



Second season of the Saudi-French mission in al-Yamāma, al-Kharj area (11 November - 18 December 2012)

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PRELIMINARY REPORT

SECOND SEASON OF THE SAUDI-FRENCH MISSION IN AL-YAMĀMA

- AL-KHARJ AREA -

11 NOVEMBER - 18 DECEMBER 2012



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1/ Preamble

The second season of the Saudi-French mission in al-Yamāma was carried out from November 11 to December 18, 2012, under the supervision of Jérémie Schiettecatte (CNRS, Ivry sur Seine) & 'Abd al-'Azīz al-Ghazī (King Saud University, Riyadh).

Team

Saudi Part

- AL-AKLABĪ 'Abdallah (Saudi Commission for Tourism and Antiquities, Bisha)
- AL-HAMĀD 'Abd al-'Azīz (Saudi Commission for Tourism and Antiquities, Riyadh – archaeologist)
- AL-HINŪ 'Abd al-'Azīz (Saudi Commission for Tourism and Antiquities, Riyadh – archaeologist)
- AL-QARNĪ 'Awadh (Saudi Commission for Tourism and Antiquities, Riyadh – archaeologist)
- AL-DAWAYSH Sultān (Koweït – archaeologist)
- AL-TAYRĪ Hāmid (Koweït – archaeologist)

French Part

- Dr Antoine CHABROL (École Française d'Athènes) – Geomorphologist
- Guillaume FORTIN (Université Paris IV Paris-Sorbonne, Master Student) – Geomorphologist
- Prof. Eric FOUCACHE (University Paris-Sorbonne, Abu Dhabi) – Geomorphologist
- David GANDREAU (CRAterre, Grenoble) – Restorer
- Bruno GAVAZZI (Université de Strasbourg, PhD student) – Geophysicist
- Dr Hervé MONCHOT (Université Paris-Sorbonne, postdoctoral fellow Labex ResMed) – Archaeozoologist
- Sébastien MORISSET (CRAterre, Grenoble) – Restorer
- Dr Michel MOUTON (CNRS, Nanterre) – Archaeologist
- Laetitia MUNDUTEGUY (Université Paris 1 Panthéon-Sorbonne, Master Student) – Archaeologist & drawer
- Mathieu NIVELEAU – Surveyor
- Prof. Christian ROBIN (CNRS, Ivry sur Seine – Académie des Inscriptions et Belles-Lettres) – Historian
- Thomas SAGORY – Photographer
- Dr Jérémie SCHIETTECATTE (CNRS, Ivry sur Seine) – Archaeologist
- Dr Pierre SIMEON (postdoctoral fellow, CNRS, Ivry sur Seine) – Archaeologist

Support

The Saudi-French Mission benefited from the financial and technical support from:

- Supreme Commission for Tourism and Antiquities, Riyadh
- King Saud University, Riyadh
- French Ministry of Foreign Affairs, Paris
- French Embassy, Riyadh
- Centre National de la Recherche Scientifique, Paris
- UMR 8167 « Orient et Méditerranée », Ivry sur Seine
- Agence Nationale pour la Recherche, Paris
- Université Paris IV Paris-Sorbonne
- Labex ResMed (Religion et Société en Méditerranée), Université Paris-Sorbonne
- École et Observatoire des Sciences de la Terre, Institut de Physique du Globe de Strasbourg

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We would like to thank these institutions most warmly for their support. We are also most grateful to people who put their trust in our work and did their best to make fieldwork possible and easier in Riyadh and Paris: HRH Prince Sultan bin Salman bin Abdul Aziz (President of Supreme Commission for Tourism and Antiquities [SCTA] and Chairman of the Board of Directors of SCTA), Prof. Ali al-Ghabban (Vice-President of SCTA for Antiquities and Museums, Riyadh), Jamal Omar (Head of the Research and Excavation Centre, SCTA, Riyadh), Jean-Louis Laveille (Cultural advisor, French Embassy in Riyadh), Pierre Vincent (cooperation attaché, French Embassy in Riyadh), Marie-Véronique Diamant (CNRS, Ivry), Magali Picone (Univ. Paris IV).

2/ Geographic and historical settings

Al-Kharj area is one of the major oases of the Najd, in the very heart of the Kingdom of Saudi Arabia (Fig. 1). This oasis owes its fertility to its specific geographic context: it is nested at the confluence of several wadis and benefits from one of the largest drainage basin in Arabia. Moreover, artesian wells provided water down to a recent time. They are now empty, due to active pumping of groundwater.

These environmental conditions made this area one of the most attractive regions of Central Arabia for settled communities. As it is one of the rare fertile areas in Central Arabia, the region of al-Kharj appears as an obvious stopping point and as a main crossroad on the commercial roads that linked Yemen and the Hijāz to the Gulf and Mesopotamia.

Geographic and physiographic settings

The area of al-Kharj, in the eastern part of the Najd in East-Central Saudi Arabia, lies between latitude 23.8° and 24.4° N. and longitude 46.9° and 48° E. It is characterized by a variety of geological features that have attracted human populations since prehistoric times (Vaslet *et al.* 1991). Today it shelters one of the main cities in the Riyadh area, 70 km southwest of the capital.

A succession of northwest-trending cuestas of Late Jurassic to Cretaceous formations, with southwest-facing scarps, marks the northern part of the Riyadh area. Further south, the scarps are oriented towards the southwest. These are:

- Jabal Tuwayq, bordering al-Kharj area to the west; it crosses Central Arabia from north to south in a crescent-shaped arc;
- Jabal al-Jubayl, which bounds the city of Riyadh to the east;
- Jabal al-'Uruma, further east, that runs parallel to the Jabal al-Jubayl.

At al-Kharj the north-south scarps are cut by the convergence of the Central Arabian graben system composed of the Nisāḥ, Awsaṭ, Bu'ayjā', Rufā' and Mughara grabens.

Fluvial structures in the region run from the Tuwayq escarpment across the Tuwayq plateau in a generally west-east course. Towards the centre of al-Kharj area, the wadi courses follow the graben structures, such as Wādī Nisāḥ and Wādī as-Sahbā'. Southeast of Riyadh, a series of parallel wadis drain southward into Wādī as-Sahbā' and have brought considerable amounts of fluvial deposits into the Kharj cluse.

Over the past millennia, the west-east axis of the dip from the Hijāz to the Central Arabian shield has caused the emergence of subsurface waters in the form of springs and marshes in the Riyadh/Kharj area. The rupture of the Arabian shield by the tectonics that created the Central Arabian graben system has activated a series of natural artesian springs in the area. In addition, chemical dissolution of limestone by groundwater led to the formation of up to 150-metre-deep karst sinkholes south of al-Kharj.

This specific geomorphological configuration around al-Kharj led to the convergence of subterranean and surface waters, to the activation of artesian springs and to the formation of karst sinkholes, which provided important perennial water sources. These features have been decisive in the sedentary occupation of this area.

Historical setting

The favourable environment made this oasis one of the main actors of the history of Arabian Peninsula. Many preislamic and Islamic sources mention the region and its main populated places: Yamāma, Jaww, al-Kharj.

According to the Arabic tradition, al-Yamāma was the centre of the kingdom of Tasim and Jadis. This tradition also mentions that this kingdom disappeared in the early 5th century, when the himyarite king Hasan Tubba (Hassān Yuha'min, son of Abīkarib As'ad) took control of the area and entrusted it to the tribe of Kinda. This event could be echoed by the South-Arabic inscription Ry 509 found in Wādī Ma'sal (Najd).

It was probably at that time that the Banū Hanifa settled in this region. This tribe went down in history with the emergence within it of the so-called False-Prophet Musaylima. Contemporary with Prophet Muḥammad, Musaylima federated the tribes from the Najd. Standing in the way of the first Muslim community, they were finally defeated in the battle of 'Aqraba (633). The area fell into the hands of the Madina administration.

During the reign of the first Umayyad caliph, Mu'awiya (661-680), thousands of families were brought from Syria to al-Yamāma so as to maintain farming areas.

The area progressively became depopulated at the beginning of the Abbasid period (750-869) so that when the fleeing army of the Banū al-Ukhaydir entered al-Yamāma, they found a region deprived of a governor. This tribe controlled the region for two centuries. From the 12th to the 15th century AD, the area is seldom mentioned and it is likely that it was depopulated.

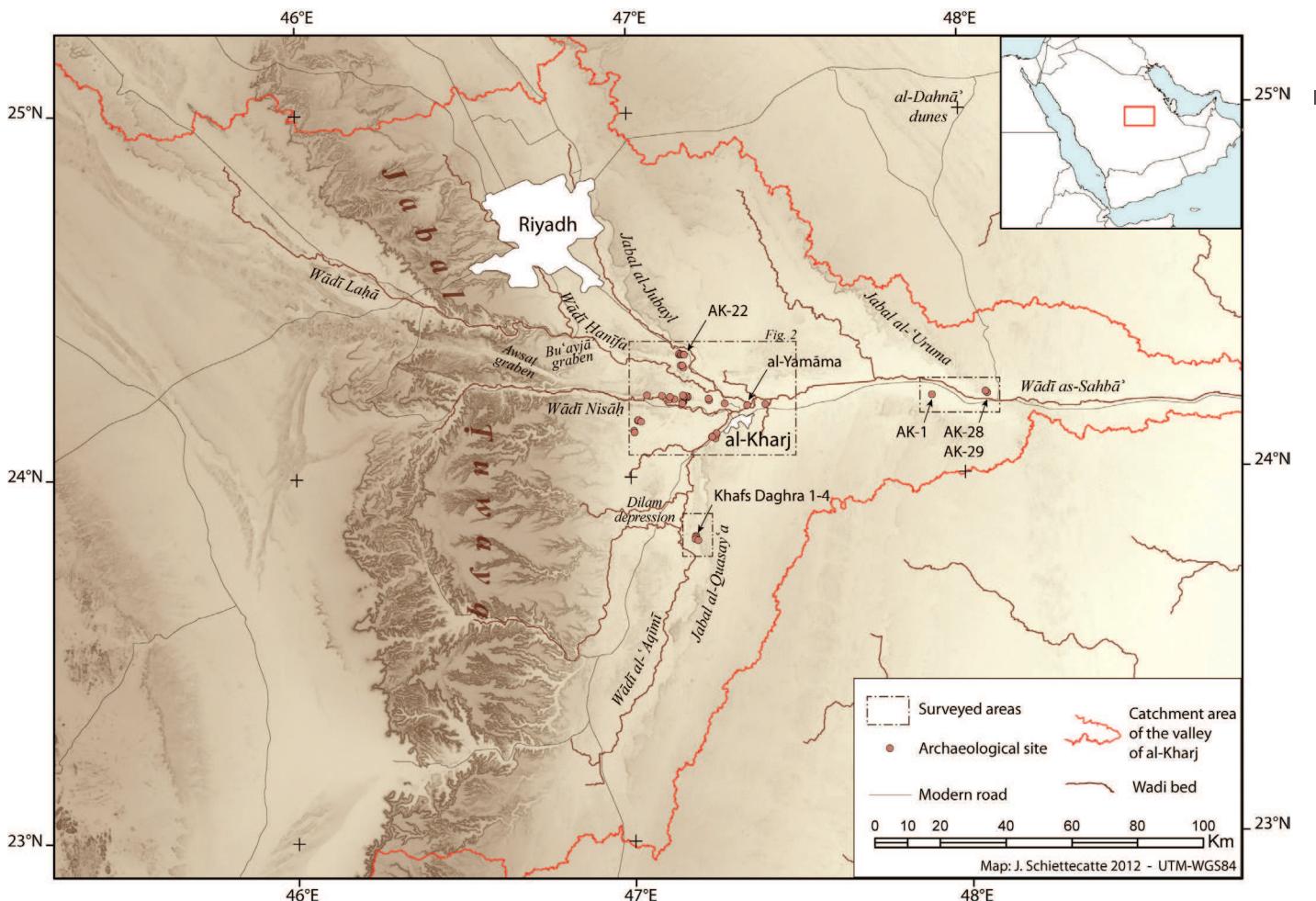


FIGURE 1 - LOCATION OF THE OASIS OF AL-KHARJ AND ITS ENVIRONMENTAL CONTEXT | ©FRENCH-SAUDI ARCHAEOLOGICAL MISSION IN YAMĀMA]

3 / Historiography of the exploration of al-Kharj area

Writing of his ventures into Central Arabia in 1917–1918, H. St J. Philby concluded his account by these words:

'I trust that I have said enough to show that there is much in Southern Najd to encourage further investigation, and to show that in Kharj and the Aflaj, in distant Jafura, in Wubar, and possibly other buried cities of the southern sands, there lies open a fruitful field for the archaeologist of the future.' (Philby 1920: 185).

These promising words should have been all the more inviting since this area is a crossroad between the Arabian Gulf, the Hijāz and Yemen, and is therefore crucial for the understanding of circulation and contacts within the Arabian Peninsula.

In spite of this, archaeological remains in Central Arabia have rarely been particularly noticed. In 1945, Col. G. de Gaury reported the presence of tumulus fields (De Gaury 1945). A few years later, Philby completed the description of the oases of al-Aflāj and Wādī Dawāsir (Philby 1949). In 1978, a comprehensive archaeological survey of the Kingdom of Saudi Arabia was carried out in Central Arabia and identified sixteen sites in the oasis of al-Kharj alone (Zarins *et al.* 1979), confirming the potential of the area. Consequently, in the late 1980s and in the 2000s, A. al-Ghazzi initiated excavations at several sites in the oasis (al-Ghazzi 1996; 2009; 2010; 2011a; 2011b).

1917-18 – Travel of Philby in the Najd in 1917-18 ; two detailed accounts have been published:

Philby H. St J. B., 1919. *Southern Nejd. Journey to Kharj, Aflaj, Sulaiyyil and Wādī Dawasir in 1918*, Cairo, The Arab Bureau.

Philby H. St J. B., 1920. "Southern Najd", *The Geographical Journal*, vol. 55 no. 3 (Mar. 1920), p. 161-185.

1940's – Stay of Gerald de Gaury in al-Kharj area and description of a necropolis

De Gaury G., 1945. "A Burial Ground in Al-Kharj", *The Geographical Journal*, vol. 106 no. 3/4 (Sep. - Oct. 1945), p. 152-153.

1948 – Travel of Philby in February 1948 in the Aflāj and Wādī Dawasir areas:

Philby H. St J. B., 1949. "Two notes from Central Arabia", *The Geographical Journal*, vol. 113 (Jan.-Jun. 1949), p. 86-93.

1978 – Comprehensive Survey carried out by a Saudi-American team for the Department of Archaeology of the kingdom of Saudi Arabia. Sixteen sites were identified and few soundings realized on a preislamic site near 'Ayn al-Dila' (today destroyed) and in the nearby necropolis:

Zarins J., Ibrahim M., Potts D.T., Edens Ch., 1979. « Saudi Arabian archaeological Reconnaissance 1978. The preliminary Report on the third phase of the Comprehensive Archaeological Survey Program - The Central Province », *Attal* 3, p. 9-42.

1988 – Sounding on the site of Hazm 'Aqīla (today destroyed):

Al-Ghazzi A., 1996. "A preliminary report of an excavation at Hazem Agila in al-Kharj oasis / central region of Saudi Arabia", *Attal* 14, p. 43-51, pl. 18-23.

Al-Ghazzi A., 2009. *Awān fūhāriyya min mawqa' Ḥazm 'Aqīla (muḥāfaẓat al-Ḥarq / Manṭaqat al-Riyād)* [Pottery of the site of Hazm 'Aqīla (al-Kharj Gouvernorate / Riyadh Province)], Riyadh, Dārat al-malik 'Abd al-'Azīz.

2004-2005 – Excavation of several tombs in the necropolis of 'Ayn Farzān supervised by 'Abd al-Aziz al-Ghazzi:

Al-Ghazzi A., 2011. *Mašrū' masāḥ w-tawṭiq al-Manṣāt al-ḥajariyya fī maḥīṭ 'Aynī Farzān. Al-mujāllad al-awal. Dirāsat maydāniyya muqārna li-l-muqābarā al-rakāmiyyat al-ḥajariyya*, Riyadh, Dārat al-malik 'Abd al-'Azīz (A.H. 1432-2011 AD) [Project of study and research on stone structures in 'Aynī Farzān area. Vol. 1. Comparative study of dry-stone funerary structures].

2004-2005 – Study of the qanat at 'Ayn Farzān supervised by 'Abd al-Aziz al-Ghazzi:

Al-Ghazzi A., 2011. *Mašrū' masāḥ w-tawṭiq al-Manṣāt al-ḥajariyya fī maḥīṭ 'Aynī Farzān. Al-mujāllad al-tānī. Qanāt al-rī fī Farzān "Aynī Farzān" wa-fuhār-ha (Dirāsat maydāniyya tawṭiqiyya atāriyya muqārna)*, Riyadh, Dārat al-malik 'Abd al-'Azīz (A.H. 1432-2011 AD) [Project of study and research on stone structures in 'Aynī Farzān area. Vol. 2. Irrigation qanāt at Farzān "Aynī Farzān" and its pottery (Documentary, archaeological and comparative studies)].

4/ Present issues for a study of al-Kharj area

By its geographic, historical and archaeological context, this oasis offers many opportunities for the study of the peopling and of the settlement process in central Arabia, from Prehistory down to the mediaeval period.

11

Prehistory

A debate now exists about trying to understand where the Arabian Neolithic comes from: Levantine influence or local developments from autochthonous populations? Recent palaeoenvironmental and palaeoclimatic studies revealed a possible influence of the wet phases in the development of a production economy. These studies, combined with the lithics analysis, help defining better and better the Neolithic of Arabia.

Beyond this period, understanding the dispersals of the first Anatomically Modern Humans (AMH) in Arabia during Paleolithic is one of the main concern for the current Prehistoric researches in the Peninsula.

Bronze Age

Several necropolises showing hundreds of dry-stone turret graves or tumuli have been identified in this area. The main issues are the date of their building, and the time span of their use. In Yemen, these tombs delivered artefacts from the 3rd and 1st millennium BC. Is this indicative of long lasting funerary practices, or of the reuse of these tombs far later on?

Furthermore, in western and southern Arabia, these tombs were collective and are generally seen as nomad tombs; on the opposite, on the shore of the Persian Gulf (Bahrain, Dhara area), they contained only a single body and were burials for sedentary people. Al-Kharj area is the buffer area between these two cultural spheres; the study of the burial practices in the area could be indicative of the very nature of people (origin, way of living).

Iron Age and turn of the Christian era

One of our main concerns is to ascribe a period of time to the sedentarization process in al-Kharj area. Has this process begun right from the 3rd millennium BC, as it can be observed in the Oman Peninsula (Hafit / Umm an-Nar periods) or in Bahrain area (Dilmun period)? Has it begun later on, at the end of the 2nd millennium BC, as in the Yemeni lowlands? Or are we to observe in al-Kharj area an alternate and specific model? Is the sedentarization process linked to the domestication of palm-tree, as in the Oman Peninsula? Is this model varying according to other criteria such as caravan trade?

A second issue is the very nature of the goods exchanged in the Arabian Peninsula. At the crossroads of the caravan tracks between frankincense-bearing kingdoms (in Yemen), the Oman Peninsula, the Gulf region and Mesopotamia, this area should throw a new light on these commercial activities.

A third issue concerns the 3rd-2nd centuries BC, a transitional period in the Arabian Peninsula. New populations appeared in historical sources and settled in the Oman peninsula (e.g. Mleiha), in South Arabia (penetration of Arab groups in the Jawf valley), in North-West Arabia (Nabateans). They all shared common features, particularly in the funerary practices. And yet, the origin of these groups is still unknown. The study of a site in central Arabia could bring new evidence to the file.

Late preislamic period and the advent of Islam

Issues regarding the Late Antiquity and the Islamic period are also numerous. A sharp decline of the settlement pattern can be observed in South Arabia, West Arabia and North Arabia from the 4th century onwards and accelerated during the 6th century. Is this process, partly linked to the evolution of the environmental context, to be seen in Central Arabia? Did Islam spread thanks to settlement vacuum? Was the Yamāma region able to compete with the new power of Medina?

Finally, the soundings already done on the site of al-Yamāma (Ghazzi, 2010) indicate a temporary abandonment of most of the site at the end of the 12th century. This makes one wonder about the reasons leading to such a situation.

5/ Purpose of the 2nd season, programme, schedule

In order to add to the current archaeological record, a Saudi-French expedition started work in al-Kharj area in September 2011 at the invitation of the Saudi Commission for Tourism and Antiquities. This expedition aims to characterize the diverse prehistoric, protohistoric and Islamic archaeological remains as well as to illustrate the environmental context that made it possible for people to settle in such an arid region.

The first field season (2011) was devoted to establishing an archaeological map of the oasis, and to the study of two significant sites: AK-22 (Palaeolithic) and al-Yamāma (Late Pre-Islamic/Early Islamic).

The second season was devoted to the pursuing of the exploration of the site of al-Yamāma, also called al-Banna, close to the city of al-Kharj. It included:

- The pursuing of Deep sounding 1
- The pursuing of the uncovering of the mosque
- The pursuing of the topographic map
- The pursuing of the geomagnetic survey
- A geomorphological study of al-Kharj area
- The processing of a restoration project of the mosque at al-Yamāma

The second season of the Saudi-French mission in al-Yamāma has been carried out from November 11 to December 18, 2012.

J. Schiettecatte arrived in Saudi Arabia on Sunday, November 11. He stayed in Riyadh three days in order to discuss the issue of the 2nd season with the cultural counsellor of the French Embassy, officials at SCTA and Prof. al-Ghazzi at King Saud University.

On Wednesday, November 14, he drove to al-Kharj. He has been joined by three members of the French team (H. Monchot, L. Munduteguy, P. Siméon). They met the members of the Saudi team already present in al-Kharj (A. al-Aklaibī, A. al-Hamād, A. al-Hinū, A. al-Qarnī, S. al-Dawaysh and H. Al-Tayrī).

On Friday, November 23, the French team increased its workforce by the arrival of B. Gavazzi, geophysicist, M. Mouton, archaeologist, M. Niveleau, surveyor, D. Gandrau and S. Moriset, restorers specialized in mudbrick architecture.

On Thursday, November 29, three geomorphologists joined the French team: E. Fouache, A. Chabrol and G. Fortin.

Finally, on Friday, December 7, T. Sagory, a photographer specialized in aerial picture (by kite and balloon) joined the team.



Resuming the excavation of Building 1 («Mosque») by removing the filling set at the end of the first season

1. Archaeological excavation at the site of al-Yamāma

Three areas were to be investigated during the second season:

1/ The deep sounding initiated during the first season in Area N6 (North of Building 1 - the “mosque”) had to be extended and carried on so as to get a complete chronological sequence of the occupation of the site and of its material assemblage.

This operation has been conducted by Michel MOUTON from November 24 to December 6.

2/ The mosque partly unearthed during the first season had to be excavated with several aims: clearing the main columned hall for restoration; looking for previous buildings (most probably more ancient mosques) under the main building by local soundings.

This operation has been conducted by Jérémie SCHIETTECATTE and Pierre SIMÉON from November 19 to December 6. They were assisted by Laetitia MUNDUTEGUY.

3/ A sounding had to be carried out in the south-western part of the site, where most of the evidence of a pre-Islamic occupation had been discovered on surface last season.

It has been carried out by Michel MOUTON from December 8 to December 11.

The drawings of pottery and artifacts have been taken in charge by Laetitia MUNDUTEGUY during the whole duration of the fieldwork.

2. Surface study, topography, geomagnetic survey

Topography

The topographic map of structures visible on the ground started last season had been achieved. The detailed mapping of excavated areas has also been done.

Staff: Mathieu NIVEAU, surveyor, from November 24 to December 8.

Material: Total Station Leica, D-GPS Trimble R4.

Geomagnetic survey

The geomagnetic survey of the fenced area initiated last season has been continued in the southern half of the site. Some particular areas have been surveyed into further detail.

Staff: Bruno GAVAZZI, from November 24 to December 8.

Material: Geomagnetic sensors, real-time laptop, HMD glasses, D-GPS.

Surface study

An aerial photo coverage of the archaeological sites of the oasis and more particularly of al-Yamāma (surface & excavated areas) has been completed thanks to the use of a kite and an air balloon.

Staff: Thomas SAGORY from December 7 to 15.

3. Restoration

Due to the very good state of preservation of the ruins of the mosque at al-Yamāma, its unearthing has to be followed by a restoration of the remains (strengthening of the mudbrick walls and preservation against weathering).

Two specialists of mudbrick restoration (an archaeologist and an architect) from the High School of Architecture in Grenoble (France) joined us for a one-week stay so as to define the best restoration procedure to be applied, taking into account the local environment and the very nature of the structures.

They subsequently submitted a restoration project for the mosque and other remains of al-Yamāma that could be applied from 2013 onwards with the agreement and financial support of the SCTA.

Staff: David GANDREAU & Sébastien MORISSET, from November 23 to 30.

Moreover, consequently to this expertise, part of the restoration work has already started over the most sensitive part of Building 1 (“Mosque”) unearthed during this season by Laetitia MUNDUTEGUY.

4. Environmental studies

Geomorphology

A team of three geomorphologists continued the geomorphological mapping of the oasis (identification of geological, hydrographical, pedological areas) carried out last year. The aim was to come up with a tool that could help us to understand how environment evolved through time and how it provided the water needed for agriculture. It will also be used as a predictive map to make the prehistoric survey easier.

Staff: Antoine CHABROL [Nov. 30 – Dec. 15], Guillaume FORTIN [Nov. 30 – Dec. 15], and Eric FOUCHE [Nov. 30 - Dec. 4].

Archaeozoology

The study of faunal remains from the excavation had to be carried out so as to identify the different faunal species present in the oasis in the past, be that domesticated ones or wild animals.

Staff: Hervé MONCHOT, from November 15 to December 19.

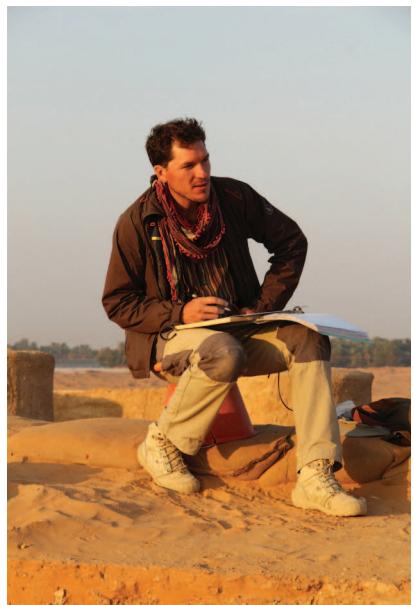
Archaeologists



Michel Mouton



Jérémie Schiettecatte



Pierre Siméon



‘Abd al-‘Azīz al-Hinū



Laetitia Munduteguy



‘Abd al-‘Azīz al-Hamād



‘Awadh al-Qarnī



Sultān al-Dawaysh & Hāmid al-Tayrī

Geophysicist



Bruno Gavazzi

Geomorphologists



Antoine Chabrol



Guillaume Fortin

Surveyor



Mathieu Niveauau

Archaeozoologist



Hervé Monchot

Photographer



Thomas Sagory

Restorers



Sébastien Moriset



David Gandreau



Team on the field - December 9, 2012

6/ Registration system

A homogeneous registering system has been set up to meet the requirements of both the survey of al-Kharj area and the excavation of the site known as al-Yamāma. It has been done by J. Schiettecatte and G. Charloux.

It is constituted of several related databases designed with the *FileMaker Pro 10* software:

- Database of the archaeological sites of al-Kharj area (Fig. 1);
- Database of the photographs taken during survey and excavation (Fig. 2);
- Database of stratigraphic units (Fig. 3);
- Database of archaeological structures (Fig. 4);
- Database of archaeological artefacts (Fig. 5);
- Database of pottery (Fig. 6);
- Database of samples (bones, charcoal, slags, etc.) (Fig. 7).

The database of the archaeological sites has been designed so as to be exported and used on a GIS (Geographic Information System), the software being used is *ArcGis Desktop 10*.

The screenshot shows the KHARJ-SURVEY database interface. At the top, there are logos for CNRS, Institut National de l'Information Géographique et Forestière (IGN), and Orient & Méditerranée. Below the header, the site name is listed as "Qawid Farzān North 1". The date of the visit is "11/12/2012". Coordinates are listed as Latitude: 24.22665 and Longitude: 47.16153889. Altitude is marked as "? m" and GPS point is marked as "?".

The interface includes several filter categories:

- Period of occupation:**
 - Undetermined
 - Pleistocene
 - Holocene
 - Bronze Age
 - Iron Age
 - Late Preislamic Period
 - Islamic period
- Remains:**
 - Isolated dwelling
 - Densely settled area
 - Place of worship
 - Tomb/nécropolis
 - Hydraulic structure
 - Well
 - Cistern
 - Workshop
- Inscription / graffiti:**
 - Graffiti - animal
 - Graffiti - symbol
 - Graffiti - human
 - Graffiti - text
- Building material:**
 - Stone
 - Mudbrick
 - Fired brick
 - Coated wall
- Graffiti & inscriptions:**
 - Rock inscription
 - Stone inscription
- Artefacts:**
 - Pottery
 - Lithic
 - Stone tools

A large text area on the right side contains a detailed description of the site: "North of the sandstone outcrop of Qawid Farzān, down the slopes, in a sand area on the edge of a paleolake. Presence of several graves. Circular or square in shape, in dry stone masonry, few with a tail up to 15 m."

Figure 1: Database of the archaeological sites of al-Kharj oasis

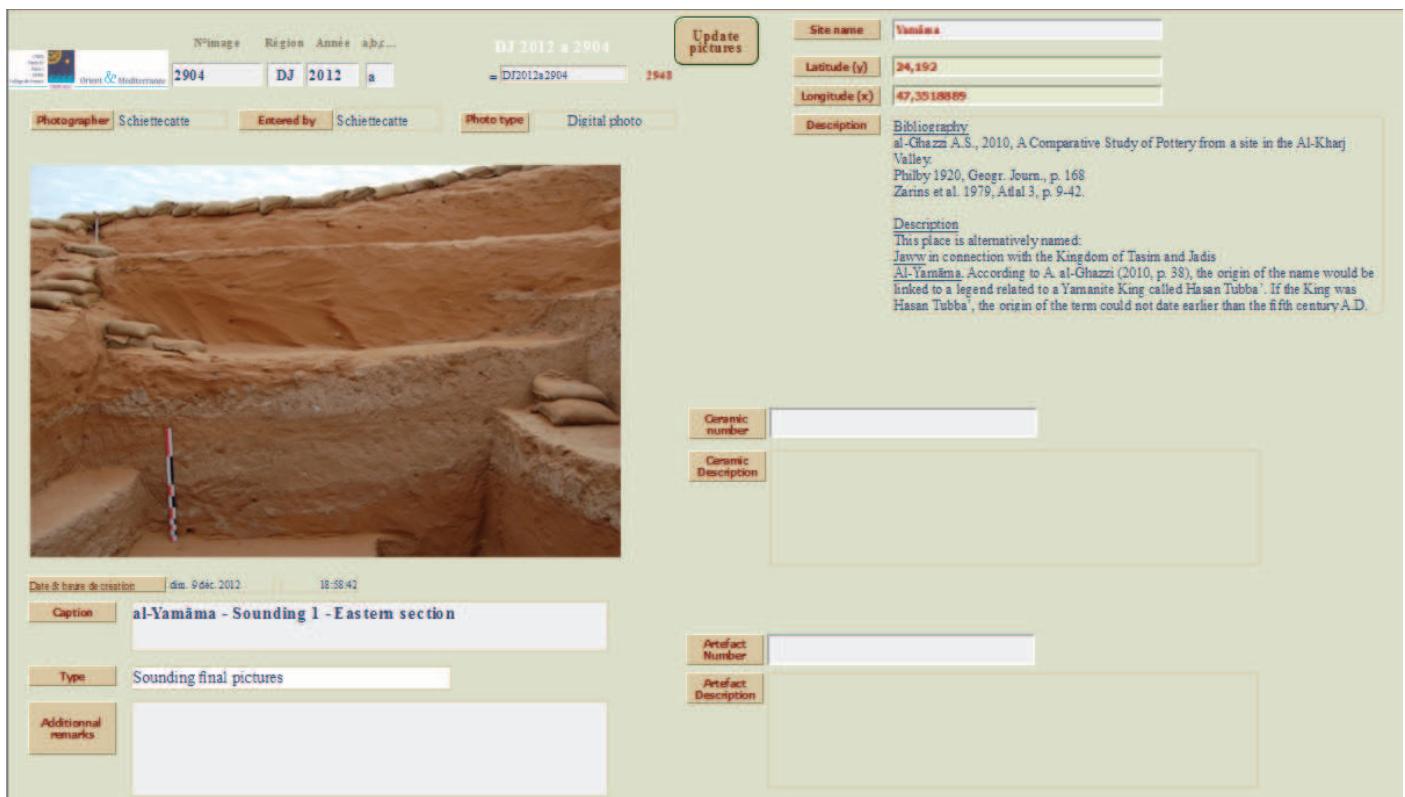


Figure 2: Database of the photographs taken during survey and excavation

YAMAMA - UF								
Number	031	Area	N6	year	2012			
under UF	029	interpretation	COLLAPSE OVER AEOLIAN DEPOSIT					
equal UF	-							
above UF	033							
Contact with structure	W 006 - W 044	upper altitude	430,03					
		lower altitude	429,47					
Nature of the sediment	Fallen mudbrick fragments over aeolian sand deposit							
Inclusions	Mudbrick fragments and nodules, plaster fragments, few stones, baked brick, 1 fragment of painted plaster							
description	<p>West of Building 1 (Mosque), west of W 006 and W 044. Removing of a layer of collapsed mudbricks coming from W 006 (2011 = UF 004). It covers a thick layer of aeolian sand deposit (60 to 80 cm). Uncovering of a "floor" made of hardened melted mudbrick at the foot of W 006. Possibly a circulation level. Clearing of the western face of W 006 : thick wall in its lowest part (ca. 1m thick) with two faces made of mudbrick and an inner filling made of sand / mudbrick. Plaster on the outer face of the wall partly preserved.</p> <p>In the upper part, the wall is only 2 bricks thick (ca. 45 to 50 cm).</p>							
sample	S.031.1 S.031.2 S.031.3 S.031.4 S.031.5 (painted)	Bones Plaster Glass Baked Brick Plaster	Artefacts	Y.031.1	Clay artefact			
Pottery								

Figure 3: Database of stratigraphic units

20

Number		052	Area	N.Trench	Year	2012	Date	03 12 12
Type	<input checked="" type="checkbox"/> Wall (W) <input type="checkbox"/> Floor (F) <input type="checkbox"/> Pit (P) <input type="checkbox"/> Built hearth (H) <input type="checkbox"/> Room (R) <input type="checkbox"/> Access (A) <input type="checkbox"/> Posthole (Po) <input type="checkbox"/> Column (Co)							
Identical to under UF	053		Constituent UF	056		UF against the structure		
above UF	056		Contact with structure					
Length	130 cm			Height	45 cm			
Width/diameter	> 40 cm							
upper altitude	426.86			Building material	Mudbrick			
lower altitude	426.40			Appareillage	not visible			
Courses number				Mean size of the stones/bricks	30 cm ?			
Description	Irregular block of mudbrick, filling a pit dug in the sand. The shape can be of a approximative round base, or the corner or extremity of a structure. Three layers of fragments of mudbricks seem to form the block, but in a very irregular manner. Re-used blocks. The fondation of some construction ?							

Figure 4: Database of archaeological structures

Number		WH1.surf.3	Type	ALABASTER VASE				
Area	Wadi	UF	Surface	Year	2012	Material	alabaster	
						Dimensions	L: 74.9 MM	
Fragmentary State of conservation Small vase or lid in polished alabaster. Flat bottom, curved wall, square & thick rim. Inner side concave & shallow.						 Drawing		
								
Description Drawing <input type="checkbox"/>								
Summary 13,1749409						Picture		

Figure 5: Database of archaeological artefacts

Number	WH1.surf.1
Pottery Category	24
Shape	Jar
Parallel in the catalogue of the pottery shapes	
Remark	Green coarse jar with chaff temper (parallel to the Hadrami preislamic productions?) - cf. catalogue form Y.048.4

Figure 6: Database of pottery

CNRS Paris IV Paris I EPHE Collège de France UMR 8667	Orient & Méditerranée	YAMAMA - SAMPLES
Number S.206.1 Area G17-H17 Locus 206 date 2012		
Type	OVEN WALL	
Material	Clay (?)	
Dimensions/Weight	376 g.	
Conservation Observation	2 bags of fragments	
Analysed	<input type="radio"/> oui	<input type="radio"/> NON
By		
Dating		
Results		

Figure 7: Database of samples

7/ Topography

By Mathieu Niveleau, surveyor

22

The purpose of the topographical task during this second season was threefold:

- Firstly, to pursue the mapping of the remains that are visible on the ground, within the fenced area.
- Secondly, to draw as precisely as possible the archaeological remains excavated this season.
- Thirdly, to survey the neighbouring area outside of the fenced area so as to identify and to map the remains visible on the ground.

The devices used for the survey of the site were:

- A Total station Leica TCR 407
- A Differential-GPS Trimble R4

A/ The completion of the mapping of visible structures within the protected area

The second week on the field was devoted to completing the map of remains showing on the surface within the fenced area. It has been done with the Total Station, in collaboration with Laetitia Munduteguy, Hervé Monchot or Jérémie Schiettecatte.

The central and south-western part of the site have been mapped. The central area did not yield a dense pattern of visible walls. The relief of this area is uneven, covered by many dunes. The natural ground level is high, compared to the rest of the site. This could explain the apparent lack of structures on the ground. On the opposite, the southern area has only been slightly covered by sand and the walls showing on the surface are numerous. Long walls and square structures are visible.

The map of the remains showing on the ground within the fenced area has been achieved at the beginning of the 3rd week. During that period, our focus was on the southeastern and central-eastern areas. To the southeast, only few outcropping walls were visible, whereas a cluster of honeycomb shaped structures have been seen in the central-eastern part of the site (fig. 8), north of the former track.

To better understand these changes in the density of showing walls, a Digital Elevation Model of the site has been done by registering as much as altitudes as possible over the archaeological area. It allowed to map of the contour lines of the site (fig. 9).

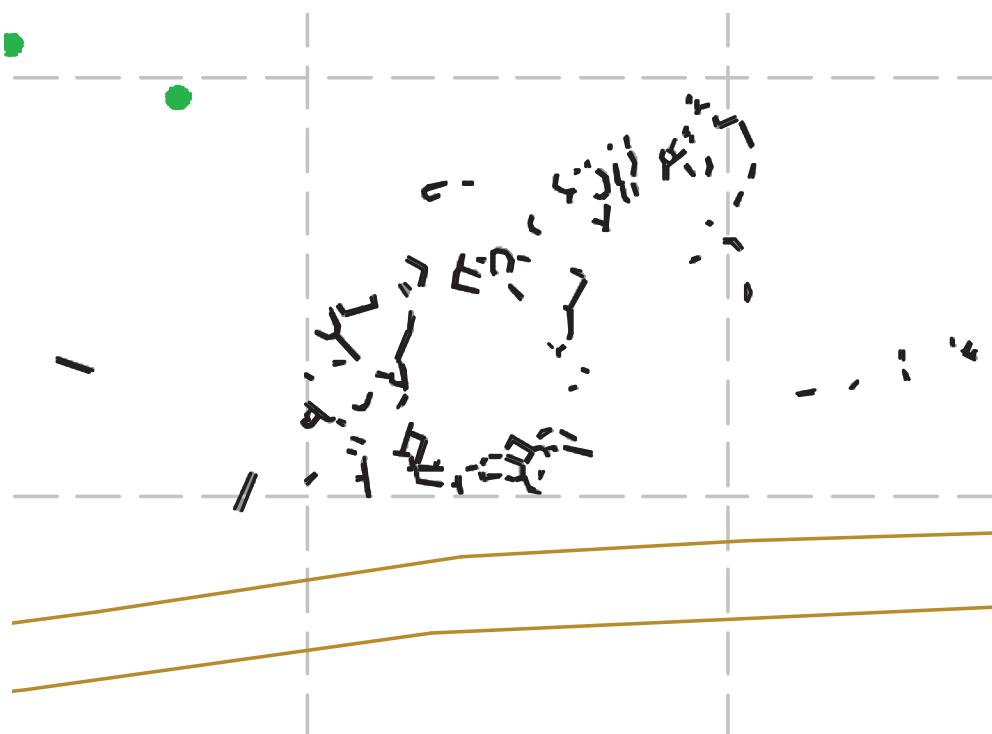


Figure 8: Honeycomb-shaped structures in the central-eastern side of the site
(Mathieu Niveleau - Saudi-French Archaeological Mission in al-Yamāma)

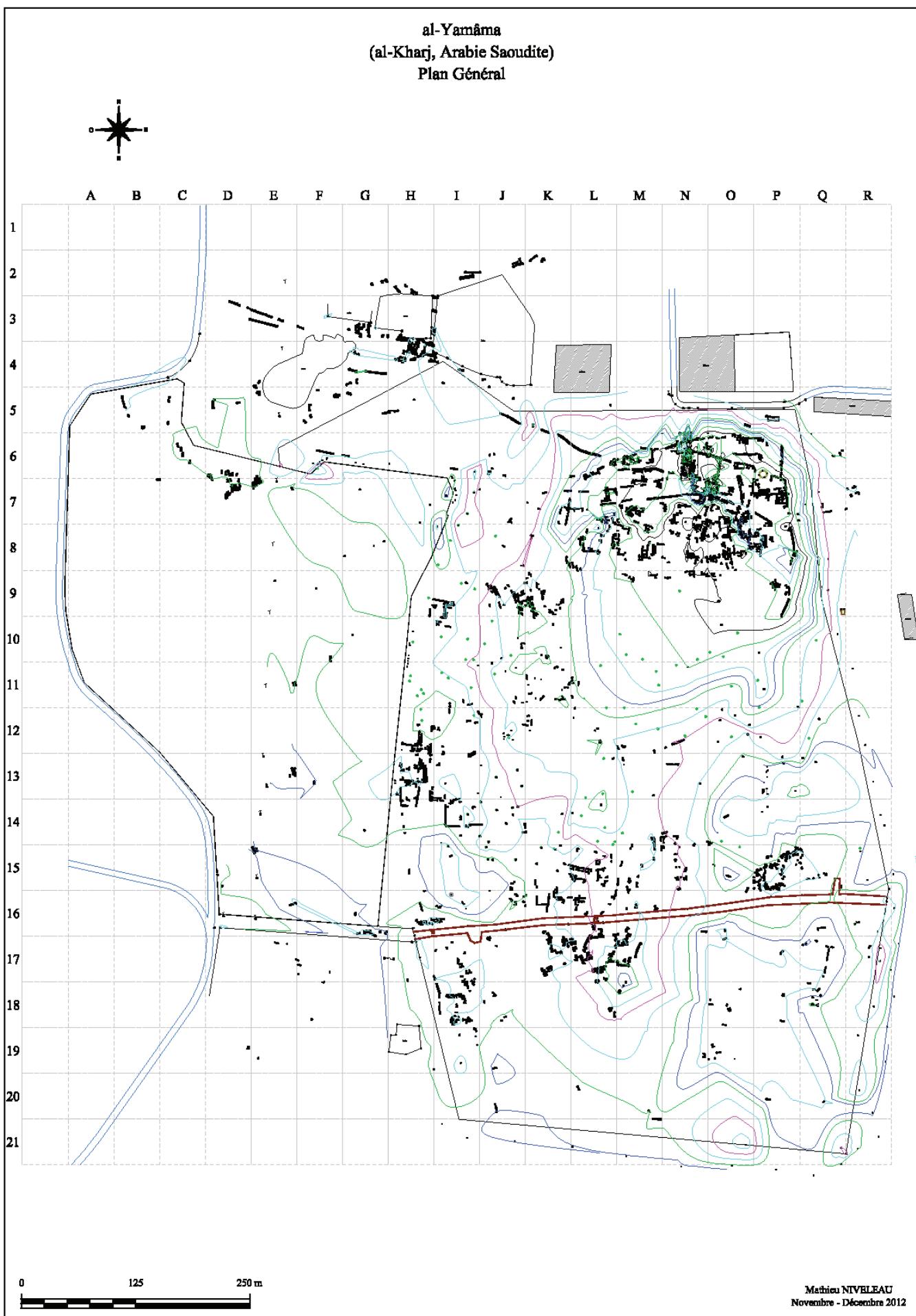


Figure 9: Map of the site with contour lines (Mathieu Niveleau - Saudi-French Archaeological Mission in al-Yamâma)

B/ Mapping the remains outside the fenced area

The mapping of the remains at al-Yamāma has been carried out outside of the fence as well (fig. 10).

24 It has been made possible by the use of a differential GPS, which can be manipulated by one operator alone. The tripod equipped with the base of the D-GPS was set over point S2, within the site. It was then possible to work within a range of 4 to 5 km around that reference point.

The recent structures around the site have been mapped so as to set the site within its context (roads, buildings, enclosures).

West of the site, inside a walled area considered as a cemetery, an important concentration of tombs has been drawn. Tombs are characterized by the presence of a mudbrick at both their extremities. North of this area, a circular structure has been identified. The presence of pebbles nearby made it possible to identify this structure with a well. No apparent wall has been recorded in this "cemetery".

The geomagnetic survey carried out in this area confirmed the absence of major underground structures.

North of the site, the presence of camel enclosures made it difficult to map all the structures outcropping in this area. Nevertheless, walls circumscribing small square rooms or caissons are frequent around the camel enclosures, in the vicinity of the fenced area. It could be seen as the continuity of the archaeological area. In this northeastern area, a long wall oriented east-west is visible over more than 90 m and could be the continuation of a long wall also visible in the protected area.

700 m north of the fenced area, another cluster of apparent walls have been observed and mapped. Nevertheless, no continuity of the settlement has been seen between this small settlement and the main site of al-Yamāma to the south.

Several walls bordering small rooms have been mapped. A larger and more complex structure has also been recorded, circumscribed by several concentric walls.

East of the site, the ground has been badly damaged by modern building activity, still in progress. Identifying ancient structures in this area is therefore difficult. Several spots of melted mudbricks coming from collapsed structures can be seen but only few walls can be distinguished. In a trench dug within the frame of modern building activity, an ancient mudbrick structure is clearly visible. This pit and the walls have been mapped before their destruction.

The southwestern part of the area has been carefully studied since most of the pre-islamic material comes from this location. Nevertheless, recently abandoned palm-groves, traces of which are still visible, have badly damaged the area. Apparent walls are rare.

To finish, no walls have been seen southeast or south of the fenced area. This part has also been badly damaged by recent palm-groves.

C/ Mapping the excavated structures

Within the excavated area, the first task has been to re-set the limits of the working area. A 18-by-30-m rectangle was established around Building 1.

Started last year, the realization of the plan of Building 1 has been resumed (fig. 11). Concerning the walls and columns whose bricks were visible, a drawing was made from zenithal photographs orthorectified through the help of AutoCAD software. This technique was effective for walls W.043 and W.006, buttresses W.034 and W.035, niches, the western access of Building 1, as well as the columns unearthed this season. The accuracy of such a map is inferior to 1 to 2 cm.

The general map of Building 1 was also accompanied with the positionning of the peculiarities of its floor (traces of former columns, game boards incised on the floor, pits).

al-Yamâma
 (al-Kharj, Arabie Saoudite)
 Plan Général

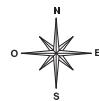


Figure 10: General map of the site (Mathieu Niveleau - Saudi-French Archaeological Mission in al-Yamâma)

al-Yamâma
(al-Kharj, Arabie Saoudite)

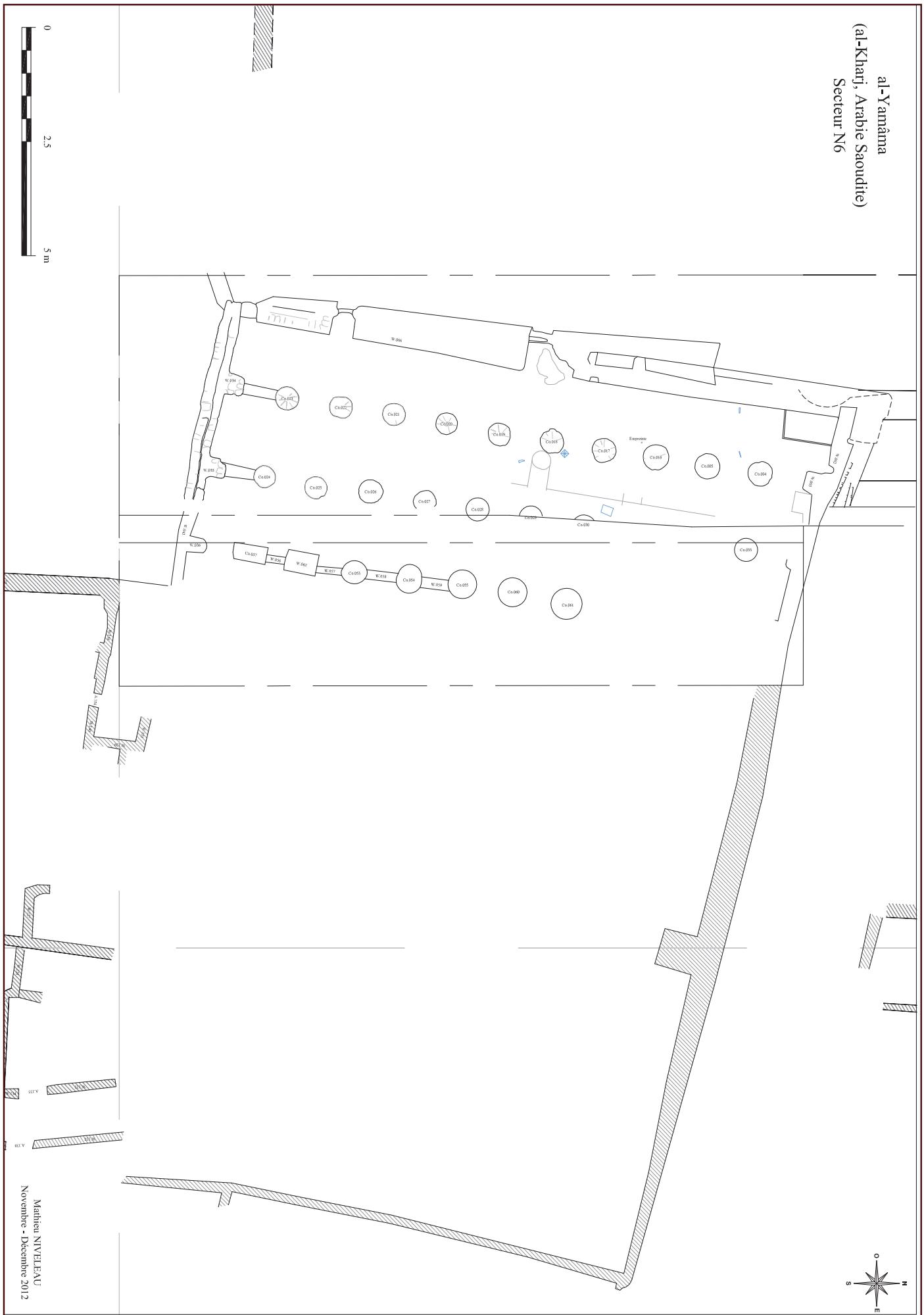


Figure 11: Plan of Building 1, «the mosque» (Mathieu Niveleau - Saudi-French Archaeological Mission in al-Yamāma)

8/ Geomagnetic survey

By Bruno Gavazzi

Université de Strasbourg, Ecole et observatoire des sciences de la terre, Institut de Physique du Globe de Strasbourg (UDS-CNRS UMR 7516), Equipe Dynamique de la lithosphère et des bassins océaniques.

A/ Method

Objectives of the geomagnetic measurements

The cartography takes place as a part of the French/Saudi Arabian archaeological project directed by Jérémie Schiettecatte on the site of al-Yamāma. The aim of the study is to reveal the human-made structures buried in the ground.

Devices

Two devices were used on the site: the “backpack” and the “sledge”. Both work on the same principle. The difference lies in the speed and precision of the measurements.

The Backpack (fig. 12) is built as follows:

- Four fluxgate magnetometers from Bartington are fixed 50 cm apart from each other on an aluminium stick. Thus the magnetic field can be measured simultaneously at a distance of 25 and 75 cm in both directions from the centre of the stick. The cadence of measurement is 30 per second, with a precision of 1nT. This combination is attached on a backpack in such a way that the stick stands in front of the operator, 1 meter above the ground.
- A GPS antenna Trimble 5800 is fixed at the top of the backpack. The position is measured every second.
- An electronic digitizer is attached on the backpack; it acquires the magnetic and GPS data and stores them on a SD card. It also has a controller to start and stop the measurements as well as to record points of importance (such as obstacles, metallic wastes, etc.).
- The digitizer is linked to a mini-PC, itself linked to a head mounted display (HMD). With such a configuration the data can be seen in real time through the HMD goggles. A controller allows the operator to interact directly with the PC without removing the backpack.

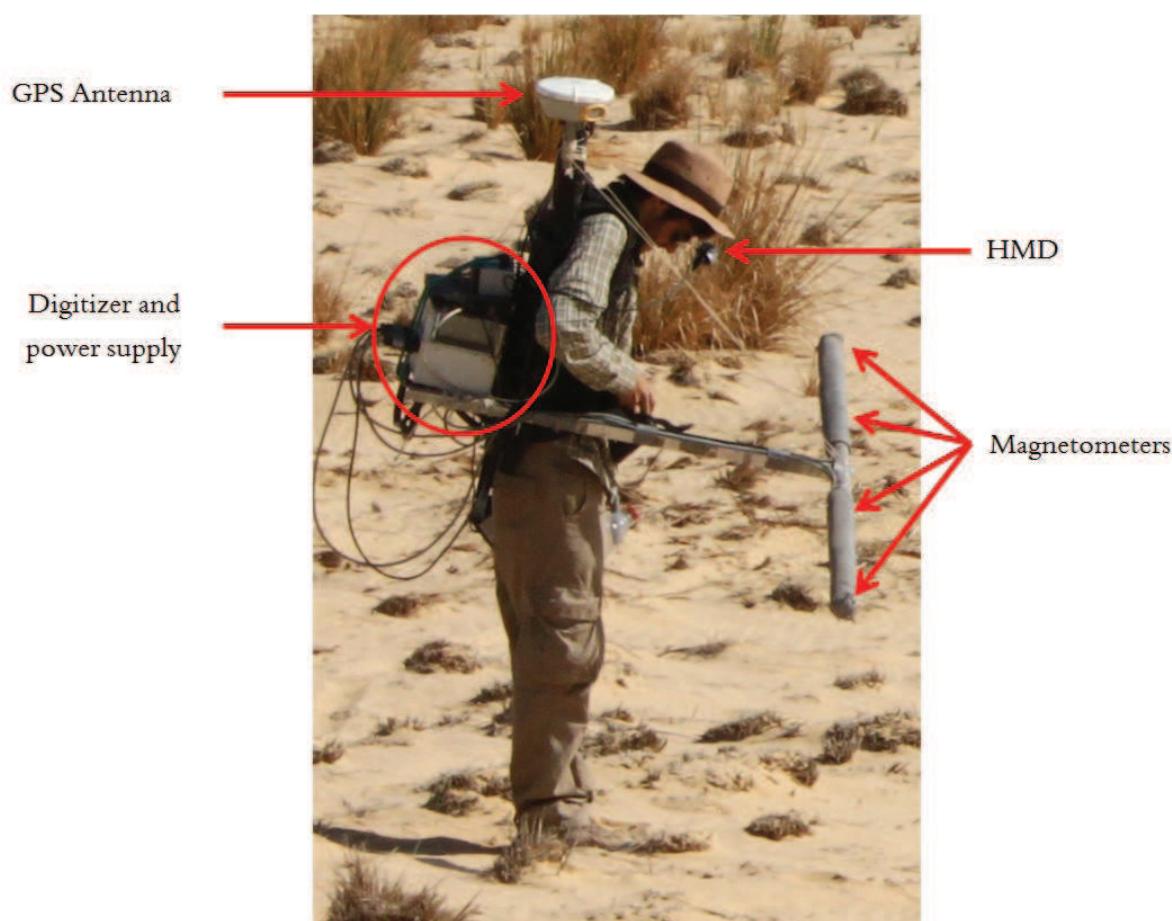


Figure 12: The «Backpack» device

The Sledge (fig. 13) uses most of the Backpack components with the following differences:

- The magnetometers are fixed at the front part of a sledge, a few centimetres from the ground, with a spacing of 10 cm.
- The GPS is attached at the back, 90 cm away from the captors.
- The digitizer is fixed in the middle.
- We don't use the mini-PC nor the HMD goggles.

In both cases the device is powered by a 12V, 7Ah lead sealed battery placed within or on top of the digitizer.

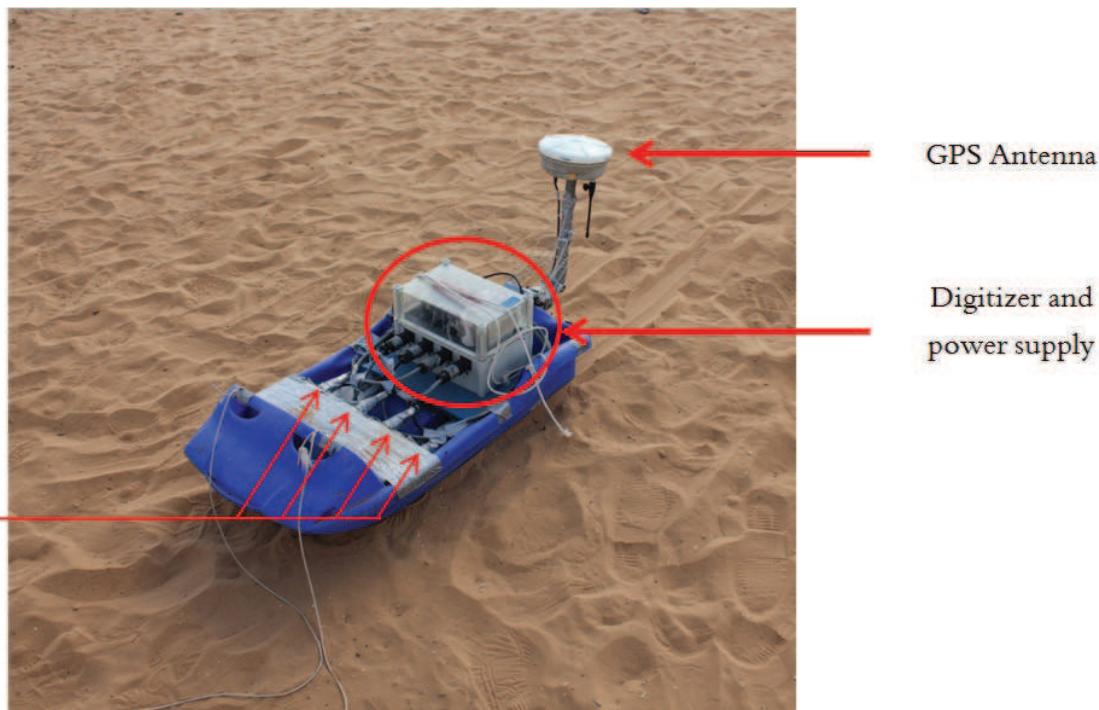


Figure 13: The «Sledge» device

Method of measurement

Once the Backpack is built and on the back of the operator, we proceed as follows:

- Calibration: the captors are calibrated above a set point in order to correct the differences of offset, sensibility and angle for each captor. The same calibration point is kept for the entire season.
- Static point: in order to correct the temporal variation (triggered mainly by the effects of temperature changes on the captors), the field is measured above an identical point before and after each session of measurements (the “mapping”).
- Mapping: the operator follows parallel profiles set every 2 meters with the mini-PC and shown on the HMD. The start and end of each profile, as well as obstacles are recorded using the remote. Thus, with respect to the spacing of the captors, he obtains magnetic profiles every 50 cm.
- In order to calculate the anomalies, measurements are made along transversal profiles perpendicular to the previous ones.
- At the end of the process the static point is measured once again and the captors re-calibrated.

The Sledge requires 2 operators. The steps are the same as with the Backpack. The device is carefully dragged on the floor by the first operator while the second one is responsible for marking the beginning and the end of each profile and push down the device if needed (to avoid it to fall in the slopes for example).

Data processing

After extraction, the data are processed using applimag, a software developed by the E.O.S.T in a matlab environment. The different steps can be summarized as follows:

1. First the data are calibrated: the differences of measurement between the magnetometers for the same magnetic field are reduced. They are due to the fact that each captor is not perfectly identical to the others.
2. Then the time-related variations are removed, using the differences between the starting and ending static points, by considering a linear variation.

3. After that, data is checked and any incoherent result (due to obstacles, someone approaching too close to the operator, important vibrations of the device, etc.) is removed.

4. The following step is to calculate the anomalies, i.e. the differences between the regional field and the measured one. They are calculated using the average at the intersecting points with the transversal profiles.

5. To display the data a grid of anomalies is calculated with a step of 0.25 m (0.05 m with the Sledge) and a sharp smooth (0.1).

6. Often, differences of intensity between captors or profiles are visible, mostly due to the imprecisions of localization and calibration. An elegant solution to reduce this effect is to recalculate the anomalies using a soft-grid.

Further treatments are then to be done in the laboratory.

B/ Results

During the two weeks of measurements, over 85 kilometres have been covered with the Backpack. It corresponds to 110 000 magnetic measurements over an area of about 170 000 m². Three zones were covered (fig. 14):

- 1- The southeastern part of the site within the fence;
- 2- A test in the necropolis out of the western wall;
- 3- A test in the southwest of the site, close to a camel field, where some fossilized agricultural patterns are still visible on the surface.

A fourth zone of 1875 m² was covered with the Sledge. It represents 18416 magnetic measurements (fig. 15).

In the following figures the scale is in metres, the colour-bar in nT.

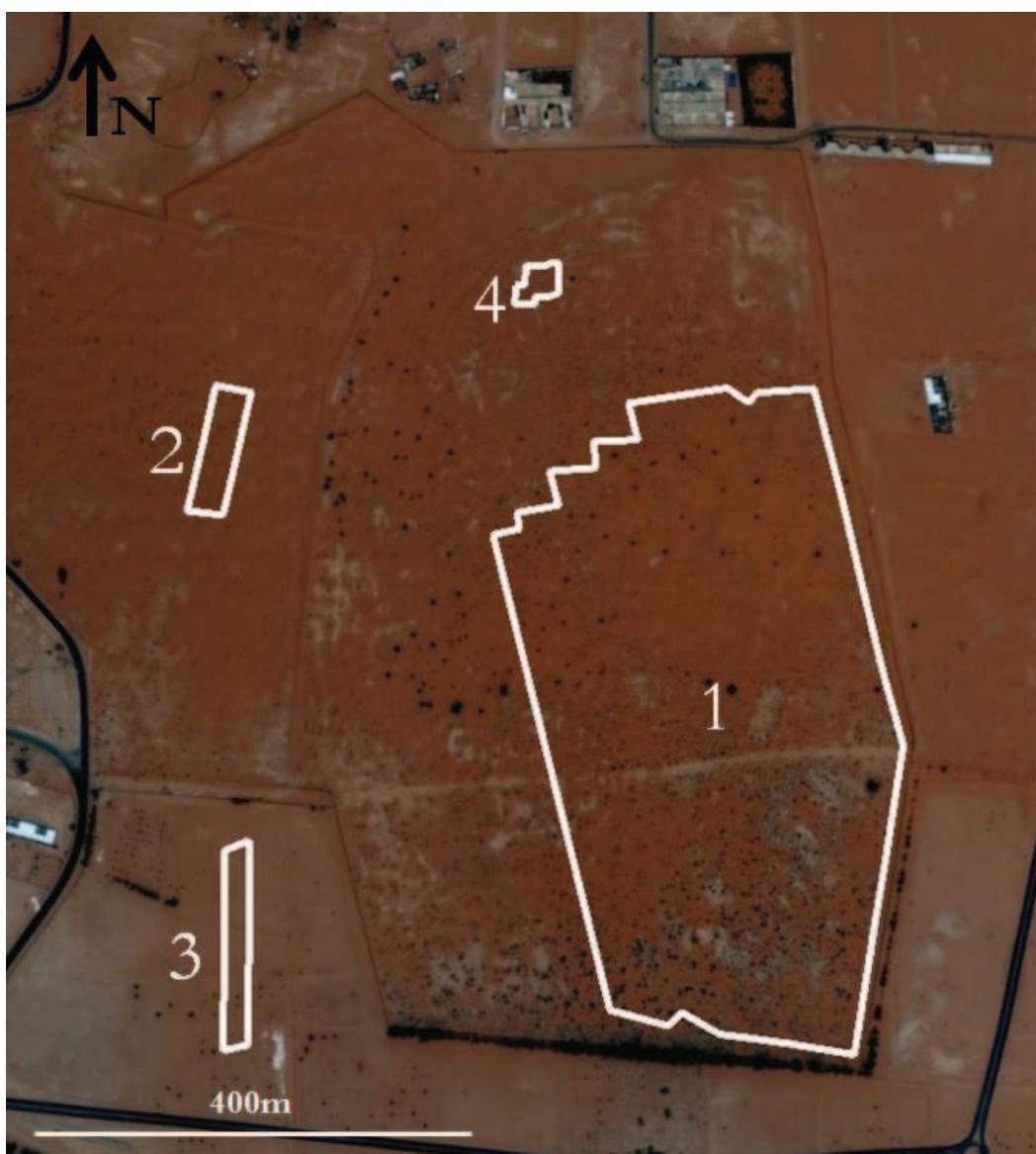


Figure 14: The four investigated zones on a satellite image from Google-earth

Backpack

Zone 1

Even if the data will need some post treatments, some features are already visible: human made structures are characterised by high frequency anomalies, i.e. a strong contrast within a short distance. The lineaments pointed by black arrows are good examples: They are most probably linked to walls. Meanwhile, the low frequency anomalies (i.e. the large

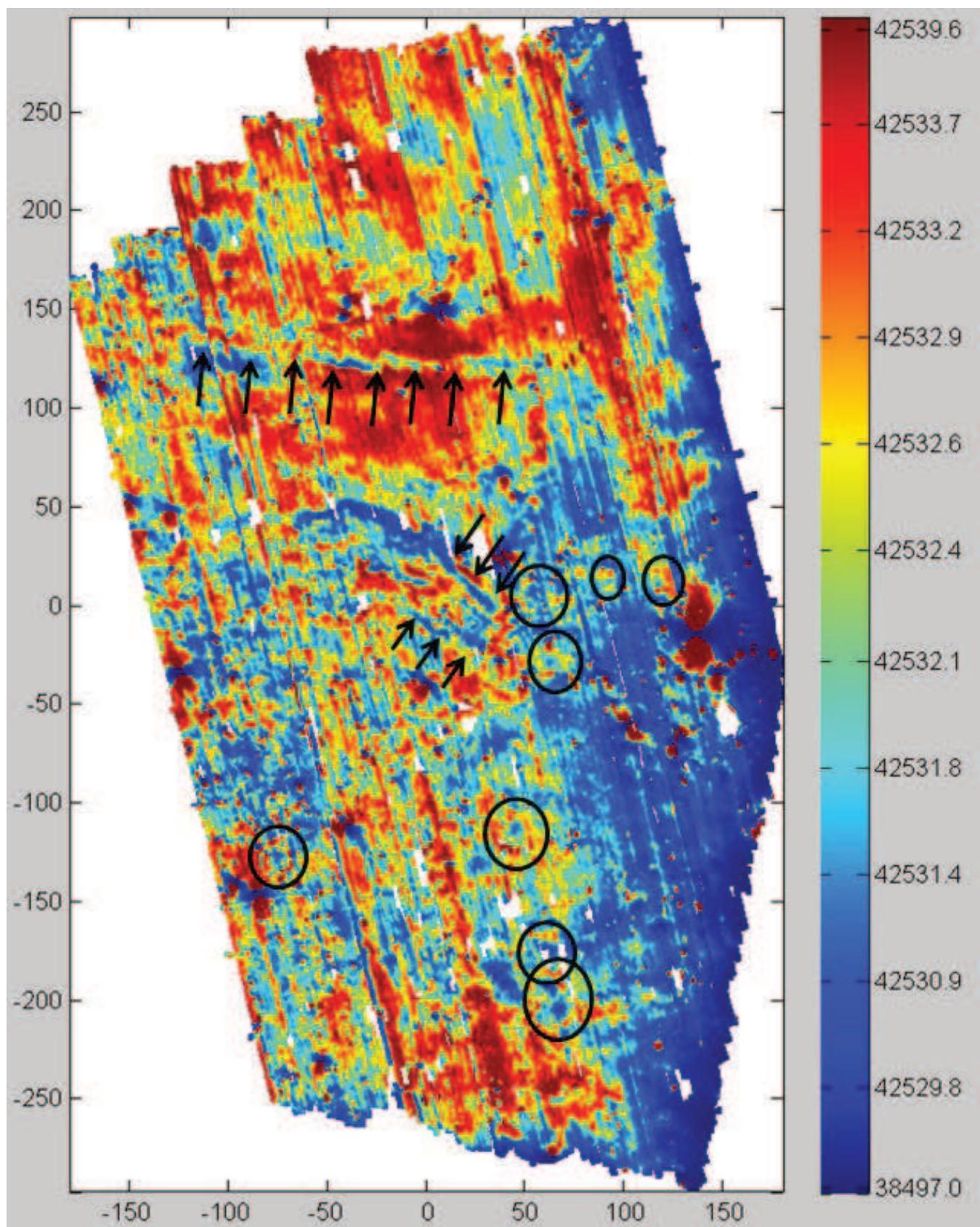


Figure 15: Map of the magnetic anomalies, zone 1

uniformly coloured sheets) are very likely due to the geological features of the site.

Another important pattern for anthropogenic structures are geometrical shapes. In the studied zone different square/rectangle forms can be identified, the black circles show the most obvious ones.

Combining the map with the results of the previous year (Figure 16) shows the continuity of some structures. The arrows point the most evident ones.

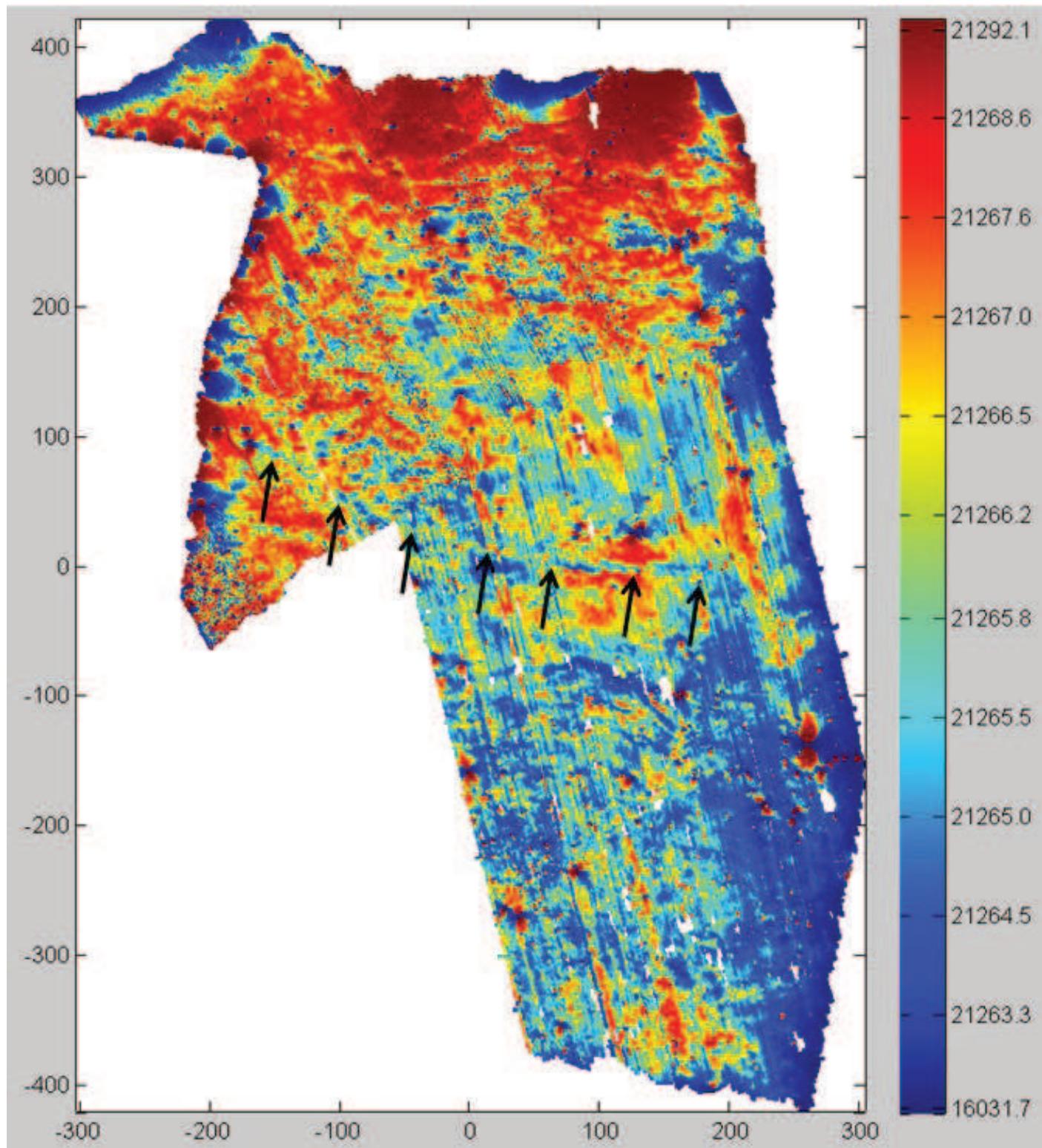


Figure 16: Combination of the 2011 and 2012 data for the zone within the fence

Zone 2

On the second zone (fig. 17) one can observe low frequency anomalies. Those are likely linked to geological variation, but the geometrical shape in the south (circled) deserve further analyses before reaching a conclusion. The lineament pointed by the arrows might also be human-related. According to these facts, it is clear that the area is worth further investigations.

Zone 3

On the third zone (fig. 18) the only noticeable element is an E-W lineament showing an anomaly of more than 1000nT. This can be linked easily to a metal waterpipe: its opening is visible a few hundreds of metres to the east. From an archaeological point of view the lack of other structures would indicate that further measurements do not seem relevant.

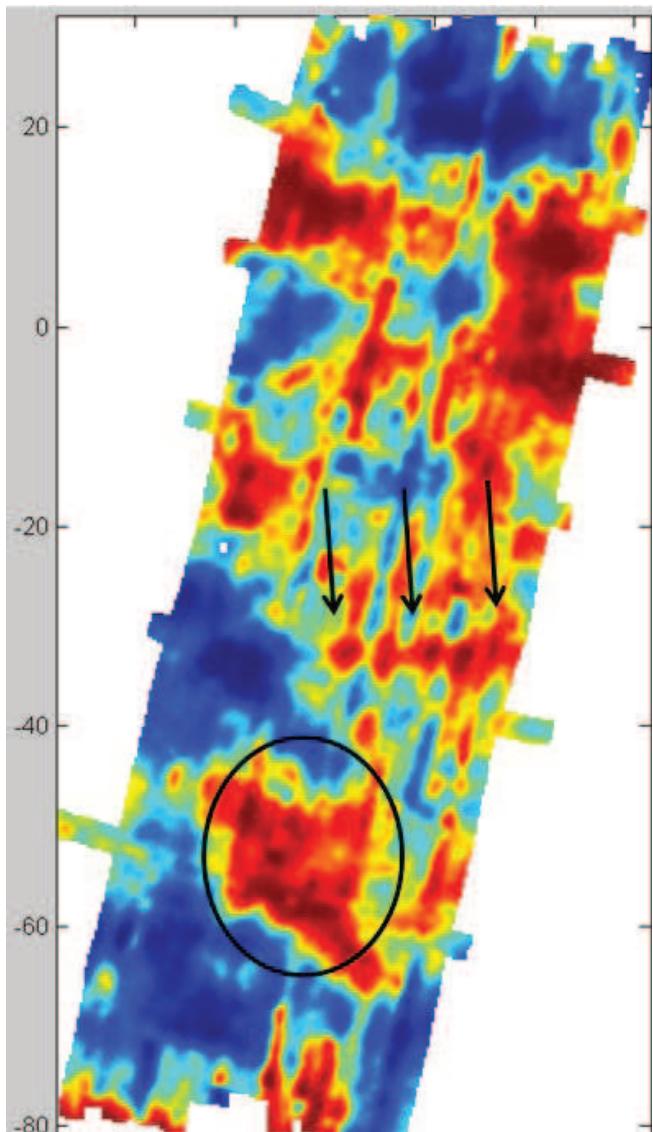


Figure 17: Map of the magnetic anomalies, zone 2

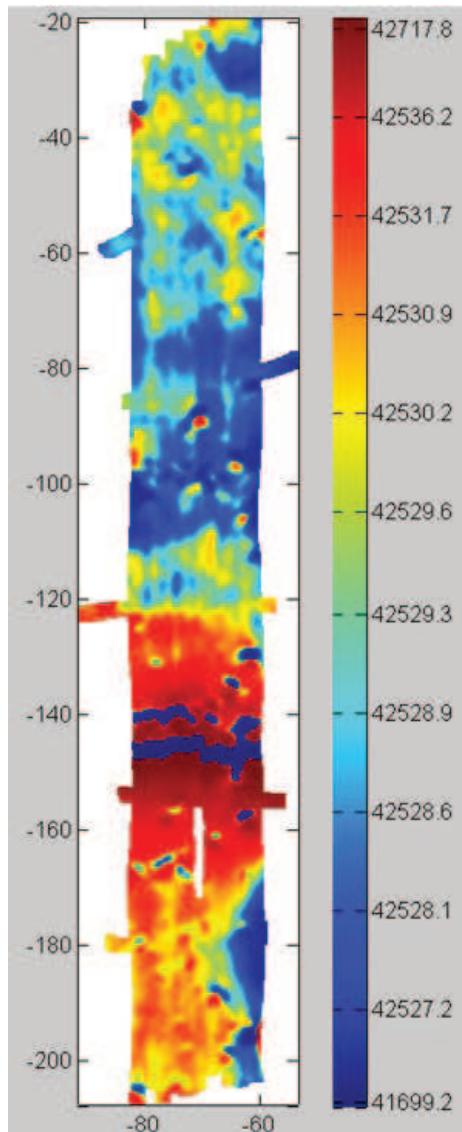


Figure 18: Map of the magnetic anomalies, zone 3

Sledge

The measurements with the Sledge (fig. 19) were carried above a zone where a strong concentration of misfired ceramics (usually found close to ovens) is visible on the surface. Moreover, the magnetic mapping of the previous year revealed a strong anomaly which could be interpreted as the trace of the burning place of an oven (fig. 20).

Despite a bad calibration on the southwestern part of zone 4 (fig. 19), different structures can be seen. The lineaments are most likely due to walls (arrows). In fact, parts of them are still present on the surface (fig. 20). The anomalies reveal their continuity within the ground. The centre of the strong anomaly in the southwest could be the place of a pottery oven (circle).

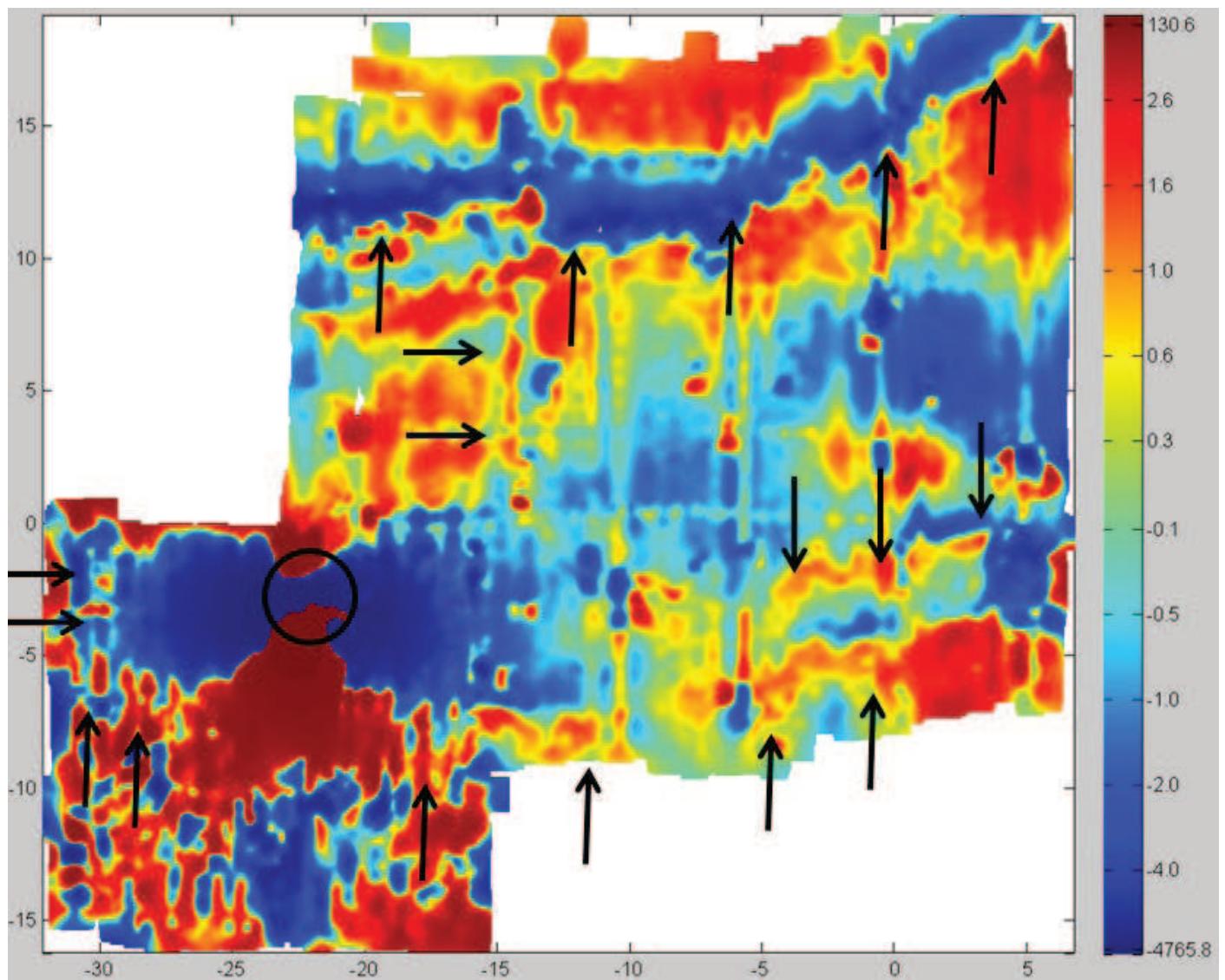


Figure 19: Map of the anomalies, zone 4

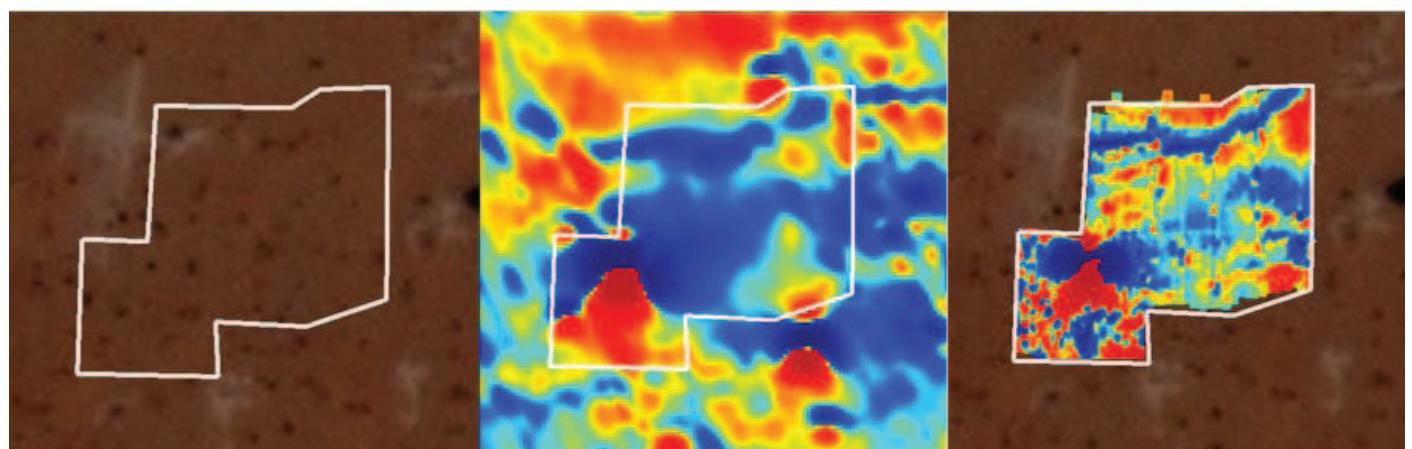


Figure 20: Zone 4, satellite image on the left, Backpack mapping in the middle and Sledge mapping on the right

9/ Archaeological exploration of the site of al-Yamāma

Building 1: the mosque (Area N6)

By Jérémie Schiettecatte & Pierre Siméon

From November 19 to December 13, we concentrated our efforts on the excavation of Building 1, located in the north of the site, in area N6. It proved to be a mosque.

In 2011, south of Sounding 1, the northwest corner of a columned hall (R 013 of Building 1) had been excavated. In that area, we had uncovered two large mudbrick walls bordering a room with a plastered floor and two huge mudbrick columns standing over this floor. This season, it has been decided to extend the excavation of this building.

Extent of the working area

To enlarge the excavated area to the whole Building 1, the southern limit of Sounding 1 has been pushed 25 metres back southwards, so that it comes to the southern edge of Area N6.

It has been enlarged by 5 metres to the west and 7 metres to the east. A bench, oriented north-south, has been spared through the building, so as to keep a stratigraphic record of the filling of the building.

The excavated area was then 30 x 18 meters – that is to say ca. 540 sq m. (fig. 21).

Cleaning the summit of the walls around Building 1

Beyond the excavated area, many structures were partly visible on the ground and it was crucial to determine the way Building 1 was tied to these surrounding buildings. Therefore, in areas N6, N7, O6 and O7, the summits of the walls have been cleaned so as to plan the immediate vicinity of the mosque. More than 50 walls have been registered and described in this area (fig. 21).



Figure 21: Plan of Building 1 and location of the working area (in white) [Plan: Mathieu Niveleau - Saudi-French archaeological mission in al-Yamāma]

Plan of Building 1

Building 1 is a monumental mudbrick structure comprising a large columned hall (R.013), 28 m in length (N-S) and 12 m in width (W-E). The room is bordered by 3 thick mudbrick walls (W.002 to the north, W.006 to the west and W.043 to the south). To the east, it is bordered by a row of two pillars and eight columns, opening onto a courtyard east of the building, ca. 27 x 25 m (fig. 21-22). The courtyard is circumscribed by mudbrick walls to the north and east. To the south, the picture is still unclear. Late occupation (such as Building 2, dated to the 17th-18th centuries) makes the plan confused.

R.013 is divided in 3 naves, oriented north-south, each being bordered by a row of 10 columns to the east (or 8 columns and 2 pillars for the eastern nave). Three buttresses are aligned with these rows of columns on wall W.002 to the north and on W.043 to the south.

Two small walls have been erected between buttress W.034 and column Co.023, and between buttress W.035 and column Co.024. These walls are not tied with the neighbouring structures but are abutting them. They did not reach the same height as the columns do and appear as a late addition. Their basis has not been reached yet. These two walls are dividing space into compartments in the southern part of R.013.

Between most of the pillars and columns of the eastern row, small mudbrick walls are closing the space between them. They are abutting the columns and pillars and have been built in a late phase of occupation of the building. It is all the more probable that they are founded at a higher altitude than the columns/pillars are.

The western wall W.006 comprises a large rectangular niche in its central part, turned toward the west. This niche has been partly disturbed by a pit dug after the building abandonment for mudbrick recycling. The western side of this niche has been disturbed in a secondary occupation of the building. It first opened onto the outside westwards, and later on closed again by a thin mudbrick wall (W.044).

In the southern half of W.006, the wall comprises a second niche (N.050), rounded in shape, and cut off from the outside by a thin mudbrick wall (W.049).

South of W.006, in the southwestern corner of R.013, a passageway leading toward the outside, to the west, is visible. It has been closed by a small mudbrick structure.

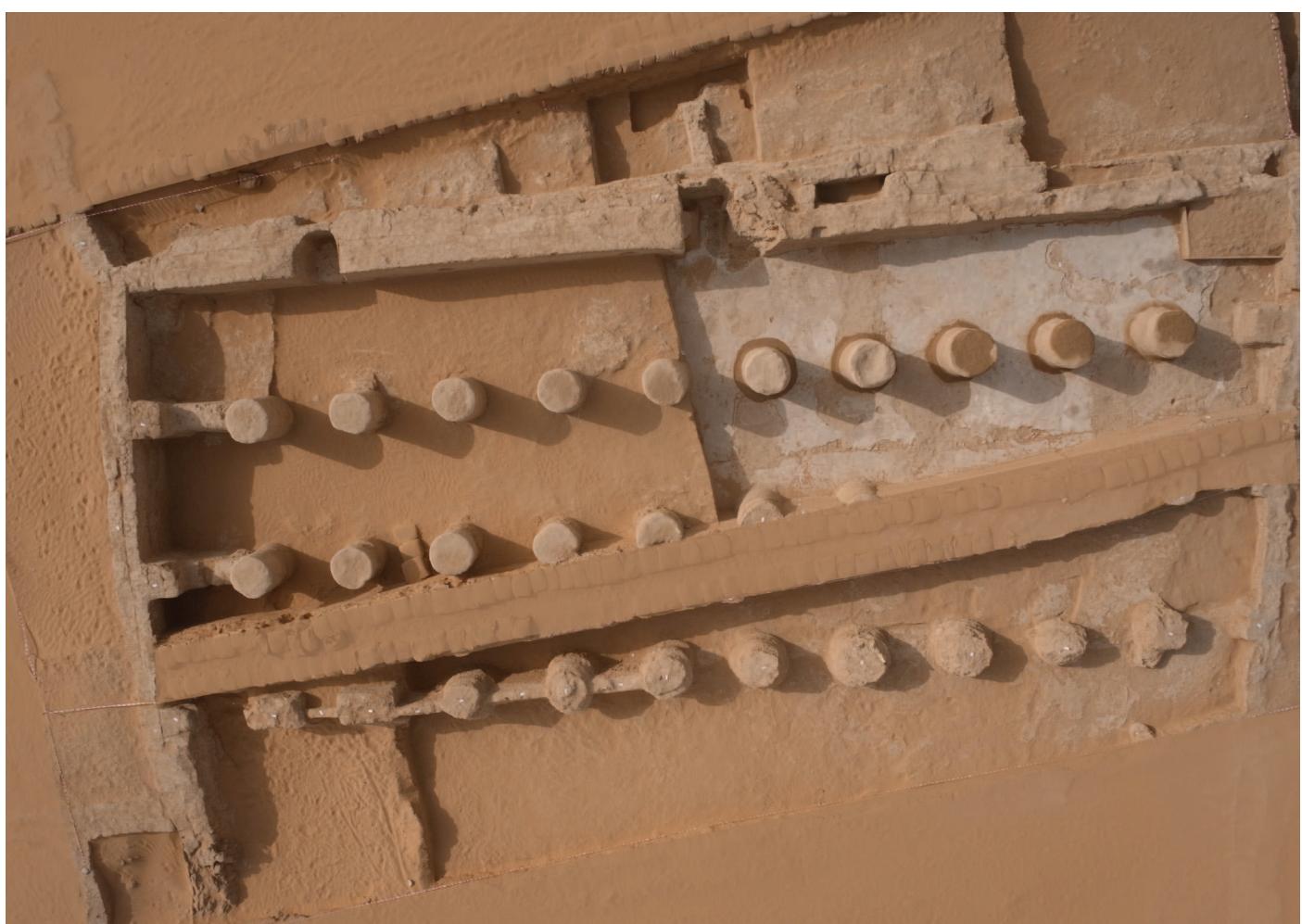


Figure 22: Aerial view of the columned hall (R.013) of Building 1 [Photo: Thomas Sagory Saudi-French archaeological mission in al-Yamāma]

Stratigraphy of Building 1

Several phases have been highlighted during the excavation of Building 1 (fig. 23):

The late collapse mixed with sand deposits and surface erosion (UF 022): at the top of the mound, we removed a layer of hardened sand with fragments of mudbricks alternating with layers of melted mudbrick. In close proximity to the central niche, some fragments of collapsed mudbrick were covered with mud coating and a thin white plaster.

This layer yielded very little pottery. Among it, a fragment of cup with an chocolate glaze outside cover (Y.022.4) comparable to sherd Y.102.3, a Chinese import found in 2011 in the occupation layer of Building 2 and dated to the late 17th-early 18th centuries. The discovery of glass bangles and rifle bullets in this layer are also indicative of a late dating.

A late recycling of building material (UF 025): Within the central niche of W.006, a large pit (P.040) has been dug through W. 006 and through the several occupation layers mentioned hereunder (floors F.039, F.046, F.014 and F. 015). This pit has badly damaged this area. It is filled with loose yellow sand (30-40 cm) topped by sand and mudbrick fragments, some of these being slightly burnt. This pit is a result of mudbrick recycling. Numerous imprints of a large tool (spade) on the northern side of the pit and at the bottom are visible.

An accumulation of aeolian sand above the 5th occupation level (UF 023 – UF 036 – UF 040): this thick layer of aeolian sand deposit has been removed under a layer of collapsed mudbrick. Floor F 039 was uncovered: a hardened ground made of grey sand with chaff imprints only partially preserved into the central niche of W.006 and in its vicinity. Immediately to the northeast of the niche, a small earthen step (5 cm high) is covered by a thin layer of plaster. This floor is abutting W. 044, at the rear of the niche and W.049, at the rear of N.050, the southern niche in W.006. This floor F.039 testifies of the latest occupation of Building 1, at a time both niches were closed by a thin and rough wall.

The 4th occupation level (UF 026 – UF 037 – UF 042 – UF 043): After having removed a dense sandy layer, a hardened floor made of grey sand (F 046) was uncovered. This floor is abutting several thin and rough walls built either to the rear of the western niches (in the middle of W.006 and N.050) or between the columns and pillars of the eastern row. All these walls are founded directly on the sand, at an higher altitude than the walls/columns/pillars against which they are abutted. This period might have been a late reoccupation of the building following a period of abandonment and aeolian accumulation.

The discovery in the southern part of the building of an ottoman pipe lead us to date this occupation to the 17th century onwards.

The 3rd occupation level (UF 026): this level has only been excavated in the northwestern quarter of Building 1. Under a thick layer of sand, a thin layer of hardened grey sand has been cleared (F.014). Over this level, foot imprints were visible near column Co.017. Palm-leaf mattress imprints have already been seen during the first season in the northwestern part of the columned hall (R.013). This floor was recovered by a layer of sand above which the small wall closing the central niche of W.006 to the west was founded. Therefore, this floor corresponds to a period during which the so-called “niche” was opened onto the west and onto the outside. It was used as a gate. The same is possible for niche W.050.

The 2nd occupation level (UF 030): this level has only been excavated in the northwestern quarter of Building 1. After the removing of a ca 20-cm-thick layer of dense orange sand under F 014, we uncovered floor F 015, a hard floor made of plaster. This floor corresponds to a major phase of restoration of the building during which a new plaster floor was poured and during which the mudbrick columns were erected over this floor. At that time, both niches N.050 and that in the middle of W.006 were closed to the west.

Over F.015, several imprints or engravings of game boards are visible in the plaster.

The 1st occupation level (UF 030): a careful study of F.015, at the base of stratigraphic unit UF 030, has yielded some evidence of a more ancient occupation. Traces of former buttresses and columns are visible on the ground; they have been levelled during the restoration phase of the so-called “2nd occupation level”. They testify of a former building already having a columned hall.

Previous occupation levels?

The excavation is still in progress and former occupation levels are to be expected beneath the layers investigated so far. Their study will be one of our aims during next field season.

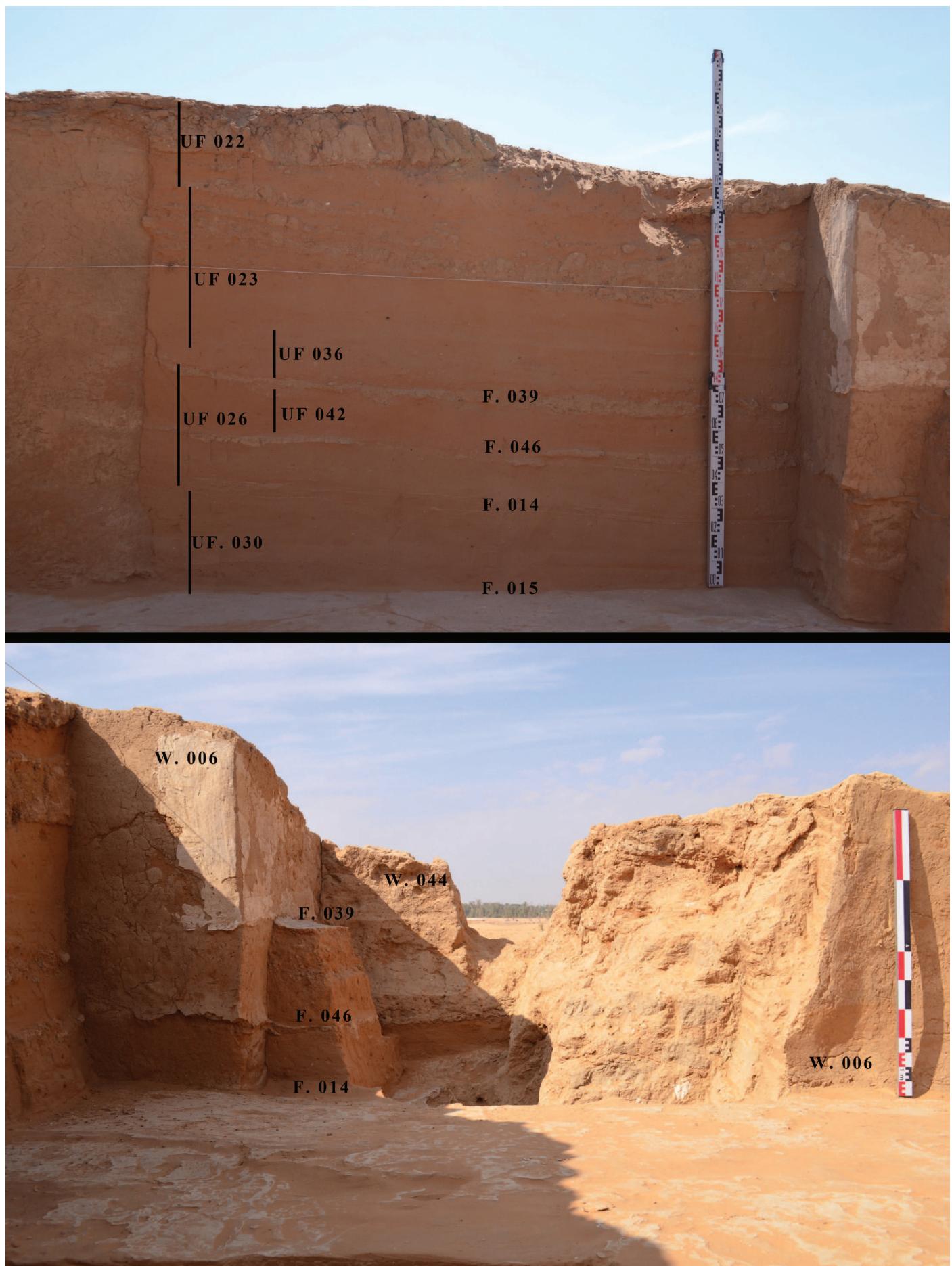


Figure 23: Building 1: section of the filling of the columned hall (R.013) (top) and superimposition of the floors in the central niche of W.006 (bottom).

Architectural description of Building 1

The walls are all built in rectangular mudbricks (ca. 36 x 20 x 12 cm), laid in horizontal courses. They vary in thickness. The northern wall W.002 and the northern part of the western wall W.006 have been damaged and repaired at least once. W.002 shows the trace of a collapse and repair with stone blocks and mudbricks. W.006 has been rebuilt in its northern part by building a thin wall over a larger base (vestige of the former wall).

The columns are all built in triangular mudbricks. They are laid directly over the plaster floor F.015. Their heavy weight occasionally caused the floor to crack. They are preserved over a height of 1.1 (Co.004) to 2.4 metres (Co.023). The columns of the central row have all been repaired at mid-height by a filling of stone and mud. This restoration dates back to one of the late reoccupations of Building 1 (4th or 5th occupation). The columns of the eastern row are badly preserved. They have been badly restored at several stages of the occupation of the building and the erosion gives them a mushroom profile.

The floors are usually simply made of hardened sand, be that by pouring water on the ground or by the repeated comings and goings. The floors are usually much more visible in the western nave. Only F.015 has been carefully built, by using a gypsum plaster over a preparation layer made up with gravels and plaster.

Architectural decors are rare. Only three small triangular niches have been found in W.006 (fig. 24). Some part of wall W.006 were covered with a white plaster.

The way the columned hall R.013 was roofed is still unclear. Only few blocks of mud with imprints of palm-leaves have been found, possibly being the remain of a mud coating recovering small branches laid over palm trunks. All this is hypothetical.

The surroundings of Building 1

To the south, the west and the north of Building 1, a thick layer of sand deposit has been removed so as to reveal the facing of the outer walls. Under this sand layer, the collapse of the western and northern wall of the building has been uncovered and removed. Several circulation levels have been cleared outside the building. Material sampled in these layers proved to be a mix of sherds from different periods (9th century white Abbasid glazed pottery together with white-and-blue porcelain). They are of no help in dating the building. They only provide a terminus ante quem to the erection of Building 1 (9th cent. AD).



Figure 24: Building 1: Western row of columns in R.013 and wall W.006 with its decorative niches.

The function of Building 1

During the 1st and 2nd occupation levels, Building 1 was without doubt a mosque. This interpretation is supported by:

- the presence of a rectangular building comprising a square courtyard and a large columned hall;
- the absence of material inside the building at that time;
- the presence of two niches in its western wall, turned toward the Kaaba. These are mihrābs and W.006 is the qibla wall.

During the 3rd occupation phase, the building probably lost its cultic function since mihrabs were opened onto the outside.

The building possibly recovered its religious function during the 4th and 5th occupation levels, if we consider the closing of both the niches by small walls.

Sounding 1 (Area N6)

By Michel Mouton

In order to explore the early layers of the hill, a deep sounding was carried out at the northern extremity of the trench, in the continuity of 2011 season's work.

The area was first extended to the west, reaching 7.50 m from east to west, and 9 m from north to south.

Benches were left against the excavation walls to avoid the breaking of the sandy sediment, which reduced progressively the excavated area (fig. 25-26).

The work was stopped at a depth of 6 m under the base of Wall W001 for security reasons. The deepest layers (UF 061) were reached in a small sounding 1m square.

The virgin soil, probably a fluvial Holocene terrace of the wadi flooding at the south of the archaeological area, was not found. The base of the sounding is at 421.30 m in absolute height, approximately at the same level than the archaeological deposits unearthed in the trench opened in the south-western farm.

The lowest excavated layer is a deposit of aeolian sand containing no material. The presence of earlier layers of occupation cannot be discarded.

A thin level of ash and earth in loose sand indicates an occupation, but not the presence of any construction (UF 061; altitude 421.70 m).

A 70-cm-thick accumulation of aeolian sand separates this deepest level from a second occupational deposit, much thicker, also directly lying on the loose sand (UF 059; altitude 422.85 / 422.40 m). A line of thin lime particles were visible at the base of the level, together with patches of mixed ash. In the 40 cm of deposit forming this layer, two fireplaces were found, concentrations of ash and charcoal which have been sampled. Nodules of clay and a few fragments of mudbricks attest the presence of some dwelling constructions nearby. Pottery sherds and faunal remains were collected.

Again, this second occupation level is covered by a thick layer of aeolian sand containing very few material: almost no pottery sherds and some badly preserved faunal remains.

A layer of mixed sand containing mudbrick fragments densely accumulated to the south seals this sand accumulation (UF 057; altitude 423.40 / 423.90 m at the base). It corresponds to the destruction of some structure probably lying southeast of the trench according to the density and thickness of the layer there (almost 85 cm) and its sloping northwards. It was the richest deposit, in terms of archaeological material, as it contained numerous faunal remains and pottery sherds, together with a few fragments of chlorite containers and glass vessels.

A sand level mixed with a few mudbricks separated this level from a heavy destruction layer sloping towards the northwest (UF 055; altitude 424.56 / 424.62 m at the base). This destruction layer includes part of a mudbrick wall fallen in the slope created by the accumulation of remains; four rows of mudbricks were visible on their side. Again, according to the slope and the density of the destruction layer, the construction must have been erected at short distance south of the southeastern corner of the trench.

Sand accumulates above this destruction layer, alternating with at least two thin layers of mud particles mixed with faunal remains (UF 051 - 053).

The occupational sequence explored in the sounding can be divided in two phases, on the base of the stratigraphical data, the structure of the remains and the characteristics of the pottery assemblage.

In stratigraphy, the upper layers UF 051-057 are separated from the lower ones UF 059-061 by a thick aeolian sand deposit, almost empty of material, representing a period of abandonment of the area.

The upper layers are the result of the erosion and destruction of nearby constructions, with a significant accumulation of mudbricks and the progressive formation of an anthropic hill. The lower layers are sloping very slightly, and represent successive occupations in the sand dune, at a distance of some constructions, which must not have been very dense in the site considering the very few remains of plaster and mudbricks collected.

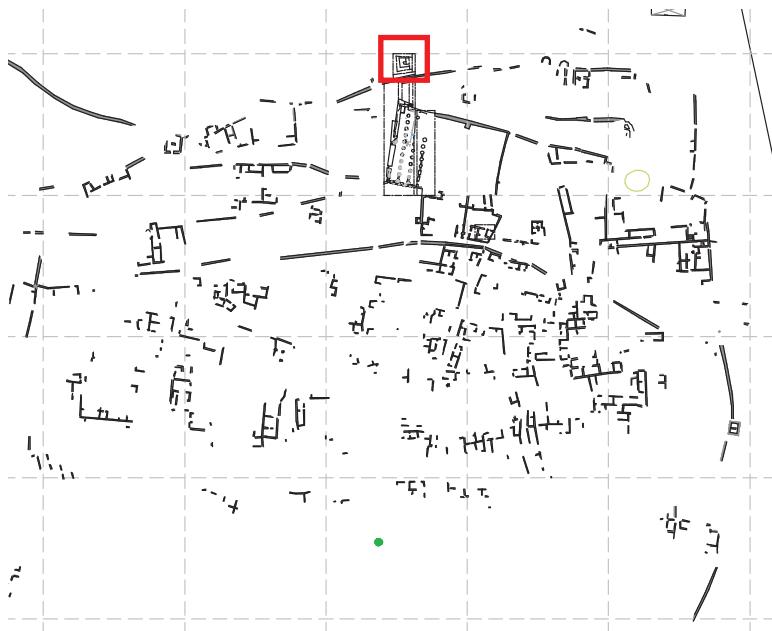


Figure 25: Location of Sounding 1

42



Figure 26 : Aerial picture of Sounding 1 (Thomas Sagory - Saudi-French Archaeological Mission in al-Yamāma)

Finally, in the upper layers, the pottery assemblage includes a large number of productions, well represented in all the late occupation of the site, where they have been found associated with diagnostic material belonging to the Islamic periods. The absence of very significant pieces does not allow any chronology to be produced; a regional common pottery sequence with precise chronological diagnostic markers is still to be defined as a reference frame. The two lower sandy occupation levels under the thick layer of aeolian sand UF 058, at the bottom of the sounding, contain a different assemblage. The collected sherds indicate a much more homogeneous assemblage, composed mainly of two or three fabrics, with a strong presence of Black and Red chaff tempered ware. The absence of greenish and yellowish wares characteristic of the Islamic industries must be underlined. The finding of carinated dishes of well levigated clinky buff fabric, together with a narrow neck of a very small green glazed flask, could indicate a pre-Islamic date for this early phase of occupation.

The counting of the pottery sherds found in this stratigraphical sounding allow some first remarks on the evolution of the assemblage. A total of 416 sherds were collected, and distributed into the 42 different fabrics described on the base of the material gathered since the beginning of the project. A few categories present a significant evolution, forming two groups of fabrics:

- fabrics 1a, 1b and 35 as the common, coarse and fine categories of a probable unique industry of yellow to greenish ware, the finest vessels been covered with a whitish buff slip;
- fabrics 15, Black and Red chaff tempered ware, and 32, Fine Cream clinky ware.

Their evolution across the stratigraphy of the northern trench can be fractioned in three levels, subdividing the upper phase in two levels:

- UF050 to UF055 :	fabrics 1a, 1b and 35 = 33%	fabrics 15 and 32 = 3,7%
- UF056 to UF057 :	fabrics 1a, 1b and 35 = 50,5%	fabrics 15 and 32 = 1,8%
- UF059 to UF061 :	fabrics 1a, 1b and 35 = 8,8%	fabrics 15 and 32 = 67,7%

The group of 1a, 1b and 35 fabrics appears to be more represented in the upper phase, and mostly at the beginning of it. If the layers of the upper phase correspond to the Islamic period of occupation, as a first hypothesis, this industry could be a marker of that period.

Fabrics 32 and 15 appear to be more represented in the lower layers, and mostly fabric 15, quasi-absent from the upper layers.

The Layla ware is poorly represented: only 8 fragments distributed in the layers of the upper phase (1,8% and 0,8% of the ceramics), none in the lower phase. It does not seem to be an industry diagnostic of the earliest occupations of the site.

Faunal remains were abundant, mainly in destruction level UF 057. Goat, cow and gazelles were identified; the sieving of the sediments revealed small pieces corresponding to some lizard, dog and bird species. The dog vertebra showed cutting marks.

Sounding 3 (Area G17)

By Michel Mouton

During the general survey of the site carried out since the 2011 season, pottery was collected in some places outside the fenced archaeological area. One of the most interesting areas identified is an ancient farm bordering the southwestern side of the site, against the corner of the walled cemetery. The abundant pottery material on the ground includes significant criss-cross painted bowls which are not to be found elsewhere on the site (a fragment found in a farm to the southeast of the archaeological area) and Layla ware.

As the land was cultivated in recent past, and for that purpose partially leveled, a sounding was needed to check if the archaeological deposits related to the material were still preserved, allowing future exploration (fig. 27).

A trench 10 m long and 1 m large was excavated 20 m from the northern fence of the farm (fig. 28), with the kind authorization of the owner of the land.

The archaeological remains were found just a few centimetres under the surface. The sediment near the surface was densely compacted, and cemented by heavy salinity due to long term irrigation in modern times. For a matter of time, the deposits were only partially explored and the stratigraphical potentiality could not be evaluated. Nevertheless, the results are of great interest and justify the protection by the authorities of that piece of land left out of the archaeological area.

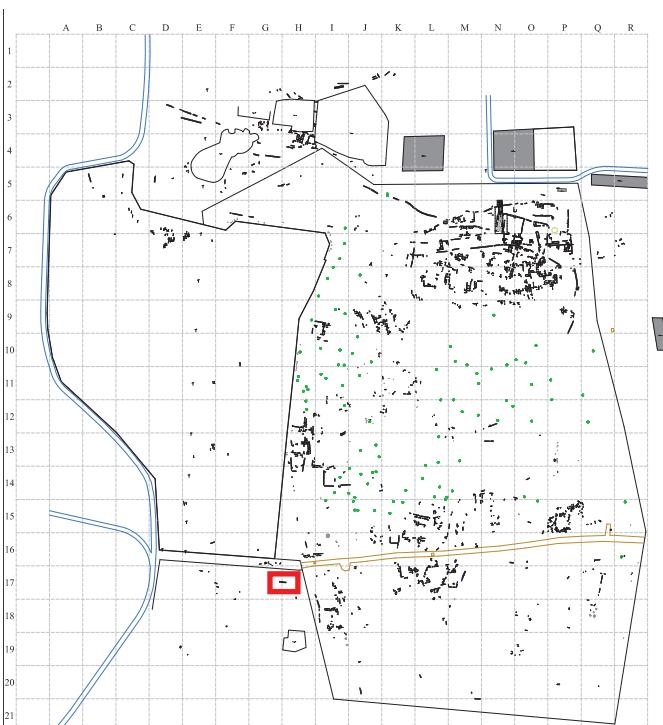


Figure 27: Location of Sounding 3



Figure 28: Aerial view of Sounding 3 (Thomas Sagory - Saudi-French Archaeological Mission in al-Yamāma)

In the western part of the trench, the remains of two kilns were found. Their function still cannot be clearly determined, but it could be related to potter activities. To the east, some badly preserved walls and undisturbed deposits were partially uncovered.

The western kiln R.068 is the largest (fig. 29). Its chamber is trapezoidal in plan, 138 cm large, lined by a 4-5 cm thick plaster, built against a massive mud layer filling a pit previously dug into an anthropic rubble deposit. The plaster lining the chamber is heavily burnt, together with the mud (reddish) on the backside of it, almost 8 cm deep.

The chamber was filled in the upper part by loose sand, and down progressively with small irregular blocks of mud (fragments of the vault?) forming a compact layer cemented by the salinity. Under this filling, a floor made of smooth yellow clay, nearly 10 cm thick, separates the upper chamber from the combustion chamber underneath. This was revealed by a pit in the floor which opens onto the empty space of the lower chamber, partially filled by loose sand progressively infiltrated after abandonment of the structure. The excavation was stopped before reaching the base of the lower chamber.

To the east, a second kiln, R.069, was excavated into the same anthropic sediment, a dense rubble deposit made of earth and fragments of mudbricks (?), and containing faunal remains, charcoal and pottery sherds. Smaller in size, and extending mostly out of the exploration trench, only a narrow strip of its southern extremity was reached.

The chamber was lined by a 4-5 cm thick plaster, heavily burnt, as the mud layer on the back side of it, deeply reddish. Inside, it was filled by a very compacted layer of mud and plaster fragments, containing many pottery sherds, of different fabrics, including an almost complete shape of a bowl. Along the eastern side of the inner chamber, a clay floor was preserved.

To the west, the limit is not clear, as the plaster is not preserved, but the deeply burnt sediment lines the structure.

The rubble sediment in which the kilns were installed contains to the west of R.068 numerous pottery sherds including many greenish wares and a few sherds showing irregular coloration of the clay, possibly belonging to misfired vessels. If, as it appears from the first observation of the stratigraphy in this very narrow exploratory trench, this sediment predates the construction of the kilns, the overfired pottery fragments it contains could indicate a long term tradition of potter activities in the area.



Figure 29: Sounding 3 : Kiln (R 068) - toward south

To the east of the kilns, room R.070 is bordered by walls W.072 to the north, W.073 to the east and W.074 to the west. To the west and the east, the limits of the inside walls appear, due to the difference of sediment. The two faces of north-south wall W.074 were clearly lined but no faces of plaster or bricks were found. The parallel wall to the east, W.073, has an internal regular face, but was it a wall or just the face of a pit excavated in anthropic deposits? In fact, its west face was clearly seen, lined by the difference of sediment of the so-called wall W.073 and the ashy filling of the room R.070, but no face was found to the east, nor any limit in the ground. To the north, W.072 was well lined near the corner but to the east its limit seems to correspond to a pit, the layer at the base forming a concavity.

The room was filled by a 40 cm thick layer of compacted ash layers, some very thin, some others including many char-coals. With the ash were mixed large animal bones, although these were not burnt: this space has been filled with rubble from different origins, but mainly ash from heavy fire. Two fireplaces were lying on the rubble, against W.073 related with heavy burning traces on the wall, and at the southwestern corner. To the west, a layer of white plaster forms a circular area, coming up against walls W.072 and W.074.

The area to the west of R.070 has not been clearly delimited. It corresponds to a space between the western face of the so-called W.073 and a limit oriented NW-SE observed in the mud at the eastern extremity of the trench. But none of these limits were confirmed as no faces of walls could be found. The filling of the area is of hard dense sediment comparable to mudbrick, mixed with some white gypsum irregular blocks and very few material. It has been excavated to a depth of 40 cm.

The ceramics collected in the southwestern farm sounding are numerous (fig. 30): a total of 948 sherds, more than the

double of the material found in the northern trench, for ten times less volume of sediments. This pottery assemblage appears to be very homogeneous, as fabrics are concerned. If we refer to the same groups than in the northern trench: fabrics 1a, 1b and 35 = 68,7% fabrics 15 and 32 = 1,2%

The remains unearthed in the southwestern farm are related to the middle stratigraphical level of northern trench. The diagnostic group of the earliest occupation is poorly represented. And the relatively strong presence of Layla ware (5%) confirms a late date for these contexts.

But these chronological indications are to be confirmed by a larger sampling of ceramics and the discovery of some diagnostic material.



Figure 30: Pottery sherds from Sounding 3 (top left: Y.206.1, category 1a; bottom left: Y.202.10, category 24; right: Y.202.1, category 1a)

10/ Ceramic typology

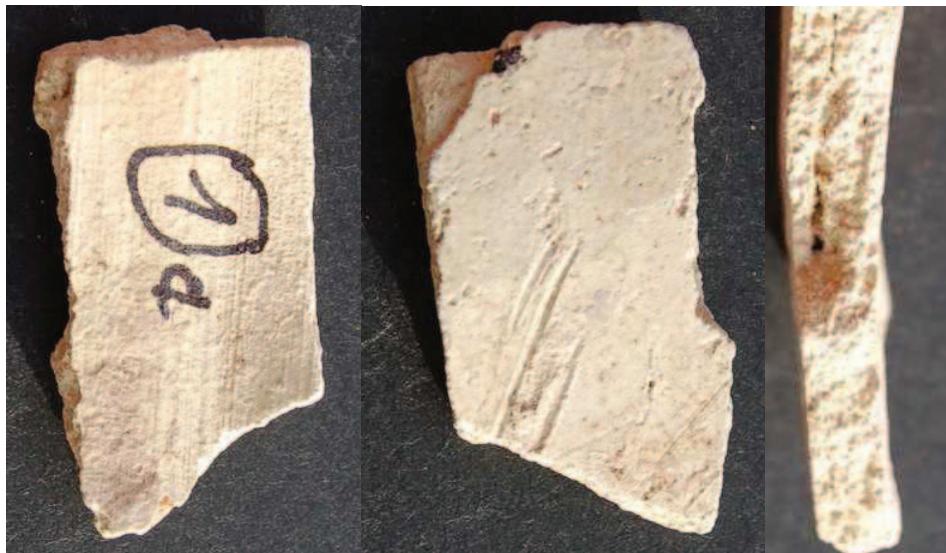
By Michel Mouton & Pierre Siméon

A preliminary pottery typology was established on the base of the fabrics during the first season (2011). This year, this typology has been partly amended and largely completed on the basis of the numerous sherds uncovered in both Soundings 1 & 3, and the excavation of Building 1 ("Mosque"). This new typology is displayed here below.

1a Common Greenish ware

Medium greenish ware; medium to thick wall; fine to medium black or red grits, some with few chaff temper ; some with yellow exploded grits. Possible tournassage.

Incised decoration: horizontal lines, wavy lines, hatched patterns



1b Coarse Greenish ware

Medium greenish ware; medium to thick wall; medium to large black or red grits, some with few chaff temper ; some with yellow exploded grits. Possible tournassage.
Incised decoration: horizontal lines, wavy lines, hatched patterns



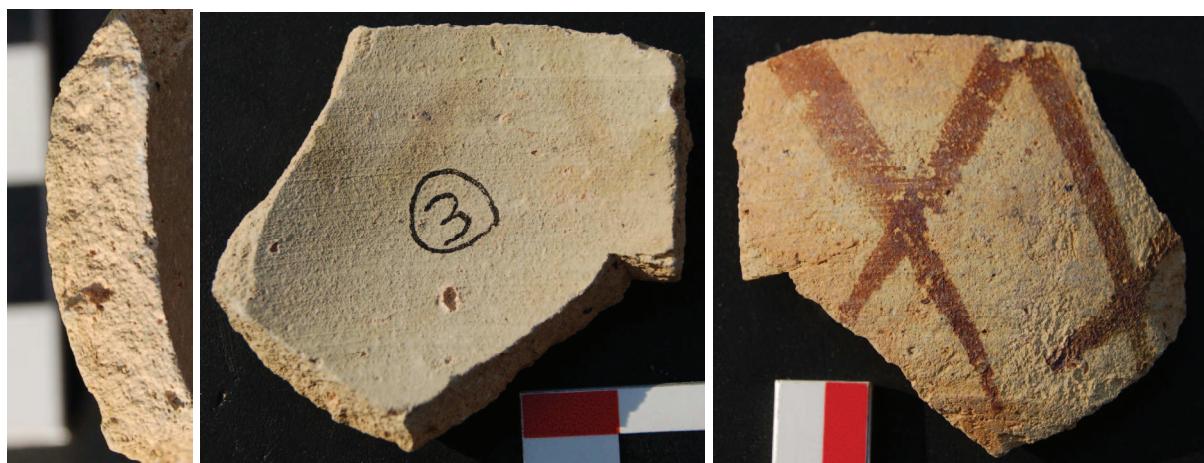
2 Coarse Reddish Buff ware Whitish slip

Well fired buff to reddish ware; medium to thick wall; few medium black (red) grits;
Plane or whitish to greenish surfaces; rare slip (black)
Incised decoration, and combed decoration: horizontal lines, wavy lines, hatched patterns
The common ware of this industry is the fabric 35.



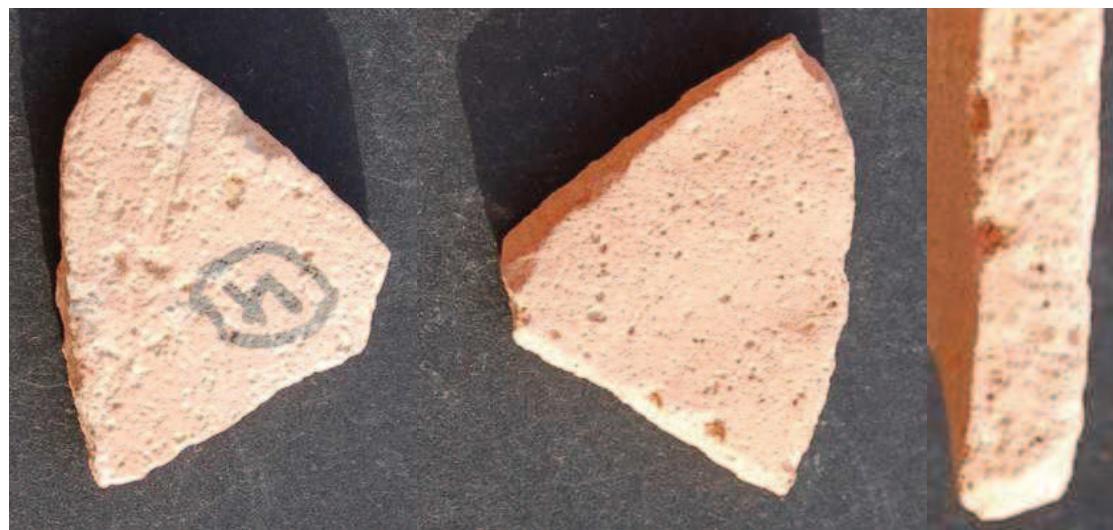
3 Common Painted ware

Well fired buff to reddish ware; medium to thin wall; few medium black (red) grits;
Whitish to greenish surfaces
Painted decoration in red to brown: criss-cross pattern (ca. Rumeilah)



4 Common Orange-Red ware

Well fired orange-red to buff ware; medium to thin wall; few thin black & red grits and thin sandy temper. Plane surfaces; the same ware with whitish slip = 35; same ware with red brown black slip = 36



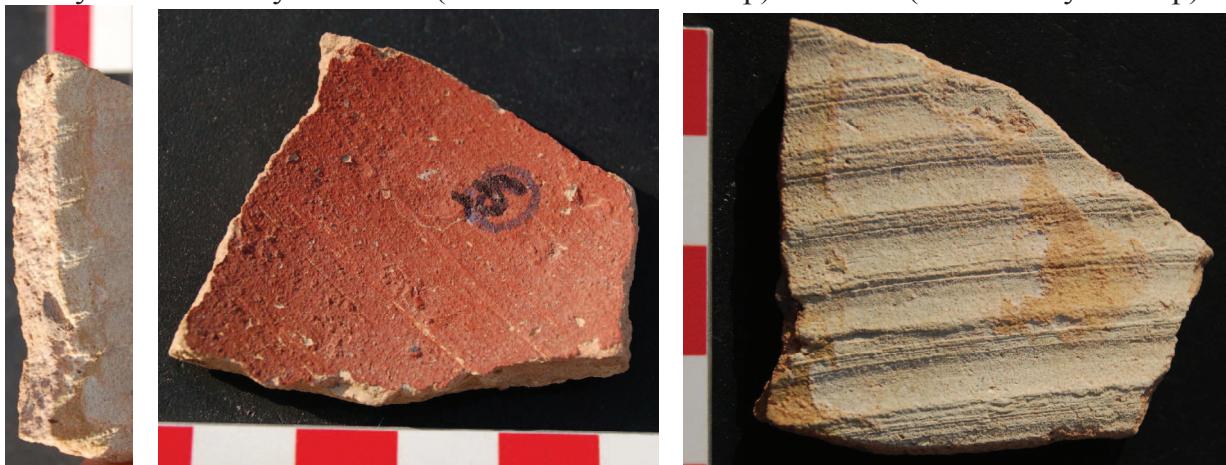
5 Fine Whitish surface with Red Slipped ware

Reddish ware (some with grey core); medium to thin wall; few medium black (red) grits; not clinky, medium fired

Partially red slipped on a whitish external surface

Grooved wall; horizontal incisions

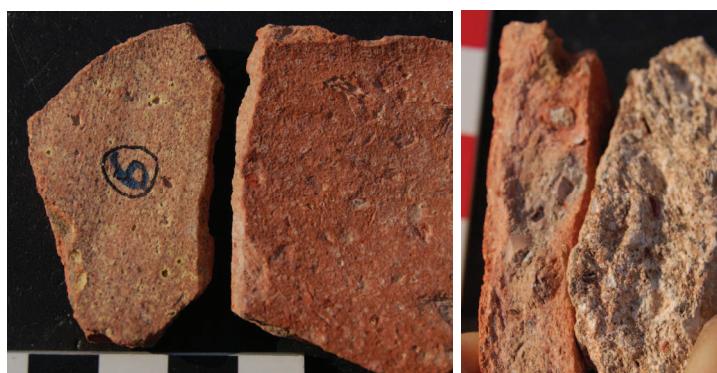
Possibly same industry than = 13 (thicker and bicolor slip) and = 35 (without any red slip)





6 Red ware with abundant white inclusions

Well fired red ware; thin to thick wall; some with grey core; few medium black or red grits and very thin white inclusions very densely distributed; the thicker vessels have white lime medium grits on the surface; very abundant yellow exploded grits on the surfaces
 External surface plane or with whitish wash.
 Plane or external whitish surface.



7 Sandy Red ware

Well fired dense red to light brown ware; medium thick wall; thin black sandy temper very abundant.

Yellow buff to light brown surfaces

Close to Sandy Red coarse ware = 8



8 Sandy Red coarse ware

Well fired dense red ware; medium to thick wall; black and white sandy temper very abundant, thin and medium; yellow white inclusions and exploded grits
 Yellowish to whitish external surface (or plane);
 Rare incised decoration: lines and patterns filled with points
 Close to Sandy Red ware = 7



9 Layla ware

Very well fired clinky grey black ware, some with reddish core; medium wall, rarely thick; scratchy surfaces, some with deep purple stains
 Combed and incised decoration in a large diversity of patterns
 Same industry = 10



10 Layla ware overfired

Very well fired clinky grey black ware, some with reddish core; medium wall, rarely thick; surfaces glossy or roughly vitrified, deep purple stains.
 Same industry = 9



11 Red Brown ware

Medium to well fired brown, red or buff ware; slightly smoothy, not clinky; medium to thick wall; small red grits and few very thin whitish inclusions

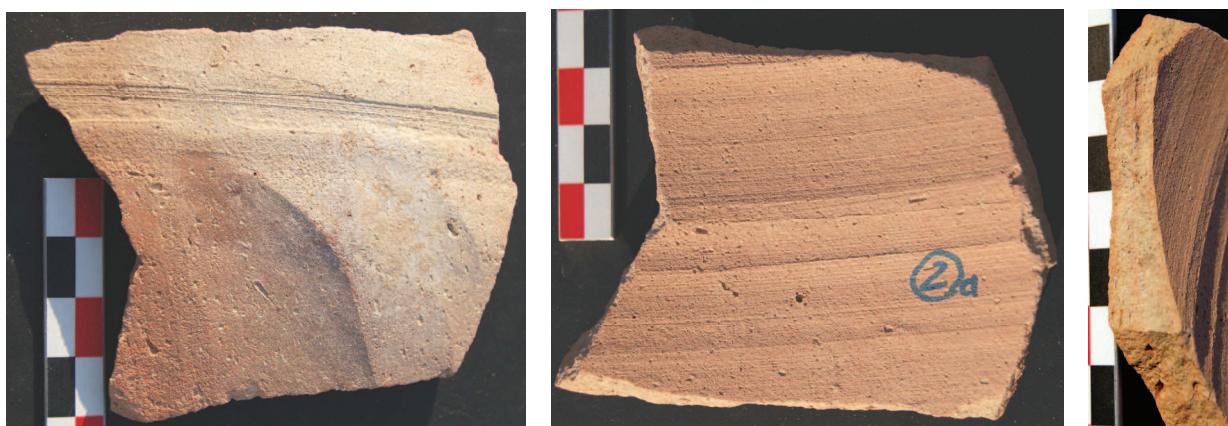
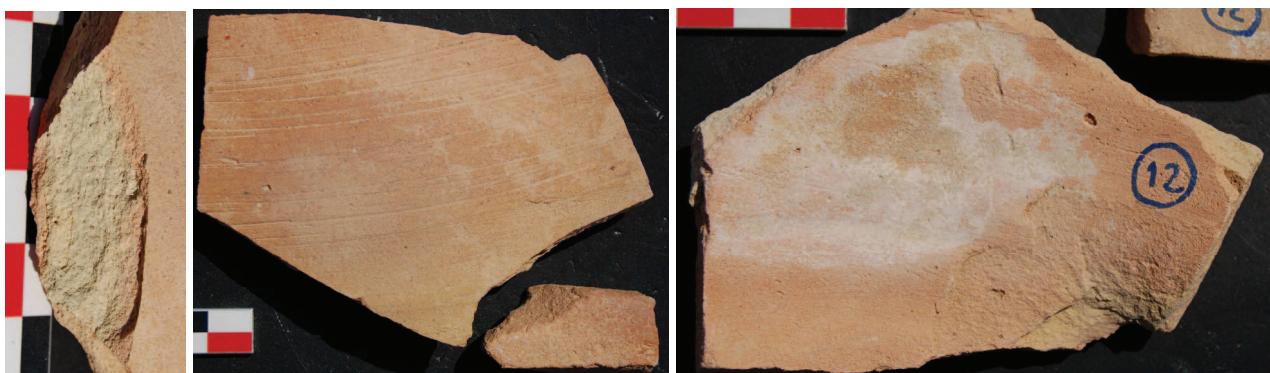
Reddish (black) slip

Incised decoration of alternated strips of zig-zag and horizontal lines



12 Medium Buff ware

Well levigated buff brown ware; medium thick walls; well fired but not clinky; thin sandy temper, not visible, sections slightly scratchy, vegetal prints; wheel turned prints.



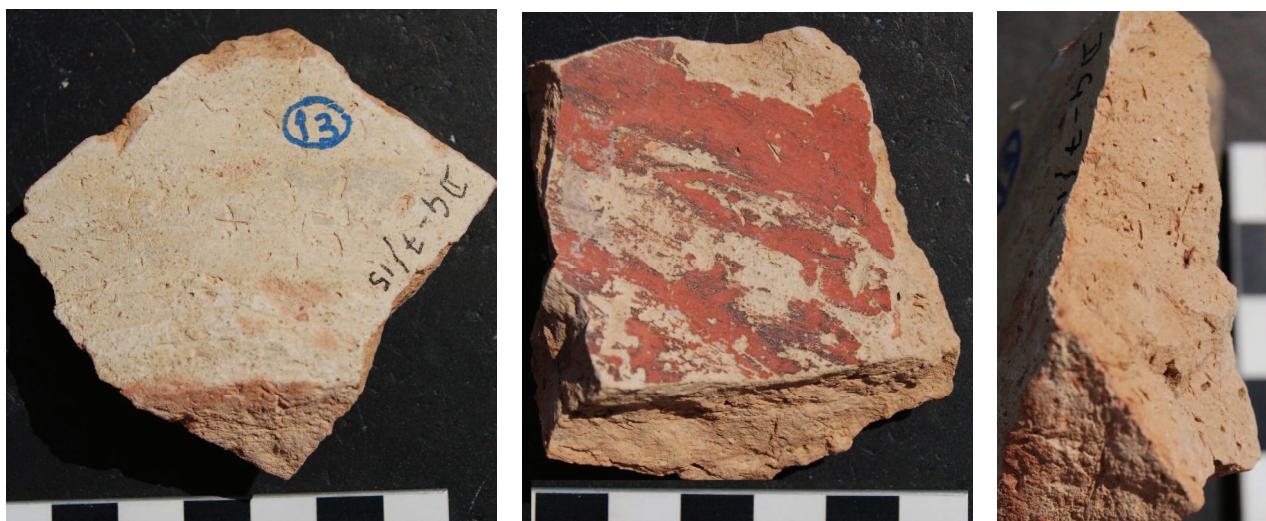
13 Black striped ware

Medium fired buff to light brown ware; thin to medium thick walls; thin air cavities and few vegetal prints; very thin mineral temper red or black

Yellowish to white surfaces

Red slip in the internal surface (rare external) with irregular strips in black (marble effect).

No parallels found at the Islamic periods (A. Rougeulles / H. Renel).



14 Grey temper ware

Well levigated buff brown to reddish (with grey core) ware; medium thick walls; well fired but not clinky; grey temper given an ashy aspect around small cavities

Incised decoration of alternated strips of zig-zag and horizontal lines (idem Red Brown ware)



15 Black and Red ware

Medium fired reddish ware with large grey black core; medium to thick wall; mineral and abundant chaff temper.

Rough plane surfaces; low wheel turned ?

Often with a cream wash outside.



16 Coarse Grey ware

Well fired grey ware; thin to thick wall; irregular plane rough surfaces, some partially reddish; abundant medium whitish inclusions and white exploded grits.

Low wheel turned ?



17 Cooking ware

Handmade, medium fired ware with abundant gritty temper, irregular sections, irregular coarse surface often hand water planed

a - deep brown ware, very thick angular white grits

b - sandy black & white medium grits

c - black to grey ware with white grits, exploded yellow inclusions



18 Red Cooking ware

Handmade, medium fired red ware to grey core; medium thick wall; grey sandy temper and chaff temper; irregular covering streaks on the surface

Light red slip or barbotine.

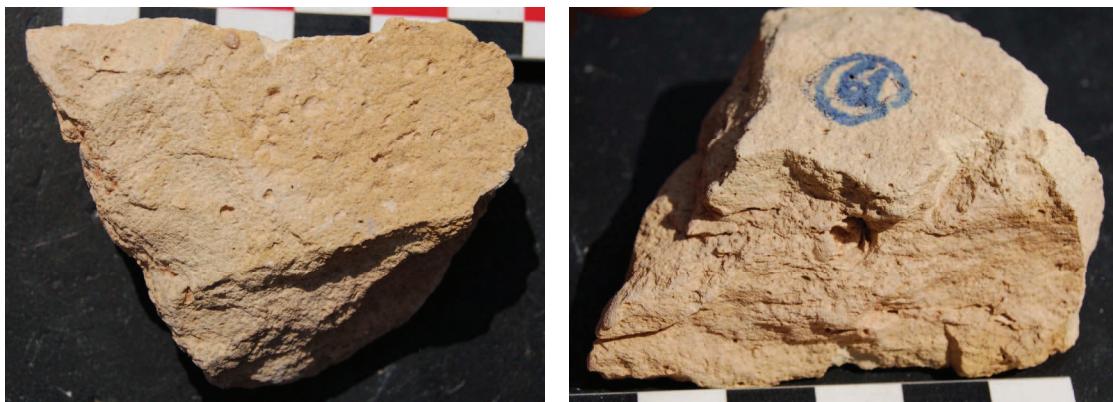


19 Coarse chaff & sandy temper

Medium fired yellow greenish ware (light buff core); thick wall; the clay is stratified with thin empty spaces; sandy temper and vegetal prints

Plane surfaces

All fragments are from large size containers and some possibly from *tanur* walls.



20 Blue and Green Glazed ware

Yellow to light buff well levigated ware; medium to thick wall

Green to blue glazed surfaces

Relief decorations: stepped horizontal lines



21 Islamic Glazed wares



Abbasid glazed

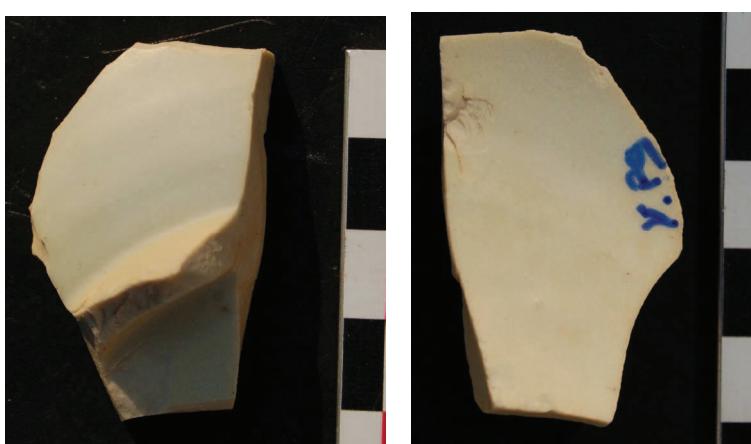
56



Medieval glazed



22 Eastern Porcelain and Stoneware



23 Western Amphorae



"It looks like a late Roman amphora, but I don't think it's the Gaza one which tends to be brown and fairly soft, quite porous. If anything, it might be the one that is called Palestinian. That tends to be orange and sandy with some limestone (yours seems to have some limestone even in the break)" (R. Tomber)

24 Others

Hadrami?



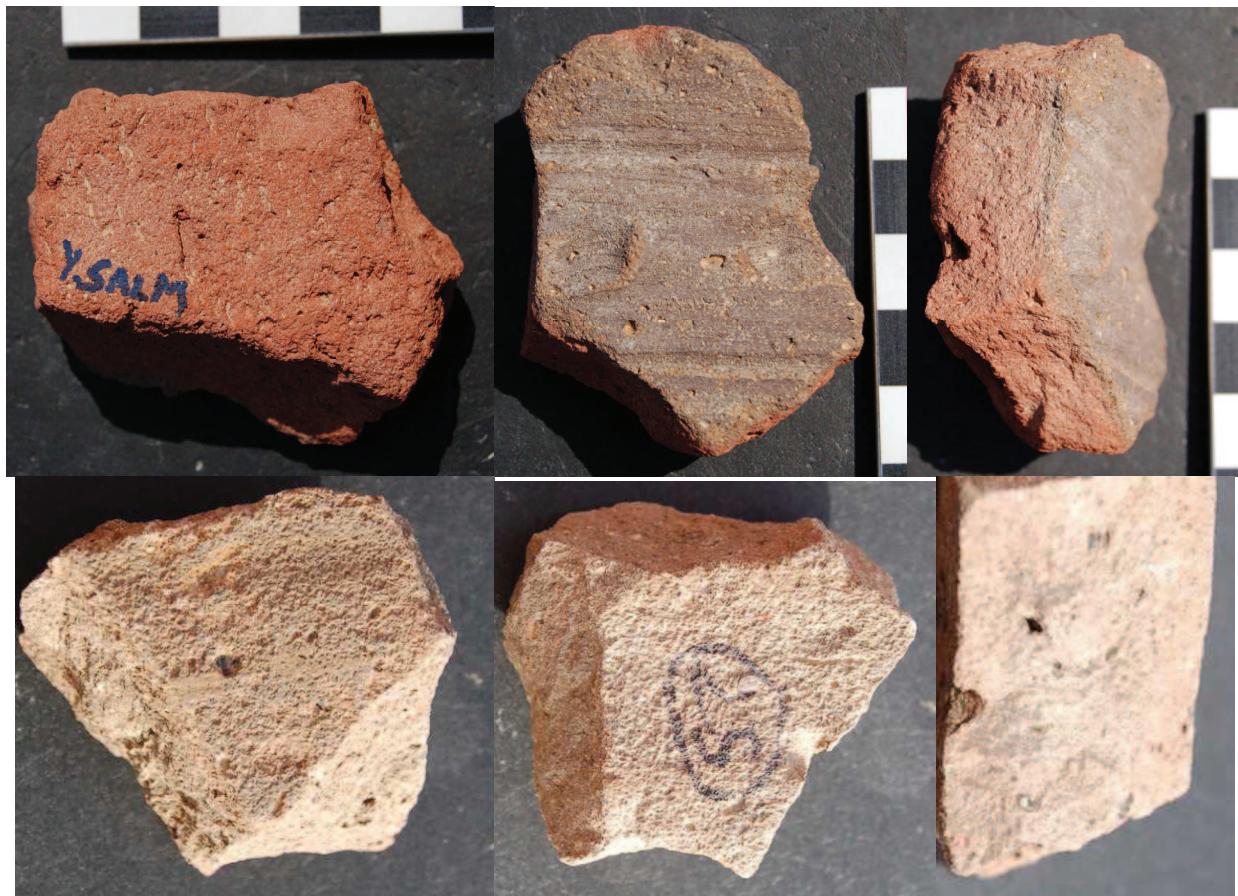
25 Thick Black ware

Medium to well fired red, deep grey or brown ware; thick wall; scratchy clay with many air

inclusions, and a few medium red and black grits

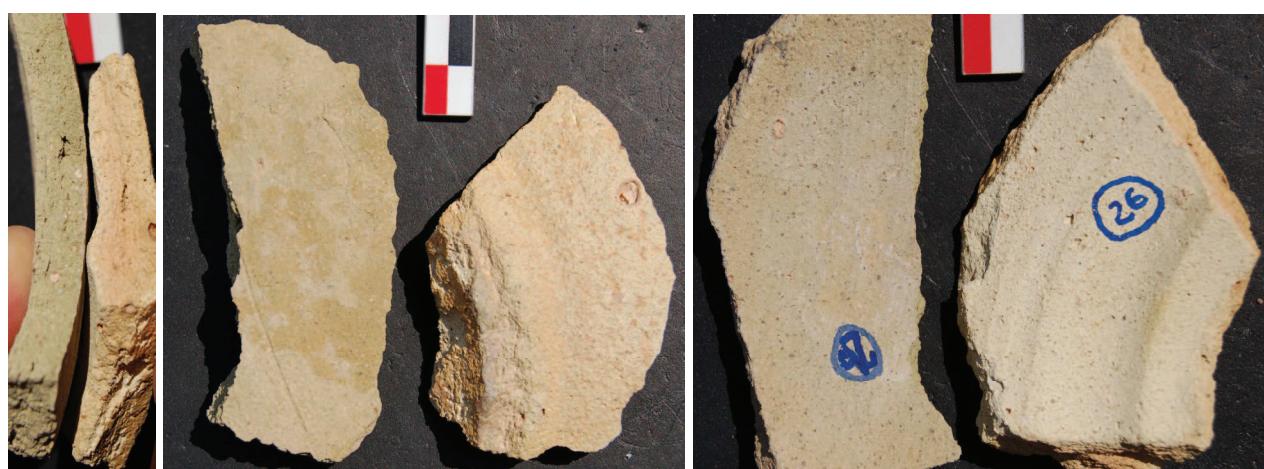
Grey external (and internal) surface

Ondulated wall, thick incised decorations (horizontal lines, pressions)

**26 Sandy Yellow ware**

Well fired yellow buff ware; medium thick wall; very dense sandy temper

Plane surfaces or slightly clearer

**27 Sandy orange torpedo jars**

Very well fired light orange to brown ware; medium thick wall; dense thin black sandy temper; slight finger pressions on the internal surface

Yellow whitish surface, not systematic; bitumen coated in the inside wall (Gulf ovoid transport jars / torpedo jars).



28 Thin Greenish Ware

Medium to thin ware, light green in color. Well levigated, well fired, fine regular surface. Fine mineral grey temper.



29 Dense Orange Red Ware

Medium thick walls, well levigated, clinky, red orange ware. Very thin mineral sandy temper.
 Light whitish buff wash, covering partly the surfaces
 Incised comb decoration

**30 Pale Grey Ware**

Medium thick walls, scratchy surfaces, light grey ware, wheel streaks inside.
 Fine sandy temper, rare exploded grits, some medium black grits
 Outside surface scratchy and more deep grey

**31 Grey slipped Pale Grey Ware**

Medium thick walls, scratchy section, light grey ware to pale buff and lightly pink.
 Fine sandy temper, rare exploded grits and some brown inclusions
 Light wheel streaks, well fired.
 Mat light grey wash inside and outside, or a mat reddish slip.



32 Fine Grey Ware

Well levigated grey ware, no visible temper, medium thick walls.
Grey-black slip partially burnished (some strip burnished)



33 Fine Cream Ware

Medium to fine wall, light orange red to buff ware, well levigated, well fired, clinky.
Thick white-cream slip, smoothy in surface, outside. Inside, thin wheel streaks.
Very thin sandy temper abundant, sections slightly scratchy, possible few thin black and red
mineral inclusions.
Tournassage at the base in one case



34 Fine White glazed / Porcelaine imitation

Buff to orange fabric, thin walls, very well levigated, no visible temper
White regular shiny glazed.



35 Common Reddish Buff ware Whitish slip

Well fired orange-red to buff ware; medium to thin wall; few thin black & red grits and thin sandy temper.

Whitish slip with thin wheel streaks.

Same ware coarse = 2; same ware plane = 4; same ware with red brown black slip = 36



36 Common Orange-Red ware Red Slip

Well fired orange-red to buff ware; medium to thin wall; few thin black & red grits and thin sandy temper.

Red brown black slip, plane horizontal strips

Same ware plane = 4; same ware with white slip = 35



37 Buff Slipped Ware

Medium fired buff ware, medium to thin walls, well levigated, wheel turned
No visible temper. Mat black and red slip.



38 Coarse Orange Clinky

Orange to red ware, grey core. Angular white and black mineral medium to thick temper.
Clinky; regular sections, with grits, medium thickness.
Redto brown slip inside and outside



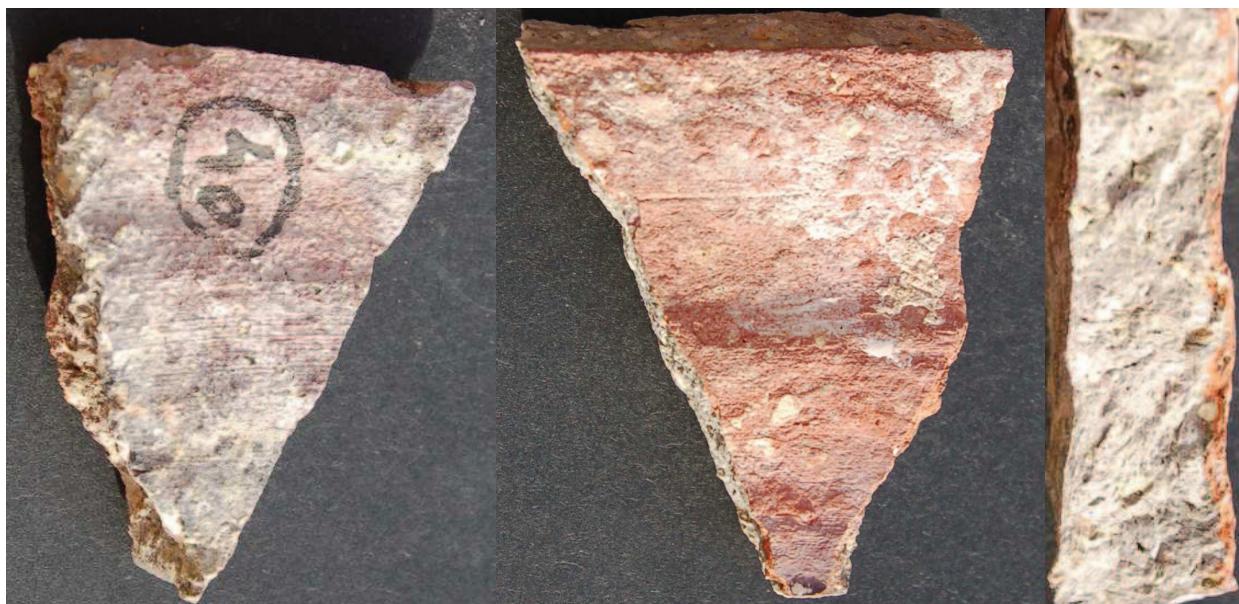
39 Yellow Green Glazed

Glazed ware very uniformly preserved, light yellow greenish in color, slightly goldy
Yellow buff ware very well levigated, no temper visible



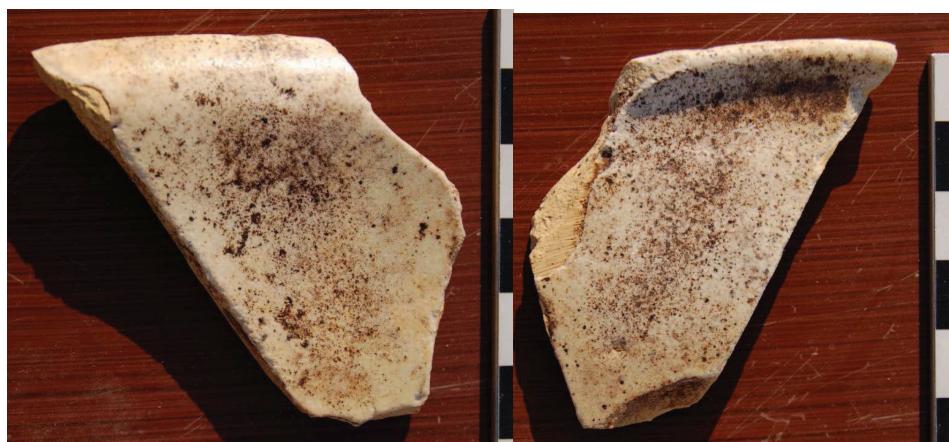
40 Whitish Slipped Coarse Grey Ware

Medium to thick walls, well fired grey ware not dense. Scratchy section, sandy temper, black angular grits and very abundant thin white inclusions, some exploded grits.
Pale greenish cream wash outside.



41 White glazed Ware

Fine yellowish ware well levigated, medium fired no visible temper.
White uniform glazed.



UF 20 ? (au pied extérieur du mur de la mosquée au nord). Tin glazed bowls that can be dated from 835 AD onwards to about late 9th in this case (Kennet 2004, IBTIN of the Samarra horizon)

42 Clinky Handmade

Thin clinky grey to brown ware. Hand made or slow whell turned. Grey surfaces

Thin sandy temper very abundant, and some exploded grits

Whitish slip

Inside surface with hand prints and wrinkled.



43 Bahla Ware



44 Monochrome Lustre Ware (Abbasid)



11 / Environmental studies

Preliminary study of the animal bones at al-Yamāma

By Hervé Monchot (*Labex Resmed, PRES Sorbonne Université*)

The zooarchaeological study is important not only to understand the environment of the al-Yamāma oasis but also for a better understanding of the subsistence strategies of the inhabitants of the site and the sources of this diet. The fauna material was identified on the field by the author during the second season (2012).

This campaign focused on the excavation of the Building 1 ("Mosque") and its western surroundings (UF 022 to UF 048), as well as on the excavation of a large deep sounding (Sounding 1), looking for the transition between pre-Islamic and Islamic periods, located in the northern third of the trench of the Sounding 1 (UF 050 to UF060).

For an exact location and a signification of the different stratigraphic units, the reader may also refer to this report for further explanation. Generally the bones came from three types of context:

- Human circulation/occupation levels (floors, pathway, fire place) substantially in the mosque or around it;
- Sedimentary (sandy) aeolian filling (dump area): bones (carcasses) have been abandoned or thrown over some structures (walls) in places away from the pathway;
- The collapse of mudbrick structures (i.e., walls).

Finally some bones came from a small pit (Sounding 3) located in the South-East at 700 m from the main excavated area (see this report for more details).

All these archaeological levels are dated to Islamic periods.

The zooarchaeological analyses will aim to better understand the developing dynamics of the management and exploitation of animal resources during each phase of occupation of each settlement and then evaluating the main diachronic changes registered. But the site is still under excavation and research, and therefore some of the conclusions presented here are preliminary hypotheses. The small sample size in each stratigraphic layers or location associated with an uncertain chronological range (i.e., work in progress) must remain tentative. Consequently, the aim of this report is not to attempt a detailed analysis of diet in Yamāma during the Islamic times, nor of temporal changes during the different phases of occupations but to give an outline and indicate areas of potential that can be addressed in the future phases of excavations.

The identified species: Sounding 1

The total of bone assemblage recovered in the 2012 field season from Sounding 1 comprises 5771 faunal remains, with a total weight of nearly 24.5 kg. **Table 1** shows that mammals largely dominate; birds and molluscs are very rare (respectively NISP = 5 and 4). No fish bones were identified. Only 1435 remains (24.87%) are determinable anatomically and specifically. The assemblage was recovered entirely by hand retrieval hand-collected except the sediment found in the northern trench which was systematically sieved (0.5 mm).

In addition, 108 remains were recovered from Sounding 3.

Using a modern animal bone comparative collection, bone specimens were identified to the lowest possible taxonomic category and the anatomical element, or portion thereof, represented. When necessary, published literature, including Barone's (1986) anatomy atlas and Smuth and Steiger's (Smuts and Bezuidenhout, 1987; Steiger, 1990) papers regarding the camel, were consulted.

The faunal assemblage shows a state of preservation characteristic of the majority of the sets known in the desert. The bone fragmentation is intense, especially for the mammals that are represented by a large proportion of splinters (e.g., unidentified fragments). So, with the exception of the small bones, short, strong and compact (i.e., carpal, tarsal and phalanxes), a few long bones (i.e., humerus, radio - ulna, femur and tibia), skull, vertebrae or bone of belts bone were complete. This fragmentation is the result of several ante-depositionnal processes (e.g., butchery techniques) and post-depositionnal (e.g., trampling, weathering and of course excavations technique).

Due to the high bone fragmentation, certain categories based on animal size were used to sort the unidentified fragment:

SM: Small-sized mammal, unidentified ovicaprids-gazelle-dog size

MH: Medium-sized mammal, unidentified veal-oryx-young camel size

LH: Large-sized mammal, unidentified horse-cattle-camel size

IND: Indeterminate fragments

The dromedary (Arabian camel)

The dromedary (*Camelus dromaderius*) with sheep/goat is in number of identified remains the species most represented in al-Yamāma (N=479). From Antiquity onwards, the dromedary has played an important role in human exploitation of desert region and it's so not surprising to find camel bones in almost all stratigraphic units (Tab. 1).

Apart from the third phalanx and some carpal bones all skeleton parts were identified among the bone assemblage (i.e., head, trunk, forelimb, hindlimb and extremities) (Fig. 31).

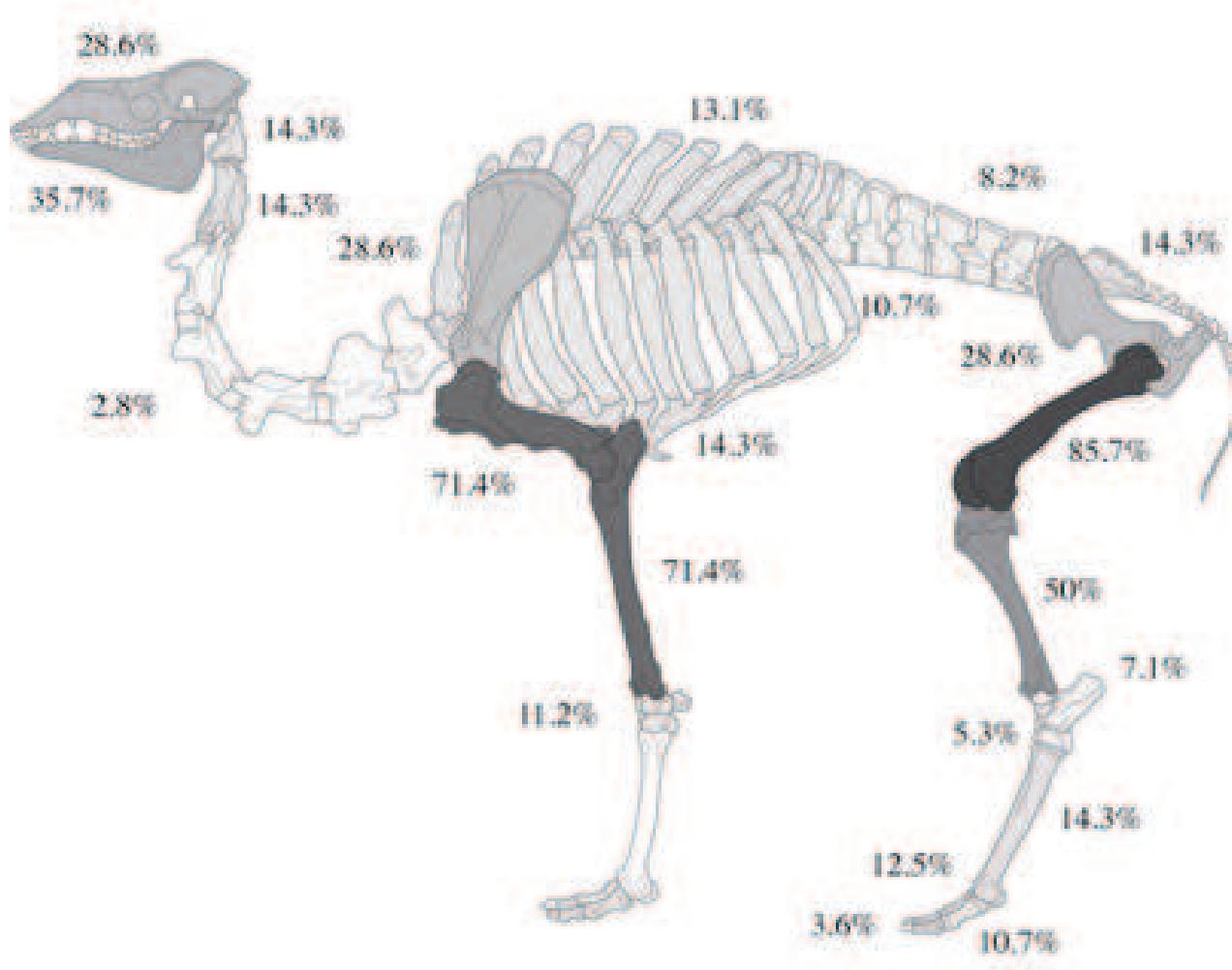


Figure 31. Percentage of bone survival for the camel (Minimum Number of Individuals=7) from the northern trench of the sounding 1 (Monchot, 2011 data)

The teeth are very weathered and so rare among the bone assemblage that the estimation of the age of the slaughtered camels is delicate. Some unfused bones indicate the presence of some juvenile. As no age data for the development of the postcranial skeleton in camels are available in the literature, we have used the data for slowly maturing from the 19th and early 20th century cattle breeds (von den Driesch and Obermaier, 2007: Tab. 6).

Nevertheless the presence of old individuals suggests that they have been rejected as such after their death, such as at the base of some walls or in filling area (midden). The several uses of the camel are a dietary element, a beast of burden, a source of raw material for artefact manufacture and a cultural symbol (Studer and Schneider, 2008).

The predominance of adult camels corresponds well to an age profile expected for pack animals. According to Horwitz and Rosen (2005), three different camel management strategies based on male-female ratio and age profile – one for milk, a second for meat and a third for transport/draught – could be expected. Furthermore, they noted that camel herd composition is expected to differ between an urban site, a camel caravan and herds kept by nomadic camel herders. These assumptions can be tested on al-Yamāma material, trying to identify the sex ratio by a modern statistical method, the mixture analysis (Monchot and Léchelle, 2002; Monchot, In press). This analysis is based on the premise that males are larger than females.

The camel consummation is attested by the presence of some fine cutmarks on bone made by a knife which reflects skinning, dismemberment, or filleting activities (fig. 32) or by the presence of chop marks (especially on vertebra) made by a cleaver which underline primary butchery of the carcass.

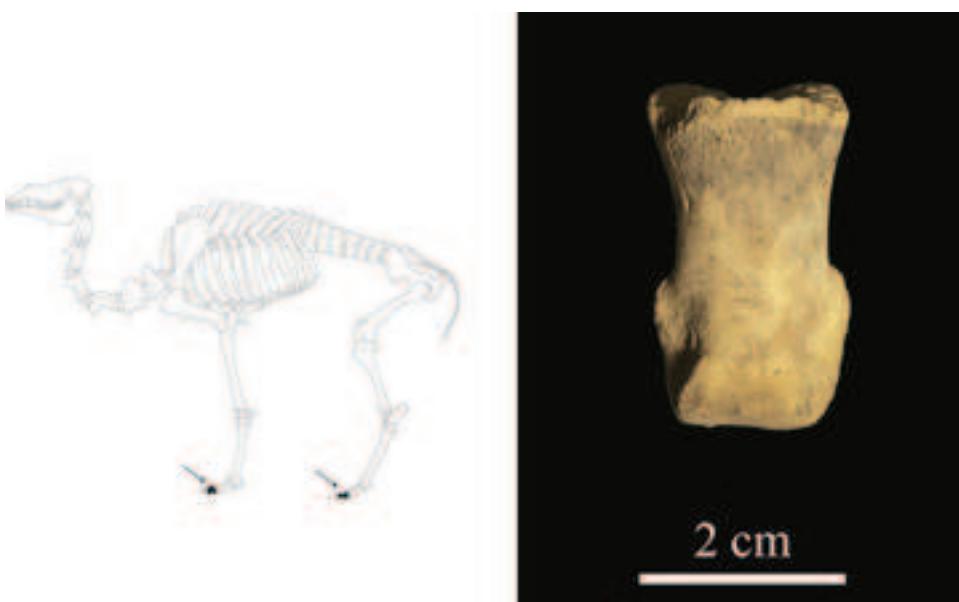


Figure 32. Fine cutmarks (incisions) on a phalanx 2 of a young camel.

The ovicaprid (sheep/goat)

Ovicaprid (*Capra hircus/Ovis aries*) are represented by 485 remains. Sheep and goats have been distinguished using morphometrical criteria (Boessneck et al., 1964). When separation of the two species was not possible, their remains were placed in a combined sheep/goat category (i.e., ovicaprid).

Bones and teeth of ovicaprids were found in almost all UF (Tab. 1), which is not surprising given the important role played by these animals in the diet of the inhabitants of the desert: sheep and goats are the main source of food in meat, but also in milk for the inhabitants of al-Yamāma. This is confirmed by many butchery marks (cut and chop marks).

Ageable mandibles plus isolated teeth have been grouped according to the stages of Payne (1973), but as for the camel, the mandibles with teeth are rare and do not allow a reliable calculation of mortality profile.

The Arabian gazelle

The inhabitants of al-Yamāma, suggesting an important hunting activity, consumed a small gazelle, which are represented by 20 remains. The gazelle bones present characteristic osteomorphological features and a preliminary biometric study shows clearly that we are in presence of a smaller species (e.g., the Arabian gazelle, *Gazella arabica* also called to the Saudi gazelle, *Gazella saudiya*) than the mountain gazelle (*Gazella gazella*) (Peters, 1989; Thouless et al., 1991; Munro et al., 2011). The Saudi gazelle, in contrary to usual practice, is not regarded as a subspecies of *G. dorcas* (Yom-Tov et al., 1995). It is important to note that the Arabian gazelle, the smallest one, was an elusive gazelle that was apparently hunted to extinction in its Middle-Eastern homeland, Saudi Arabia.

Gazelle inventory:

- UF 041 (N=1): a complete distal metapodial;
- UF 050 (N=4): two phalanx 1; one phalanx 2; one distal metapodial;
- UF 055 (N=2): one phalanx 1; one fragment of a left mandible with M1M2 (old individual);

- UF 056 (N=7): a phalanx 2; a distal metapodial unfused; a left distal tibia; a fragment of a proximal radius; a complete left metatarsal; a distal condyle unfused of a metapodial; a right proximal fragment of a tibia;
- UF 057 (N=4): a right cubonavicular; a horncore fragment; a proximal scapula; XX
- UF 059 (N=1): a complete left talus;
- UF 060 (N=1): a complete right talus.

The cattle

Suspected last year several elements (N=12) confirms the presence of cattle (*Bos taurus*) in the bone assemblage:

- UF 033 (N=1): a second complete phalanx;
- UF 051 (N=2): a fragment of a proximal metatarsal; a distal fragment of a humerus;
- UF 052 (N=2): fragment of a mandible; diaphysis fragment of a tibia;
- UF 053 (N=7): four teeth (a upper M3 right; a upper M2 right; a lower M2 right; a fragment of a upper molar); a fragment of a left cubonavicular; a fragment of a right cubonavicular; a proximal fragment of a right metatarsal.

Nevertheless, the presence of cattle remains is marginal compared to ovicaprids and camel and could be explained by its strong ecological requirements (e.g., water and pasture) and its easy replacement by the camel.

The Equid (Donkey/Horse)

In UF 041, the Equid is represented by three donkey (small sized) bones: a complete right navicular, a distal extremity of a metapodial (BD= 28.0; DD= 22.8) and a medial fragment of a right distal tibia extremity.

In UF 031, a complete distal extremity of a metapodial might belong to a large Equid (BD= 28.0; DD= 22.8). They can be attributed to the horse or even possibly to a hybrid (mule). Given the small size of the assemblage analysed to date, it may instead indicate that Equid meat was rarely consumed in this part of the site or so Equids are not very often used in al-Yamāma.

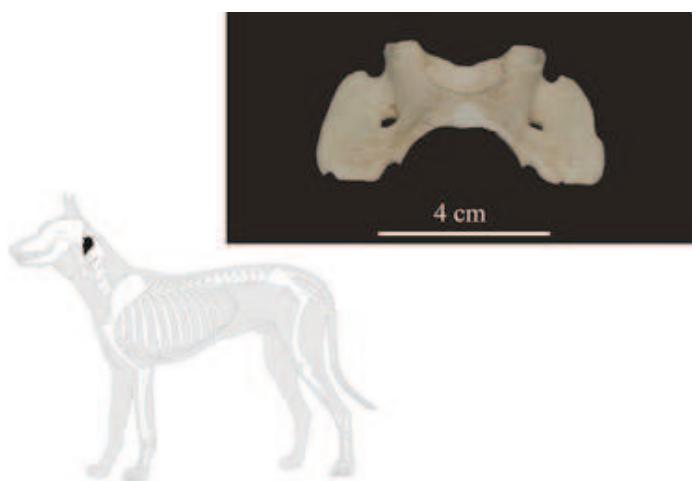
Equid (horse/donkey) meat and Islam: Eating the meat of all kinds of horses is permissible as recorded by the majority of Muslim scholars. The evidence is the Hadith reported from Jabir Bin Abdullah that “On the day of Khaibar, Allah’s Apostle [Muhammad] forbade the eating of donkey meat and allowed the eating of horse meat”.

The dog

Many dog (*Canis lupus f. familiaris*) remains were represented in the al-Yamāma filling (N= 36) and especially a right hand in connexion with 23 bones recovered from UF 055 context.

In UF 053, the atlas or first cervical vertebra presents numerous disarticulation cut marks for the head removal (fig. 33). These traces are not rare and were described in the Mosque in Bahrein (Smith, 2005). They can be interpreted as a sign of meat consumption (Bettini, 1998). Some cutmarks on dog bones were found also in the zone 9 of Madâ’ in Sâlih (Studer, 2011).

- UF 023 (N=1): a left distal radius;
- UF 034 (N=1): a metapodial diaphysis;
- UF 035 (N=3): an atlas; a fragment of an axis;
a right distal of radius
- UF 038 (N=1): a complete left mandible without teeth;
- UF 041 (N=2): a right fragment of a maxillary;
a canine;
- UF 053 (N=3): an atlas; an axis; a diaphysis;
- UF 055 (N=25): 4 phalanx 1; 4 phalanx 2; 4 phalanx 3; 4 sesamoids; 1 capitatum; 1 hamatum; 1 trapezoid; 4 metacarpals; a left distal of a femur; a left proximal of a femur.



It is worth noting the very low marks (i.e., pits, furrows...) on bones made by dogs or other small carnivores (fox), which are generally rummage through the garbage or scavenge some abandoned herbivores carcasses.

Figure 33. Dog atlas with cut marks (UF 053). (Dog drawing, Michel Coutureau & Vianney Forest, 1996, www.archaeozoo.org)

The fox

In the UF 053, a proximal radius clearly shows the presence of a small-sized canid, certainly a fox (*Vulpes sp.*). The exact species will be determined (e.g., red fox, Ruppell's fox or Blanford's fox). A small canid is represented also in UF 057 by a canine.

The desert hedgehog

A mandible of hedgehog, certainly belonging to the genus *Paraechinus*, which represents the desert hedgehogs, was found in the UF 052.

Desert hedgehogs (*Paraechinus aethiopicus*) primarily eat insects and other invertebrates, but will sometimes also consume eggs, small vertebrates, and vegetation (fig. 34 & 35). It is widespread throughout arid desert and dry steppes. It tends to favour areas where food is more easily available, such as oasis and vegetated wadis (Hutterer, 2008).



Figure 34. Desert Hedgehog (Photo Yazeed Alsahli; www.yazeedalsahli.net © 2012).

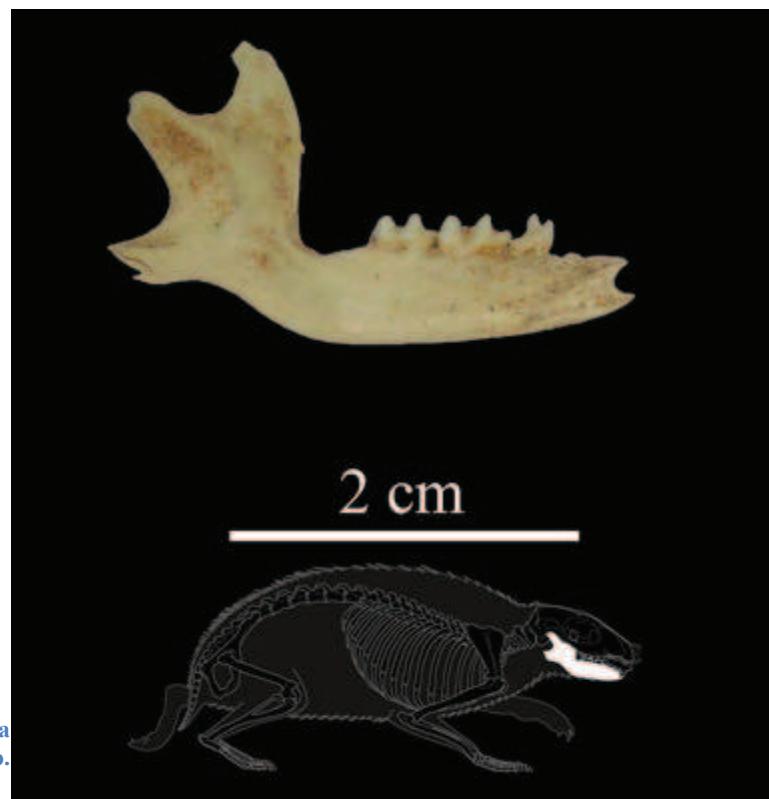


Figure 35. The desert hedgehog's mandible of al-Yamâma (Hedgehog drawing, M. Coutureau, 1997, www.archaeozoo.org)

Birds

Five bird bones were identified:

- The ostrich (*Struthio camelus*) is represented by one fragment of eggshell found in the UF 102. The Middle Eastern Ostrich or Arabian Ostrich (*Struthio camelus syriacus*) is an extinct subspecies of the ostrich which once lived on the Arabian Peninsula and in the Near East. If the bones of ostriches are rare in prehistoric archaeological sites (with the possible exception of the Palaeolithic site of Umm El Tlel, Bonilauri *et al.*, 1990), the fragments of eggs are more frequent, e.g., Dūmat al-Jandal or Madā'in Sālih (Studer, 2010; Monchot, In press).
- One fragment of a diaphysis of a tibiotarsus and one fragment of eggshell found in UF 059 represent the domestic fowl (*Gallus gallus f. domesticus*). They can be interpreted as food refuse, although no butchery marks could be observed.
- In UF 057 a scapula and a carpometacarpus were found (identification in progress).

Reptilia

Many bones belonging to lizards of the genus *Urostamyx* were discovered. The specific identification is underway. The *Uromastyx* is a genus of lizard whose members are better-known as Spiny-tailed lizards, uromastyxes, mastigures, or dabb lizards. *Uromastyx* are primarily herbivorous, but occasionally eat insects, especially when young. They spend most of their waking hours basking in the sun, hiding in underground chambers at daytime or when danger appears. They tend to establish themselves in hilly, rocky areas with good shelter and accessible vegetation.

While some individuals have been buried in a natural way during the collapse of some walls of Building 1, it must not be forgotten that these lizards is a popular food for the Bedouin Arab (Thesiger, 1978; Thigani Elmahi, 2002).

Concerning the consummation of lizards and other small animals by Muslims, Malik said that there is no harm in eating lizards, gerbils and snakes. It is permissible to eat snakes and vipers, large lizards, hedgehogs and frogs.

Mollusks

Four fragments of seashell were found, and the species determination is in progress. The presence of seashell is a solid indication of exchange with groups coming from the Persian Gulf or from the Red Sea.

The identified species: sounding 3

Very few bones (n=108) were recovered from Sounding 3 (see this report for the exact location and more explanation). The material is badly preserved and very weathered; it belongs to five stratigraphic units:

YM 201 - Surface layer - N=15: all are indeterminate fragments.

YM 202 - Destruction and agricultural land - N=61: 56 indeterminate fragments; two ovicaprids bones (a distal left humerus; a phalanx 2); two camel fragments belonging to a left mandible; and a body fragment of a vertebra of medium size.

YM 203 - Rubble? - N=1: a distal right of an ovicaprid tibia.

YM 204 - Filling of kiln - N=6: five splinters and one fragment of a distal left femur of camel.

YM 205 - Ashy layer - N=25: 23 indeterminate fragments; a fragment of an unfused proximal humerus and one fragment of a body of a rib (Large sized individual).

Conclusion

The preliminary zooarchaeological 2012 results are consistent with those of the previous year and clearly show a subsistence economy largely based on the camel and sheep/goat (Tab. 2). These animals are purveyors of meat, milk and wool. For the camel, it would be simplistic to see an animal only as sheep and goat for the human consummations. The camel, one of the symbols of the Bedouin life, served as transportation during many trips into the desert from oasis to oasis.

Besides that, the share of wild animals, eaten or not, is relatively important. For the herbivores, the gazelle could be largely hunted by al-Yamāma's inhabitants in the vicinity of the city or brought by different visitors as they pass in the oasis.

Carnivores could be killed during hunting sessions, or simply killed within the walls of the city, attracted by food or garbage.

Finally nothing in pigs has been identified, which seems quite consistent with the period, the natural environment and Muslim habits.

These results are comparable to the ethnographic description of Bedouin life in recent decades in the desert of Saudi Arabia. These results are very encouraging for the future. The continuation of these two seasons of excavations, and the extension to other areas in the city, should allow us to better understand the lifestyle and alimentary behaviour of the inhabitants of al-Yamāma and its evolution over the last two millennia.

UF	Type of deposit/structure	W	N	Number of identified specimens														
				Dro.	Cap.	Gaz.	Bos	Equid	Dog	Fox	Hed.	Bird	Micro	LH	MH	SH	Ind.	
UF 022	Sand deposit, collapsed mudbricks	150	95	24	1												70	
UF 023	Collapse/Accumulation post abandonment of aeolian sand	512	86	8	13				1					30	1	1	1	31
UF 024	Pit filling	10	4			4												
UF 025	Pit filling	22	7	1	6												2	
UF 026	Accumulation between two occupations	8	5		3													
UF 027	Collapse filling a niche in the wall	8	4														4	
UF 028	Filling between two walls	18	23	1	1												21	
UF 029	Aeolian sand deposit	9	5		1												4	
UF 030	Occupation/Accumulation	5	3														3	
UF 031	Collapse over Aeolian deposit	766	87	10	9			1 (H?)						8			59	
UF 032	Aeolian sand deposit	1444	45	23	1												21	
UF 033	Circulation/Accumulation	1268	124	23	20		1							10	3	2	65	
UF 034	Collapse/Accumulation post abandonment of aeolian sand	2424	231	48	20			1						11	1		150	
UF 035	Aeolian deposit/Collapsed walls	764	98	9	16			3						14	7	7	49	
UF 036	Accumulation above occupation - Aeolian sand deposit	18	1	1													2	
UF 037	Accumulation above occupation - Aeolian sand deposit	8	2															
UF 038	Accumulation above occupation - Aeolian sand deposit	183	14	6	1			1									7	
UF 039	Aeolian sand deposit	484	42	7	7									4			24	
UF 041	Accumulation in a gullying area	1450	320	31	34	1		3 (D)	2					6	16	6	221	
UF 043	Accumulation between two occupations	102	5	1	3												1	
UF 044	Collapse layer (upper part of wall 006) and circulation level	398	78	8	5									2			63	
UF 045	Collapse layer (W 084) over circulation level	30	5														5	
UF 046	Collapse mudbrick (North W 084)/Accumulation (South W 084)	744	36	10	9									2	1		14	
UF 048	Accumulation mixed with fragment of mudbricks	648	17	1	4												12	
UF 050	Aeolian sand accumulation	390	33	9		4								1	3		16	
UF 051	Loose sand, with an irregular layer of mud fragments on the top	1130	306	37	61	2								30	1	3	172	
UF 052	Occupation remains in secondary deposit/Eroded destruction	2018	160	26	19	2								6	6		100	
UF 053	Aeolian deposit and secondary deposits of occupation	2600	1007	39	62	7		3	1				2	49	2	10	832	
UF 054	Fire place	210	77		25									4	6	1	41	
UF 055	Sand and mudbricks fragments. Destruction?	264	726	76	32	2		25					2	24	1	4	560	
UF 056	Aeolian sand/Occupation?	1884	501	49	34	7						1 (O)	9	14	17		370	
UF 057	Occupation in a secondary context	2800	722	19	69	4		1		2 (I)	5	17	6	19			580	
UF 058	Aeolian occupation	152	74	1	8								2		2		61	
UF 059	Aeolian sand/Occupation	682	264	6		1				2 (C)			5		3		247	
UF 060	Sand accumulation/Occupation	572	474		14	1							4	4			451	
UF 061	Sand accumulation/Occupation	356	90	6	3												81	
	Total	24531	5771	479	485	20	12	4	36	2	1	5	58	220	27	83	4339	

Tab. 1. Number of animal remains from the various levels of the sounding 1- Excavation 2012. W = weight in grams; (Dro = Camel/Dromedary; Ovi = Ovicaprid (sheep/goat); Gaz. = Gazelle; Bos = cattle; Equid =donkey (D)+horse (H); Hed. = Hedgehog; Bird = Eggshell of ostrich (O); Chicken (C); Indeterminate (I); Micro = microfauna (rodent/reptilia: Agamidae); LM = Large-sized Mammal; MM = Medium-sized Mammal; SM = Small-sized Mammal; Ind. = indeterminate;).

AL-YAMAMA	BUILDING 1		BUILDING 2		TOTAL	
	2011		2012		2011+2012	
	NISP	NISP	NISP	NISP	% NISP	
Herbivores						
<i>Camelus dromedarius</i>	480	479	149	1108	47.8	
Ovicaprid (sheep/goat)	310	484	85	879	37.9	
<i>Gazella</i> sp.	48	20	26	94	4.0	
<i>Oryx leucoryx</i>			1	1	0.1	
Bovid	39			39	1.7	
<i>Bos taurus</i>		12		12	0.5	
<i>Equus asinus</i>	6	3	1	10	0.4	
Carnivores						
<i>Canis lupus f. familiaris</i>	4	36	5	45	1.9	
<i>Vulpes</i> sp.	3	2		5	0.2	
<i>Felis silvestris f. familiaris</i>			2	2	0.1	
<i>Mellivora capensis</i>	3		1	4	0.2	
Birds						
<i>Gallus gallus f. domesticus</i>		2	2	4	0.2	
<i>Struthio camelus</i>	1	1	1	3	0.1	
<i>Pterocles</i> sp.			1	1		
Bird indet.		2	1	3	0.1	
Insectivora						
<i>cf. Paraechinus</i>		1		1	0.1	
Reptilia						
<i>Urostomyx</i> sp.	36	58	11	105	4.5	
Molluscs						
Small mammal	129	220	54	403	--	
Medium mammal	43	27	11	81	--	
Large mammal	22	83	29	134	--	
Unidentified	90	4339	213	4642	--	
Total	1212	5770	593	7575	100	

Tab. 2. Species list from al-Yamama, 2011-2012 excavations. Sector N6+O7
(NISP = Number of identified Specimens; %NISP, only for the identifiable element)

Geomorphological study of al-Kharj oasis

By Eric Fouache (Université de Paris-Sorbonne, Institut Universitaire de France, Vice Chancelier de l'Université Paris-Sorbonne Abou Dhabi, UMR ENEC 8385.)

Guillaume Fortin (Université Paris-Sorbonne, Master Espaces, Dynamiques des Milieux et Risques)

Antoine Chabrol (Membre de l'Ecole Française d'Athènes, Université Paris I)

Following the first year of Master research work done by Guillaume Fortin, it was agreed with Jeremie Schiettecatte that a second mission would be devoted to the creation of a regional geomorphological map.

The achievement of this map has been retained as the subject of a M2 research paper by Guillaume Fortin, master student in physical geography in La Sorbonne - Paris 4 University, Paris. Eric Fouache came for the implementation of the geomorphological team.

The MEDEE program led by Eric Fouache, financed the part of the airline tickets (round trip Athens / Riyadh of Antoine Chabrol and Adu Dhabi / Riyadh of Eric Fouache), while the al-Yamama archaeological mission funded Guillaume Fortin's Paris / Riyadh ticket and living expenses of the team.

The aim of this map is to delineate clearly areas of holocene geomorphological dynamics and assist the interpretation of survey results in terms of distribution of archaeological sites.

1/ Geological and tectonic background

The site of al-Yamāma is located near al-Kharj, a major town in the central region of the Najd in Saudi Arabia, in the Arabian Peninsula. The Peninsula belongs to the Arabian Plate, and is divided into three major geologic parts (fig. 36):

- The coast along the Red Sea, called Tihama, is the eastern margin of the Red Sea rift. It is a sedimentary plain from the northwest of the Arabian coast to the south, and is bounded in the east by the Sarawat Mountains. This margin partly represents the opening graben of the Red Sea, 30 million years ago.
- The Arabian Shield represents the uplift of the plate because of compressive and tectonic uplift events. Bound in the west by the Tihama coastal plain, the Precambrian crystalline rocks of the Shield are limited to the north, south and east by younger sedimentary rocks. Multiple evidence of volcanic activity (crater, lavas, etc.) is found within the Shield, until medieval times (lava flows near Medina during the 13th century).
- Last, the Arabian platform underlies the Arabian Shield from the center of the Peninsula to the plain of the Arabian Gulf, and consists of Phanerozoic sedimentary rocks. This is a plateau region (inherited from the uplift of the Arabian Shield) in the central part and a plain area near the Arabian Gulf. Sedimentary rocks (mostly limestone and sandstone) are the result of numerous cycles of marine transgression/regression, with a thickness increasing from the West to the East.



Figure 36: Geological units of Saudi Arabia (Grainger, 2007)

The location of the study area in the Arabian Platform explains the geological context of only sedimentary rocks. Large units of limestone and sandstone of Jurassic and Cretaceous form more or less eroded plateau, bordering valleys carved by a water system very low nowadays (wadis) but sufficient in the past to incise several tens of meters. The major part of wadis within the oasis of al-Yamama are influenced by series of grabens originating from the opening of the Red Sea, marked by west-east direction faults. In the valleys, more recent sedimentary cover includes both fluvial deposits (silt, clay, etc.) and eolian deposits, with barchan fields in numerous places. The current erosive context is mainly from wind, since very low rainfalls have minimal impact on the ground.

2/ Topography

The geological context, pretty simple, offers an easy explanation of the topographical context of the area of al-Yamāma. The oasis is a large funnel-shaped valley between sandstone and limestone plateaus incised by many wadis (fig. 37). The joint action of drainage and uplift of the crystalline basement in depth led to the formation of escarpments, the most important being faces of cuestas in the north, northwest and southwest of the oasis.

The study area of the oasis is bounded in the west by a Jurassic mountain, the Jabal Tuwayq, through which flows the Wādī Nisāḥ from west to east inside grabens. The Wādī Hanīfa comes from Riyad in the northwest, along the cuesta of the Jabal al-Jubayl mountain. This escarpment then forms the northern boundary of the oasis. Southwest, the Wādī al-‘Ayn comes from Jabal Tuwayq slopes then follow the escarpment of the Jabal al-Armuh mountain south of the oasis. These three main wādīs reach the center of the oasis to form the Wādī Sahba, which crosses the whole oasis from west to east in the valley bounded by the Jabal Jubayl and Jabal al-Armuh, then continue in the east in sands of ad-Dahna desert.

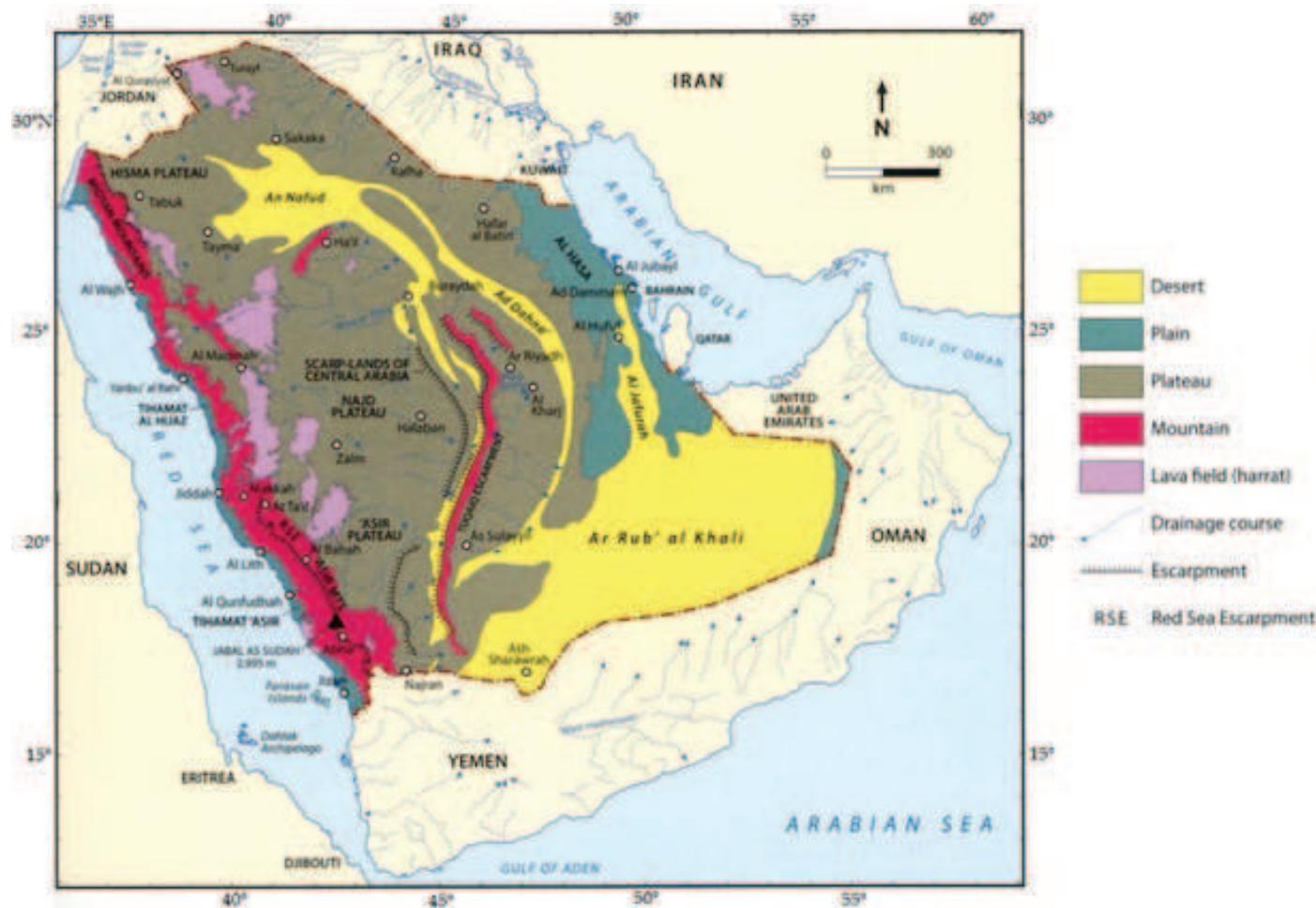


Figure 37: Simplified landform map of Saudi Arabia (Grainger, 2007)

The three mountain massifs located in the oasis are almost parallel and bound in the north, west and south the study area. The confluence of the wadis within these mountains forms the al-Kharj cluse, cutting in two the Jabal Jubayl and Jabal al-Armuh (fig. 38). The Jabal Tuwayq's highest elevations are around 1050 m in the study area, while the Jabal Jubayl and Jabal al-Armuh have average maximum altitudes around 550 m north of the oasis and 500 m south of the oasis. The central valley in which flow the wadis has a gentle slope from west (470 - 480 m on average elevation) to east (380 m) at the eastern end of the oasis, the beginning of the al-Dahna desert.

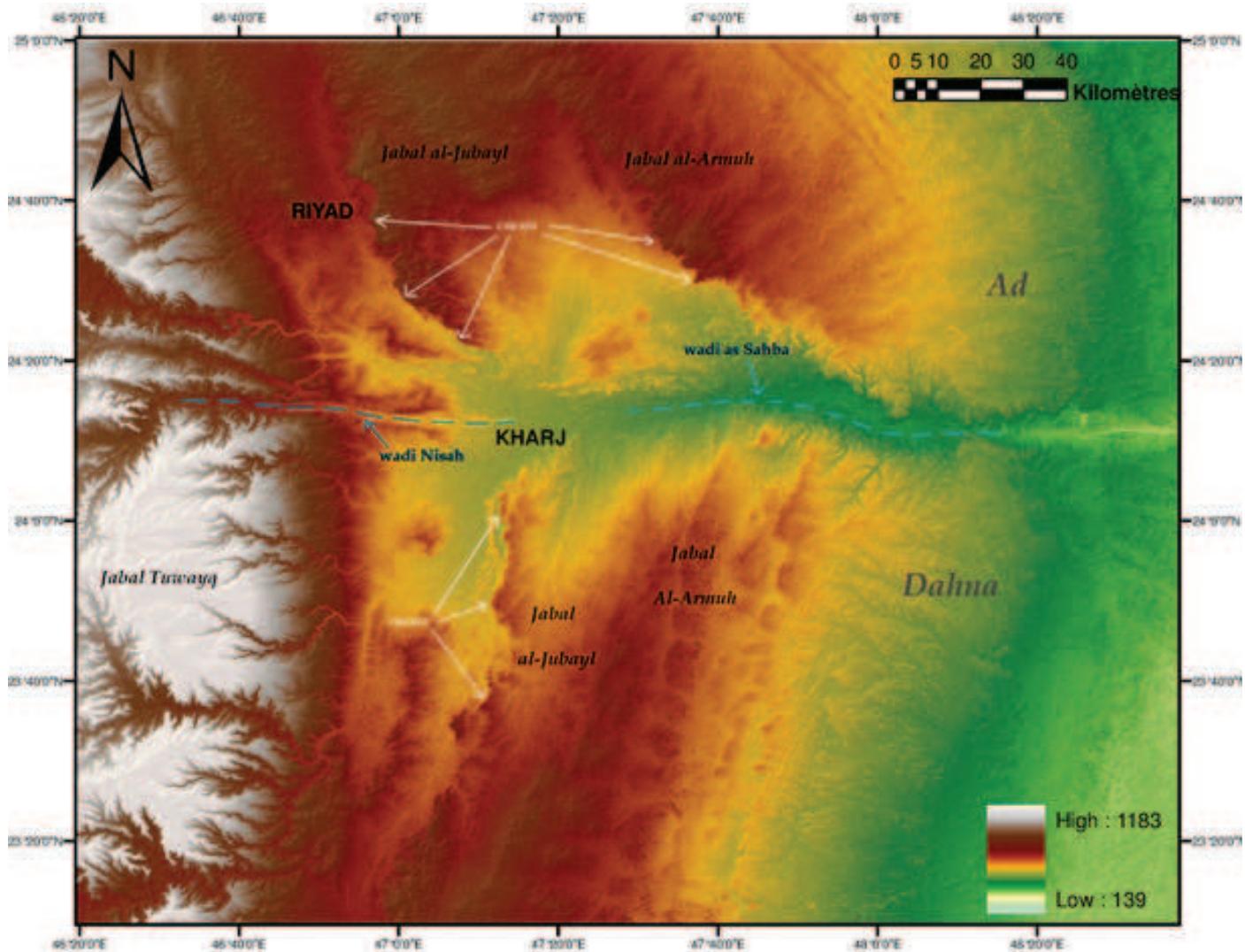


Figure 38: General overview and elevations of the Oasis of Yamama

3 / Methodology of the geomorphological map

The geomorphological study and the general map is based on a cartographic analysis as well as exploration and field surveys. All data were entered into one same Geographic Information System (ArcGis 10, UTM WGS 84 system).

- Digital and cartographic sources available

Document	Date	Number of copies
Geological map 1/250 000e	1991	1
Saoudian topographical maps, 1/50 000e	1983	8
Russian topographical maps 1/200 000e	1979	1
Landsat imagery ETM+	1983-89-2003-2011	4
SPOT imagery	2011	4
Quickbird imagery	2011	1
Corona imagery	1976	2
DEM ASTER (30m)	2010	1
DEM SRTM (90m)	2005	1
Couverture Google Earth	2003-2011	

The preparatory work was carried out from maps and satellite imagery. Depending on areas that seemed interesting or necessary for the understanding of dynamics, structures and soil implementation (lacustrine or stream deposits, faults, surface geology, etc.), field explorations have been conducted. Each excursion was recorded with photographs, GPS coordinates and notes in association with indications of the geological map.

When all necessary data have been collected, older and newer ones, the first work consisted of a centralization using the GIS software ArcGIS 10. Digital and cartographic sources mentioned above have been georeferenced if necessary, allowing overlays. Archaeological sites discovered during the previous campaign as well as newly discovered have been added, with their GPS coordinates.

Secondly, the geological map was digitized using polygons (fig. 39).

Once fully digitized, ArcGIS data was saved and exported in the Adobe Illustrator software. Starting from the polygon layer, the work consisted in targeting the study area and grouping into geological features polygons with similar values, then linking a corresponding illustration to the nature of the rock. We mainly focused on the quaternary dynamics related to our research topic (alluvial deposits, inherited terraces and paleolakes). Finally, illustrations indicating tectonic and structural elements have been added as well as known elevations. The final map is intended to show the general geomorphological background in the oasis of al-Yamāma (Fig. 40).

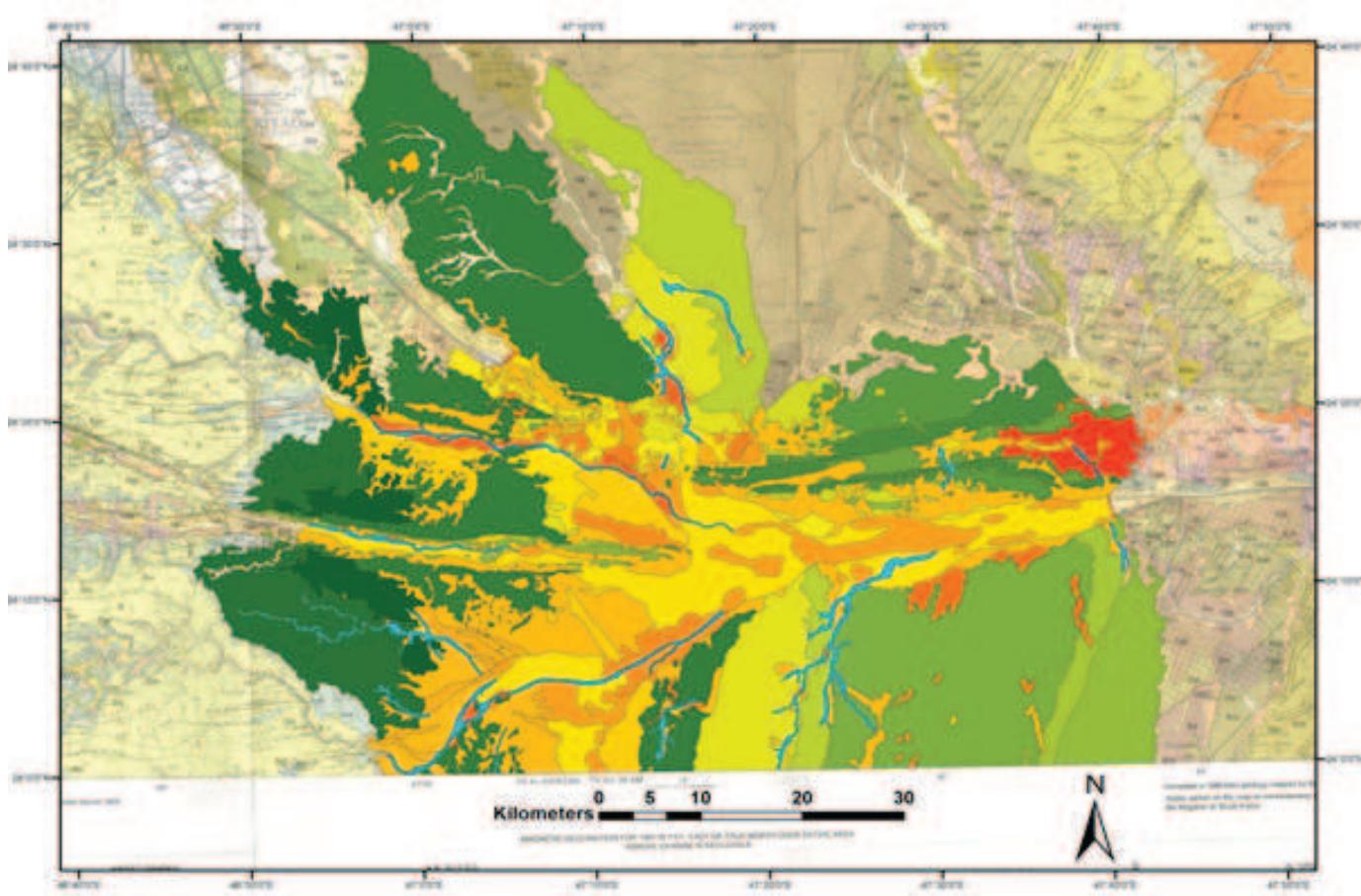


Figure 39: Vectorization of the maps (ArcGis® 10)

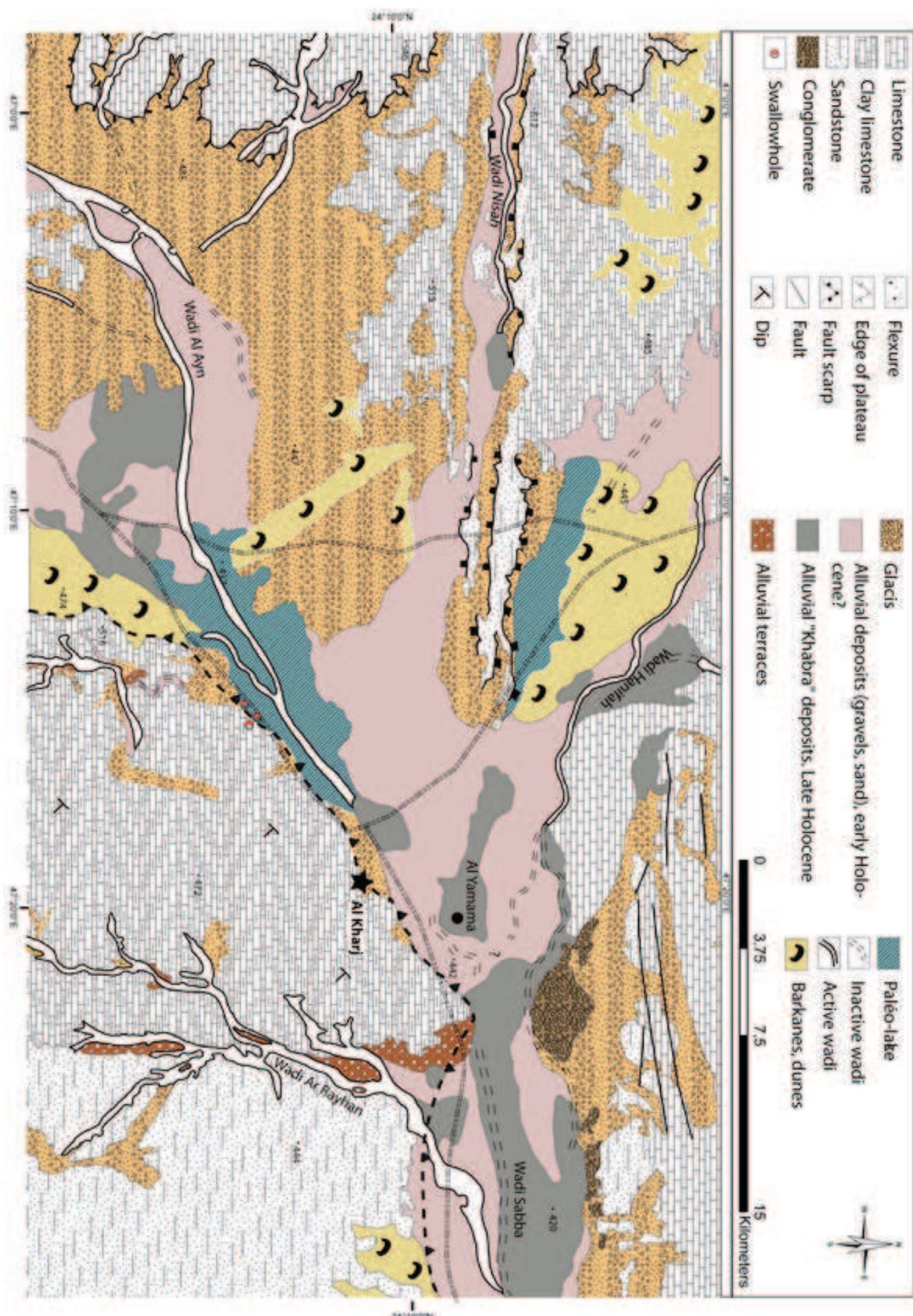


Figure 40: Geomorphological map of the studied area

4/ Holocene geomorphological dynamics

The geomorphological study focused on five different areas whose dynamics have structured the landscape of the oasis (Fig. 41). In this field study, we can make an initial assessment of the holocene geomorphological dynamics.

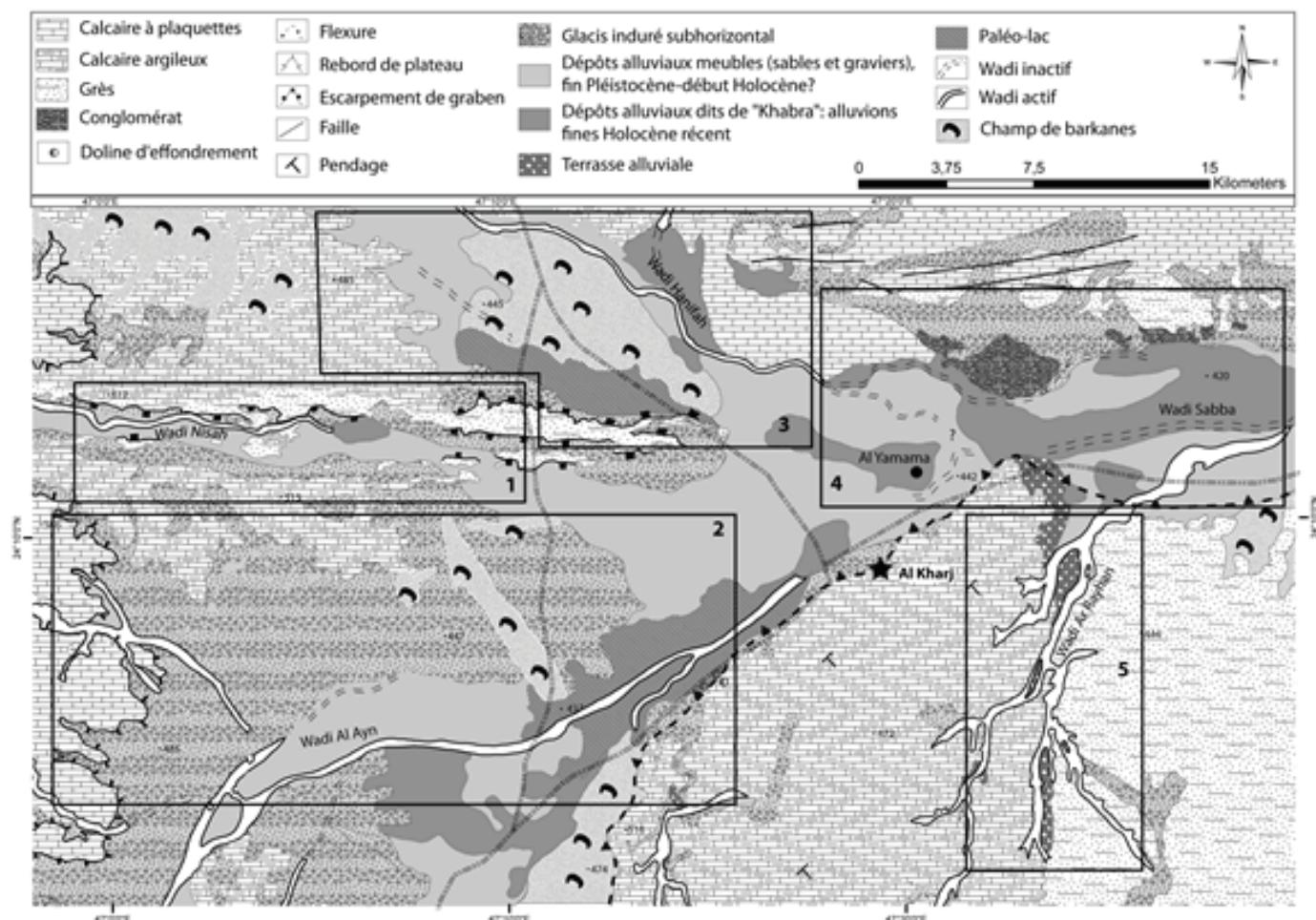


Figure 41: Location of the field-surveyed areas

Slope dynamics

The slope dynamics are very low in the region. These slopes are mainly affected by the phenomena of thermal fracturing. The fine particles (clay, silt, sand) are in turn subject to a sometimes intensive deflation, especially in the north of the Wādī Nisāḥ (many fields of Barkanes). South of the Wādī Nisāḥ, we note the presence of a large “glacis”, which lies at the foot of a limestone plateau (zone 2). This “glacis”, whose slope is very low, is cut through by the Wādī al-'Ayn. Even the slopes that are affected by large-scale faults are not subject to intense erosion, as in the north of the Wādī Sahba. Rivers often incise already fractured rocks (fig. 42) and their dynamics do not allow them to form large alluvial fans at the mouths of the valleys. The best clue to illustrate the weakness of these dynamics is archaeological. This is the cemetery located on the south side of Kharj: even the tombs on the line of the greatest slope are still in place and have not been affected by erosion.

Regionally, all the observations argue for a high slope stability, at least during the Holocene.

Wadi dynamics

Regionally, the three main wadis are the Wādī al-'Ayn to the south (zone 2), the Wādī Hanīfa to the northwest (zone 3-4), the Wādī Nisāḥ to the west (zone 1) and the Wādī al-Rayḥān to the east (zone 5).

Physiography

The Wādī Nisāḥ flowing is a graben and is bordered by the slopes of limestone and sandstone. Its course is constrained. Its course stops fairly quickly and it does not reach the plain of al-Yamāma.

Wādī al-'Ayn, to the south, is larger and has a few tributaries. They have incised the limestone plateau to the west and the large “glacis”. The talwegs are more pronounced but the bed of the Wādī al-'Ayn remains narrow and shallow in the plain. Currently, its course stops at the town of al-Kharj.

The Wādī Hanīfa is more complex. Associated with several tributaries, it is probably the cause of most of the alluvial sedimentation in the plain of Yamāma. It stops around Yamāma. Several palaeo-channels found downstream of the site, in the valley of Wādī Sahba, can however be attributed to him. This is a sign of more important past dynamics.

The Wādī al-Rayhān, southeastern part of the site, is the most active. The downstream part is still in water and is used for the irrigation of agricultural areas, particularly through a reservoir of approximately 200 meters in diameter. In the upper part, the Wādī al-Rayhān has incised its bed with well marked alluvial Pleistocene terraces. These terraces refer to past hydrological dynamics incommensurate with those currently underway and certainly back in the Pleistocene.

Terraces

The alluvial terraces are only present in the Wādī al-Rayhān. Several factors may explain their presence: it is a small stream and its slope is steeper than the other wadis. We can assume that it is most sensitive to past changes in climate and hydrology. The terraces are mainly located in the middle course as well as upstream. We found at least three different levels of terraces (Fig. 43). All are made of pebbles and gravel, sometimes cemented for the highest terraces. These terraces are the only morphological indicators of regional Quaternary climatic fluctuations.

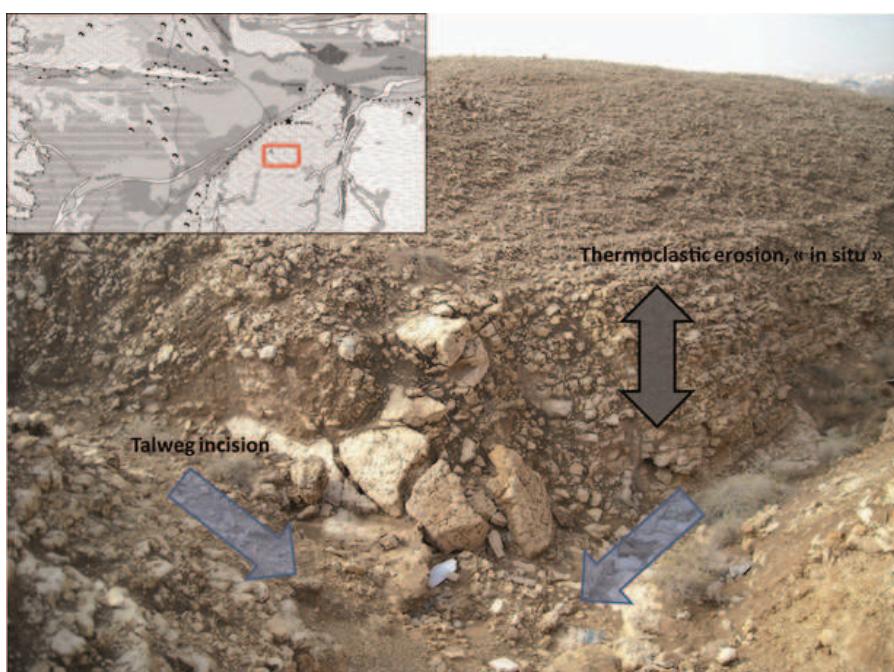


Figure 42 : «In-situ» thermoclastic erosion and incision of the talwags



Figure 43 : Alluvial terraces in the Wādī al-Rayhān

The lower alluvial terrace in the plain of al-Yamāma

The thickness of the Holocene alluvium is quite low in the plain of al-Yamāma. The study of abandoned wells in villages around the site shows the existence of a low terrace consisting of pebbles and gravel (fig. 44). This terrace refers to much more powerful past alluvial dynamics. The study of six different wells allows us to situate this terrace between 3 and 5 meters below the actual topographic surface. Without any absolute date, it is difficult to comment on the age of this lower terrace, but it is generally accepted in the Arabian Peninsula that these terraces were established during the Lateglacial or during the early Holocene. It can therefore be inferred a sedimentation of about 4 meters for the last 8000 years at the middle of the plain.

Palaeo-lakes (Fig. 45)

Southwest of Kharj and north of the Wādī Nisāḥ are two large flat areas. The first is currently crossed by the Wādī Al-'Ayn and the second is located at the foot of the graben, near a paleo-course of the Wādī Hanīfa (fig. 40).

These large tracts of former lakes were filled with water in favor of a rise of the water table, probably during periods of wetter climate. These lakes are conspicuous in topography. A survey conducted in the first lake indicates the presence of a very hard brown clay layer, about 60 cm deep. This clay, encrusted with gypsum, witnesses the sedimentological setting of a shallow water area. It is difficult to precisely date the end of the existence of these lakes. However, a radiocarbon date was made on a shell into the lake of the Wādī Hanīfa. The resulting date is: 7000 + - 400 y.BP.

General dynamic of the rivers

Overall, the Holocene dynamics are low. Sedimentation is slightly marked and refers to past dynamics. Surface flow is also very low. We can assume that most of the water resource is underground and is through groundwater underflow that could locally emerge and create lakes.

At this point of our study, we can conclude that the large surfaces of the Yamāma plain are today fossil surfaces, mainly affected by the phenomenon of deflation and accumulation of sand.

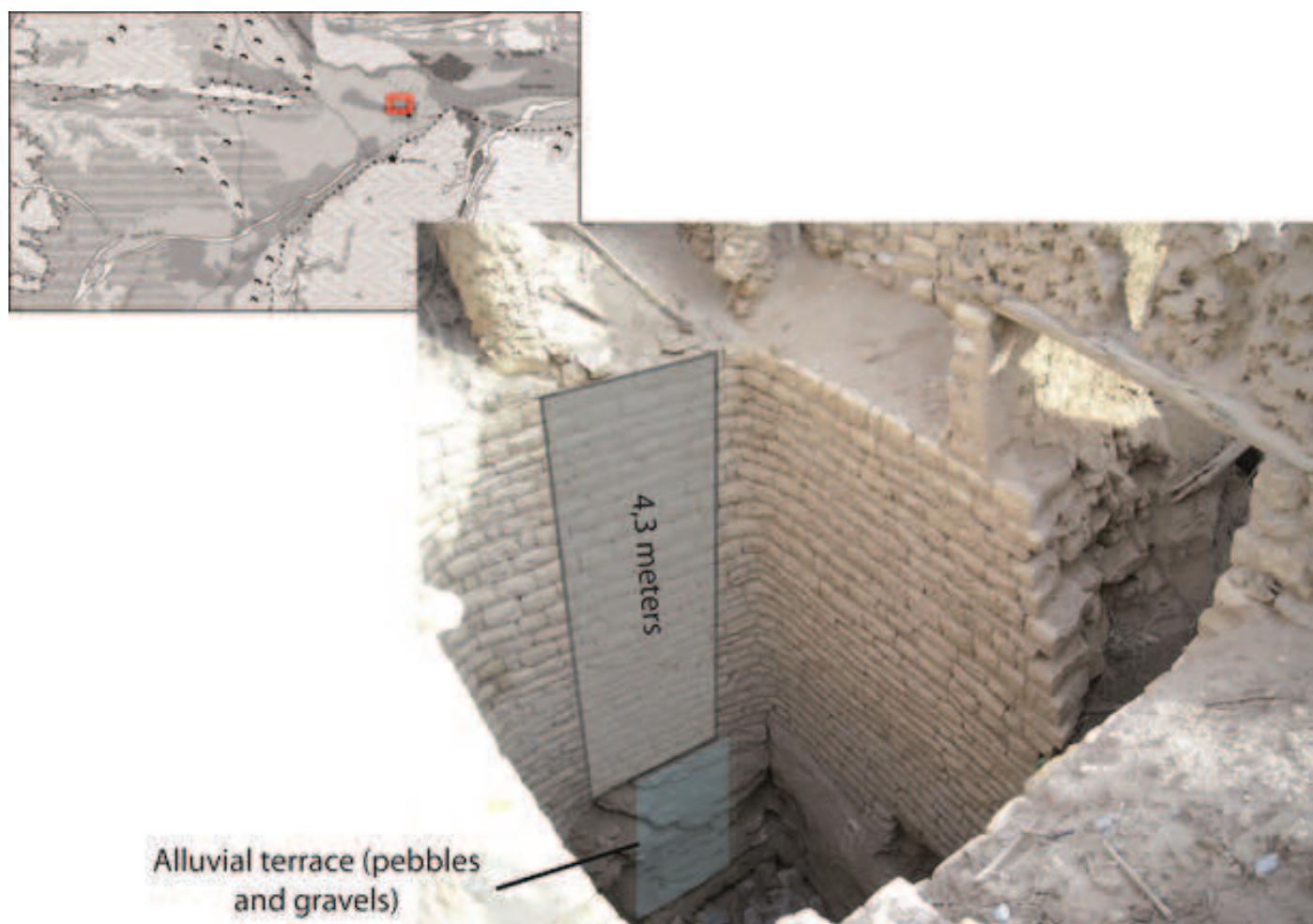


Figure 44 : Low alluvial terrace in the wells

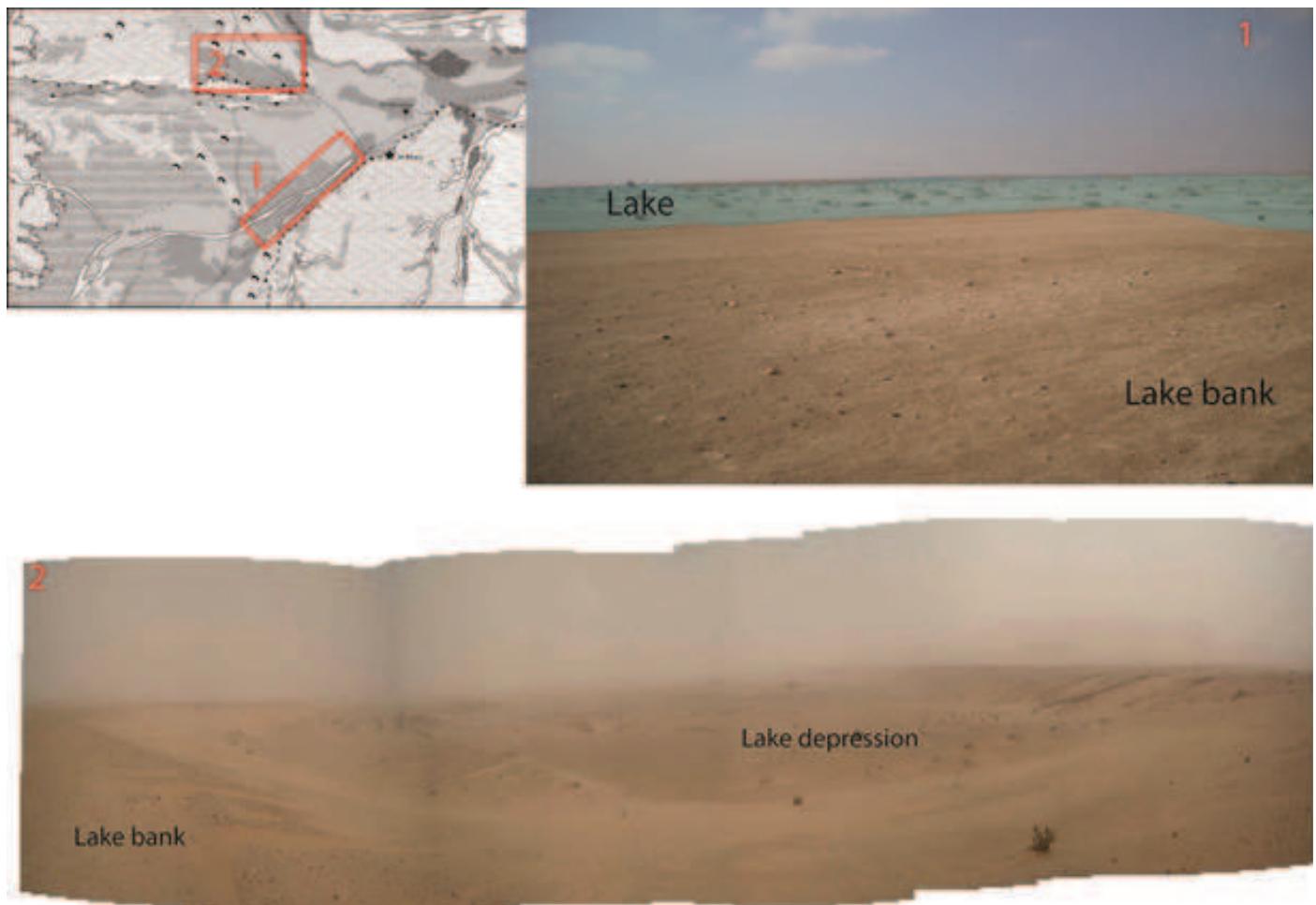


Figure 45: Pictures of the palaeolakes. The low topography clearly indicates the palaeo-banks

5 / Discussion on the links between geomorphological, palaeoenvironmental changes and human occupation

The issue of the water resource

In desert environments, this issue is central in archeology. It is also difficult because it requires to take into account the dynamics of past environmental indices which are sometimes tenuous.

In the plain of al-Yamāma, the last major flows back to the surface seem Late glacial and early Holocene, as evidenced by the existence of the lower terrace with observed in the wells. There is no evidence of development of surface water courses. Lakes must not even have been a valuable resource: the amount of gypsum found at their surface indicates a brackish or salty taste, so probably unsafe. Thus, the main source of water is groundwater.

This groundwater is underflow. Several archaeological evidences inform us on the weakness of this groundwater: the qanat near the Wādī Nisāh were dug several times (at least twice), which indicates a fast and important decrease of the water level, at least during the last 2000 years.

Today, irrigation is done by pumping fossil water about 300 meters below the surface.

The location of the archaeological sites

It is interesting to superimpose the archaeological map obtained during surveys and the geomorphological map drawn this year. All sites are located on stable areas and near formerly water areas.

During palaeolithics ages, the location of lithic resources is very important for many occupations which were found near quartzite deposits, never far from the actual wadis.

During the Bronze Age, the vast necropolises are all located on the slopes overlooking old water areas: south of al-Kharj, it overlooks the paleo-lake. In the graben of the Wādī Nisāh, they overlook the river and are located around the paleo-lake. In the Wādī al-Rayhān, dozens of similar tombs were discovered during the geomorphological survey: they are all located on a slope overlooking the river.

Study prospects

To further understand the relationship between archaeological and geomorphological dynamics, environmental contexts

should be studied throughout the Holocene.

- A systematic study of the fluvial terraces, combined with OSL dates should bring up a chronology of the hydrological dynamics throughout the late Quaternary.
- A drilling campaign in the plain of al-Yamāma, associated with radiocarbon dates should allow us to reconstruct the dynamics of the Holocene infilling.

The diachronic approach of the results, coupled with the results of archaeological surveys will make it possible to create maps of “predictive archaeology” that can answer archaeological questions as essential as the location of Neolithic sites.

6/ Conclusion

This first regional geomorphological study has allowed the creation of a geomorphological map. This study was conducted with several cartographic sources and an intensive field survey.

Overall, it appears from this study that the Holocene dynamics are very low in the area, the slopes are stable and only affected by deflation. The study of streams showed that their surface dynamics also are very low. The thickness of the Holocene alluvial plain confirms these low flows. Water resource is groundwater and through groundwater underflow, exceptionally on the surface.

The study of the past environmental dynamics is very important for the archaeological study of the area: it allows to understand the logic of implementation which eludes us today and helps to focus future archaeological surveys.

Preliminary studies for the consolidation of the archaeological remains in

Al Yamama Saudi Arabia



David Gandreau, archaeologist, Sébastien Moriset, architect, CRAterre-ENSAG, 23-30 November 2012
Mission organised by the CNRS - UMR 8167 "Orient et Méditerranée"



NOVEMBER 2012

CRAterre Project code: SAU 009

Preliminary studies for the consolidation of the archaeological remains in

84

Al Yamama Saudi Arabia

Mission undertaken by David Gandreau, archaeologist and Sébastien Moriset, architect, CRAterre-ENSAG
23-30 November 2012

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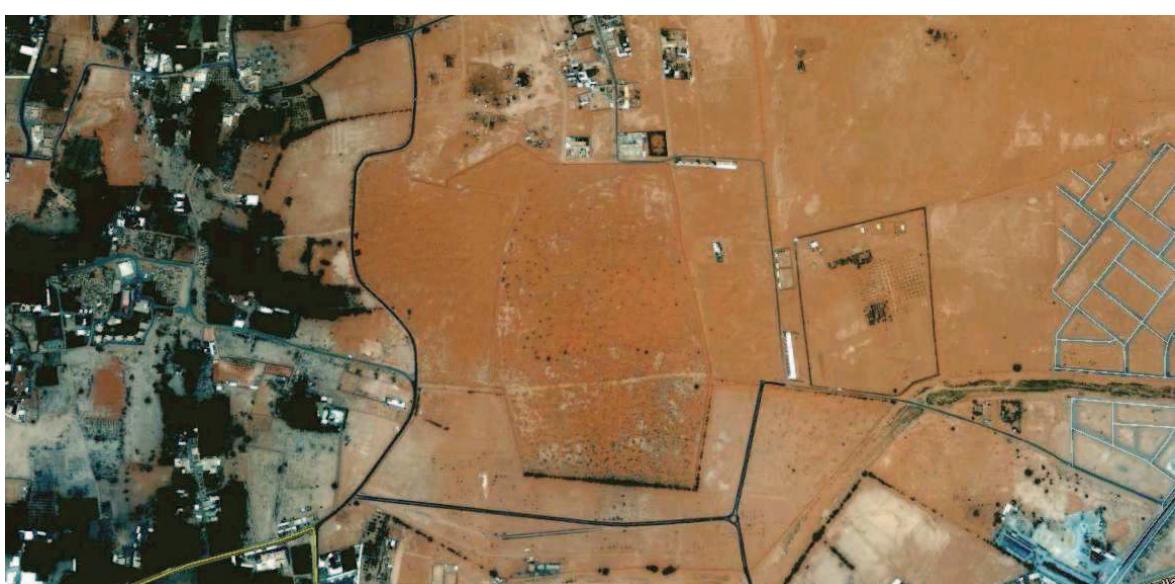
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Al Yamama in 2003, 2005 and 2011 (Google Earth images)

1. Preliminary assessment

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1.1. Main deterioration processes

The mission was too short to study the degradation processes in detail, but by observing and comparing with other sites in the region, we can already say that the ruins mainly suffer from natural factors. With time and with the implementation of a monitoring protocol, we will better understand how the structures deteriorate and how fast they crumble.

Natural factors

Humidity migration

Despite the depth of the water table, moisture movements take place every day in the sand. This can clearly be witnessed early in the morning; the top of walls and columns are very wet and the clay particles are swollen. This is particularly visible at the top of the columns. Water drops are also visible under the plastic sheets laid on the floor.

Capillary action particularly affects the exposed surfaces, where water evaporates. Standing walls being exposed to direct sunlight, they dry very quickly and suck out underground moisture. The core of the walls is not affected by this process.



Salt efflorescence

The presence of salt needs to be confirmed. But the lamellar structure of the wall surfaces show that the soil deteriorates in flakes. This is typical of salt efflorescence. A soil sample has been taken at the surface of a wall and will be analysed in France.



Rain

The mission team was lucky enough to observe the site under the rain, which is very rare in the region. This rain was coming from the southwest. Only the top surfaces and the vertical surfaces exposed to the southwest were wet.



Wind

The wind can blow continuously for days, and sand storms are frequent. The sand is especially destructive to surfaces moistened by capillarity or more rarely by rains. The wind becomes even more destructive when it carries sand.



Human factors

Uncontrolled activities

The site is relatively well protected at the moment, but young people actually jump the fence to stroll on the site. We could see this when we visited the site on Tuesday afternoon. This is not a serious problem for the moment, but it could become one if they decide to turn the site into a playground for quad bikes.

Archaeological campaigns

Even if archaeologists are very careful, excavation campaigns bring many workers on site, and the movement of wheelbarrows and people contribute to the deterioration of exposed surfaces. Walls also suffer abrasion when sand is removed from the ruins. The clearing of house N°2 showed that workers easily scratch the walls with their shovels and buckets when removing sand.



1.2. SWOT Analysis

Strengths

- Outstanding heritage.
- The excavated elements are well conserved.
- The site is apparently well drained (topography and sandy nature of the ground, very low water table).
- The site is legally protected and entirely fenced.
- Local inhabitants show interest for the site.
- Scientific research is ongoing.
- Vandalism is not a problem.
- The Saudi-French scientific team is dynamic and very open. They consider conservation a necessity and want to plan conservation measures.
- The excavated elements are rather stable (large diameter of the columns in the mosque).

Weaknesses

- The site is surrounded by the city. Urban development seems to be uncontrolled.
- Remains are exposed to weathering after excavation. The top of the columns for example retain water.
- There are visible traces of efflorescence and rising damp.
- Erosion of humid surfaces by wind and sand is continuous
- Pathways during excavations erode the remains.
- No permanent conservation/maintenance team.

Opportunities

- The urban context and the presence of an antiquities office is an opportunity to integrate the site in the city development policy.
- Local authorities can easily be brought to the site.
- Local capacities to manage and conserve archaeological sites made of earth could be developed.
- Excavation and conservation works can be coordinated.
- Many conservation techniques can be implemented in this urban context (preventive conservation techniques, maintenance between excavation campaign, temporary shelters, reburial, permanent sheltering ...) because the materials and technical capacities are available on site.
- Local people can be targeted as direct beneficiaries if the site is opened to the public.
- Conservation techniques can be tested on small structures before being applied on the mosque.
- Technicians of the Antiquities office can ensure regular monitoring of the site (monitoring). Riyadh is not far, archaeology students could be invited to participate to on-site training sessions.
- The Ad-Diryah experience offers interesting comparison.

Threats

- Permanent silting.
- Sand storms.
- Fast and extensive excavations.
- Trampling of walls during excavation campaigns
- Limited funding.

2. Field experimentations

2.1. Mortar preparation

On the first day of the mission, the surroundings of the site were explored to source soil quarries, but none could be found. It seems that the soil was taken from the river bed of the Wadi, on the western side of the site. But due to important silting of the area, we could not find any soil at the surface of the ground.

We therefore decided to acquire soil from the ruins of mud buildings, approximately 1 km away from the site. Only bricks from collapsed walls were taken. Simple field tests showed that this soil is very similar to the soil used for the walls of the mosque on site.

The mortar was prepared 2 days in advance, which is a minimum. The mortar was prepared as follows:

Day 1

1. spreading a waterproof tarpaulin on the ground to keep the mixture wet
2. spreading broken bricks on the tarpaulin
3. sprinkling large quantities of water on the bricks
4. premixing to allow penetration of water in the mixture
5. Addition of camel dung, previously crushed
6. Addition of straw, cut in short sections (less than 3 cm)
7. Second mix to integrate the straw and the dung into the mixture
8. Addition of water. The mix should be almost liquid
9. Wet curing overnight

Day 2

10. Remixing and addition of water if necessary

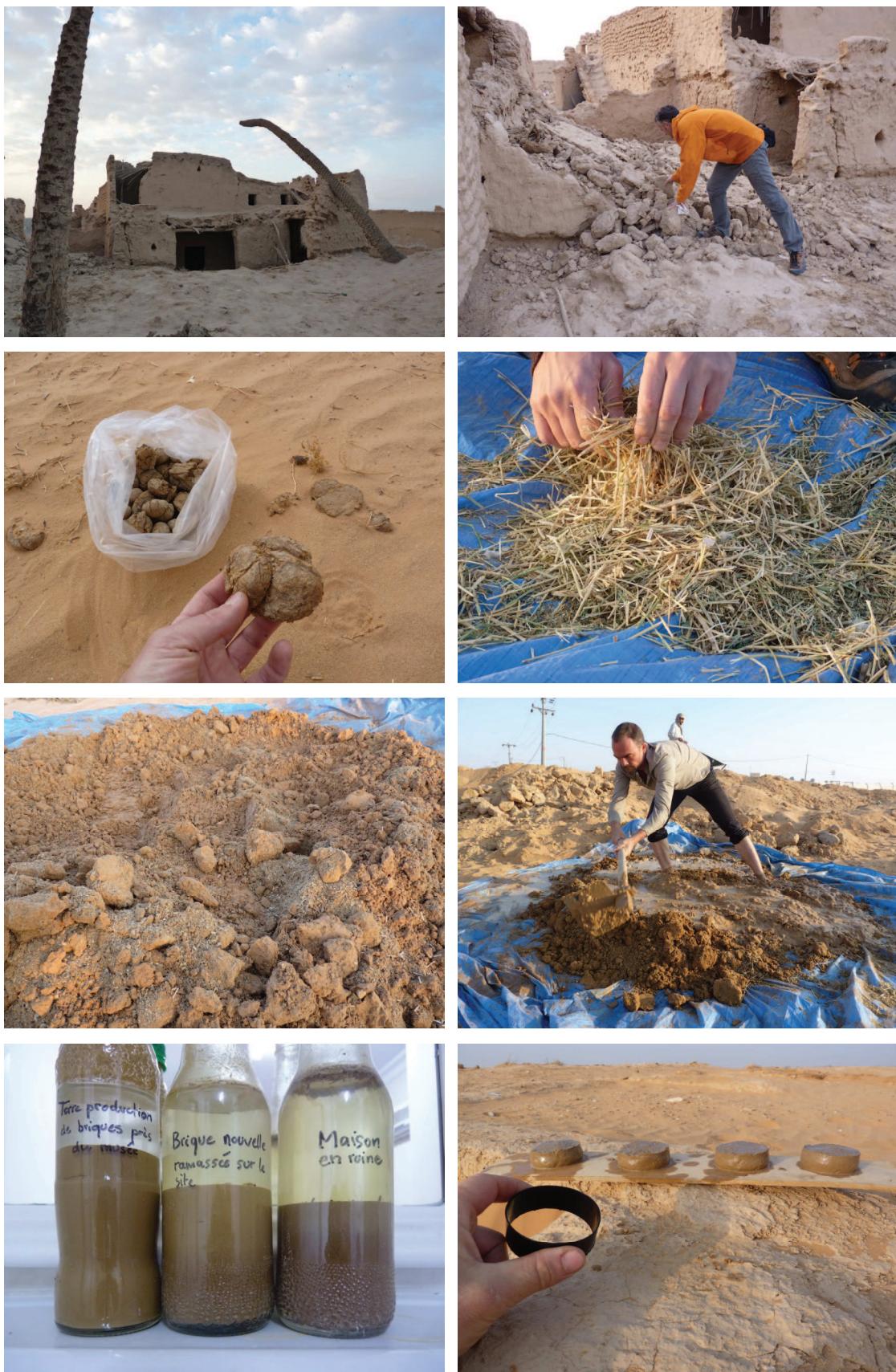
Day 3

11. Remixing and use

Quantities used for the first mortar mixtures

	First mortar mix	Second mortar mix
Soil	250 litres	500 litres
Water*	50 litres	90 litres
Straw (straw mainly serves to reduce shrinkage)	25 litres	40 litres
Camel Dung (to reinforce the resistance to erosion)	20 litres	50 litres

* The quantity of water needed varies depending on the climatic condition and humidity content in the bricks.



Photos illustrating the mortar preparation

2.2. Conservation samples

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Saving Al-Yamama archaeological remains is a great challenge. Earth is a rather fragile material, and soft interventions are compulsory to avoid serious disturbances. Past experiences have proved that vigorous conservation methods changing the physical properties of the material (sealing earth surfaces with chemicals or applying waterproof layers) or introducing new materials, are generally ineffective and often irreversible.

It is therefore proposed to follow a slow experimentation process to develop specific conservation techniques, adapted both to the local context and to international conservation norms. Large scale conservation programmes will only be possible after testing preventive conservation options at an experimental scale during a 2-3 years period.

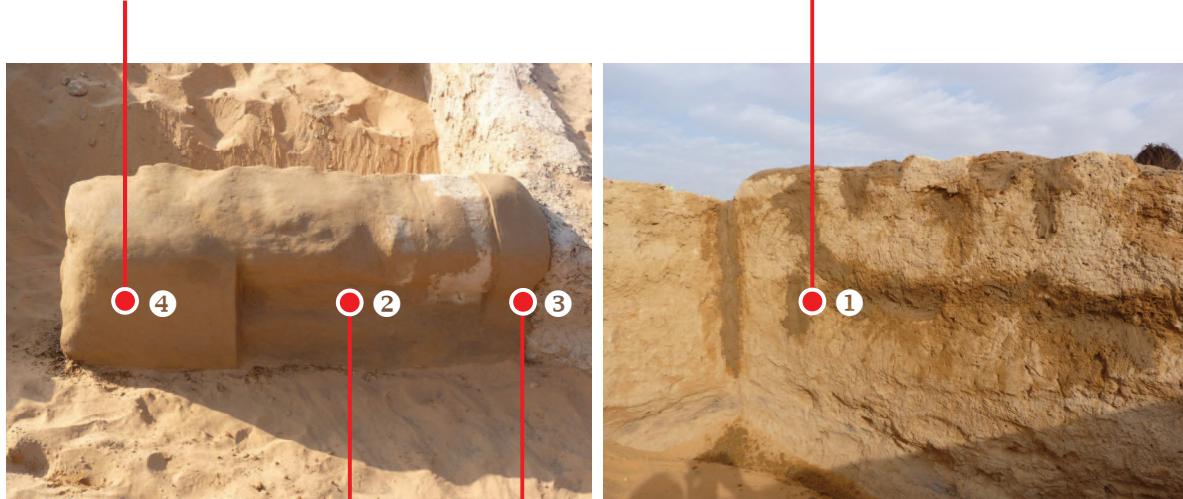
The proposed interventions make use of the same soil as the original one. The only exception is the rice bags (jute fabric), which has been used in one sample to separate the original fabric from the conserved part, but also to reinforce the mortar.

Sample 1: minimal surface repairs

Thickness : 0-3 mm, not applied everywhere

Sample 4: Partial reconstruction of vertical surfaces

Thickness : 10-100 mm, depending on the shape of the eroded surface



Sample 2: thin sacrificial layer

Thickness : 3-5 mm

Sample 3: thick sacrificial layer, with or without reinforcement

Thickness: 20-30 mm

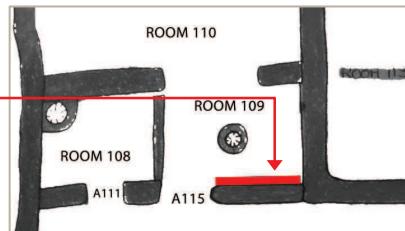
Sample 1: minimal surface repairs

Location: Southern elevation of the test wall

Thickness : 0-3 mm, not applied everywhere

Materials : mud mortar (soil, water, straw and camel dung)

Quantities : Approximately 1 litre of mud mortar per m²



Implementation steps:

- Clearing the sand around the wall ①
- Cleaning the wall with a brush to remove the sand and other loose elements ②
- Sprinkling water onto the clean wall surface ③
- Filling of cracks, gullies, voids and depressions with a thin layer of mortar applied by hand and with a brush ④
- Curing overnight
- Checking after 24 hours to eventually add mortar where needed.
- Gentle brushing of the surface with a mud slurry to fill in the hair cracks and seal the surface ⑤

Output : 20-40 m² per day for 2 workers, excluding soil preparation time

Mobilization: One day + a few hours



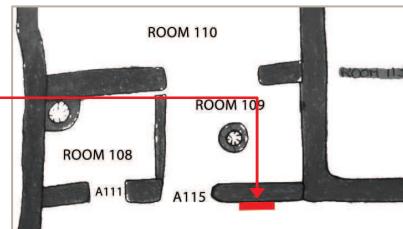
Sample 2: thin sacrificial layer

Location: Northern elevation of the test wall, in the central part

Thickness : 3-5 mm

Materials : mud mortar (soil, water, straw and camel dung)

Quantities : 3-5 litres (1 bucket) of mud mortar per m²

*Implementation steps:*

- Clearing the sand around the wall ①
- Cleaning the wall with a brush to remove the sand and other loose elements ②
- Sprinkling water onto the clean wall surface ③
- Filling of cracks, gullies, voids and depressions with a thin layer of mortar applied with the hand and if needed with a brush. Water should not be applied on the mortar to smoothen it. It would lead to cracks. ④
- ☀ Drying (2-3 hours)
- Application of the thin mud layer by hand ⑤
- ⚒ Curing overnight
- Gentle brushing of the surface with a mud slurry to fill in the hair cracks and seal the surface ⑥

Output : 10-15 m² per day for 2 workers, excluding soil preparation time

Mobilization: 1 day



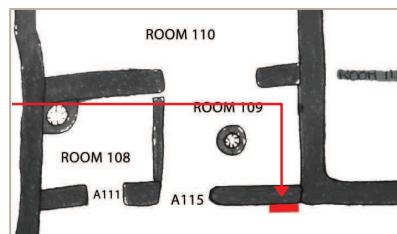
Sample 3: thick sacrificial layer, with or without reinforcement

Location: Northern elevation of the test wall, on the right hand side

Thickness: 20-30 mm

Materials: mud mortar (soil, water, straw, camel dung) rice bags

Quantities: 20-30 litres of mud mortar per m²



Implementation steps:

- Clearing the sand around the wall ①
- Cleaning the wall with a brush to remove the sand and other loose elements ②
- Sprinkling of water onto the clean wall surface ③
- Filling cracks, gullies, voids and depressions with a thin layer of mortar ④
- ☀ Drying (2-3 hours)
- Application of an even mud layer by hand (10-15 mm thick), following the shape of the wall ⑤
- ⚒ Curing overnight
 - *Optional reinforcement:* Application of a mud slurry on the surface
 - *Optional reinforcement:* Pasting rice bags onto the surface, after soaking them in the slurry ⑥
- ☀ Drying (2-3 hours)
- Application of a second mud layer by hand (10-15 mm thick) ⑦
- ⚒ Curing overnight
- Gentle brushing of the surface with a mud slurry to fill in the hair cracks and seal the surface.
- Cleaning of the site

Output: 4-6 m² per day for 2 workers, excluding soil preparation time

Mobilization: 3 days + a few hours



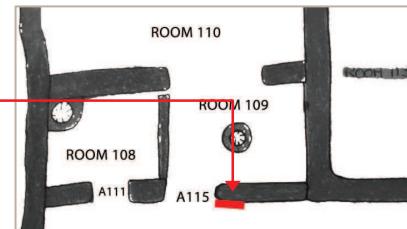
Sample 4: Partial reconstruction of vertical surfaces

Location: Northern elevation of the test wall, on the left hand side

Thickness : 10-100 mm, depending on the shape of the wall

Materials : mud mortar (soil, water, straw, dung and broken bricks)

Quantities : 50-100 litres of mud mortar per m²



Implementation steps :

- Preparation, see option 1
- Application of an even mud layer by hand (10-15 mm thick), following the shape of the wall ①
- Curing overnight
- Application of a second mud layer by hand (10-15 mm thick)
- Pasting pieces of broken bricks in the fresh mortar to recreate the missing earth volume. If the undercut is too high, the infill should be done in steps, filling 30 cm maximum per day ②
- Curing overnight
- Filling the gaps between the brick pieces with mud mortar ③
- Curing overnight
- Checking after 24 hours to eventually add mortar where needed
- Application of a final mud layer to level the wall (5 mm thick)
- Drying (2-3 hours) ④
- Gentle brushing of the surface with a mud slurry to fill in the hair cracks and seal the surface ④
- Cleaning of the site

Output : 1-3 m² per day for 2 workers, excluding soil preparation time

Mobilization: 4 days. This sample was actually prepared within 2 days because of the little time available. This is not recommended, because it leads to cracking and flaking.



3. Recommendations

3.1. Planning

The future should be planned with the authorities to define a shared vision for this site. It is still too soon to produce a detailed site presentation strategy, but it is important to share important questions with the authorities, such as:

- What will happen to the site once it has been searched?
- What role will the site play in the city?
 - education?
 - science?
 - recreation?
- Should it be developed or backfilled? Can we afford to maintain it?
- Which kind of visitors do we want, and what do we provide to make their stay enjoyable?
- Who will take care of the site, guide visitors ?
- How do we ensure that developments in the buffer zone do not conflict with the site values?
- Etc ...

The issue of the buffer zone should also be discussed with the authorities. The satellite images reveal how fast this area develops. Two houses are currently under construction near the site, one on the northern side and on the eastern side. The city council has probably drawn detailed plans which could be examined and discussed with them, to make sure that new developments do not threaten the site. If they do threaten the site, specific measures could be defined to mitigate their impact. By-laws could be taken for instance to limit the height of new buildings erected in the buffer zone.



What will happen to this area in the future?

*Mitigation measures should be planned now to reduce the impact of development on the archaeological site.
(based on Google Earth image 2011)*



3.2. Conservation

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Conservation options for the remains

To conserve Al Yamama archaeological remains, we suggest different technical options depending on:

- the significance of the element,
- the size of the element,
- the orientation (exposure or not to harsh climate conditions),
- the scarcity of this type of element on site,
- the educational value,
- etc...

There is no single conservation option that can be applied to the entire site, but rather a series of conservation techniques that will suit specific situations. A scientific committee composed of members of the Franco-Saudi team has to be set-up to decide on the best option for each element.



Conservation options for each element should be decided in group discussions

Option 1: backfilling with sand

This option was already tested in 2011. It is effective but time consuming. In the future, this option can be used to protect rare and very fragile elements, but without inserting the waterproof membrane in between the soil and the sand (plastic sheet or tarpaulin). It makes sense to insert a thin material to indicate the difference between the excavated and unburied levels, but this material should breathe. A porous geotextile or rice bags can do the work.

Even if backfilling offers good protection against wind erosion and efflorescence, it should be noted that the process of removing sand has proved to be quite destructive, because of the workers movements around the structures.

Option 2: thin sacrificial layer

This is a minimal approach which has been shown during the mission. The layer is called "sacrificial" because it suffers the erosion instead of the original fabric.

Applying this thin layer only helps to reconnect fragile elements to the wall, and avoid gullies when it rains. A new layer should be applied every year. The sacrificial layer is applied by hand on a clean and moistened wall.

Option 3: thick sacrificial layer (with or without reinforcement)

A thicker layer can also be applied onto the walls, especially on the top. Proper preparation of the surfaces is essential to avoid problems such as : cracks, glazing or lack of adherence. Preparation consists in coating the wall with the thin layer described before (option 2), which allows the mortar to stick to the fragile surfaces.

The soil should be applied in the shade preferably, to avoid fast drying and cracking. If the wall is exposed to the sun, the mortar can be applied at the end of the afternoon. Each layer should be no more than 1,5 cm thick since fragile walls cannot withstand heavy coatings. This means that 2-3 layers of soil are necessary. Complete drying is necessary in between each new layer. The entire process can last 3 to 5 days, depending on the curing speed.

Option 4: partial reconstruction (of the top and vertical surfaces)

This option has only been demonstrated on a vertical surface during the mission, but it can also be applied on horizontal surfaces, as it was done in Fayaz Tepa, Uzbekistan (see images in appendix 1).

Reconstruction is particularly interesting to reveal walls to visitors, when the ruins do not project beyond the sand surface. It also reduces the effect of destruction by trampling by visitors. Workers hardly walk on reconstructed walls; they rather use them as benches, which is less destructive.

In the case of Al-Yamama, adding 2 to 3 layers of mud bricks at the top of the walls would be sufficient to protect the walls for several years and help the visitor understand how the houses were organised.

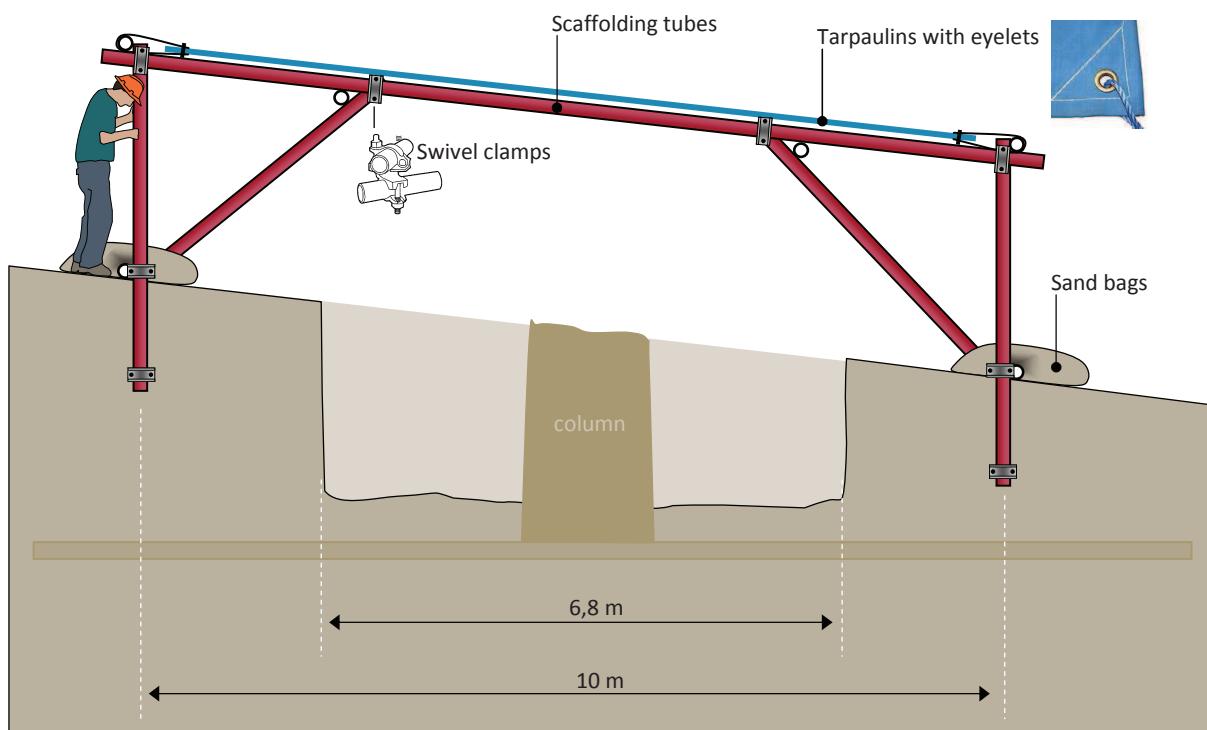
Option 5: sheltering

To protect walls which have lost the roof that originally protected them, creating a new shelter can be an option. But sheltering has proved to be a very expensive and sensitive option, because many parameters need to be considered. The cost is one of them. A shelter is not an everlasting solution, it requires regular maintenance and replacement after some times. This option should be reserved to the most sensitive elements such as the mosque, which is unique. Regardless of the visual impact, protecting shelters require careful studies first, for a deep understanding of the complex decay factors, and to avoid endangering the structures.

Specific conservation options for the columns of the mosque

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	Backfilling	Wrapping	Sacrificial layer	Temporary Roof
Advantages	<ul style="list-style-type: none"> - Known to be efficient - Easy to implement - No skills required - Cheap - Reversible - The columns are safe 	<ul style="list-style-type: none"> - Easy to implement - Fast - Cheap - Reversible 	<ul style="list-style-type: none"> - Easy to implement - Fast - Cheap - Discrete - Reversible 	<ul style="list-style-type: none"> - Easy to build with scaffolding tubes and tarpaulin - Can be dismantled and re-assembled every year - No maintenance - The columns remain visible for visits or monitoring
Inconvenients	<ul style="list-style-type: none"> - Time consuming - Wheelbarrows, shovels and workers damage the walls - The columns are not visible 	<ul style="list-style-type: none"> - Not yet experimented - The columns are hidden - Unsightly - Visitors may try to tear the material to see what is behind 	<ul style="list-style-type: none"> - Requires yearly maintenance - Requires an experimental phase on the materials 	<ul style="list-style-type: none"> - Requires to drill holes in the archaeological layers - Unsightly - No physical protection - People or animals may use the sheltered space to rest/picnic : risk of deterioration



4. Proposal for CRAterre interventions in 2013-2014

4.1. Framework

Saudi Arabia has a rich and diverse earthen heritage, which demonstrates the talent of its artisans and the performance of earth, which has been used as a building material in many areas, until the end of the 20th Century. This material is very present in the archaeological context, as confirmed by the excavations started in 2011 at Al Yamama by a Franco-Saudi team. They revealed several mud structures including a mosque buried in the sand. At the request of Mr. Jeremie Schiettecatte, co-director of the excavation, a first technical expertise mission was carried out from the 24th to the 30th November 2012 by two CRAterre experts to advise on the conservation of the uncovered remains. Avenues of cooperation with the Saudi authorities for the management and conservation of earthen heritage in Saudi Arabia were also discussed with the Counsellor for Cooperation and Cultural action at the Embassy of France, Mr. Jean Louis Laveille before and during the mission.

4.2. Objectives

Develop a pilot project on Al-Yamama for the conservation of Saudi archaeological heritage together with the Saudi French archaeological mission to:

- Build Capacities in terms of earthen heritage conservation



- Define and implement conservation techniques that can be applied in between excavation campaigns



- Plan the site development



4.3. Activities

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2013

january february march april may june july august septem octobre novemb decemb

Fundraising

Preliminary studies

Definition of a site development plan (concepts and strategies)

Mission 1



- Presentation or the study to Saudi and foreign stakeholders
- Discussion and adjustment of the preliminary project and discussions on the vision
- Preparation of mission 2



Mission 2



- Experimentation
- On-site training on conservation for technicians
- Data collection for the conservation and site presentation project (phase 1)

2014

january february march april may june july august septem octobre novemb decemb

Graphic work

Additional studies for the site presentation



Mission 3



- Presentation Data collection for the conservation and site presentation project (phase 2)
- 2 training sessions for the Antiquities staff

Mission 4



- On-site training on conservation for technicians
- Implementation of the site presentation project (phase 1)
- Planning of further activities

4.4. Cost estimate

Missions (4 missions, 8 flights, visas, per diems)	21 000 €
Fees (120 days for preparation, graphic work, missions and reporting)	54 000 €
TOTAL	75 000 €

This cost excludes the cost of presentation materials (presentation panels, stands, etc...)

5. Appendix

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5.1. Mission content

Friday	23	Trip Grenoble → Al-Kharj
Saturday	24	Site visit Work on the report Preparation of a PowerPoint presentation on the conservation options
Sunday	25	Preparation of a mortar sample with materials collected in the landscape (mud bricks from ruins, straw, water and camel dung) Sand removal in room 109, sector 7 to prepare for the testing of sacrificial mortars Discussion of conservation options with the French archaeological team
Monday	26	Meeting with Jean-Louis Laveille, Counsellor for Cooperation and Cultural affairs Visit of Al-Kharj private museum Work on the temporary protection options
Tuesday	27	Sacrificial mortar testing Discussions on the protection options Sourcing soil quarries
Wednesday	28	Preparing a new mortar mixture Filing-in hair cracks in the sacrificial layer Visit of At-Turaif District in Ad-Dir'iyah, World Heritage Site
Thursday	29	Visit of the site under the rain Discussion with the team on the conservation options Correction of the report with Jeremie
Friday	30	Work on the report Trip back Al-Kharj → Grenoble
Sunday	1	Arrival in France

PROSPECTIVE RECOMMENDATIONS

13/ Prospective recommendations

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Improving touristic development by preventing site destruction

By its location in the vicinity of al-Riyadh, a touristic development of al-Kharj area is highly conceivable by the combination of its natural and archaeological potential.

An archaeological tour could be easily realized, going through the Bronze Age necropolises of 'Ayn al-Dila' and al-'Afja, the sources of 'Ayn al-Dila', the qanat of 'Ayn Farzān, the archaeological site of al-Yamāma and the ancient mud-brick villages of Salmiyya and Yamāma.

Nevertheless, none of this could be done if these sites are not protected from the threat of an imminent destruction. During our survey of the oasis of al-Kharj, it appeared that some of the archaeological sites mentioned in the late 1970's or in the 1990's had been destroyed by the ongoing urbanization, industrialization and agricultural practices in the area.

Moreover, presently, two archaeological sites are under the immediate threat of this process:

- the qanat at Ayn Farzān (fig. 46) ;
- the Bronze-Age necropolis at al-Afja (fig. 47-48).

These two sites are unique, by their location, the scientific information they hold and the touristic potential they have. Therefore, we urge the Saudi Commission for Tourism and Antiquities to make their best to:

- acquire the plot of land where these sites are located (fig. 49-50).
- fence these areas in order to prevent destruction, looting, or damaging by rubbish deposit.



Figure 46: the ongoing process of damaging and destruction of the qanat at 'Ayn Farzān

PROSPECTIVE RECOMMENDATIONS

PROSPECTIVE RECOMMENDATIONS

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Figure 47: Al-'Afja: uniqueness of the bronze age necropolis in the area



Figure 48: Al-'Afja: the threat of mountain quarrying over the necropolis

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PROSPECTIVE RECOMMENDATIONS

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Figure 49: al-'Afja: area to protect (red: in priority - purple: in a second time).



Figure 50: 'Ayn Farzān: area to protect in priority

PROSPECTIVE RECOMMENDATIONS

PROSPECTIVE RECOMMENDATIONS

Preventing the destruction of valuable remains at al-Yamāma by enlarging the fence

Outside the fenced area of the archaeological site at al-Yamāma, two areas yielded evidence of remains of outmost importance (fig. 51):

- to the northwest of the site, under modern camel enclosures, the remains of a huge building, possibly being a former palace or an elite residential building, are visible on the ground. They have been mapped during the 2nd field season. They would deserve to be protected and excavated.

- to the southwest of the site, near modern camel enclosures, a small trench has been done this season, showing the presence of Islamic pottery workshops of uttermost importance. They attest a large scale pre-industrial production of pottery in Central Arabia that might have flooded the market in the Peninsula during the Abbasid period. To protect this area and to excavate the remains would provide us with valuable information regarding the economic practices during the early Islamic period and regarding the commercial network within the Peninsula at that time.

Therefore, we urge the SCTA on purchasing and protecting these areas so as to prevent the destruction of unique archaeological features in Central Arabia and to enable their exploration in the immediate future.

Restoring the mosque at al-Yamāma

A restoration project for the mosque excavated at al-Yamāma has been proposed (pages 101-102) of the present report. It would be the first step toward touristic development on the site of al-Yamāma. It includes the formation of specialists in Saudi Arabia. We call upon the SCTA's authorities to consider it and to inform us about eventual remarks and about the acceptance of the SCTA to finance this project.

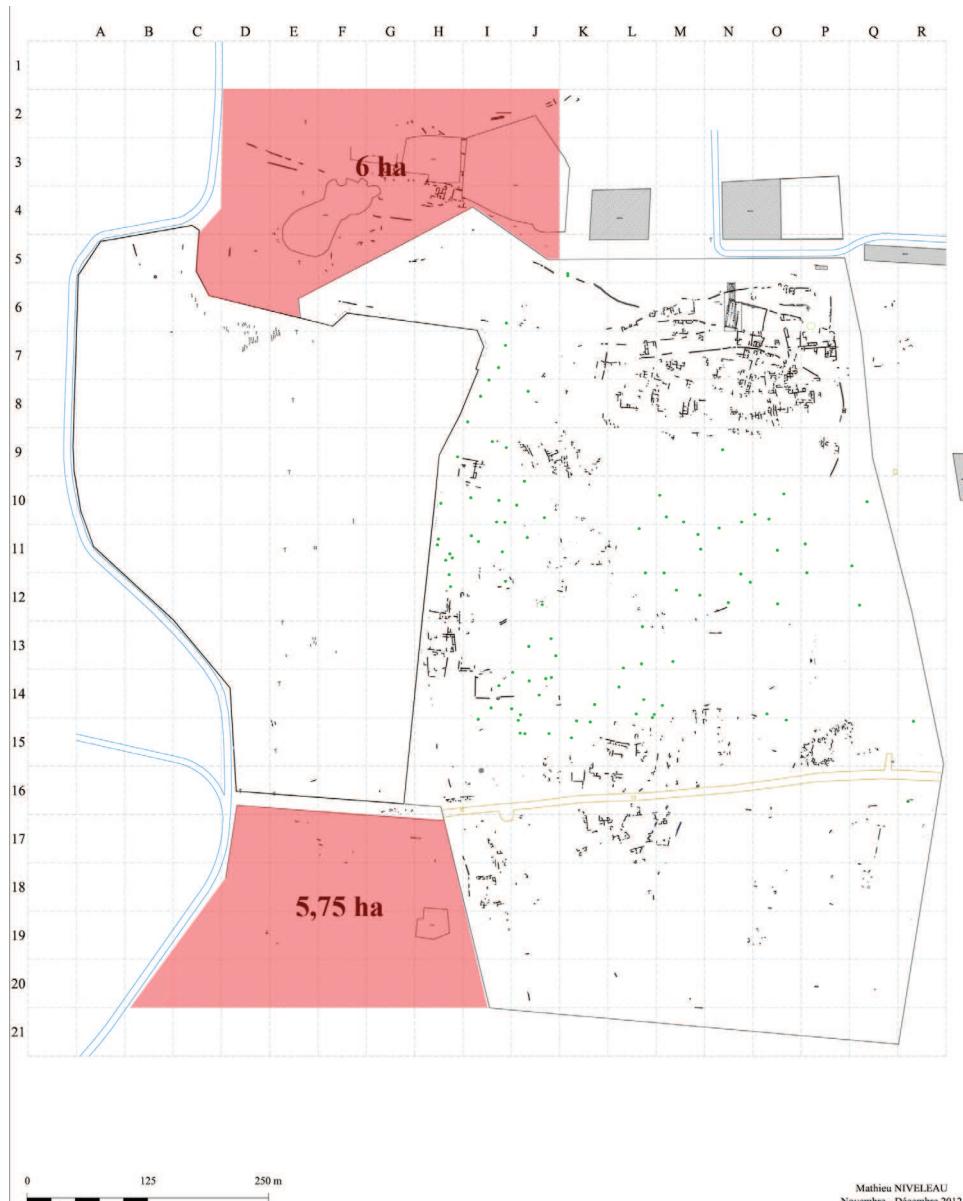


Figure 51: Areas to be fenced around the archaeological site of al-Yamāma

PROSPECTIVE RECOMMENDATIONS

References

- Barone R. 1986. *Anatomie comparée des mammifères domestiques. Tome 1. Ostéologie*. Vigot Frères Éds, Paris.
- 108** Bettini, L. 1998. Alimentation et poésie: un exemple du “Taghil al-Gahiliyya”. *Arabica* 45: 73-87.
- Boessneck, J., Müller, H.-H., Teichert, M. 1964. *Osteologische Unterscheidungsmerkmale zwischen Schaf* (*Ovis aries*, Linné) und Ziege (*Capra hircus*, Linné). *Kühn-Archiv* 78.
- Bonilauri S., Boëda É., Griggo G., Al-Sakhel H., Muhsen S. 1990. Un éclat de silex moustérien coincé dans un bassin d'autruche (*Struthio camelus*) à Umm El Tlel (Syrie centrale). *Paléorient* 33(2): 39-46.
- Driesch von den A., Obermaier M. 2007. *The hunt for wild dromedaries during the 3rd and 2nd millennia BC on the United Arab Emirates coast Camel bone finds from the excavations at Al Sufooh 2, Dubai, UAE*. Documenta Archaeobiologiae 6, 133-167.
- Horwitz L.K., Rosen B. 2005. A review of camel milking in the Southern Levant. In Mulville, J. & Outram, A.K. (Eds), *The Zooarchaeology of Fats, Oils, Milk and Dairying, Proceedings of the 9th ICAZ Conference*, Durham 2002, Oxbow Books, Oxford, p. 121-131.
- Hutterer, R. 2008. *Paraechinus aethiopicus*. In, *IUCN 2012. IUCN Red List of Threatened Species*. Version 2012.2. <www.iucnredlist.org>
- Monchot H, Léchelle J. 2002. Statistical non parametric methods for the study of fossil populations. *Paleobiology*, 28(1), p. 55-69.
- Monchot, H. In press The faunal remains: preliminary results. In, Charloux G. & Loreto R. (Eds.) *Dûma II. Report of the Saudi-Italian-French Archaeological Project at Dûmat al-Jandal (Saudi Arabia)*. Saudi Commission for Tourism and antiquities.
- Munro, N.D., Bar-Oz, G., Hill, A.C. 2011. An exploration of character traits and linear measurements for sexing mountain gazelle (*Gazella gazella*) skeletons. *Journal of Archaeological Science* 38: 1253-1265.
- Payne S. 1973. Kill-off patterns in sheep and goats: the mandibles from Asvan Kale. *Anatolian Studies* 23, 281-303.
- Peters J. 1989. Osteomorphological features of the appendicular skeleton of gazelles, genus *Gazella* Blainville 1816, Bohor Reedbuck, *Redunca redunca* (Pallas, 1767) and Bushbuck, *Tragelaphus scriptus* (Pallas, 1766). *Anat. Histol. Embryol.* 18: 97-113.
- Smith I. 2005. The mammal, Bird, Reptile and Molluscs remains . In, Insoll, T. Ed, *The Land of Enki in the Islamic Era. Pearls, Palms and Religious identity in Bahrain*, London-New-York-Bahrain, Kegan Paul: 193-231.
- Smuts M.M.S., Bezuidenhout A.J. 1987. *Anatomy of the dromedary*. Clarendon Press, pp. 230.
- Steiger C. 1990. *Vergleichend morphologische Unter-suchungen an einzelknochen des postkranialen Skeletts des Alt-weltkamele*. Gedruckte Dissertation, Ludwig-Maximilians-Universität, München.
- Studer J., Schneider A., 2008. Camel use in the Petra Region, Jordan: 1st century AD. In, Vila, E., Gourichon, L., Choyke, A.M. & Buitenhuis, H. (Eds.). *Archaeozoology of the Near East VIII, 2. International Symposium on the Archaeozoology of Southwestern Asia and Adjacent Areas*, 8, Lyon: Maison de l'Orient et de la Méditerranée, p. 581-596.
- Studer J. 2010. Preliminary Report on Faunal Remains. In: L. Nehmé, D. al-Talhi and F. Villeneuve (ed.). Unpublished report. *Report on the Third Excavation Season (2010) of the Madâ'in Salih Archaeological Project*: 285-293. Unpublished report. <http://halshs.archives-ouvertes.fr/halshs-00542793>

Studer J. 2011. Étude préliminaire des ossements analysés en 2011. In : Nehmé L (dir.), *Rapport sur la quatrième campagne (2011) de la mission archéologique de Madâ'in Sâlih* (unpublished report).

Thesiger, W. 1978. *Le Désert des déserts*. Plon, collection Terre humaine.

Thigani Elmahi, A. 2002. The spiny-tailed lizard: a constituent of the occasional diet of traditional inland societies in Oman. *Proceedings of the Seminar for Arabian Studies* 32: 31-46.

Thouless, C.R., Grainger, J.G., Shobrak, M., Habibi, K. 1991. Conservation status of gazelles in Saudi Arabia. *Biological Conservation* 58: 85-98.

Vaslet D., al-Muallem M.S., Maddah S.S., Brosse J. M., Fourniguet J., Breton J.-P., Le NindreY.-M. 1991. *Geologic Map of the Ar Riyâd Quadrangle, Sheet 24 I, Kingdom of Saudi Arabia [1:250.000] & Explanatory Notes to the Geologic Map of the Ar Riyâd Quadrangle, Sheet 24 I, Kingdom of Saudi Arabia*. Riyadh: Ministry of Petroleum and Mineral Resources.

Yom-Tov, Y., Mendelsson, H., Groves, C.P. 1995. *Gazella dorcas*. *Mammalian Species* 491: 1-6.