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Catchment area analysis of Umm an-Nar rectilinear architecture sites in northern central Oman

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Summary
Umm an-Nar period sites (2700–2000 BC) in south-eastern Arabia comprise varying combinations of collective tombs, monumental towers, and rectilinear architecture. While towers and tombs have long dominated discussions of settlement organization, rectilinear architecture has received comparatively less attention. This paper addresses this imbalance by examining the spatial organization and chronological distribution of rectilinear architecture, with particular focus on northern central Oman, and reassessing its role within broader Umm an-Nar settlement systems. Using Least-Cost Site Catchment (LCSC) analyses, the study demonstrates substantial overlaps between the catchment areas of sites with rectilinear architecture, as well as between such sites and tower sites. These overlaps suggest shared resource zones and interconnected patterns of movement, rather than isolated or autonomous villages. Chronological evidence, although still limited, indicates that individual sites were typically occupied for only a short time. These findings support an understanding of Umm an-Nar communities as multi-sited, with rectilinear buildings representing a selective, context-dependent architectural and social strategy.

Keywords: settlement pattern, multi-sited communities, site catchment analysis, rectilinear architecture, Umm an-Nar

Introduction

Umm an-Nar-period (EBA, 2700–2000 BC) sites in south-eastern Arabia are made up of a mixture of collective overground tombs, monumental 'towers', and domestic, rectilinear structures (for recent overviews of Umm an-Nar rectilinear architecture, see Deadman et al. 2022 and Döpper 2018a; for EBA towers see Döpper 2024; for Bronze Age tombs see Williams 2024). Wherever at least one of the first two is present, those sites have been referred to as settlements. Flannery (1972) pointed out that, although a settlement is a permanent feature of a landscape, it does not require the year-round presence of sedentary life. Rather, he sees a settlement as a kind of base camp, a place to which a group usually returns, but not necessarily where all essential activities and social interactions take place. Nevertheless, Swerida demonstrated in her article (2022) that the notion of the term 'settlement' usually goes together with the idea of sedentism. Initial investigations in south-eastern Arabia emphasized the allegedly urban characteristics of EBA sites (e.g. Frifelt 1976; Orchard & Stranger 1994; Potts 1997), followed by debates on settlement hierarchies, largely based on the number of so-called towers present at a site (e.g. Al-Jahwari & Kennet 2010; Döpper 2018b; Phillips 2007). The structures referred to as towers have always played a significant role in these discussions, with much less attention given to rectilinear architecture and its role in defining the site type.

Different terms have been suggested, such as 'residential structures' (Magee 2014), 'common houses' (Cleuziou & Tosi 2020), 'unfortified settlements' (Potts 2001), 'rectangular structures' (Schreiber 1998), 'domestic architecture' (Döpper 2018a), and 'vernacular architecture' (Olijdam et al. 2025). Here, the term 'rectilinear architecture' (see Swerida 2022) will be used to encompass structures that are characterized by a rectangular plan, usually consisting of several rooms, and built from stone and/or mud brick. The general consistency of their internal layout both across the region and throughout the Umm an-Nar period indicates a shared social logic and day-to-day way of life (Swerida et al. 2024). Usually, these structures are interpreted as places where people lived and fulfilled tasks of their daily lives, including food preparation, storage, and manufacture of goods. Today, more than

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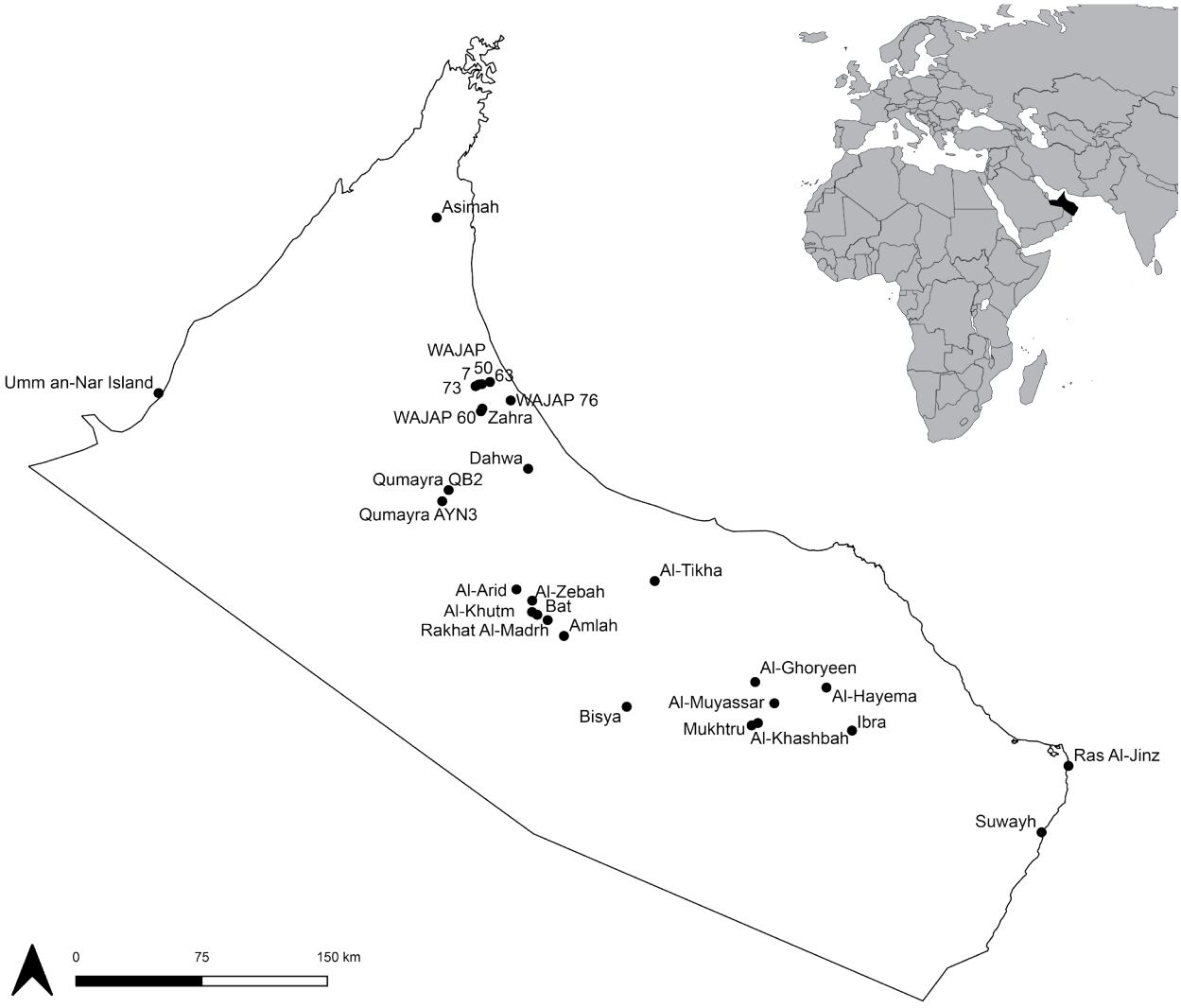


Figure 1. *A map of sites with rectilinear architecture in south-eastern Arabia (see also Fig. 5).*

thirty sites with rectilinear architecture have been published from Umm an-Nar Island in the west to Ras Al-Jinz in the east (Figs 1 & 5). An increasing number of rectilinear architectural sites have been (re-)examined in recent years, leading to significant advancements in our understanding, particularly regarding chronology, subsistence, and function (e.g. Al-Jahwari, Douglas & Williams 2022; Al-Jahwari, Douglas & Hesein 2020; Azzarà & De Rorre 2017; Castel et al. 2025; Dollarhide 2019; Jean et al. 2023; Swerida et al. 2024). This paper investigates the spatial organization of rectilinear architecture across the landscape, with special emphasis on modelling mobility and movement, aiming to shed light on how these were structured during the Umm an-Nar period. It also examines the chronological distribution of this phenomenon, using radiocarbon data to trace its emergence and decline within the Early Bronze Age.

Location and layout of Umm an-Nar sites

Many scholars have suggested that location choices for Umm an-Nar sites — not differentiating between sites

with rectilinear architecture, towers, or both — were made based on resource availability. In the semi-arid environment of south-eastern Arabia, access to water was crucial (e.g. Al-Jahwari, Douglas & Williams 2022; Deadman et al. 2022; Nathan & Harrower 2023). It is therefore believed that sites were commonly situated near wadis, taking advantage of the water flow during the rainy season. These areas could retain water for longer periods after runoff, helping to replenish underground reservoirs. Many sites were also located close to the confluence of two wadis, where water availability was particularly reliable. Additionally, several other factors have been suggested as important considerations for site location choices. These include access to arable agricultural land and copper resources for sites in the interior, fishing grounds for sites along the coast and the presence of wild animals, strategically advantageous locations along trade and exchange routes, locations offering protection or a wide viewshed, as well as sites with other raw materials such as stone (e.g. Al-Jahwari, Douglas & Williams 2022; Al-Jahwari 2009; Al-Tikriti 2011; Beuzen-Waller et al. 2018; Cleuziou & Tosi 2000; Costa & Wilkinson 1987: 99; Frifelt 1995; Méry & Marquis 1998: 223; Weisgerber 1981). Given the wide range of potential resources, a varied topography is often regarded as essential for ensuring a location that could provide the basic resources necessary to support a community for all or part of the year (Swerida et al. 2024).

Different ideas on the layouts of Umm an-Nar sites have been proposed, both with relation to their physical environmental setting and to their internal structures. One observation is that larger sites especially do not present themselves as single, unified complexes, but as a conglomeration of different elements scattered around a wider area (Al-Jahwari & Kennet 2010). For the Al-Tikha region, Deadman et al. (2022) proposed an agglomerated settlement model in which a string of sites is located at intervals of 1–2 km, potentially sharing a cemetery and other features, including towers. Sites are often positioned at the edge of wadi channels, either on slopes or low alluvial terraces. This is explained by providing natural protection from seasonal floods while simultaneously allowing easy access to water and agricultural lands (Castel et al. 2020; Swerida et al. 2024). According to Swerida et al. (2024) this situation also served to augment the viewsheds from settlement spaces while avoiding the need to sacrifice farmland to accommodate domestic structures.

Larger sites — often associated with one or more towers — are often referred to as 'oasis settlements' or 'tower hamlets', while smaller sites were labelled 'rural settlements', 'wadi villages', '(agglomerated) hamlets', or 'extra-oasis spaces' (Al-Jahwari 2009; Deadman et al. 2022; Swerida et al. 2024). While a central function is commonly associated with the first category of sites, the function of the smaller sites of the second category is interpreted differently, ranging from the agricultural basis of the society (Al-Jahwari 2009) to sites where agropastoralism and seasonality played larger roles in the lifeways and subsistence strategies practised (Swerida et al. 2024). The distribution of Umm an-Nar sites in the landscape is currently not well understood. Deadman et al. (2022) suggested an agglomerated settlement model for the Al-Tikha region, where a string of sites is located on the east bank of Wādī Far at intervals of 1 or 2 km. Swerida and Jean (2025: fig. 1) proposed that Umm an-Nar sites are located at distances of *c.*25 km on routes linking the southern foothills and coastal regions.

The rectilinear architecture within these sites can thereby form a linear chain of buildings, such as at the Settlement Slope in Bat, Al-Khutm, or Ibra, where they are built along the hillside (Kluge 2024; Swerida 2018), or more dispersed when erected on flat alluvial terraces such as in Al-Arid (Castel et al. 2022). Deadman et al. (2022) envision that structures that were not built from stone, such as arish or date-palm frond huts, might have formed parts of the sites that have since vanished and are today only hinted at by pottery scatters. They further noticed that occupations were not equal in terms of the size and/or number of buildings across different areas of a site. Their explanation for this is that the different parts of the settlements represent different groups that chose the same site due to favourable availability of resources or different degrees of mobility, where largely mobile groups gathered in seasonal camps around groups following a fully sedentary lifestyle.

Site catchment analyses

To add to the discussions presented above and to gain a better understanding of how people of sites with rectilinear architecture interacted with their

surrounding landscape, Least-Cost Site Catchment (LCSC) analysis was performed. LCSC examines the area around a site from which people could reasonably obtain resources such as food, water, or raw materials, usually defined by travel time (Bailey 2005; Conolly & Lake 2006; Higgs & Finzi 1972; Wheatley & Gillings 2002). Analysing the site catchment area helps to determine whether a specific range of resources available was likely to have been a factor influencing site location. The cost limit most commonly found in the literature is a one-hour walk for a sedentary agricultural site and a two-hour walk for a herding/hunting community (Roper 1979; Wheatley & Gillings 2002: 160). These figures are seen as a threshold where the diminishing returns (in labour, time, transport of goods, etc.) start to outweigh the benefits. However, this is only an average and might differ for individual goods, as a person might conceivably walk further for something with more benefits (Bailey 2005). Bailey (2005) further points out that transportability is relevant. As water is probably one of the least transportable resources, proximity to water supplies may be more determinant of site location than proximity to other resources. Thus, LCSC serves as a tool for thought rather than a representation of exact realities, which leads to a better understanding of interactions and potential within a site's surroundings.

For this paper, analyses were conducted in the QGIS environment using the GRASS module r.walk and the walking formula used within it.[1] This creates a raster map showing the anisotropic cumulative cost of moving between different geographic locations on an input raster map whose cell category values represent cost. 'Anisotropic' means that the raster map behaves differently when measured in different directions — for example, it takes more effort to walk up a slope than it does to walk down the same slope. A simple cost surface was generated depending on slope in percentage, based on the Copernicus GLO-30 DEM. Although other factors such as terrain, vegetation cover, mode of transportation, and load (Herzog 2020) were ignored, setting friction costs to 0, it is nevertheless deemed sufficient for the aims of the study. For areas with documented Umm an-Nar rectilinear architecture, centroids were generated and used as starting points in the r.walk module, with travel time intervals set at 1 hour and 2 hours. Contour polygons were then created for both intervals using the corresponding function. The same methods were applied to tower sites (tower coordinates taken from Döpper 2024). For sites where the precise location is unknown to the author or for sites where the modern landscape differs significantly from that of the Early Bronze Age — e.g. Umm an-Nar Island — simple Euclidian buffers were calculated at 5 and 10 km, giving a rough estimate of the site's catchment area. Starting points were approximations to the sites' coordinates published by Deadman (2017). Umm an-Nar tombs were inserted as single points without calculating any catchment areas for them, as their distribution, as available from the literature, is highly biased by data availability in publications, and therefore reflects reality much more incompletely than rectilinear architecture and towers. Substantial efforts have been made to compile comprehensive datasets for the latter, including precise geographic coordinates, from the existing literature. In contrast, no comparable systematic effort has been made for the Umm an-Nar tombs.

Acknowledging the biases introduced by uneven research intensity, which can result in sites being overlooked, the LCSC results discussed here are from well-surveyed and -researched regions. These are the wider Bat region, including the sites of Al-Arid, Al-Zebah, Al-Khutm, Rakhat Al-Madrh, and Amlah (Fig. 2) and the region of Al-Muyassar, Al-Ghoryeen, and Al-Khashbah (Fig. 3). The results reveal recurring patterns of spatial overlap among catchments of sites with rectilinear architecture. Areas within a two-hour travel radius show substantial overlap, indicating shared or intersecting zones of movement and resource use. Although less common, overlaps within one-hour catchments are also observed, suggesting closer and potentially more direct interactions. For example, the one-hour catchments of Rakhat Al-Madrh and the Settlement Slope at Bat converge, demonstrating a tightly interconnected local landscape. Additional overlaps occur within two-hour catchments, including Al-Zebah intersecting with both the Settlement Slope and Al-Arid, as well as a two-hour catchment overlap between Rakhat Al-Madrh and Amlah. Comparable patterns are observed for tower structures of the wider Bat area, whose catchments similarly intersect. In the area of Al-Muyassar, Al-Ghoryeen, and Al-Khashbah, the catchment areas of the rectilinear architecture at

[1] https://grass.osgeo.org/grass-stable/manuals/r.walk.html

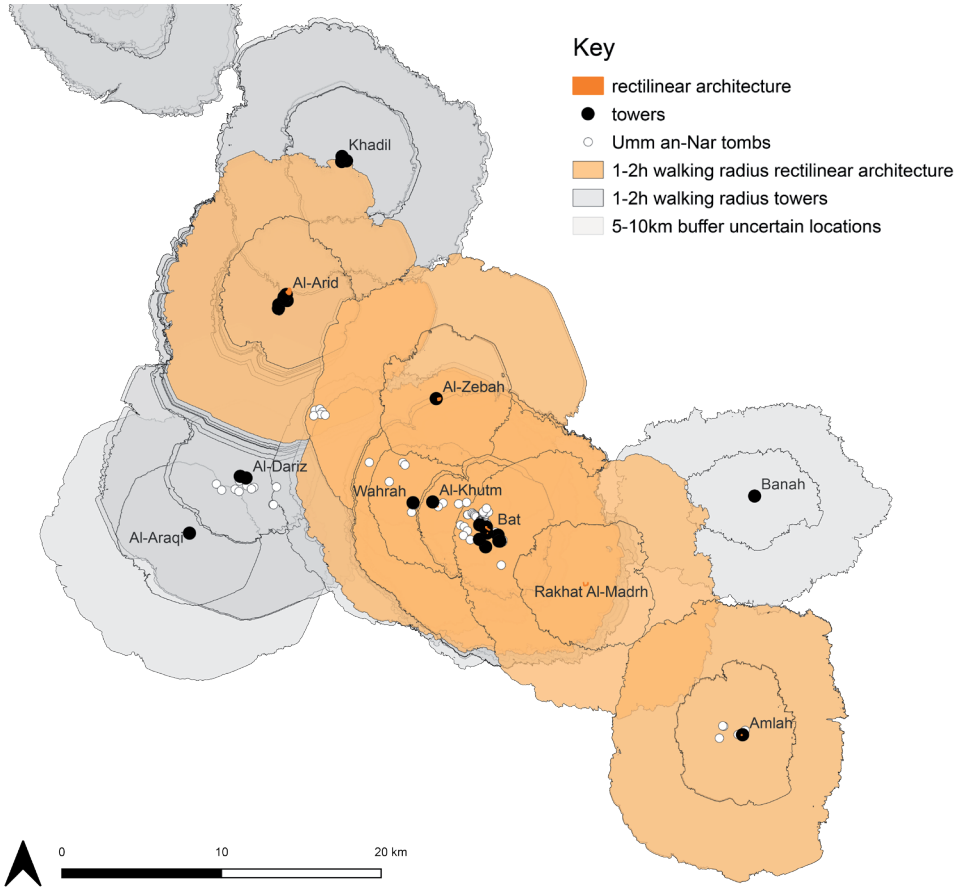


Figure 2. *Least-Cost Site Catchment (LCSC) analysis of the wider Bat area.*

Mukhtru and Al-Khashbah exhibit substantial overlap within their one-hour travel catchments. Al-Muyassar and Al-Khashbah also share portions of their two-hour catchments. Notably, Al-Khashbah displays significant overlap with nearby tower sites, including Al-Qabrayn and Al-Fath, reinforcing its position within a dense local network. In contrast, Al-Ghoryeen demonstrates a more limited pattern of interaction. It shows no catchment overlap with Al-Muyassar and intersects only with the tower site MASPAG-3 and possibly with Khadra Bani Dhaffa, although the latter remains uncertain owing to its inferred site location. Nevertheless, these connections would link Al-Ghoryeen indirectly to the Al-Muyassar catchment area.

Overall, these two regions exhibit frequent overlap in catchment zones of sites with rectilinear architecture, raising the possibility of shared resource areas or seasonal movement of the same populations among multiple sites. This pattern is not restricted to the modelled catchment areas themselves, but rather suggests more broadly that mobility and interaction across the landscape indicate interconnected systems rather than isolated occupation units. This, in turn, raises important questions regarding chronology and contemporaneity: were these sites occupied simultaneously, or do the overlaps reflect diachronic use of the same landscapes? Resolving this issue is important for determining whether the observed spatial convergence represents interaction among coexisting communities or successive occupations by related groups.



Figure 3. *Least-Cost Site Catchment (LCSC) analysis of the wider Al-Muyassar, Al-Ghoryeen, and Al-Khashbah areas.*

Chronological distribution

The chronology of Umm an-Nar rectilinear architecture remains a subject of debate. As in much of south-east Arabian archaeology, the limited availability of radiocarbon dates poses difficulties, although recent fieldwork has improved the situation. Looking at radiocarbon dates (see Fig. 6), we see that Umm an-Nar rectilinear architecture is sometimes found at sites with Hafit-period towers, for example in Bat (Thornton, Cable & Possehl 2016), Al-Arid (Castel et al. 2025), and Al-Khashbah (Schmidt et al. 2021), and is sometimes found evolving out of places intensively used by people during the Hafit period, evidenced by radiocarbon dates from ephemeral occupation traces below rectilinear architecture,

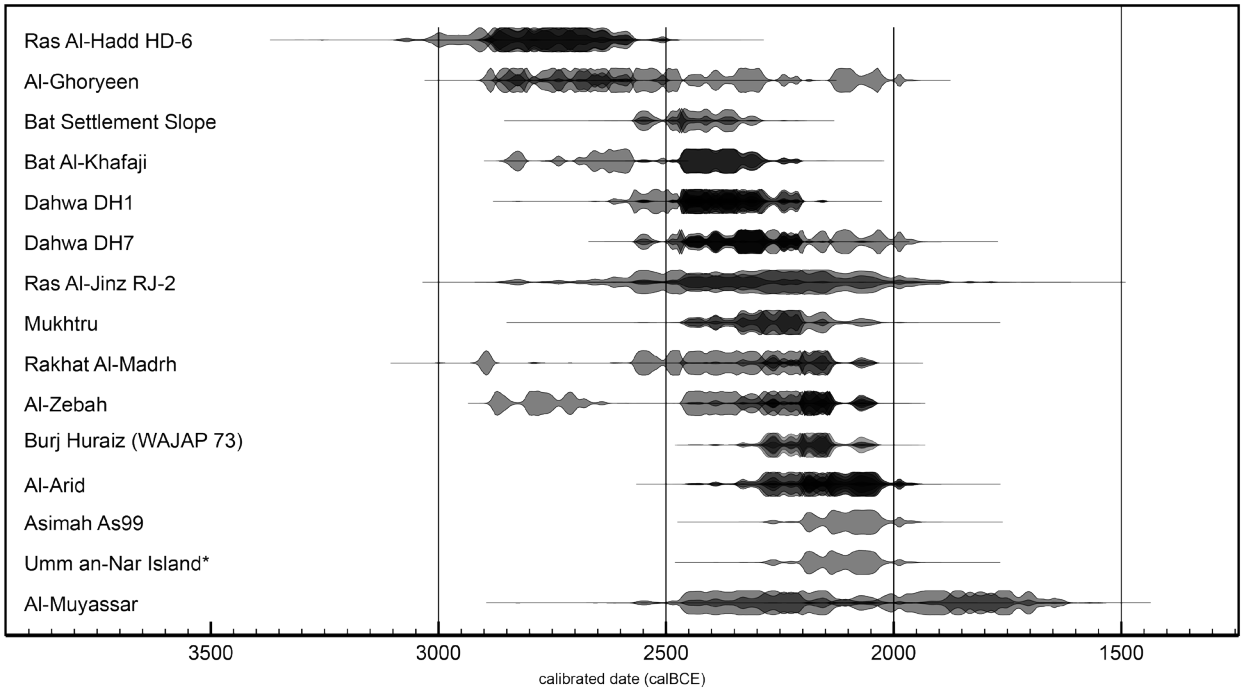


Figure 4. *Superimposed radiocarbon dates from Umm an-Nar rectilinear architecture. OxCal v.4.4. (made available by C. Bronk Ramsey), r:5 Atmospheric data from Reimer et al. (2020). Calibrated date for Umm an-Nar Island is taken as no raw data is published (for the individual dates for all sites, see Fig. 6).*

such as fireplaces (e.g. at Rakhat Al-Madrh) (Swerida et al. 2024), and possibly also at Al-Zebah (Schmidt 2018). The oldest radiocarbon-dated rectilinear architecture comes from the site of Ras Al-Hadd HD-6, dating to the (very late) Hafit period (Azzarà 2013) (Fig. 4). The site was subsequently abandoned. Fourteen mud-brick buildings have been excavated here, often with a tripartite layout. Similarly, the rectilinear architecture of Al-Ghoryeen has a strong Hafit and early Umm an-Nar period component (Al-Jahwari, Douglas & Hesein 2020). The excavators distinguish two occupation phases: the first (Period I), probably lasting less than a century, dates to the late Hafit period; the second (Period II) dates to the Umm an-Nar period. Both phases are associated with rectilinear architecture, although they differ in layout and sizes. The reasons some sites appear to evolve from Hafit-period predecessors while others do not require further investigation. The majority of rectilinear architecture found, however, dates to the period from around 2500–2100 BC, which is classified by Swerida, Dollarhide and Jensen (2021) as the Middle Umm an-Nar period (Fig. 4).

Radiocarbon evidence shows that occupation of sites with rectilinear architecture did not continue uninterrupted throughout the Umm an-Nar period. Instead, the sites appear to have been used for only a few hundred years at most. Other components of the same sites, particularly towers, were often in use both before and/or after the rectilinear structures. How this pattern relates to Umm an-Nar period tombs at these sites remains uncertain for now, as too few tombs are securely dated to estimate their precise chronological relation with the rectilinear architecture at the site. The available radiocarbon dates further demonstrate that several Umm an-Nar rectilinear sites were abandoned before the end of the Umm an-Nar period, raising broader questions regarding the function of rectilinear buildings — for example, regarding their seasonality and why their use appears to have been

Site	UTM 40N East	UTM 40N North	Tower(s)	Radiocarbon Dates	References
Al-Ayn ALA-2	n/a	n/a	0	n/a	Blin 2020; 2012
Al-Arid	461802	2587706	6	yes	Castel et al. 2020; 2022; 2025
Al-Ghoryeen	604371	2532377	1	yes	Al-Jahwari et al. 2020
Al-Hayema	646922	2529065	0	n/a	
Al-Khashbah	605993	2529065	10	n/a	Schmidt et al. 2021: 248–249
Al-Khutm	471142	2574223	1	n/a	Swerida 2018; Swerida et al. 2024
Al-Tikha S1	544189	2592073	5	n/a	Deadman et al. 2022
Al-Tikha S2	544400	2592732	5	n/a	Deadman et al. 2022
Al-Zebah	471215	2580976	1	yes	Schmidt 2018
Amlah-4	490159	2559921	1	n/a	de Cardi, Collier & Doe 1976; Dollarhide 2019
Asimah As99	n/a	n/a	0	yes	Görsdorf & Vogt 2008; Vogt 1994
Bat Khafaji	474233	2572573	9	yes	Swerida 2018
Bat Settlement Slope	474238	2572857	9	yes	Swerida 2018; Swerida & Thornton 2019
Bisya Al-Dhabi 2	527662	2517598	8	n/a	Jean et al. 2023
Dahwa DH1	468785	2659813	0	yes	Al-Jahwari et al. 2022
Dahwa DH5	469386	2659965	0	n/a	Al-Jahwari et al. 2022
Dahwa DH6	469220	2660116	0	n/a	Al-Jahwari et al. 2022
Dahwa DH7	469514	2660314	0	yes	Douglas et al. 2024; 2021
Dahwa DH8	469760	2660226	0	n/a	Al-Jahwari et al. 2022
Falaj Al-Shrah	n/a	n/a	1	n/a	Deadman et al. 2022
Ibra South (Ibra 2)	662219	2503350	1	n/a	Hastings, Humphries & Meadow 1975; Kluge 2024
Khor Bani Bu Ali (SWY-3)	n/a	n/a	0	n/a	Méry & Marquis 1998
Al-Muyassar (Maysar-1)	615838	2519683	2	yes	Abar, in preparation; Weisgerber 1980; 1981
Al-Muyassar (Maysar-6)	615718	2519008	2	n/a	Abar, in preparation; Weisgerber 1980; 1981
Mukhtru	602217	2506457	0	yes	Döpper 2022
Qumayra AYN3	417468	2640397	4	n/a	Pieńkowska 2019
Qumayra QB2	421272	2647084	0	n/a	Bieliński et al. 2024
Rakhat Al-Madrh	480419	2569349	0	yes	Swerida et al. 2024
Ras Al-Jinz RJ-2	791484	2482255	0	yes	Azzarà & De Rorre 2017; Cleuziou & Tosi 2000
Umm an-Nar Island	248082	2705011	0	n/a	Al-Meqbali & Eddisford 2024; Al-Tikriti 2011; Frifelt 1995
Wadi Fizh 1 (WAJAP Site 63)	445962	2711674	0	n/a	Costa & Wilkinson 1987; Düring & Botan 2018
WAJAP Site 7	439184	2710123	0	n/a	Düring, pers. com., 02/02/2026
WAJAP Site 50*	441121	2710396	0	n/a	Düring & Botan 2018
WAJAP Site 60*	440567	2694098	0	n/a	Costa & Wilkinson 1987
WAJAP Site 73 (Burj Hurrais)	437399	2709181	1	n/a	Olijdam et al. 2025
WAJAP Site 76	458363	2700645	0	n/a	Düring, pers. com., 02/02/2026
Yiqa	n/a	n/a	1	n/a	Deadman et al. 2022
Zahra 1 (WAJAP Site 14)	441432	2695745	0	n/a	Costa & Wilkinson 1987; Düring & Botan 2018

Figure 5. *Early Bronze Age sites with rectilinear architecture (*=no Umm an-Nar period finds, Düring, pers. com., 02/02/2026).*

Site	Context	Period	Material	Lab Code	^{14}C age	±	2-sigma cal. BC	References
Al-Ghoryeen	building S.9:R1, floor	Period I (late Hafit)	wood charcoal		4240	25	2909–2759	Al-Jahwari et al. 2020
Al-Ghoryeen	building S.3A, L026	Period I (late Hafit)	wood charcoal		4150	25	2875–2631	Al-Jahwari et al. 2020
Al-Ghoryeen	building S.71 in Tr.1, IVD3b:L009 (hearth 1)	Period I (late Hafit)	wood charcoal		4120	20	2863–2581	Al-Jahwari et al. 2020
Al-Ghoryeen	building S.71 in Tr.1, IVD3b:L008 (hearth 2)	Period I (late Hafit)	wood charcoal		4080	20	2840–2499	Al-Jahwari et al. 2020
Al-Ghoryeen	building S.19/21:R1, floor	Period II (Umm an-Nar)	wood charcoal		4010	25	2576–2473	Al-Jahwari et al. 2020
Al–Ghoryeen	building S.3A, R9:L012	Period II (Umm an–Nar)	wood charcoal		3860	20	2459–2214	Al-Jahwari et al. 2020
Al-Ghoryeen	building S.3A, L013, hearth inside the trench	Period II (Umm an-Nar)	wood charcoal		3680	20	2141–1984	Al-Jahwari et al. 2020
Al-Muyassar	Maysar-1, House 1, Loc 4		wood charcoal	HD 5722	3865	65	2489–2141	Abar, in preparation; Weisgerber 1980; 1981
Al-Muyassar	Maysar-1, House 1, Loc 2a		wood charcoal	HD 5728-5295	3780	60	2434–2034	Abar, in preparation; Weisgerber 1980; 1981
Al-Muyassar	Maysar-1, House 1, Loc 2b		wood charcoal	HAM 1171	3560	70	2134–1694	Abar, in preparation; Weisgerber 1980; 1981
Al-Muyassar	Maysar-1, House 1, Loc 1		wood charcoal	HD 5737-5294	3460	50	1895–1625	Abar, in preparation; Weisgerber 1980; 1981
Al-Zebah	Room G		wood charcoal	MAMS24433	4186	29	2888–2671	Schmidt 2018
Al-Zebah	Room G		wood charcoal	MAMS24432	3889	26	2465–2295	Schmidt 2018
Al-Zebah	Room G		wood charcoal	MAMS24434	3822	26	2432–2148	Schmidt 2018
Al-Zebah	Room GA		wood charcoal	MAMS22617	3789	25	2290–2141	Schmidt 2018
Al-Zebah	Room U		wood charcoal	MAMS19316	3758	18	2275–2060	Schmidt 2018
Al-Zebah	Room U		wood charcoal	MAMS19317	3753	19	2273–2050	Schmidt 2018
Al-Zebah	Room GA		wood charcoal	MSMS22618	3750	25	2277–2041	Schmidt 2018
Al-Zebah	Room U		wood charcoal	MAMS19315	3739	18	2202–2044	Schmidt 2018
Asimah	As99, fireplace in layer below the building (AS 88/11)	Middle & late Umm an-Nar;	wood charcoal	Bln-4544	3708	40	2210–1960	Görsdorf & Vogt 2008; Vogt 1994

Site	Context	Period	Material	Lab Code	^{14}C age	±	2-sigma cal. BC	References
Bat	Al-Khafaji, fire pit level with curving stone feature, abutting revetment wall	Early Umm an-Nar	wood charcoal	D-AMS6427	4093	24	2700–2570	Swerida 2018
Bat	Settlement Slope, SS12, ash lense associated with clay oven, Lot 221269	Middle Umm an-Nar 1	wood charcoal	D-AMS-48475	3976	26	2475–2455	Swerida 2018; Swerida et al. 2024; Swerida & Thornton, 2019
Bat	Settlement Slope, SS12, clay oven, Lot 212272b	Middle Umm an-Nar 1	wood charcoal	D-AMS-48474	3947	26	2497–2343	Swerida 2018; Swerida et al. 2024; Swerida & Thornton, 2019
Bat	Settlement Slope, fire pit east of SS1	Middle Umm an-Nar	wood charcoal	D-AMS6424	3916	29	2480–2270	Swerida 2018; Swerida & Thornton 2019
Bat	Al-Khafaji, fire pit in courtyard	Middle Umm an-Nar	wood charcoal	Beta 316664	3904	40	2460–2200	Swerida 2018
Bat	Al-Khafaji, fire pit associated with surface running against revetment wall	Middle Umm an-Nar	wood charcoal	D-AMS6426	3904	26	2470–2310	Swerida 2018
Bat	Al-Khafaji, fire pit in courtyard	Middle Umm an-Nar	wood charcoal	Beta 316663	3900	40	2480–2270	Swerida 2018
Dahwa	DH1, S.10-B1:L005, corridor R8, floor		wood charcoal	MAMS 23205	4025	25	2621–2469	Al-Jahwari et al. 2022
Dahwa	DH7-2018-S.42, R5: L010, destruction layer		wood charcoal	UGAMS 36622	3970	20	2462–2287	Douglas et al. 2021
Dahwa	DH7-2018-S.42, R5: L002, floor		wood charcoal	UGAMS 36620	3950	20	2565–2348	Douglas et al. 2021
Dahwa	DH1, S.10-B1:L006a, corridor R8, ash layer		wood charcoal	MAMS 23204	3932	24	2557–2305	Al-Jahwari et al. 2022
Dahwa	DH1, S.10-A1:L008, room R2, fill layer inside pit A-A1:L007		wood charcoal	MAMS 23203	3926	24	2476–2299	Al-Jahwari et al. 2022
Dahwa	DH1, S.10-B2:L006, room R1, floor		wood charcoal	UGAMS 24911	3910	25	2469–2299	Al-Jahwari et al. 2022
Dahwa	DH1, S.10-A1:L004, room R2, floor		wood charcoal	MAMS 23201	3892	25	2464–2296	Al-Jahwari et al. 2022
Dahwa	DH1, S.10-A1:L011, room R2, ash layer		wood charcoal	MAMS 23202	3892	27	2466–2291	Al-Jahwari et al. 2022
Dahwa	DH1, S.10-B1:L008, corridor R8, ash layer		wood charcoal	UGAMS 24912	3880	25	2464–2239	Al-Jahwari et al. 2022
Dahwa	DH7-2018-S.42, R5: L009 (Floor)		wood charcoal	UGAMS 36621	3860	20	2459–2214	Douglas et al. 2021
Dahwa	DH7-2019-S.42, R4: L007, filling in silo		wood charcoal	UGAMS 41307	3860	30	2461–2210	Douglas et al. 2021
Dahwa	DH7-2019-S.42, R8: L007, floor		wood charcoal	UGAMS 41308	3860	20	2459–2214	Douglas et al. 2021

Site	Context	Period	Material	Lab Code	^{14}C age	±	2-sigma cal. BC	References
Dahwa	DH7, Building S1		wood charcoal	UGAMS 51564	3850	25	2456–2204	Douglas et al. 2021
Dahwa	DH1, S.10-B2:L010, rooms R3/8, ash layer		wood charcoal	UGAMS 24910	3850	25	2456–2204	Al-Jahwari et al. 2022
Dahwa	DH7-2019-S.42, R4: L002, floor		wood charcoal	UGAMS 41306	3850	25	2458–2207	Douglas et al. 2021
Dahwa	DH1, S.10-B2:L012, rooms R3/8, floor		burned date stone	UGAMS 24909	3840	25	2454–2201	Al-Jahwari et al. 2022
Dahwa	DH7, Building S1		wood charcoal	UGAMS 51565	3790	25	2296–2138	Douglas et al. 2024
Dahwa	DH7-2019-S.42, R4: L006, fireplace		ash	UGAMS 41310	3670	25	2137–1966	Douglas et al. 2021
Mukhtru	fireplace, trench 1, MKT-A-Fs0005, MKT20A-10689		wood charcoal	MAMS46426	3848	22	2454–2204	Döpper 2022
Mukhtru	fireplace, trench 1, MKT-A-Fs0007, MKT20A-10683		wood charcoal	MAMS46424	3818	22	2395–2148	Döpper 2022
Mukhtru	fireplace, trench 1, MKT-A-Fs0007, MKT20A-10684		wood charcoal	MAMS46425	3808	58	2460–2047	Döpper 2022
Rakhat Al-Madrh	below RaM 1 foundation, Lot 221551	Hafit	wood charcoal	D-AMS-048471	4272	29		Swerida et al. 2024
Rakhat Al-Madrh	mortar in RaM 1 interior wall foundation, Lot 201528	Middle Umm an-Nar 1	wood charcoal	D-AMS–038700	3987	29	2576–2460	Swerida et al. 2024
Rakhat Al-Madrh	mud brick associated with RaM 1 primary occupation, Lot 221555	Middle Umm an-Nar 2	wood charcoal	D-AMS–048472	3879	30	2465–2283	Swerida et al. 2024
Rakhat Al-Madrh	earth on lower courtyard floor in RaM 3, Lot 233282	Middle Umm an-Nar 2	wood charcoal	D-AMS–053204	3806	26	2342–2192	Swerida et al. 2024
Rakhat Al-Madrh	oven Feature 221844 in RaM 2, Lot 221831	Middle Umm an-Nar 2/late Umm an-Nar	charred seed	D-AMS–053202	3765	24	2237–2132	Swerida et al. 2024
Rakhat Al-Madrh	burned context on upper courtyard floor in RaM 3, Lot 233287	Late Umm an-Nar	wood charcoal	D-AMS – 053205	3755	24	2210–2127	Swerida et al. 2024
Ras Al-Jinz RJ-2	unit 6020, close to the phase of abandonment of the Southern Compound	Phase III	wood charcoal	Beta-72913	3970	80	2849–2206	Cleuziou & Tosi 2000
Ras Al-Jinz RJ-2	in stratigraphic contexts related to the phase when the Southern Compound is abandoned and the northern still used	Phase III	shell	Beta-25905	3820	90	2560–1984	Cleuziou & Tosi 2000

Site	Context	Period	Material	Lab Code	^{14}C age	±	2-sigma cal. BC	References
Ras Al-Jinz RJ-2	in stratigraphic contexts related to the phase when the Southern Compound is abandoned and the Northern still used	Phase III	wood charcoal	Beta-25903	3760	100	2468–1925	Cleuziou & Tosi 2000
Umm an-Nar Island	midden						2274–2036	Al-Meqbali & Eddisford, 2024
Al-Arid	Building I in sector 2, room 2019, fireplace 2022, ashy fireplace fill, MBA A1.2029	phase 3b	wood charcoal	Beta-523412	3810	30	2401–2141	Castel et al. 2020; 2022
Al-Arid	Building I, hearth 2049	phase 4b	wood charcoal		3700	35	2201–1976	Castel et al. 2022
Al-Arid	Building I, hearth 2060	phase 4b	wood charcoal		3750	35	2286–2036	Castel et al. 2022
Al-Arid	Building I, hearth 2098	phase 4b	wood charcoal		3730	35	2280–1985	Castel et al. 2022
Al-Arid	Building I, sector 2, hearth 2103	phase 5b	wood charcoal		3700	35	2201–1976	Castel et al. 2022
Al-Arid	Building I, sector 2, hearth 2099	phase 5b	wood charcoal		3710	30	2201–1984	Castel et al. 2022
Al-Arid	Building I, sector 2, hearth 2100	phase 6	wood charcoal		3790	35	2395–2051	Castel et al. 2022
Ras Al-Hadd HD-6	T.T. 95, lense of loose sand, rich in charcoal	phase I-1	wood charcoal	LTL5047A	4316	45	3088–2877	Azzarà 2013
Ras Al-Hadd HD-6	Building 7, room 55, SU 5314, fireplace	phase I-2b	wood charcoal	LTL8081A	4205	45	2904–2632	Azzarà 2013
Ras Al-Hadd HD-6	SU 841, ashy sandy layer	phase I-3a	tooth enamel (Camelus dromedarius)	LTL5135A	4160	50	2886–2582	Azzarà 2013
Ras Al-Hadd HD-6	Building 1, Room 12, SU 3008, fireplace	phase I-3a	wood charcoal	LTL8082A	4152	45	2881–2583	Azzarà 2013
Ras Al-Hadd HD-6	Building 9, Room 34, SU 3025, fireplace	phase I-3c	wood charcoal	LTL8083A	4132	50	2879–2575	Azzarà 2013
Burj Huraiz (WAJAP 66/73)	Building 4, Trench AS25, fire pit		wood charcoal	GrM-35725	3800	26	2340–2141	Olijdam et al. 2025
Burj Huraiz (WAJAP 66/73)	Building 4, Trench AS25, fire pit		wood charcoal	GrM-35729	3744	24	2276–2038	Olijdam et al. 2025
Burj Huraiz (WAJAP 66/73)	Building 4, Trench AS25, fire pit		wood charcoal	GrM-35723	3765	24	2286-2050	Olijdam et al. 2025
Burj Huraiz (WAJAP 66/73)	Building 4, Trench AS25, fire pit		wood charcoal	GrM-35728	3770	24	2287-2061	Olijdam et al. 2025
Burj Huraiz (WAJAP 66/73)	Building 4, Trench AS25, fire pit		wood charcoal	GrM-35724	3788	24	2291-2140	Olijdam et al. 2025

Figure 6. *Radiocarbon dates from Early Bronze Age rectilinear architecture.*

confined to a relatively brief timespan. With the onset of the Wadi Suq period, those sites that remained in use declined in size and were gradually abandoned altogether.

Rethinking Early Bronze Age rectilinear architecture in northern central Oman

How sites with rectilinear architecture of the Umm an-Nar period fit within broader settlement patterns is a question that must be addressed by moving beyond traditional settlement hierarchies and instead considering them as part of dense relational networks, characterized by shared identities and interactions that extended beyond individual sites (Wallis & Pluckhahn 2023). For the Umm an-Nar period in south-eastern Arabia, sites display various combinations of rectilinear architecture, tombs, and towers in differing numbers and sizes. This variation supports Swerida's (2022) observation that no universal settlement configuration can be applied to the Umm an-Nar period. Furthermore, evidence from LCSC in northern central Oman indicates that different sites shared parts of the landscape, whether they feature rectilinear architecture or not. Sites with rectilinear architecture therefore should not automatically be interpreted as autonomous villages. They fit more convincingly into the framework of the term 'multi-sited communities' (Bernbeck 2008), societies that make use of multiple locations at different times and for different purposes, allowing the exploitation of diverse resources and the performance of varied activities. Within this complex network of temporary sites, locations combining rectilinear architecture, tombs, and towers may have functioned as focal places (Bernbeck 2008), facilitating contact between different subgroups of a community. In this sense, they can be understood as communal centres, possibly with civic-ceremonial functions (Wallis & Pluckhahn 2023), serving as central nodes of interaction within and between spatially dispersed communities. Other, more ephemeral sites correspond to what Weeks et al. (2018) term 'persistent temporary places', locations repeatedly used for specific activities without permanent structures. A landscape structured around multi-sited village communities also helps to explain the workforce required to construct monumental towers and tombs, emphasizing the communitarian character of Umm an-Nar social organization.

A key limiting factor in analyses of rectilinear architecture remains the availability of radiocarbon dates. The current evidence suggests that rectilinear architecture was present throughout the Umm an-Nar period and even extends back to the preceding Hafit period. Individual sites, however, appear to have been occupied for relatively short durations, at most a few hundred years, while other features of the same sites, such as tombs and towers, continued to be used both before and after these occupations. Rectilinear architecture therefore does not seem to have been a strict necessity of life during the Umm an-Nar period. This argument is further strengthened by the fact that significantly more sites with so-called towers are known than are sites with rectilinear architecture. Taken together, this supports the interpretation that such buildings represent a selective and context-dependent architectural and social strategy. However, it must be acknowledged that this pattern may to some extent reflect biases in archaeological visibility and research intensity, as towers are often more prominent and therefore more frequently surveyed or reported than less conspicuous rectilinear remains. Focusing on well-studied areas in this paper was intended to minimize these biases, although they cannot be fully excluded. Additionally, it will be important for future research to further investigate the relationships between the sites, including their occupation phases, settlement density, architectural plans, material assemblages, and the nature of resources exploited.

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