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The Contribution of the Domesticated Camel and Advanced Irrigation Techniques (the Horizontal Well/Falaj System) to the Iron Age Economy and Settlement Patterns of the Oman Peninsula and Arabia.

Kamel Moussa ,Noha
MA Archaeology of Arab and Islamic World, University College London, Qatar., n.mousa@ucl.ac.uk

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Cover Page Footnote

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• **Noha Kamel Moussa**

Abstract:

Iron Age II is considered the classical period of the Iron Age (figure: 2[(1)]). This period shows sudden increase in distribution and diversification in settlement pattern, in South-eastern Arabia [(2)]. The settlements during this period expanded to include inland [(3)], mountains [(4)] and coastal sites [(5)]. Settlements became more diverse to include non-residential architecture. An appearance of irrigation technology (*Falaj)* along with camel domestication coincides with this increase. This increase was accompanied by

• **MA Archaeology of Arab and Islamic World, University College London, Qatar.** n.mousa@ucl.ac.uk

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(1) MAGEE, P.Beyond the Desert and the Sown: Settlement Intensification in Late Prehistoric South-eastern Arabia. *Bulletin of the Late Prehistoric Southeastern Arabia.*2007, p.85

(2) MAGEE, P. Settlement patterns, polities and regional complexity in the southeast Arabian Iron Age Paléorient 24. PERSEE Program: 1998b, p.49

(3) HERRMANN, J.T., J. CASANA. & H.S. QANDIL. A sequence of inland desert settlement in the Oman peninsula: 2008-2009 excavations at Saruq al-hadid, Dubai, UAE Arabian Archaeology and Epigraphy 23. Wiley-Blackwell: 2012, p.50–69.

(4) Haser in AVANZINI, A. (ed.) Eastern Arabia in the First Millennium BC. Italy:'L'Erma' di Bretschneider. 2010, p.162

(5) MOUTON, M. & J. SCHIETTECATTE. *In the Desert Margins: The Settlement Process in an Ancient South and East Arabia*. Italy: 'L'Erma' di Bretschneider. 2014

regional [6](between the varied types of settlements) and trans-regional contact (with south Arabia) and goods exchange[7] [8] [9] The layout, the location, the structure and the material culture excavated from this period reflects a complex community [10] [11]. This manifested in the appearance of a belief system related to both irrigation and bronze production (the snake cult) [12], specialized labour in pottery [13], metal production [14] [15] and administration systems [16], fortification structures related to the agriculture activity [17], symbolic (axe heads on the stamp seals) and prestigious goods for elites [18].

This paper argues that irrigation technology was responsible for creating a social elite class. This class was responsible for cyclic production, the expansion and the diversification of settlement patterns using the domestication of the camel.

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[6] BENOIST, A. & S. MÉRY. Initial results from the programme of petrographic analysis of Iron Age pottery from the United Arab Emirates *Arabian Archaeology and Epigraphy* 23. Wiley-Blackwell: 70–91.2012, p.88

[7] MAGEE, P. The impact of southeast Arabian intra-regional trade on settlement location and organization during the Iron Age II period *Arabian Archaeology and Epigraphy* 15. Wiley-Blackwell: 24–42. 2004

[8] MAGEE, P. The production, distribution and function of Iron Age bridge-spouted vessels in Iran and Arabia: Results from recent excavations and geochemical analysis *Iran* 43. JSTOR. 2005, p.93

[9] Magee.2007

[10] MAGEE, P. & E. THOMPSON. 2001. Excavations at Muweilah 1997-2000 *Proceedings of the Seminar for Arabian Studies* 31. Archaeopress: 115–30. http://www.jstor.org/stable/41223675 2001, p.129

[11] Magee.1998b, p.54

[12] BENOIST, A. An iron age II snake cult in the Oman peninsula: Evidence from Bithnah (Emirate of Fujairah) *Arabian Archaeology and Epigraphy* 18. Wiley-Blackwell: 34–54.2007, p.50

[13] Benoist & Méry. 2012, p.88

[14] MAGEE, P. New Evidence of the Initial Appearance of Iron in Southeastern Arabia Arabian Archaeology and Epigraphy 9. Wiley-Blackwell.1998a, p.114

[15] Nashef in AVANZINI, A. (ed.) 2010. *Eastern Arabia in the First Millennium BC*. Italy:'L'Erma' di Bretschneider.2010, p.215

[16] Al- TIKRITI, W. in A. Avanzini (ed.) *Eastern Arabia in the First Millennium BC*. Italy: 'L'Erma' di Bretschneider. 2010, p.240

[17] Magee. 2014, p.237

[18] Magee. 1998b, p.56

Key words*:* Iron Age II؛ Settlements Pattern؛ Irrigation Technology؛ *Falaj*؛ Domesticated Camel؛ Economy.

The Iron Age is divided into three sub periods based on ceramic evidence from Tell Abraq: I (1200–1000 BC), II (1000-600 BC) and III (600-300BC)[19]

Table 1: Brief description of the settlement patterns and economy of Iron Age I and III:

	Iron Age I (13001000BC)	**Iron Age III (600-300 BC)**
Settlement Patterns `	Known sites are Shimal, Tell Abraq, al- Hamriyah and possibly Kalba; on the Gulf coast, and the East Coast (Fig. 1[20]) [21].	One-third reduction in number of sites when compared with Iron Age II. Known sites are Tell Abraq, Shimal, Rumeilah, Hili17, Hili 2, Nud Ziba, al-Thuqaibah, graves in the Wadi al-Qawr and Dibba oasis [22].
Economy	a) Dependency of the inhabitants on fish and shellfish [23]. b) Metrical and technological analysis suggest that pottery was produced on a part-time or occasional basis with non-	Little is known about Iron Age III. However, excavations in Thuqeibah shows that the economy consisted of agriculture, stock breeding and goods exchange with the

[19] Magee. 2001, p.115
[20] Magee. 1998b, p.51
[21] POTTS, D.T. Before the Emirates: an Archaeological and Historical Account of Developments in the Region c. 5000 BC to 676 AD, in P. Vine, P. Hellyer, I. Al-Abed, & I.A. Abed (ed.) *The United Arab Emirates: A New Perspective*. United Kingdom: Trident Press.2001, p.50
[22] Potts. 2001, p.50
[23] POTTS, D.T. *The Arabian Gulf in Antiquity: Volume I: From Prehistory to the fall of the Achaemenid Empire (Arabian Gulf in Antiquity)*. New York: Oxford University Press, USA.1990, p.103-109

	specialized labor, and that the main reason for production was to satisfy domestic needs [24].	coast[25].
Cause of decline in Number of sites and Economy.	May be due to: a) Drought conditions that impacted water resources, b) The decline of maritime trade which might have been caused by the Mesopotamian replacement of Omani copper production with that from Anatolia, c) The political instability in the Indus Valley during Aryan invasion which led scholars to speculate that this may have caused further disruption, through a cultural effect, in south-eastern Arabia [26] [27].	May be due to: a) The limitation of archaeological surveys in some regions versus the intensive explorations of others restrict the knowledge about this period[28]. b) The collapse of the Iron Age II Irrigation technology[29] [30]

[24] Magee. 2005, p.51
[25] DELCERRO, C. Accessed November 11. http://www.anthropology.uw.edu.pl/07/bne-07-02.pdf. 2015, p.23

[26] Brunswig in Potts.1990, p.29
[27]CARTER, R. The Wadi Suq period in south-east Arabia: a reappraisal in the light of excavations at Kalba, UAE *Proceedings of the Seminar for Arabian Studies* 27. Archaeopress: 87–98. http://www.jstor.org/stable/41223590. 1997, p.95-7
[28] Mouton & Schiettecatte. 2014, p.45
[29] Al-Tikriti. 2010, p.240
[30] Mouton & Schiettecatte. 2014, p.45

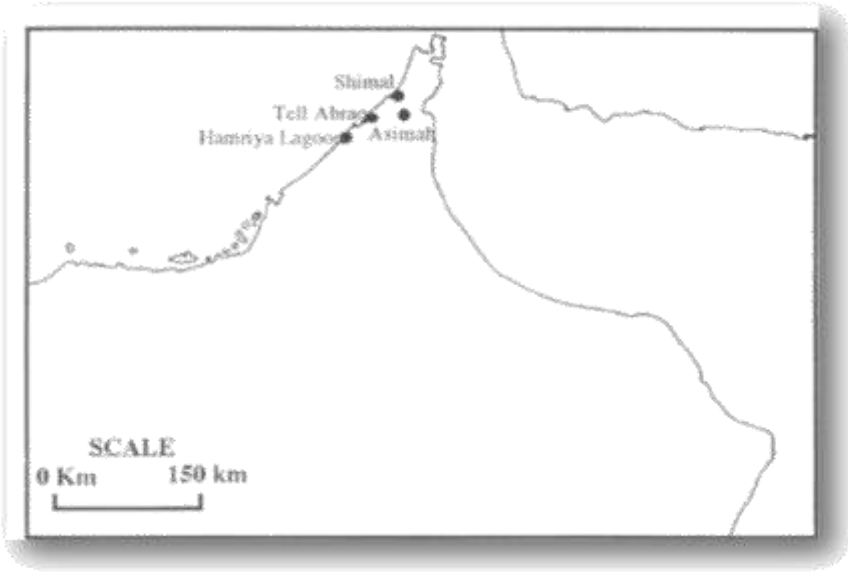

Figure (1)
Iron Age I sites.
The Iron Age II settlement pattern associated to *Falaj*

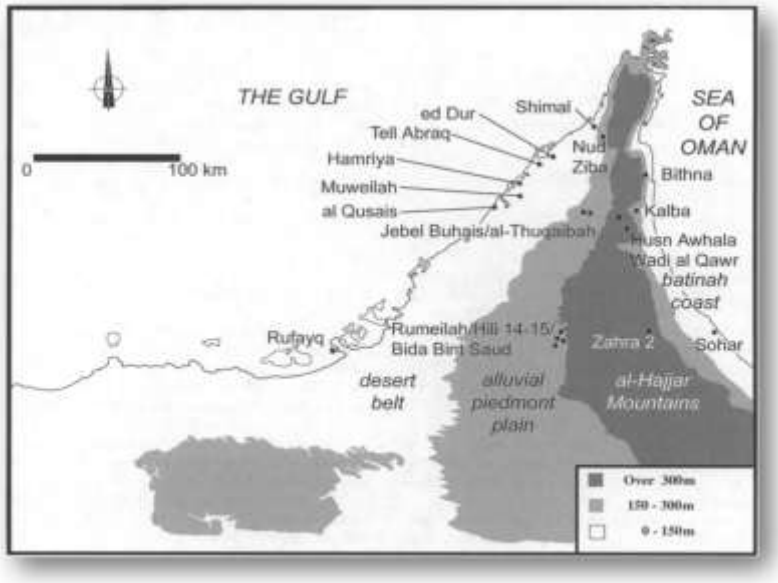

Figure (2)
Map shows Iron Age II sites in different environmental zones.

Excavations and surveys in al-Madam Region and Central Oman show relation between an irrigation technology (*Falaj)* and Iron Age II settlements. For example, Magee [31] attributes two *Aflaj* (*Falaj plural*) to al-Thuqaibah, Tawi al-Hosun and Umm Sufah settlements. While the five Iron Age II settlements in the al-Ain region Hili 2, Hili 14, Hili 17, Rumeilah and Bint Saud survived on the western drainage area and alluvial plain of the mountains. Hili, Hili 2 and Rumeilah were founded beside the *Falaj* of Hili 15.

The same relation between settlements and *Falaj* technology in central Oman also existed. In the Wadi Bani 'Umar, there are three Iron Age II settlements: Zahra 2, al-Qarn al-Mu'allaq and a site referred to as (Point A'32) beside the remains of a *Falaj* located near al-Qarn al-Mu'allaq. Another settlement in Wadi Samad (Maysar) was located alongside a *Falaj* system. (Figure 3[32])

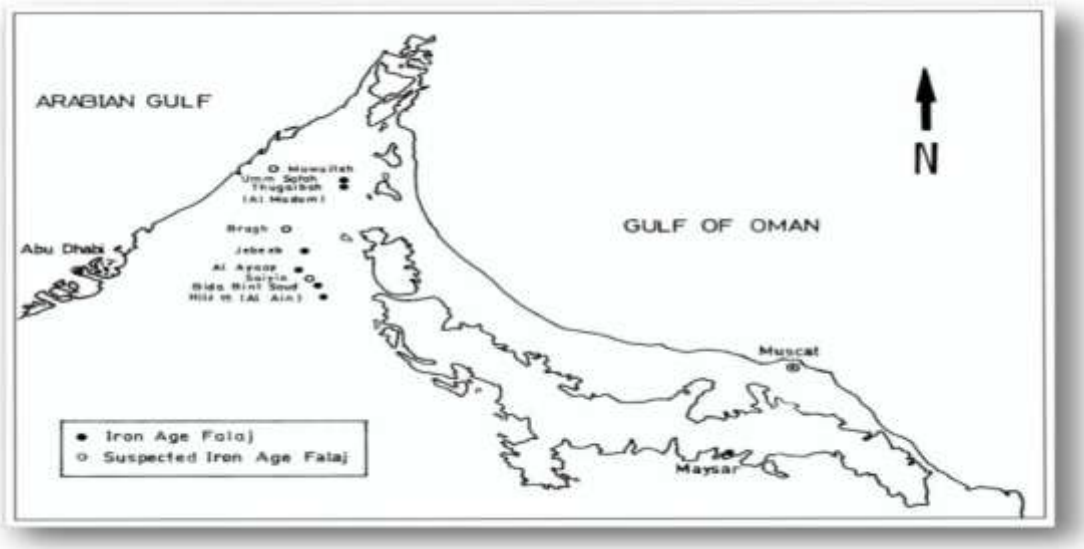

Figure (3)
Map shows the distribution of the Iron Age *Falaj*.

[31] Magee. 1998b, p. 54
[32] Al-TIKRITI, W. The south-east Arabian origin of the *falaj* system Proceedings of the Seminar for Arabian Studies 32. Archaeopress Publishing:117–38. http://www.jstor.org/stable/41223728. 2002, p.119

What is Iron Age irrigation technology?

Three reasons -along with camel domestication- have lead scholars to conclude that an irrigation technology was responsible for the increase, distribution and diversification of the settlement patterns.

1- The recovery of a *Falaj* beside Iron age II settlements.
2- The continuous aridity of the weather during Iron Age II [(33)].
3- Archaeobotanical evidence from Salut in central Oman provided evidence for cultivation of wheat, date palms, sesame and basil [(34)]. The recovery of grinding equipment and agricultural tools suggest cereal cultivation was practiced [(35)].

Other scholars highlight camels' role in the growth of settlements because:

1-That camel domestication (900-800 BC) coincided with Muweilah occupation (850 BC), indicate that camels were one of the main reasons of Muweilah site existence [(36)];

2-The faunal and archaeobotanical analysis suggests goods exchange between inland agricultural settlements and coastal settlements [(37)].

Scholars debate over the type of irrigation technology. Al-Tikriti[(38)] and Magee[(39)] argue that *Falaj* is the Iron Age II irrigation technology. They built their argument on the following facts;

[(33)] Parker et al. in CHARBONNIER, J. Groundwater management in Southeast Arabia from the Bronze Age to the Iron Age: a critical reassessment *Water History* 7. Springer Science + Business Media: 39–71. 2015, p.50
[(34)] Bellini et al. in Magee. 2014, p.215
[(35)] Magee. 1998b, p.53
[(36)] MAGEE, P. Writing in the Iron Age: The earliest south Arabian inscription from southeastern Arabia *Arabian Archaeology and Epigraphy* 10. Wiley-Blackwell: 43–50.1999, p.47
[(37)] MAGEE, P. *The archaeology of prehistoric Arabia: Adaptation and social formation from the Neolithic to the Iron Age*. Cambridge: Cambridge University Press.2014, p.226
[(38)] Al-Tikriti. 2010, p.228
[(39)] Magee. 1998, p.53

1-*Falaj* is located alongside Iron Age II settlements such as: *Falaj* of Hili 15, which was found beside the Hili17 settlement, and a fortified structure named Hili 14;
2-Iron Age II pottery was found within the *Aflaj*.
However, Charbonnier [(40)] who agrees with al-Tikriti on the inevitability of the presence of hydraulic structure, doubts the dating of the *Falaj* irrigation technology because:
1-The dating of the *Falaj* depended on its location beside Iron Age II settlements;
2-Is not stratigraphically related to the near Iron Age building as in the case of Hili 15;
3-The presence of Iron Age pottery within the *Falaj* may mean that these *Aflaj* cut through an Iron Age site. This means that some *Aflaj* do not necessarily date back to the Iron Age especially as some sites were repeatedly occupied during Islamic period leaving the dating of the *Falaj* questionable between Iron Age and Islamic period such as Umm Safah.
Mouton & Schiettecatte [(41)] prove that the underground water gallery (*Falaj*) of Am21 and the Iron Age settlement in Um Safah are related based on the evidence below:
1-The remoteness of the *Falaj* means that the pottery could not have been material scattered from the inhibited areas;
2-The excellent preservation of the pottery and "stratigraphic position inside the undisturbed waste dump";
3-The remains of unintentionally buried snake during the digging of the channel.
All confirm the direct relationship between the *Falaj* and the Iron Age II sites.
Though Mouton & Schiettecatte [(42)] agree with al- Tikriti on the relation between the Iron Age II sites and the irrigation

[(40)] Charbonnier. 2015, p.50
[(41)] Mouton & Schiettecatte. 2014, p.38
[(42)] Mouton & Schiettecatte. 2014, p.38

technology, they disagree on the technology type and believe they are underground water galleries.

Boucharlat describes *Falaj* or *Qanat* technology as it taps into the deep aquifers of the ground water through a vertical tunnel called a Mother well, it has a series of vertical shafts for maintenance and a horizontal sloping channel that transports the underground water to lower-lying areas for cultivation (figure 4[43]) [44]. On the other hand, the underground water galleries follow the same process, though the shaft does not tap the aquifer deeply and depends on collecting the rainfall in the main shaft, then directs collected water in the same way to the lower-laying areas.

Given this debate it can be concluded that, the Iron Age irrigation technology is *Falaj*, because Iron Age II suffered climate deterioration during. So it is hard to believe that irrigation technology depended mainly on the rainfall, rather than tapping the aquifers.

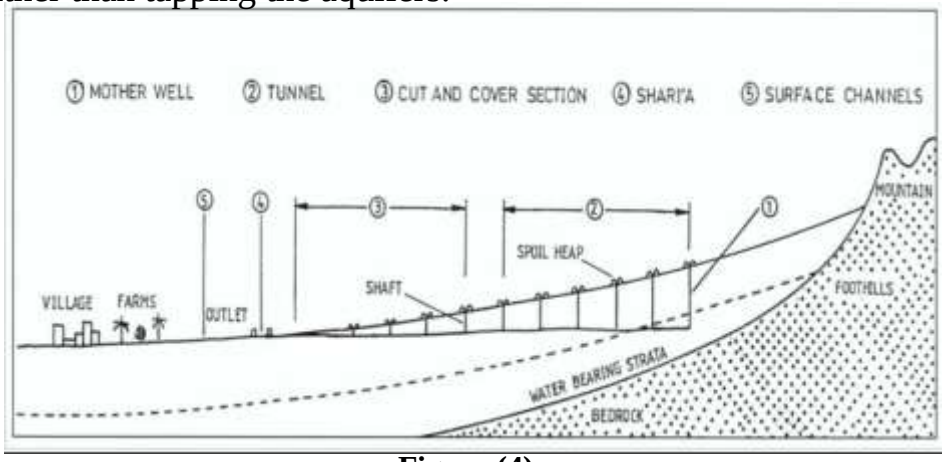

Figure (4)
Standard *Falaj*

How an irrigation system could theoretically impact the diversity and distribution of settlement patterns?

[43] Al-Tikriti. 2002, p.118
[44] Charponnier. 2015, p.40

Lees [45] illustrates that irrigation plays a direct role in creating wealth and power. The wealth and power stems from those who control the critical resources on which agriculture depends, managing human collaboration of sharing water and the tasks of constructing and maintaining water conveying facilities. In addition, the management of water resources often requires technical expertise that is limited to only a few. So the power remains for those who control the water access and the knowledge of the technology. This class usually becomes the elite of any society.

Gamble explains the importance of elites in motivating agricultural production surplus, bringing potential surplus into life and creating social stability, because the success of managing the surplus ensures the wealth continuity [46].

Blanton et al. [47] explain that surplus very often entails complexity. They define complexity as "the extent to which there is functional differentiation among societal units, dividing such units horizontally" (e.g. specialization of production) and "vertically" (e.g. ranking, stratification). In this context surplus causes a division in labour (specialization), presence of a hierarchy, and a belief system that create communal solidarity.

Diaz-Andreu claims that identifying complexity in archaeology relies on the existence of fortified settlements, hierocracy between settlements, the unequal distribution of luxury objects and specialized production[48]. This means that settlement patterns explains the communal complexity.

[45] LEES, S. Irrigation and society, *Journal of Archaeological Research 2.* Springer Science + Business Media: 361-78. 1994, p.362

[46] CHAPMAN, R. & C. ROBERT. *Archaeologies of complexity*. New York: Taylor & Francis.2003, p.166

[47] Blanton et al.1981, p.21in Chapman & Robert. 2003, p.165

[48] Chapman & Robert. 2003, p.165

The impact of *Falaj* on settlement patterns:

The layout of settlements dramatically changed from Bronze Age. The circular stronghold buildings of the Bronze Age, were replaced by open villages comprised of separate units of multi roomed houses (figure 5 [49]).

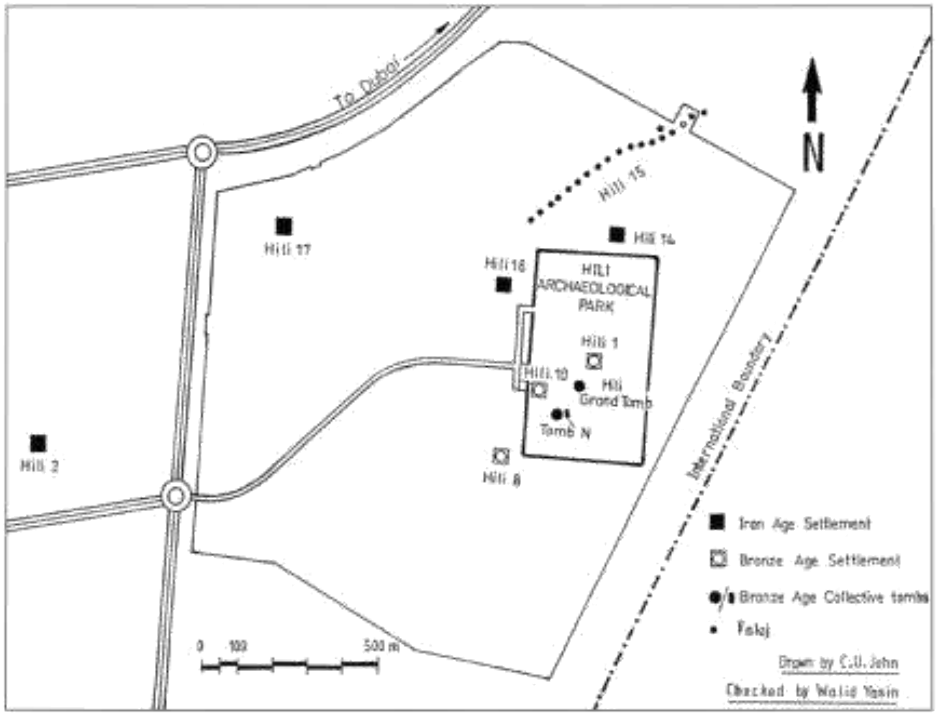

Figure (5)

Map shows differences between Bronze Age and Iron Age settlement pattern at Hili.

In Bronze Age the fortified buildings were built around wells as in the Hili settlements, such as site 1 (called site 1066, Hili 82 and Hili 103. and Bidya in FujairaW, at Tell Abraq and Kelba). While after the introduction of the *Falaj* the settlement patterns changed and became open villages, especially those located in

[49] Al-Tikriti. 2002, p.121

the oases where a *Falaj* were in operation. This became the main architectural character of the Iron Age [(50)].

Also, *Falaj* had an impact on the direction and shape of Iron Age settlement patterns. The availability of underground water was the determinant for constructing the *Falaj*. This resulted in settlements following the availability of the underground water resources.

For example, due to the decline of the underground water in Hili oasis, settlements extended west where the underground water was available, rather than concentrating around the Bronze Age sites of Jebel Huglah. Also, the shape of linear settlements from Hili in the south to Dubai and Qusais in the north was influenced by the availability of water pockets and underground water near the mountains.

In addition to the inland distribution, *Falaj* might have played a role in the coastal distribution of sites. Coastal sites exchanged goods with the inland sites. These communities were exchanging fish, shells and sea products with the agriculture products of the inland settlements. This means that inland settlements that were constructed beside the *Falaj* played an important economic role for the coastal settlements. So the location of the coastal sites were concentrated as near as possible to the inland settlements. This may explain the decline in number of coastal sites in the western province of Abu Dhabi compared to the northern province where the distance between al-Madam and the sea was only 50 km in the north compare to 130 km between Al-Ain and Abu Dhabi in the west[(51)].

The impact of Falaj on Non-residential architecture:

The Iron Age II witnessed the construction of non-residential fortified structures often built of stone or mudbrick. Stone strongholds can be found in the mountain as in, Jebel Buhais,

[(50)] Al-TIKRITI, W. *Archaeology of the Falaj: a field study of the ancient irrigation systems of the United Arab Emirates*. 1st ed. Abu Dhabi: Department of Historic Environment, Abu Dhabi Culture & Heritage.2011, p.150

[(51)] Al- Tikriti. 2010, p.239

Husn Madhab and Lizq[52]. They probably defended the *Falaj* and the agriculture area around it [53]. Large mudbrick fortified buildings occur around the *Falaj* on the alluvial plain. For example, building in Bida Bent Saud has a columned hall, measuring 10 x 13 meters length. This hall has a staircase leading to a narrow room which opens onto the *Falaj* itself. The purpose of this building may be to administrate and control water distribution (figure 6 [54]).

Al-Tikriti[55] believes that these buildings are *Beit el Falaj*, the house of Falaj. They are assumed to have had a social and commercial function because of the large amount of storage jars found there. For example, storage jars from Hili 17.

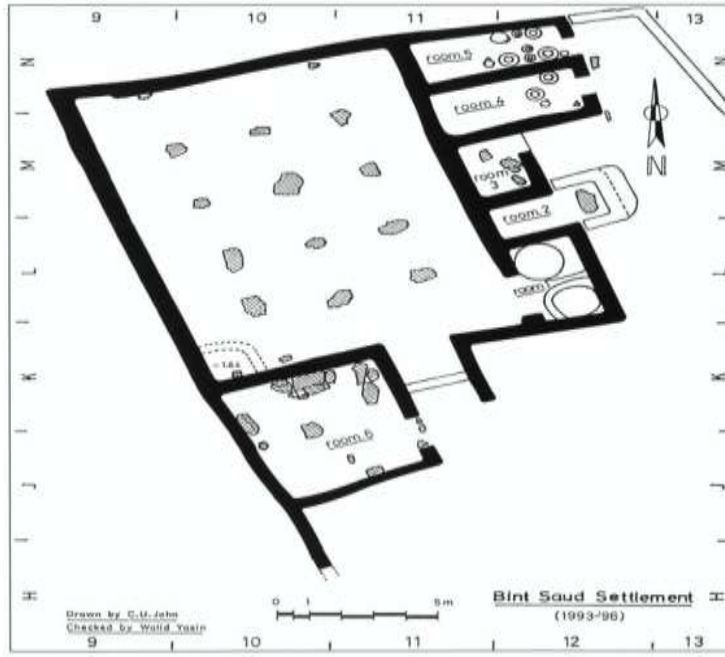

Figure (6)
Plan of Beit al Falaj at Bida bint Saud.

[52] Magee. 2014, p.215
[53] Magee. 1998b, p.53
[54] Al-Tikriti. 2002, p.133
[55] Al-Tikriti. 2010, p.240

Religious centres:

Cultic centres are represented in a number of buildings which have platforms and open-air alters. These sites appear from the East to the West Coast and are identified by the representation of applique of snakes on ceramics and bronze materials. For example, a long rectangular building made out of beach rock called the mount of serpents had a wide variety of ceramics with the representation of snake applique. Other examples are al Qusais on the west coast, Sarouq al-Hadid in the desert, Raki 2, Masafi and Bilad al-Madain, located in the central Oman Mountains, also Bithna at the interface of the mountains and the east coast. During Iron Age II these sites provided evidence for extraction of copper or refining and producing copper objects. These site locations suggest that it played a role in binding cultic activity with copper production and trade (figure 7 [56] &8 [57]).

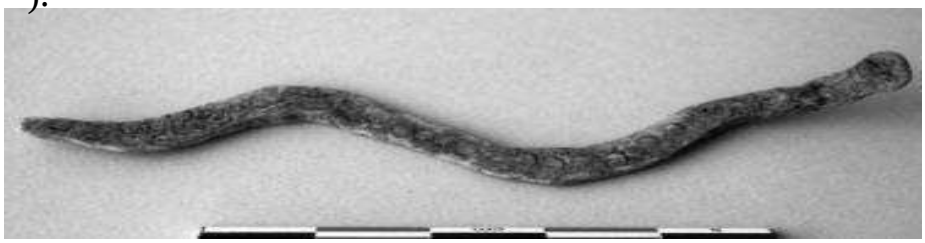

Figure (7)
Copper snake the Iron Age sanctuary at Masafi

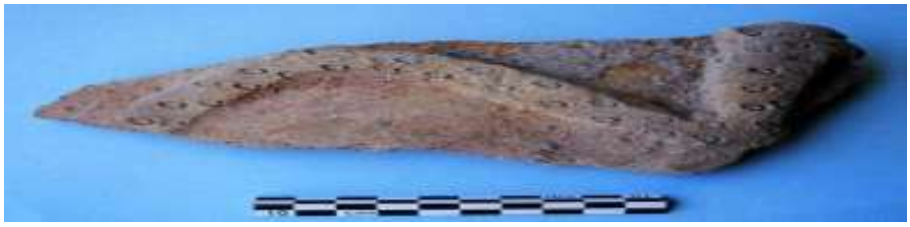

Figure (8)
Iron Age ceramic fragment decorated with snake from sanctuary at Bithnah.

[56] MUTON, M., A. BENOIST. & J.M. CORDOBA. The Snake Figuration in Iron Age Society. *Journal of National center of Documentation and Research.* http://www.na.ae/en/Images/LIWA05.pdf. 2011, p.5
[57] Muton et al. 2011, p.6

The representation of snakes and their attribution to ritual activities have had several interpretations. Benoist argues that snake as a cultic symbol may represent the Levantine approach, in that the toxicity of its poison is seen as a power over life. Conversely, the south-western Arabia and Bahrain approach see the snake as a symbol of healing, representing the God Wadd. In south Arabian temples bronze snakes have also been interpreted as votive offerings [(58)].

Other scholars like Mountain and al-Tikriti attributed the snake cult to Falaj technology. First, because of the ceramics decorated with snakes in the administration buildings of the *Falaj*. Second, they claim that the zigzagging in the underground channels of the *Falaj* imitates the shape of snake and is a symbol for the snake cult (figure 9[(59)]). Finally, snakes may reflect the Middle Eastern approach of snakes as a symbol of fertility which is related to water, soils, and granaries [(60)].

Giving these different approaches, the snake cult may have acted as a common belief system which was used as social cohesion for the Iron Age community with its diverse classes including farmers, craftsmen, traders and communities along the coast.

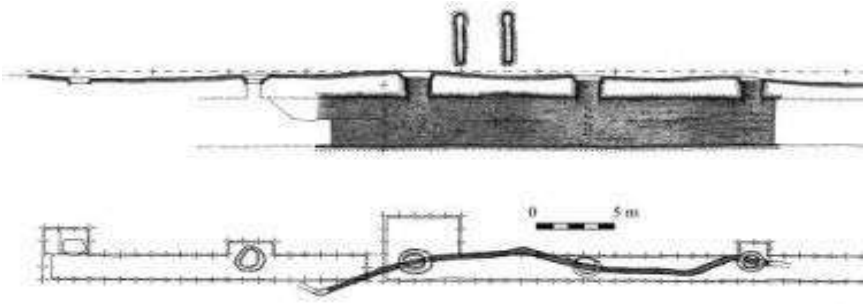

Figure (9)
Section of the *falaj* of Tuqeibah, al-Madam shows the zigzagging in the underground channels

The impact of *Falaj* on Iron Age II economy:

[(58)] Magee. 2014, p.239
[(59)] Muton et al. 2011, p.13
[(60)] Mouton & Schiettecatte. 2014, p.43

Falaj allowed intensive and year-round agriculture in the small 20-30 km strip of alluvial piedmont that flanks the al-Hajjar Mountains to the east and west[(61)]. The new technology created agricultural surplus [(62)]. Petrographic analysis from the internal structure of the piedmont settlements shows the existence of craft specialist in the form of ceramic producers [(63)]. This means that *Falaj* technology's surplus permitted a differentiation in labour structure.

Pottery and bronze specialization*:*

Specialization in labour was one of the results of the advanced irrigation technology that brought surplus. Iron Age II bowls and storage jars are decorated and shaped differently than they were in the pre-Iron Age period. For example, Al Ain was a centre for sandy ware ceramic production and the local imitations of the Iranian bridge-spouted vessel [(64)] [(65)].

Iron Age II also shows specialization in Metal production including iron, bronze and gold. Large quantities of Iron have been discovered in Saruq Al-Hadid. Objects such as spears, arrows, axe heads, daggers and hilts coated with bronze were found. Also gold wasters have been discovered suggesting that gold was manufactured within the same area. Absence of stone structures from the site suggests that Saruq al-Hadid was an industrial area occupied by industrial activities while the living occupation and public administrative structures were not far from the site[(66)]. This presents further strong evidence for labour specialization during Iron Age II.

The impact of camel domestication on economy:

The domestication of the Arabian camel (Dromedary) appeared at 800-900 BC based on faunal remains from Tell

[(61)] Magee. 2007, p.90
[(62)] Al-Tikriti. 2011, p.151
[(63)] Magee. 1998b, p.50
[(64)] Magee. 2014, p.215
[(65)] Benoist & Méry. 2012, p.72
[(66)] Nashef in Avanzini. 2010, p.215

Abraq [67]. The camel could convert useless fibrous and salty plants into nutritious food like meat and milk [68], though during Um Al Nar period wild camels were used as a game camel. Iron Age II communities approached the benefits of the domesticated camel differently. Faunal analysis from Tell Abraq shows that cattle during Iron Age II had the same economic impact and remained to supply the community with meat and milk. While domestic dromedaries provided all the advantages of the possession of a strong load- carrying animal [69]. This animal can roughly travel between 25 and 30 km a day [70]. The discovery of large numbers of camel figurines in Rumeilah and a camel figurine with a saddle from Muweilah, explain the use of the camel as a mean for transportation [71]. Camels facilitated the rapid transportation of water and food, by taking fresh fish and shell fish to the interior, or cereals and dates to the coast [72].The domesticated camel opened up new possibilities for inland trade including regional and transregional.

Evidence of regional trade:

1-Petrographic analyses of potsherds from various Iron Age II sites suggests the existence of regional trade networks. For example, the exportation of sandy buff ware of Al Ain to al-Madam, Muwailah and Kalba[73],

The hypothesis of the FRPW Iranian origins in the spotted jars is taken up after the confirmation of the Omani origin of the FRPW

[67] UERPMANN, M. The appearance of the domestic camel in south-east Arabia. https://www.academia.edu/15648682/The_Appearance_of_the_Domestic_Camel_in_South-east_Arabia. 2015, p.235

[68] Köhler-Rollefson, I. Camels and Camel Pastoralism in Arabia the Biblical Archaeologist 56. American Schools of Oriental Research: 180–88. http://www.jstor.org/stable/3210371 1993, p.185

[69] UERPMANN, M. Remarks on the animal economy of tell Abraq (Emirates of Sharjah and Umm al-qaywayn, UAE) *Proceedings of the Seminar for Arabian Studies* 31. Archaeopress: 227–33. http://www.jstor.org/stable/41223685. 2001, p.232

[70] Magee. 2004, p.26

[71] Benoist. 2007, p.50

[72] Uerpmann. 2001, p.232

[73] Benoist & Méry. 2012, p.88

and that the parallels between the Omani and the Iranian jars are only stylistic parallels. This may confirm the importance of the inland trade over the maritime trade during this period. While, Sandy Buff Ware (SBW) could have been produced in Hili-17 where wasters were found at the oasis of Al Ain and exported to other parts of the UAE (e.g. al-Madam, Muwailah, Kalba, Husn Madhab and Rafaq) through regional trade systems.

2-Communication with the coast suggested by the faunal analysis for Iron Age II and III from a central settlement like al-Madam-Thuqeibah. The settlement is 80km far from the Indian Ocean and 70km from the Persian Gulf though it contained fifty marine species, six mother-of-pearl shells (*Ostrea sp*) used as pigment containers, and some gastropods worked into ornaments. The high consumption of marine molluscs' al-Madam– Thuqeibah portrays the quantity of the goods movement between the central and coastal zones [(74)].

Evidence of Trans-regional trade:

The camel domestication facilitated Trans- regional inland trade and this is shown in the material culture for examples ;(Table 2: shows three examples of trans-regional trade).

[(74)] Del Cerro. 2015, p.25

In Muweila	Rumeilah	Saruq al-Hadid
a) The recovered camel figurine with a saddle on the back imitates the north Arabian suggests contacts with north Arabia.(figure:10[75]) b) The discovery of locally produced storage jars with three Sabaen letters (figure 11[76]) and the recovery of a highly decorated incense burner with a painted figurine of a humped zebu bull was found in a columned hall (figure 12[77]). These discoveries suggest that South-Eastern Arabia was in contact with South Arabian kingdoms [78].	One yellow sherd of 'Mesopotamian' pottery indicates the existence at the end of the Iron Age of trans-regional caravan trade linking Rumeilah to the Mesopotamian World[79].	Communication with Northern Arabia and Assyria suggested by recovery of a variety of highly decorated iron and golden objects including jewelry, beads, coils and leaf parallels to northern Arabia and Assyria[80]. Also, excavations revealed large amount of metal working slag and rich metal artefact. It included large amount of bronze objects, iron spears and swords, a highly decorated tripod representing a snake which draws parallels to bronze tripods from Assyria and Urartu.

[75] Magee. 2014, p.210
[76] Magee. 1999, p.44
[77] Magee. 2007, p.98
[78] Magee. 2014, p.210
[79] Benoist & Méry. 2012, p.89
[80] Potts. 2001, p.49

Figure (10)
Camel with a saddle on the back

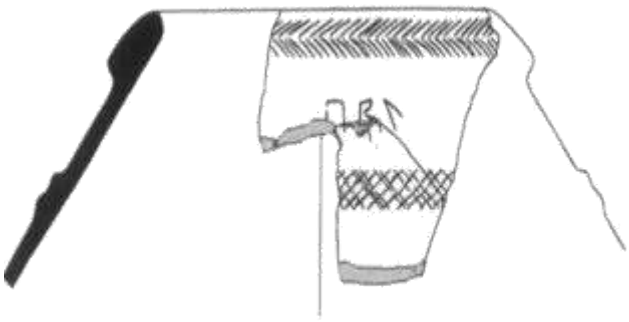

Figure (11)
Storage jar with three Sabean Letters from Muweilah

Figure (12)
Decorated Incense burner from Muweilah

The impact of camel domestication on settlement pattern:

The increase in intra-regional trade in raw materials and finished goods and the importation of goods from other areas of Arabia and the Middle East had an impact on settlement pattern and location.

For example, Saruq al-Hadid was an industrial complex for metal production located in a desert zone. Though the site is located 50-100 km far from ore, water or fuel sources[(81)], its location between the inland oases and coasts facilitated the transportation of refined copper from the mountains and exportation of fabricated bronze objects to local and regional markets. The domesticated camel enabled such cycles to exist.

Muweilah is another example of an emerged settlement as a result of domesticated camel. Muweilah is located nearly 50 km from the inland oasis of al-Madam and nearly 15 km from the present-day coastline. Architectural and ceramic analysis from Muweilah shows that it was receiving ceramics from multiple local and foreign production centres. Muweilah's played the role of caravan serai which was controlling and restricting the movement of goods to and from coast [(82)]. (Figure 13 [(83)])

[(81)] Hermann *et al.* 2012, p.50
[(82)] Magee. 2004, p.41
[(83)] Herrmann et al. 2012, p.51

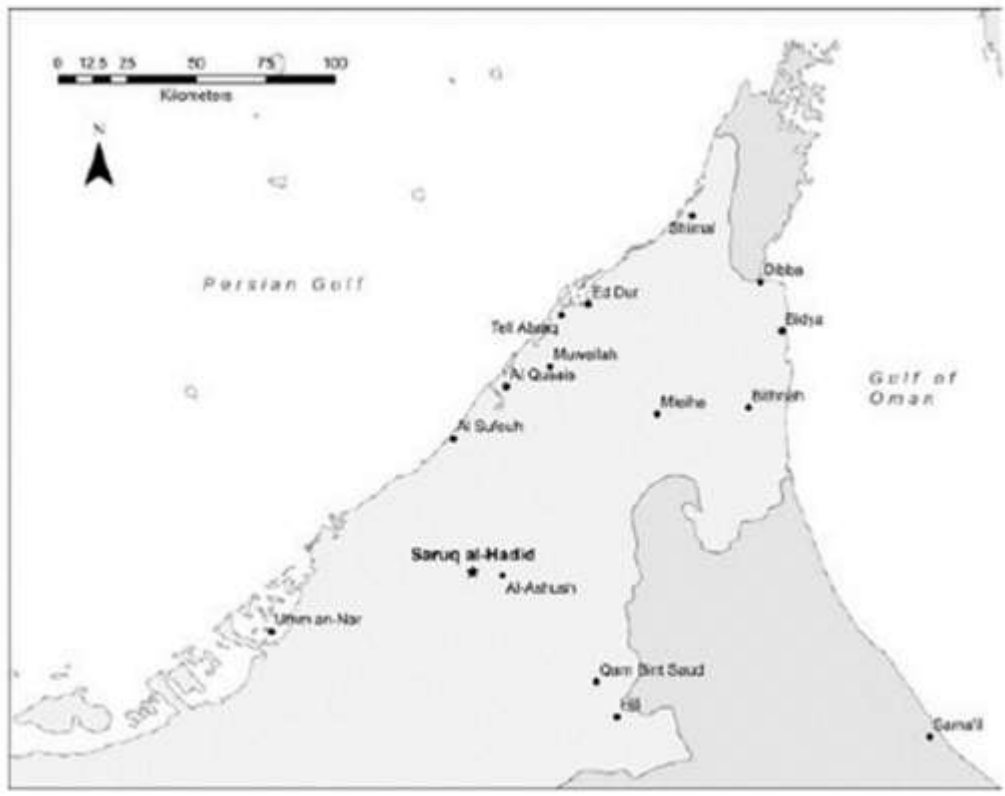

Figure (13)
Map shows the location of Muweilah and Saruq al-Hadid in the desert zone.

Elite class and the rise of complex society:

The Fortified structures in piedmont (as in HIli 17) and desert zones (Muweilah), tradition of stamp seal manufacture as in Rumeilah, Tell Abraq and Bint Saud, distribution of ceramics which imitate Iranian ones (bridge spouted jars) (figure 14[84]) and other classes of objects that represent status and authority suggest status differentiation and the rise of elite class during Iron Age II. Also, other objects from coastal, mountains and desert zones suggest connection with foreign centres of power, such as, a local soft-stone vessel decorated with Assyrian griffins and imported Assyrian cylinder seals. In Rafaq, a decorated bronze bowl with Assyrian parallels iconography,

[84] Magee. 2000, p.123

'Nimrud bowls' in ed-Dur[85], the south Arabian inscription and north Arabian imitation of camel figurine and the iron elements which is reflected as symbols of strength and power but also as a statues and prestigious item in Muweilah[86].

The distribution of these goods suggests that elite's class existed in piedmont, desert and on the coastal zones.

Also, a historical evidence from an Assyrian cuneiform inscription speaks of king of Qade who lived at Is-ki and sent a tribute to the Assyrian emperor Assurbanipal around 640 BC [87]. In this context, Oman seemed that it reached a level of social and economic complexity during Iron Age II which caused not only the emergence of elite class but also rise in political figures like the king of Qade.

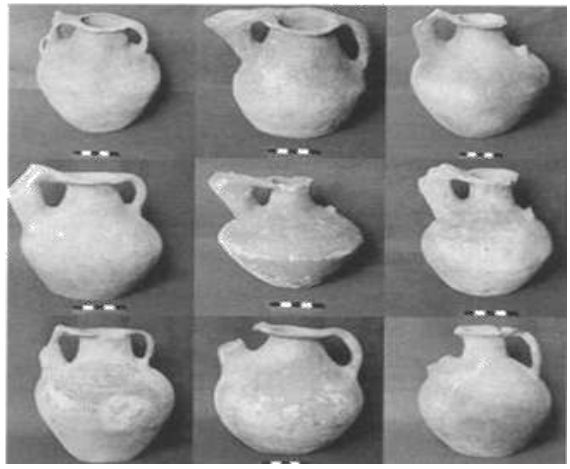

Figure (14)
Bridge spotted jars found in Muweilah

Elite class and production cycle:

The decline in maritime trade and the decline in water resources were two challenges faced Iron Age communities. These challenges seemed that it pushed the community to interact internally [88] and combine their previous irrigation techniques, inherited from a

[85] Magee. 1998b, p.56
[86] Magee. 1998, p.116
[87] Potts. 1990, p.393
[88] Al-Tikriti. 2010, p.245

previous local sedentary tradition that dates back to the 2nd millennium BC[89]. These previous experiences and additional agricultural innovations included and was not limited to:

1-Extracting sub-surface water from artesian wells to the surface and then transporting it to small plots of land. This started in third millennium BC and Umm an-Nar period [90]. For example, the second millennium BC discovered wells and irrigation canals around the site of Hili 8 in the al-Ain oasis [91];

2-Inventing *saruj* which is strong hydrological plaster for the spring water channels. This plaster holds out the pressure of the spring and without it the channels would collapse. This plaster maintained the water access to Mountain settlement e.g. at Balad Sit in wadi Bani Awf and on the Sayq plateau of the Jabal al Akhdar.

3-Transformation of soil to the terraced fields was also a technique used in Balad Sit where the land is difficult to obtain [92];

4-Cultivation using the hoe [93].

These examples of additional innovations related to the irrigation system maintain the argument that the *Falaj* technology is a result of a long period of accumulated experiences [94] [95].

Evidence of the political and economic control related to managing the *Falaj* technology appears in the administration structure such as Hili 15, Magee[96] suggests that the emergence of an elite class was a direct result of the introduction of the *Falaj* technology which created a surplus[97].

[89] Mouton & Schiettecatte. 2014, p.36
[90] Mouton & Schiettecatte. 2014, p.36
[91] Cleuziou in Potts. 2001, p.39
[92] Haser in Avanzini. 2010, p.177
[93] Potts. 2001, p.49
[94] Magee. 2014, p.219
[95] Al-Tikriti. 2010, p.240
[96] Magee. 2007, p.90
[97] Al-Tikriti. 2010, p.246

Elites might be the main motivation for domesticating the camel, because firstly the inhabitants of south eastern Arabia were familiar with the transport capacity of Bactrian camels from the middle of the third millennium BC[98]. Secondly, they were also familiar with methods of husbandry and domestication during Bronze Age [99].

Thirdly, using the camel for transportation rather than using it as a source of protein, was the reason behind camel domestication.

Finally, domestication chronologically came after the introduction of the *Falaj* technology and probably after the presence of elite class.

Elites played an important role in the production cycle and internal expansion.

[98] Magee. 2014, p.210
[99] Uerpmann. 2001, p.230

Conclusion:

The *Falaj* technology and the emergence of elite class played a key role in expansion, diversity and distribution of Iron Age II settlement patterns. The diversity of settlement patterns was a result of specialization of labor (Saruq al-Hadid) and manipulating the rest of the community by a belief system in order to guarantee the social cohesion between different groups combining farmers, craftsmen and traders. Camel was the needed tool for achieving their ambitious in opening up the way for trans-regional trade (such as, to south Arabian kingdoms) and opening new environmental zones for regional trade (such as Muweilah). Elites successful management of the agriculture surplus brought by *Falaj* and their desire of wealth continuity was key role in cyclic production in different economic activities which consequent flourishing in the economy, expansion and diversity of settlements.

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العصر الحديدي وأنماط الاستيطان في شبه جزيرة عمان والجزيرة العربية

نهى كامل موسى•

الملخص :-

يعد العصر الحديدي الثاني الفترة الكلاسيكية للعصر الحديدي. تلك الفترة شاهدت زيادة ملحوظة في توزيع و تنوع نمط المستعمرات في جنوب شرق الجزيرة العربية.امتدت مستعمرات تلك الفترة لتحتوي على مواقع داخلية، جبلية و ساحلية. كما تنوعت المستعمرات لتشتمل على مواقع عمرانية غير سكنية. تزامن ظهور تقنية الرى التي تعرف بالفلاج إلى جانب إستئناس الجمل مع هذة الزيادة. كما صاحبت زيادة المستعمرات إتصال إقليمي بين مختلف أنواع المستعمرات و أتصال عبر الأقاليم مع جنوب الجزيرة العربية و تبادل البضائع. إن النسق، البناء و المواد الثقافية المكتشفة من هذة الحقبة تعكس وجود مجتمع معقد.

و قد تبين ذلك من ظهور نظام عقائدي يرتبط بكل من الزراعة و إنتاج البرونز (عقيدة الثعبان)، وجود عمالة متخصصة لإنتاج الفخار، أنتاج المعادن، نظم الإدارة، أبنية تحصينية مرتبطة بالنشاط الزراعي، بضائع رمزية (رأس فأس على أختام) و بضائع قيمة للنخب. هذا البحث يناقش أن تقنية الرى كانت مسؤلة عن خلق طبقة النخبة و هذة الطبقة بدورها كانت مسؤلة عن تدوير عجلة الأنتاج، توسع و تنوع المستعمرات عن طريق إستئناس الجمل.

الكلمات الدالة : العصر الحديدي الثاني ؛ نمط المستوطنات ؛ تقنية الري ؛ الفلاج ؛ أستئناث الجمل ؛ اقتصاد العصر الحديدي.

•ماجستير في الآثار العربية و الإسلامية، كلية لندن الجامعية، قطر n.mousa@ucl.ac.uk