putting Arabia at centre-stage for understanding the history and development of human populations and societies.

In closing, we dedicate this special journal issue to two individuals who have made significant contributions to our understanding of the cultural heritage of the Arabian Peninsula, HRH Prince Sultan Bin Salman Bin Abdulaziz Al-Saud and Professor Ali bin Ibrahim Al-Ghabban, of the Saudi Commission for Tourism and Antiquities (Fig. 2). In addition to promoting the cultural heritage of the region, HRH Prince Sultan Bin Salman is a former space shuttle astronaut for NASA, a programme that included the launching of satellites that have so effectively helped to map the environments and

archaeology on Earth's surface. Professor Al-Ghabban has pioneered archaeological research of Saudi Arabia and he has tirelessly supported international collaborative archaeological research in the region. We look forward to many years of productive research on the natural and cultural history of Arabia.

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