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# THE SAUDI-ITALIAN-FRENCH ARCHAEOLOGICAL PROJECT AT DŪMAT AL-JANDAL
(*Preliminary Report of the 2012 Season*)

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## *Introduction*

The present paper intends to give a preliminary overview of the activities carried out by the joint Saudi-Italian-French archaeological project at Dūmat al-Jandal (ancient Adummatu), between September 20th and November 20th 2012[1].

The fourth campaign focused on the continuation of the activities set up during the 2009-2011 campaigns, and on new systematic analyses of the archeological site and its surroundings (Charloux & Loreto 2012, in press). Research topics ranged from the identification of palaeoenvironments in the ancient al-Jawf landscape to a better understanding of the site's chronology, by means of extensive excavations, without omitting the use of many archaeometric methods and the setting up of fieldwork training activities, and also and above all, of the conservation of local ancient and Islamic monuments which are in danger of disappearance[2].

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[1] The activities described in this article have been realized thanks to the contributions by Mounir Arbach (CNRS, UMR 8167), Hammoud M. al-'Arjan (Saudi Commission for Tourism and Antiquities) (SCTA), Marianne Cotty (Musée du Louvre), Paul Courbon (French Federation of Speleology) (FFS), Andrea D'Andrea (UNO), Majeed I. al-Faqir and Mousa al-Garni (SCTA), Giancarlo Iannone (Cyprus Institute) Frédéric Imbert (Aix-Marseille University), Emmanuel Lanoë (graduate, EPHE), Martin Makinson (University of Geneva), Thamer al-Maliki (SCTA), Andrea Marcolongo (Centro Nazionale delle Ricerche, CNR), Bruno Marcolongo (CNR), Abdul Majeed N. al-Marshd (SCTA), Hervé Monchot (Paris IV, Labex Resmed), Ahmad A. al-Qeyaed (SCTA), Dara'an M. al-Qahtani (SCTA), Christian J. Robin (CNRS, UMR 8167), Pierre Siméon (CNR, UMR 8167), Olivier Testa (FFS), Samir al-Tawati (SCTA), Ariane Thomas (Musée du Louvre), Matthieu Thomas (FFS), Abdulhadi K. al-Traad (SCTA), Rosario Valentini (UNO).

[2] Financial and technical support for the 2012 archaeological season was provided by the Ministero degli Affari Esteri (MAE), the Università degli Studi di Napoli" L'Orientale" (UNO), the Centro Interdipartimentale di Servizi di Archeologia (CISA) of UNO, the

*Geo-morphological Survey* (by B. Marcolongo, R. Loreto and T.A. al-Maliki)

A component of the comprehensive study of al-Jawf's geology, the geomorphological survey intends to identify paleo-lakes and paleo-wādīs related to pre-historic and historical periods, in order to study the development of the al-Jawf region and identify ancient settlements where water was previously flowing (Marcolongo in press; Aurino, Loreto in press; Loreto in press).

Two main paleo-water systems were identified during the 2012 campaign (Figs. 1-2). A paleo-lake already known in literature at ash-Shuwahityie (al-Sayari and Zötl 1978; Wallace *et alii* 1997) (Fig. 2) and a paleo-wādī near the modern village of an-Nazaif was discovered by the Joint project. The an-Nazaif site appears to be a complex and huge settlement including thousands of both lithic fully-processed tools and discarded lithic processed fragments (Fig. 3). The vast amount of lithic material lies along the main water stream, which shows at least three different canalization structures comprizing stone channels and basins (Fig. 4). The lithic tools observed differ from the collected materials from Asfān, dated back to the 8th 6th millennium BCE. Due to the presence of identified monolithic channels, we suggest a later date, contemporary to the Chalcolithic monolithic funerary site of Rajājīl[3], attributed to a period between the 4th and 3rd millennium BCE (Nayīm 1990).

Study of the wādī al-Sirhān hydrological system in its North Arabian geographic setting enables one to understand the interregional dynamics between northern Saudi Arabia and Jordan (Fig. 5). The geo-morphological analysis intends to clarify how people settled on wādī al-Sirhān between the two aforementioned regions during pre-historic times and the Iron Age, prior to the well-documented times of Nabataean caravan routes.

Identification of Trade Routes in North Arabia

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French Ministry of Foreign Affairs, the French National Center for Scientific Research (CNRS), the French Embassy in Riyâdh, the French Federation of Speleology (FFS), the Labex Resmed (University of Paris IV), the European Aeronautic Defense and Space Company (EADS France), the Musée du Louvre and the Saudi Commission for Tourism and Antiquities.

[3] Further analyses will be conducted with the collaboration of the German Archaeological Mission at Rajājīl directed by Dr. Hans G. Gebel, Institut für Vorderasiatische Archäologie, Freie Universität in Berlin.

A study of the paleo-hydrography of the region east of Dūmat al-Jandal has made possible the suggestion of ancient caravan routes from Adummatu to Assyria (Fig. 6).

This analysis began by looking at the Assyrian inscription from Abu Kamal, ancient Hindanu in Iraq (Cavigneaux-Ismail 1990, 351; Robin 1991, 50).

The inscription mentions a caravan from Saba and Taymā' arriving at Ḫindanu, in the Kingdom of Suhu. If one admits that the caravans travelling to Assyria and originating from western flank of the Arabian Peninsula crossed the al-Nafūd desert we can easily state that ancient Adummatu was a natural port of call in the network of trade connecting Taymā' with ancient Iraq.

Study of the ancient widiyyan whose courses lead from the al-Nafūd desert to the Mesopotamian alluvial plain, perhaps enables one to identify the ancient routes used by caravans and the Arab armies to reach Assyria.

Geo-morphological analyses, conducted at a macroscopic scale on aerial photographs and satellite images enable to trace various paleo-water courses leading to the east, and two main hypothetical trade routes passing through a major oasis (ʻArʻar). This hypothesis relies on the same scheme as the one connecting Dūma with Jordan during Nabataean times through the wādī al-Sirhān, a natural route with water supplies. Future surveys will be conducted along these eastern wādī courses, within the boundaries of the Kingdom of Saudi Arabia.

*Study of the Hydraulic System at Dūmat al-Jandal (qanāts and wells)* (by P. Courbon, O. Testa and M. Thomas)

The results of Prehistoric, historic and archeological studies are the proof of the ancient and long human occupation in the region. This occupation depended mainly on the artesian water resources in the Dūmat al-Jandal oasis. The latter consists of beautiful palm groves and, below the palm trees, much miscellaneous farming. Numerous wells and qanāts allowing this water to be used are also visible in the landscape. The wells are vertical and deep, and are impossible to explore without special equipment and training. As a result, the study was attributed to the French

Federation of Speleology (FFS), in collaboration with the Saudi-Italian-French Project.

The search for qanāts, visible on the aerial pictures of 1964, was unfortunately unsuccessful just looking at the ground surface: the qanāts have now disappeared and are blocked due to intensive urbanization or new watering methods. However, twenty-four wells with water were explored during the 2012 season, these being between 12 and 28 m in depth (Fig. 7). About ten waterless wells were also researched. Inside three wells qanāts were found opening into rock faces at a depth of 15 m (Fig. 8). The longest exceeds 150 m. On the top of the qanāts several climbing pits were recorded, but these have all been blocked.

Unfortunately our short season of exploration only enabled the collection of a large amount of data without giving answer to the archaeological questions, in particular: the wells' chronology and an understanding of the precise use of such qanāts. The next season should enable us to remedy these gaps in information.

*The Epigraphic Survey* (by M. Arbach, G. Charloux, M. Cotty, M.I. al-Faqir, F. Imbert, E. Lanoë, M. Makinson, T. al-Maliki, A.M.N. al-Marshd, M. al-Garni, D. al-Qahtani, H.M. al-'Arjan, Ch. Robin, P. Siméon and A. Thomas).

Though time-consuming, the non-comprehensive survey of the landscape around Dūmat al-Jandal has increased our knowledge of occupation in the oasis and of the regional historical context.

Nine new sites were added to the list established in 2010-2011 (a total of 39 archaeological and epigraphic sites), both to the east of the oasis, in the Jabal az-Zilliyat, on the road leading to the wādī al-Sirhān, and to the north in the Jabal Hamāmiyāt (Fig. 9). One is essentially dealing here with the rock carvings of the Neolithic or Classical periods, with human representations as well as dromedaries, ibexes, bulls, felines, etc., sometimes of large dimensions, or Thamudean, Nabataean and Arab graffiti carved by passers-by.

Frédéric Imbert (Aix-Marseille University) took over research on the Arab inscriptions of the Islamic period. He particularly focused on the sites of Muwaysin and Qārat Nīsa (Imbert in press) where 199 Arab texts were thus recorded. Among them, two short poems describe the experience of

being at this place and the desire to be buried on the day of death. One of them begins with *qifā fa-salā yā sāhibayya*… "Oh my good friends, stop here and ask my love…", which is one of the classical ways to begin a poem. However the most interesting graffiti have been found on a hill which marks the southernmost point of the Jibāl Hamāmiyāt (site 38). Another one is a prayer addressed to Prince al-Walīd b. ʻAbd al-Malik before he was granted the caliphate as al-Walīd I (Fig. 10).

Finally, one should recall that systematic survey of the oasis, combining a grid of "squares" (300 × 200 m) containing data provided by GPS instruments, both manual and Trimble differential, as well as an interconnected data base (photographs, sites, GPS coordinates, etc.), were made in tandem with the region's non-systematic survey (Arbach *et alii*, in press).

*Excavations in Dūmat al-Jandal oasis, Sector A* (by R. Loreto, T. al-Maliki and M. al-Garni)

The 2012 excavation in Sector A focused on trench 1, which was extended in a southerly direction, increasing the excavated surface to 25 × 18 m. The aim of the 2012 campaign was to reach the structures related to Building A, a Nabataean monumental construction identified in 2010 (Fig. 11) (Loreto 2011; 2012). Meanwhile the 2011 campaign was focused on the early Islamic re-occupation of Building A, the 2012 activity focused on the pre-Islamic level tentatively dated to the Nabataean period.

The excavation provided new data both on the Nabataean Building A and on previous structures identified after a sounding (S4) was opened in the Locus 9, the southern main room (7 × 5 m) of Building A.

A brief synthesis of the early Islamic level and later occupation will be exposed below. The complete sequence will be studied in the final report, and will deal with the results of the 2009-2011 campaigns (Loreto in press ).

First Results - Data on Nabataean Urbanism

Building A, dated according to pottery from the foundation level and the floor level to the I$^{st}$ century AD (Loreto 2012) was apparently a rich and important construction judging from its impressive proportions: 20 m north-

south and 13 m east-west. According to the huge open court (L8) and the high quality level of the pseudo-isodomic masonry, it could be defined as an élite residence.

The excavation between Building A and the hill's rocky flank to the west brought to light an early feature related to the ancient urbanism of Nabataean Dumat. A ten metre long wall (M68) was built along the flank of the hill to create: a terrace for retaining the rock and a floor, paved in compacted earth, to allow passage outside of Building A (Fig. 12). M68 was composed by stone and upper mud-brick rows, with thin white plaster covering the entire wall (Fig. 13). The white plaster also covered the floor and external wall of locus 9. White plaster also was found in 2010 inside the building's west portico. This could be of great interest in reconstructing the original aspect of Building A, which might have been completely plastered in white (Fig. 14).

Sounding S4 inside Building A

A sounding of 2.5 × 3 m was opened inside locus 9 in Building A. It provided new architectural evidence and materials related to a phase earlier than the 1st century AD (Fig. 15).

The sounding revealed a huge collapse of well dressed stone blocks covered by the foundation level of Building A (Fig. 16). The collapse contains also terracotta figures (camels) and pottery, which will be studied for chronological parallels (Fig. 17).

At this stage, various elements related to a phase prior to the 1st century AD could be recorded: M44, a wall identified during the 2011 campaign (Fig. 18), the collapse in S4 and the pottery found in Building A's foundation level. All this evidence suggests an occupation of the site by wealthy residents before the construction of Building A in the 1st century. AD. The 2013 campaign will enlarge trench 1 in a southerly and easterly direction, in order to provide a wider excavated area in which new soundings can be opened in earlier levels.

## The Collapse of Building A and the Roman-Byzantine Phases of Reoccupation

The excavation of Building A revealed that the building collapsed before the advent of Islam. Roman-Byzantine potsherds recovered in the floor and collapse levels of the building suggest that the edifice was already reoccupied at the end of the Nabataean period. However, only part of the building was reoccupied. The collapse identified was located inside locus 9 (Fig. 19), inside the west portico of the building (Fig. 20) and outside Locus 9 (Fig. 19), between the building and M68. Only the open court was found empty of traces of collapse (Fig. 21). This suggests that the building was only partially reoccupied after the collapse. No traces of fire were recognized and no wooden elements were found, implying that the building possibly was not destroyed by fire or by a sudden event; it was probably abandoned until the collapse.

## The Reoccupation Phases: Early Islamic II

During the early Islamic period, dated back to the 8$^{th}$-10$^{th}$ century AD, the Nabataean Building A was affected by the removal of most of its dressed stone blocks for the construction of new buildings. Locus 9 was partially reoccupied in its eastern half by an imposing structure (Figs. 22-23); the whole northern limit of Building A was also almost completely dismantled (Figs. 24-25).

## The Reoccupation Phases: Early Islamic I

A second early Islamic phase can be recognized in the construction of wall M11, built above the early Islamic structure I. M11 runs north-south, above the open court of Building A and the early Islamic walls and floors (Fig. 26).

## The Reoccupation Phases: Middle Islamic

A Middle Islamic III phase was suggested after the 2010 season. It consists of a huge amount of discarded small stones (level 3b) coming from the construction of the medieval village of Dira', which lies at the foot of

the Mārid Castle (Figs. 27-28). This jumble of discarded stones was found on the top of all the excavated structures, probably abandoned before the 15th century AD.

A Middle Islamic II and I phase could be recognized in the structure built above level 3b. Two north-south walls, M10 an M14, were built during the first phase. The latter was followed by the construction of Building L6 (Fig. 28), a small chamber with a low door for animals, and L21 (Fig. 29), a small room with a four stepped staircase.

These structures were finally covered by level 2, a 1.50 m thin level of Aeolian sand, above which stands wall M1, the only structure related to the Late Islamic period.

*Pottery from Trench 1, Sector A* (by P. Siméon, T.A. al-Maliki and R. Loreto)

A preliminary study (drawings, photographs and description) of 260 Nabataean diagnostic sherds from levels 10 (DJ.10.A.124, DJ.10.A.106) and 9 (DJ.10.A.77) was carried out, within a total of a thousand pre-Islamic sherds (also Roman-Byzantine) (Fig. 30). The recorded material appears to be the richest pre-Islamic pottery assemblage from the al-Jawf region. It will enable a complete typology and typo-chronology of Nabataean ceramics found at Dūmat al-Jandal since 2010.

Two main aspect of the analysis should be developed in future research:

1) the study of glazed-ware fabrics, which in manufacture might represent a clue for an eastern (Iranian?) provenance. Furthermore, the next season will result in the selection of potsherds from each 25 fabrics defined, in order to make thin sections of each fabric, and to proceed to physico-chimical analysis, and if possible - depending on cost - lead isotope analysis on glaze;
2) a catalogue of ceramics (pots, bowls, jars, jugs and other shapes), constituting a general typology of forms and functions, which would become useful tool for any researcher interesting in the material culture of the Northern side of the Arabian Peninsula.

Finally, the team has been involved in the successful training of a colleague, Thamer A. al-Maliki, an archaeologist of the Saudi Commission for Tourism and Antiquities, who completed the study of ceramics from

locus 6, Trench 1 in sector A, with advice from Pierre Simeon. He was in charge of photographing the pottery and patiently drew selected sherds, as well as being responsible for the first computer-drawn plates. This collaboration will be continued in the future.

*The Western Settlement, Sector C* (by G. Charloux, M. Cotty, M.I. al-Faqir, M. al-Garni, E. Lanoë, M. Makinson, D. al-Qahtani, S. al-Tawati and A. Thomas)

Excavations in Sector C (Dūmat al-Jandal's Western Sector) - whose exploration began in 2010 (Charloux, al-Traad *et alii* 2012, in press) - were continued in 2012, thanks to the opening of four new soundings in the sector's lower part (SD6, 7, 8, 9), in order to better understand space encircled by the ancient enclosure wall, and therefore to explain its function (Fig. 31).

Soundings 6 and 9, opened at the location of stone structures visible on the surface or in recent sections created by bulldozers, have sought to clarify the nature of settlement on both opposing slopes in the valley, at two locations currently neither built up or cultivated. The picture gathered at the end of the season showed the presence of vast terraced structures, perpendicular to the slope.

Sounding 6, at the base of the promontory, is certainly the most promising in terms of architecture (Fig. 32). Excavations have brought to light stone and mud brick remains preserved over a height of 2 metres. Three phases were identified. These built remains are perhaps related to the presence of a well or cistern going back to the Roman period (and probably even earlier). The sounding will be extended in the next season.

By contrast, Soundings 7 and 8, which were approximately aligned with Sounding 3 carried out in 2010 (Charloux, al-Traad *et alii* 2012, 203-219), attempted to better understand the different activities taking place at the centre of the valley: Sounding SD3 has in effect exposed small agricultural installations, and it was possible to surmise the existence of gardens, of divided small installations and perhaps of farms, comparable to what can be observed nowadays. The loamy, thick and quite fertile soil is actually favourable to this kind of agricultural activities. The results of excavations carried out in 2012 appear to strengthen this suggestion.

Research was carried out in 2012 on the rocky promontory of *al-Burj*, where a vast structure identified as a *triclinium* in the previous year was cleared (SD4, Fig. 33) (Charloux, al-Traad *et alii*, in press). Two phases of use were distinguished. Fine excavation of the structure, with systematic sieving of the layers, the floatation of fine soil, the topographic outline of the structures and of stones, together with photography with a telescopic rod, will enable a better interpretation of the function of this ancient construction.

Finally, one should recall the activities carried out by the expedition in order to preserve the ancient remains. The team decided to infill Soundings SD1, SD3, SD7 and SD8 with sand and earth moved by bulldozer[4], in order to safeguard ancient structures unearthed in 2010 and 2012; soundings were in particular at risk from collapse (SD1), and security was also of major concern (SD3, 7, 8), to the extent that it was urgent to solve this problem prior to our departure. The 2012 season, moreover, gave new opportunities to become involved with the protection of the Western enclosure: a presentation was given at the Jawf Archaeology and Ethnology Museum on November 21st, 2012, together with participants of the al-Sudairi Foundation symposium on the protection of Saudi Arabian Heritage, and on November 28th 2012, we also presented the expedition's activities to His Excellency Ahmad Āl-Sheikh, Vizier of the Jawf Emirate, who favourably received our requests for the protection of the enclosure area.

*Survey Using 3D Technology*

3D laser scanning of the Western Enclosure using 3D Laser Scan (by A. D'Andrea, G. Iannone and R. Valentini)

During the on-field campaign (September 29th to October - 4th) a systematic architectural reconstruction of the Enclosure Wall's excavated structures (Sector C) was carried out in order to obtain 3D documentation prior to a restoration project of the wall, built both in stone and mud brick. 36 shots were made with a phase-shift Laser Scanner *Imager 5003* (*Zoller & Froilich*). The project focused on a track of approximately 85m from unit

[4] Work was carried out under the supervision of G. Charloux and E. Lanoë.

3[5]. Flat targets have been located around the monument to guarantee the alignment of contiguous scans in the post-processing phase. In order to produce a photorealistic rendering they have also made pictures of the walls.

The figures show the post-processing of the point-clouds nos 1 and 2 after registration and meshing (Figs. 34-36). 5 Giga of scan data of the western enclosure are being processed to construct a 3D model (D'Andrea *et alii*, in press.).

Systematic 3D Reproduction of the Excavated Structure in Trench no 1 (by A. Marcolongo)

Accessibility to cultural heritage is one of the most important factors in the cultural heritage conservation, as it ensures knowledge, monitoring, public administration management and a wider interest on cultural heritage sites. Nowadays 3D surveys constitute the geometric basis for effective artefact reconstruction, but mostly often 3D data are not deeply and comprehensively investigated to extract other useful information on historical monuments, with the aim of preserving and safeguarding them. In this framework, during the 2012 survey campaign at Dūmat al-Jandal, new technologies in the digital photogrammetric field were tested. A Photo Scanner 3D system was chosen: this is a photogrammetry-based survey technology for point clouds acquisition and 3D model configuration derived from digital images processing. This technology allows one to obtain clouds of points (xyz coordinates) with RGB *information* and geometries at different levels of complexity, by processing a number of images taken with a limited set of constraints, thanks to the use of a simple acquisition equipment and through an image-matching algorithm (ZScan, by Menci Software) (Figs. 37-40)[6].

Survey technologies play a leading role in the acquisition of knowledge on cultural heritage insofar as they are finalized for data acquisition used to describe geometric features and peculiarities of historical monuments, which in themselves allow to the conservation and safeguard.

[5] For the identification of the rampart's architectural units, see Charloux *et alii* 2012.

[6] Menci Software Homepage. http://www.menci.com/

Moreover the demand for 3D models of historical monuments is continuously growing in the field of archaeological and architectural applications. Zscan technology used during the 2012 archeological survey in Dūmat al Jandal, based on an innovative proprietary algorithm for multifocal image analysis, permitted to reconstruct with both geometric and chromatic accuracy all the walls and plans of sector A so as to record, in this very first phase, geometric data, obtaining ortho-photos and Digital elevation Models: these are raster representations of surface elevations based on a reference UCS (Figs. 41-42). The aim of this season was to accurately reconstruct the entire archaeological site so to obtain the 3D model of all remains and plan all interventions aimed at restoration.

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# FIGURES

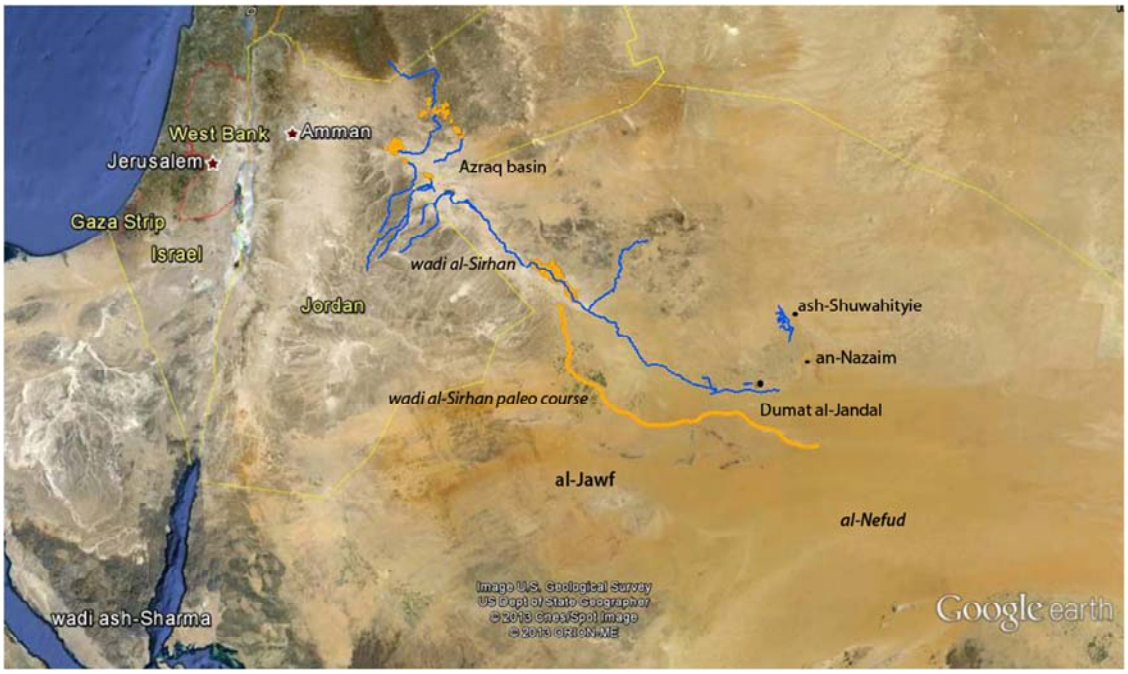


Fig. 1 - Surveyed area


Fig. 2 - Silt deposit of a paleo-lake at ash-Shuwahityie

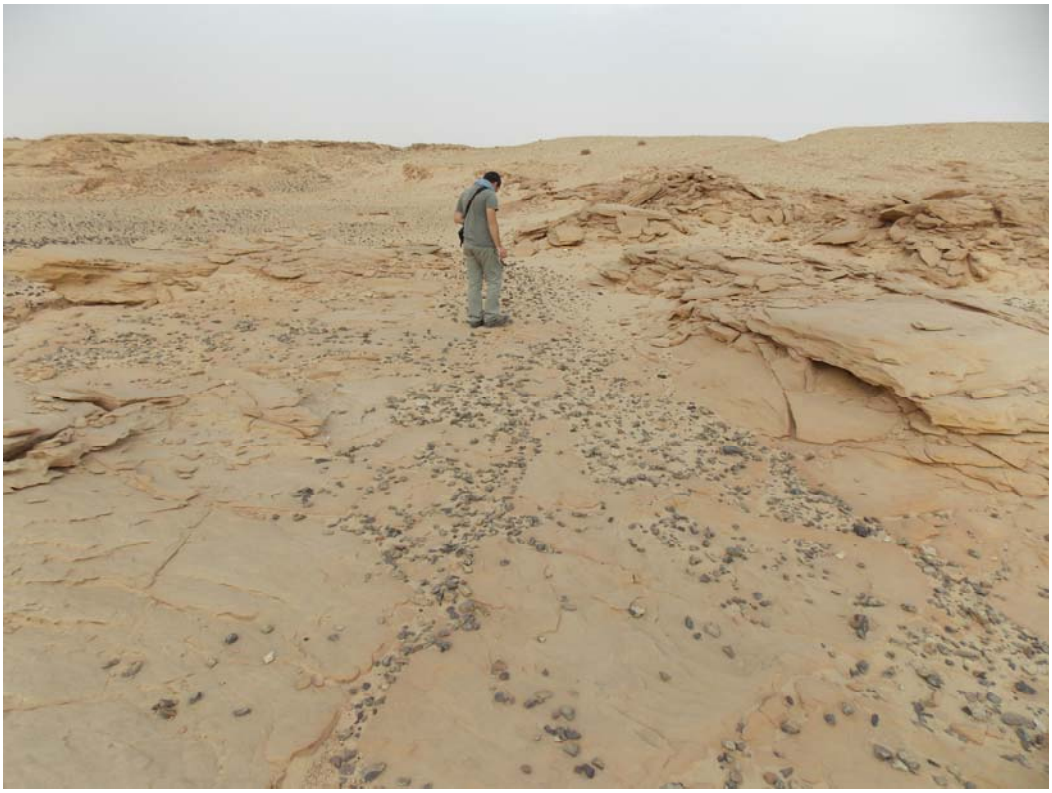

Fig. 3 - Lithic tools from an-Nazaim

Fig. 4 - Stone channels at an-Nazayim

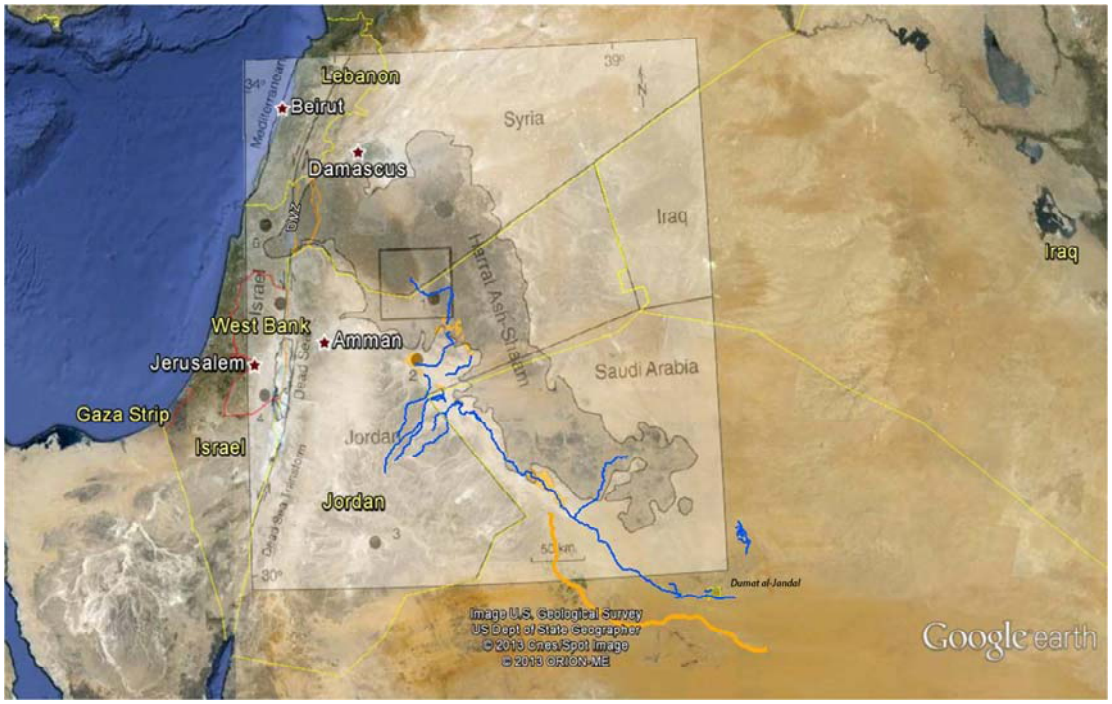


Fig. 5 - Al Sirhan Region and Harrat ash-Shamm black desert. Ancient way of communication between al-Jawf and northern Nabataean regions


Fig. 6 - Defining of the wādī al-Sirhān hydrography in order to recognize ancient caravan routes

Fig. 7 - Exploration of a well by a speleologist of the French Federation

Fig. 8 - A speleologist standing inside a qanāt at Dūmat al-Jandal

Fig. 9 - The Jabal Hamamiyāt visited during our survey

Fig. 10 - Prayer for Caliph al-Walīd b. Abd al-Malik (J. Hamāmiyāt, site 38)

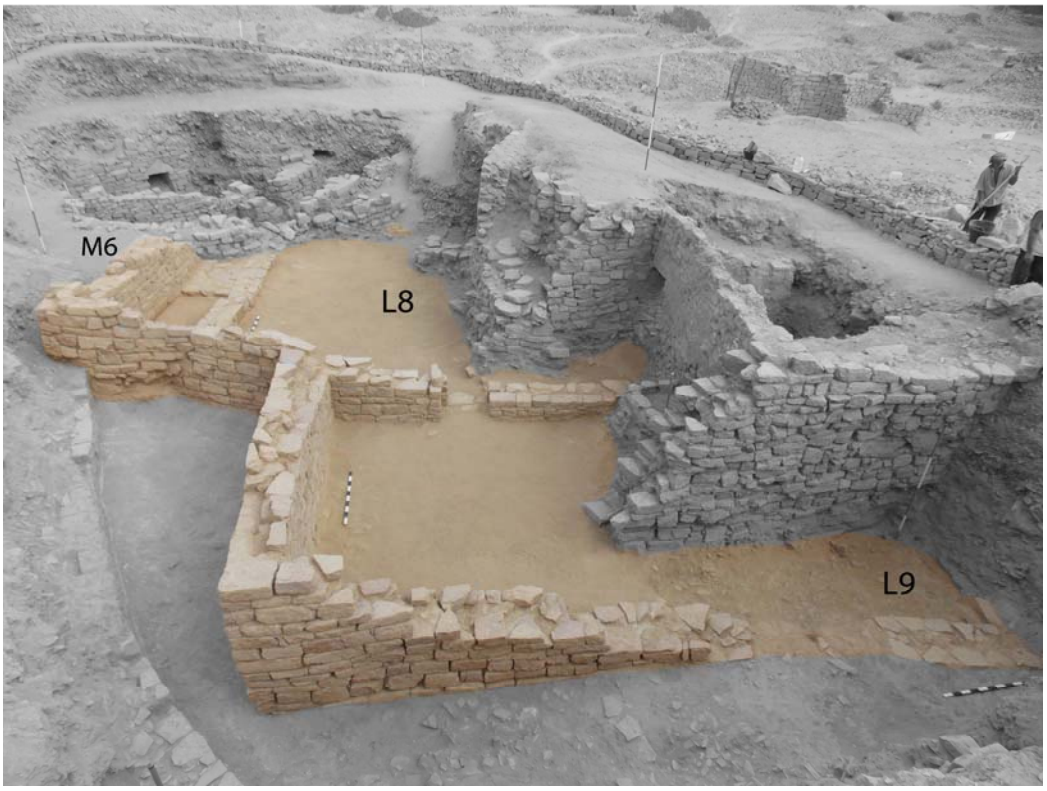


Fig. 11 - In color, Building A related structures


Fig. 12 - Retaining wall or terrace wall M68

Fig. 13 - White plaster on M68

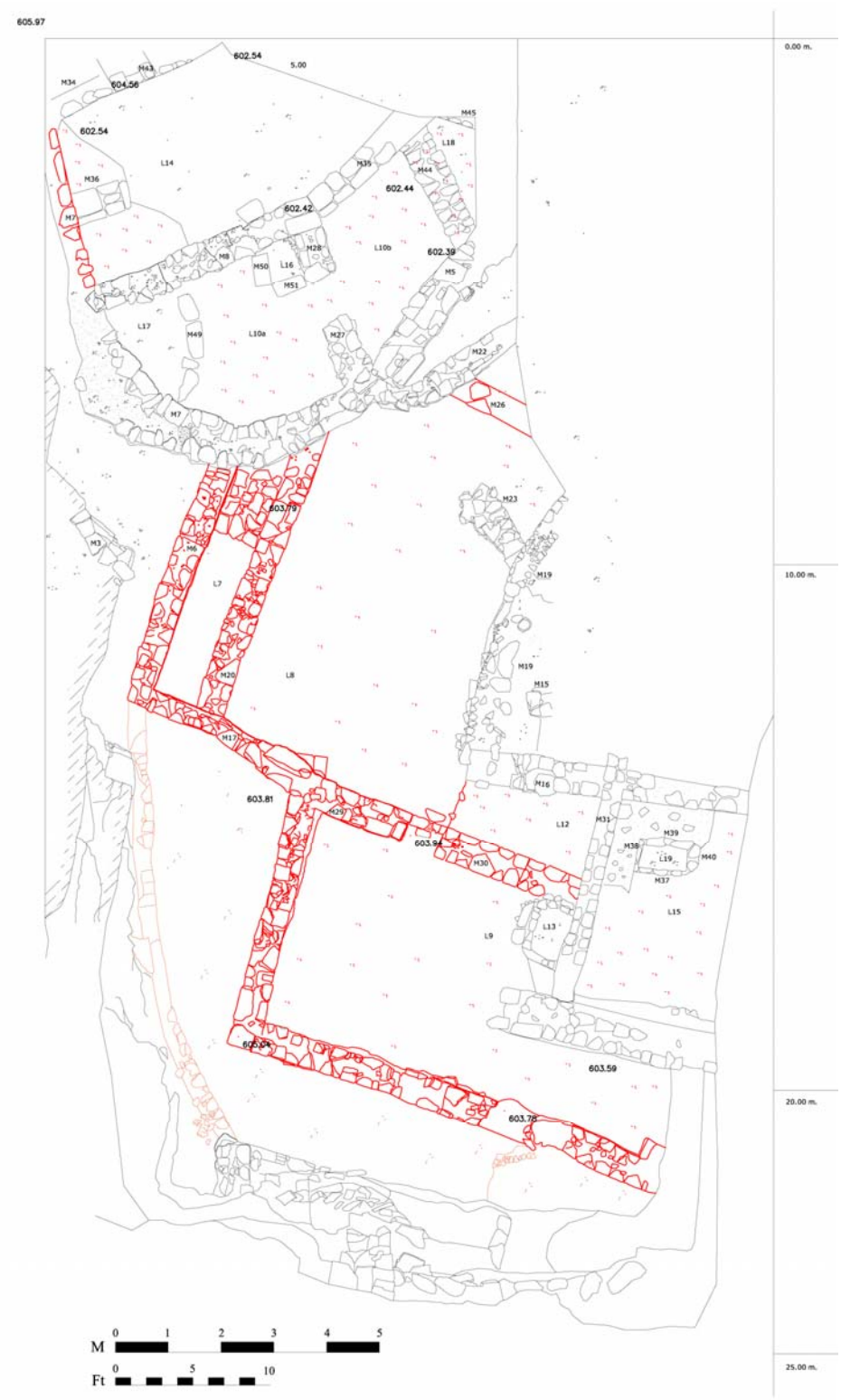


Fig. 14 - In red Building A. In brown M68, retaining wall in stone and mudbrick

Fig. 15 - Sounding inside Locus 9

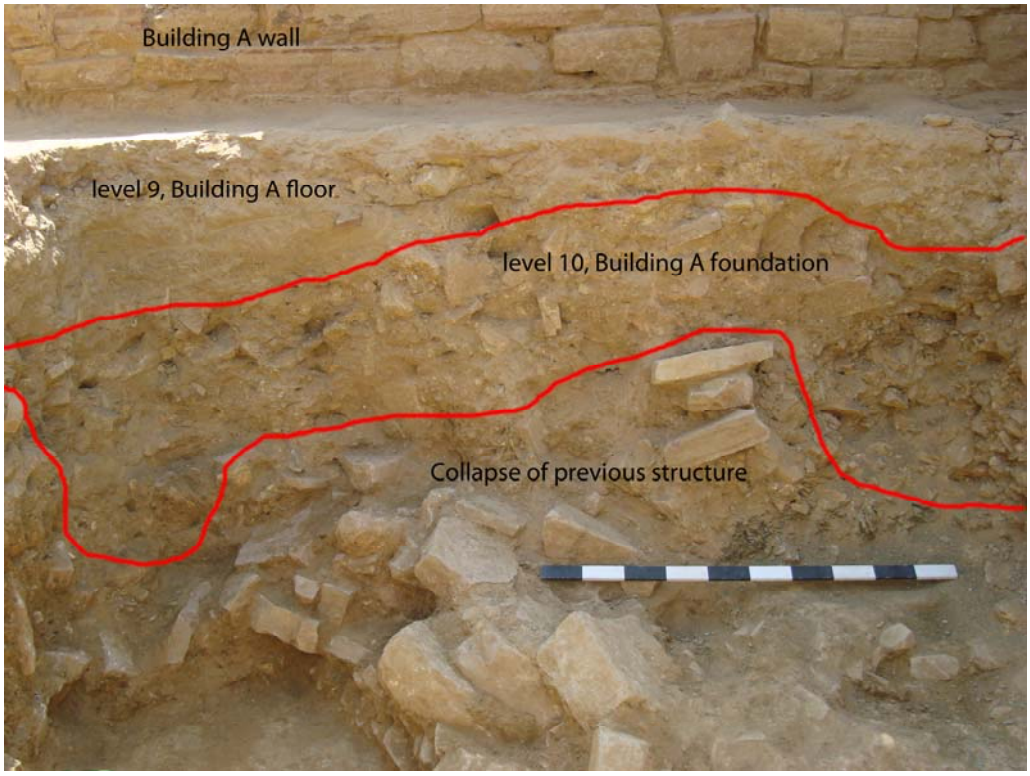


Fig. 16 - Stratigraphy inside locus 9

Fig. 17 - Collapse inside locus 9


Fig. 18 - In red, first architectonic evidence from Sector A. M44, at the top, and collapse in S4


Fig. 19 - The collapse inside locus 9

Fig. 20 - The collapse of the west portico

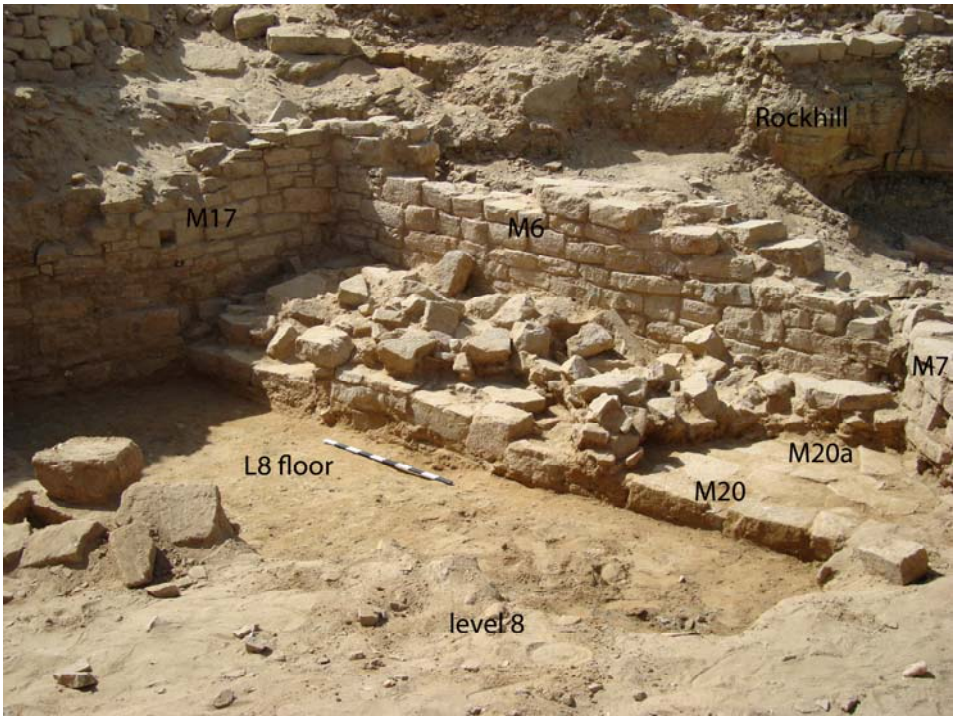


Fig. 21 - In red, Building A levels of collapse identified. Building A collapsed both inside the perimeter of the structure and outside


Fig. 22 - Reoccupation of the eastern half of locus 9 (Early Islamic II)

Fig. 23 - Reoccupation of locus 9 (Early Islamic II)

Fig. 24 - North reoccupation of Building A after 2011 excavation

Fig. 25 - Detail of the northern reoccupation of Building A


Fig. 26 - Wall M11 (Early Islamic I) built above the earliest Islamic structures


Fig. 27 - Level 3b above the northern early Islamic reoccupation of Building A


Fig. 28 - Level 3b above the southern early Islamic reoccupation of Building A

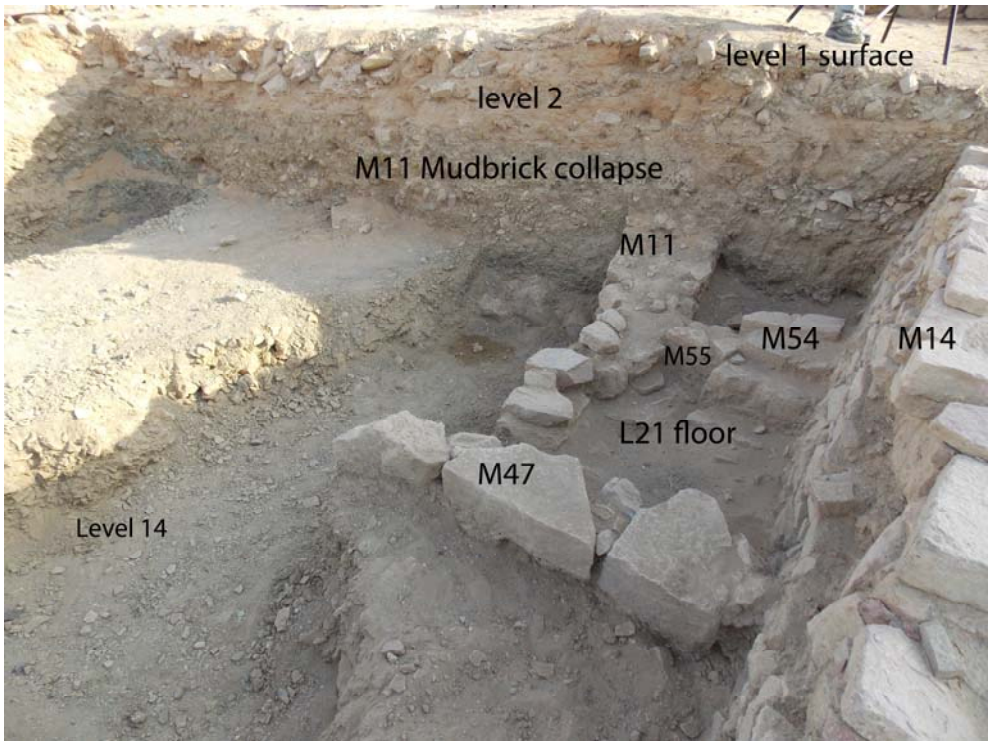


Fig. 29 - L21 built above level 3b, upper courses of M11 and against M14

Fig. 30 - Complete stock of level 10 diagnostic sherds (Nabataean)

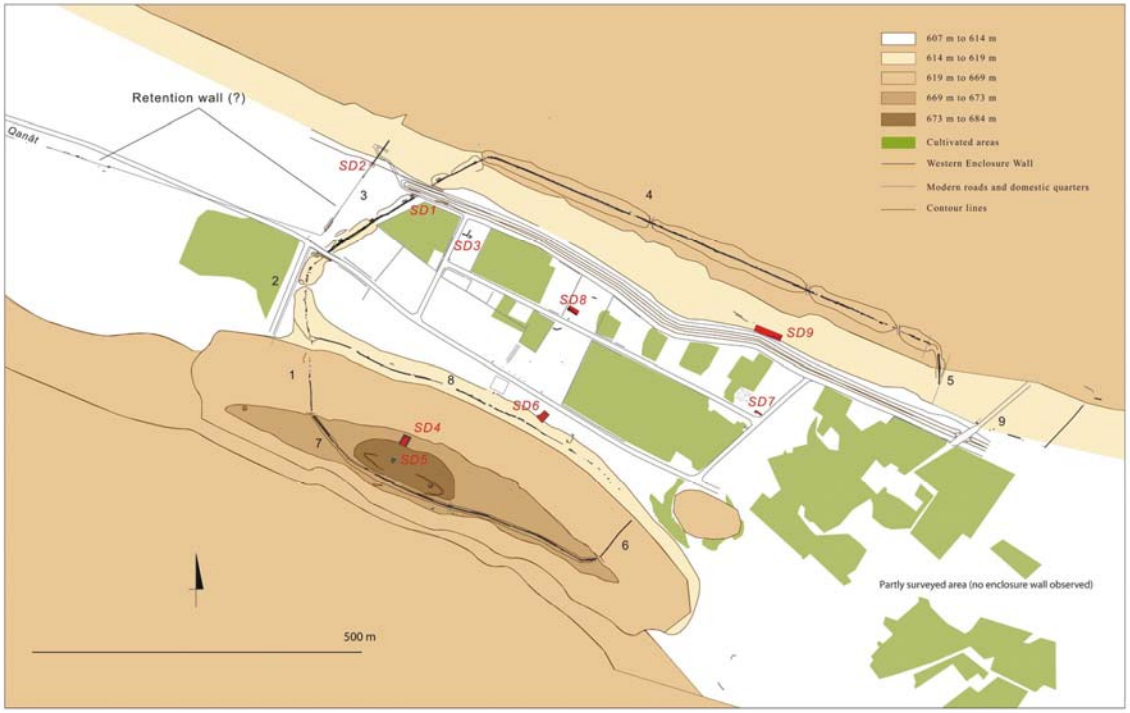


Fig. 31 - Plan of the western settlement at Dūmat al-Jandal (sector C). In red, the soundings opened in 2012

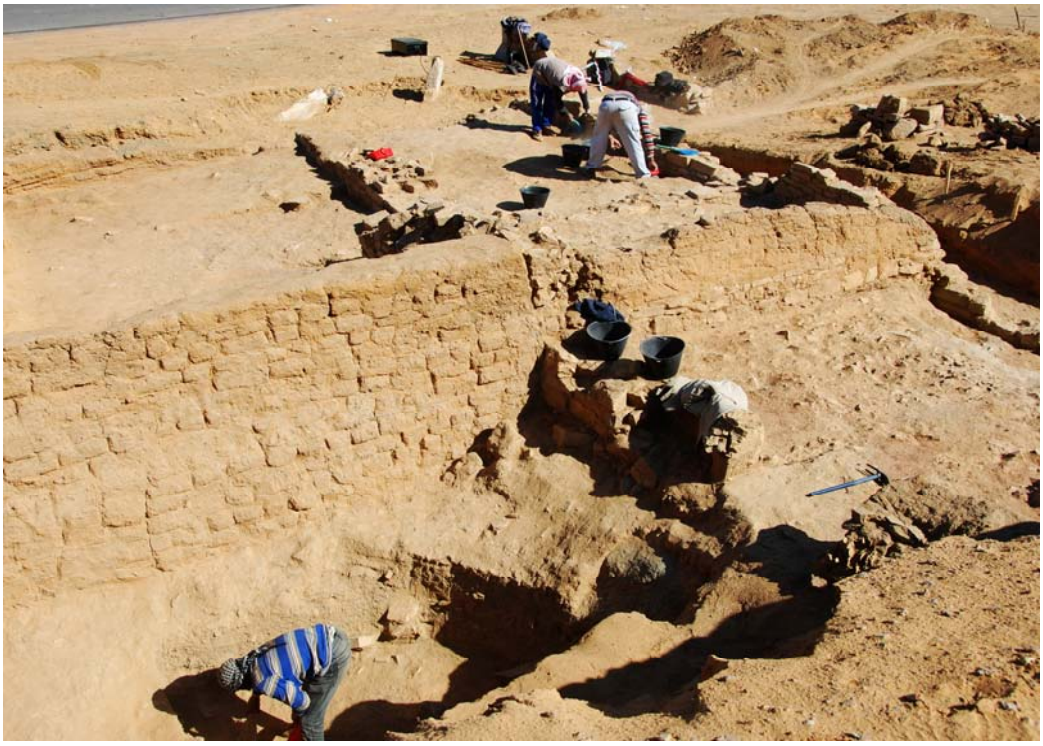

Fig. 32 - A large building excavated in sector C (Sounding 6)

Fig. 33 - The *triclinium* in sector C (sounding 4)

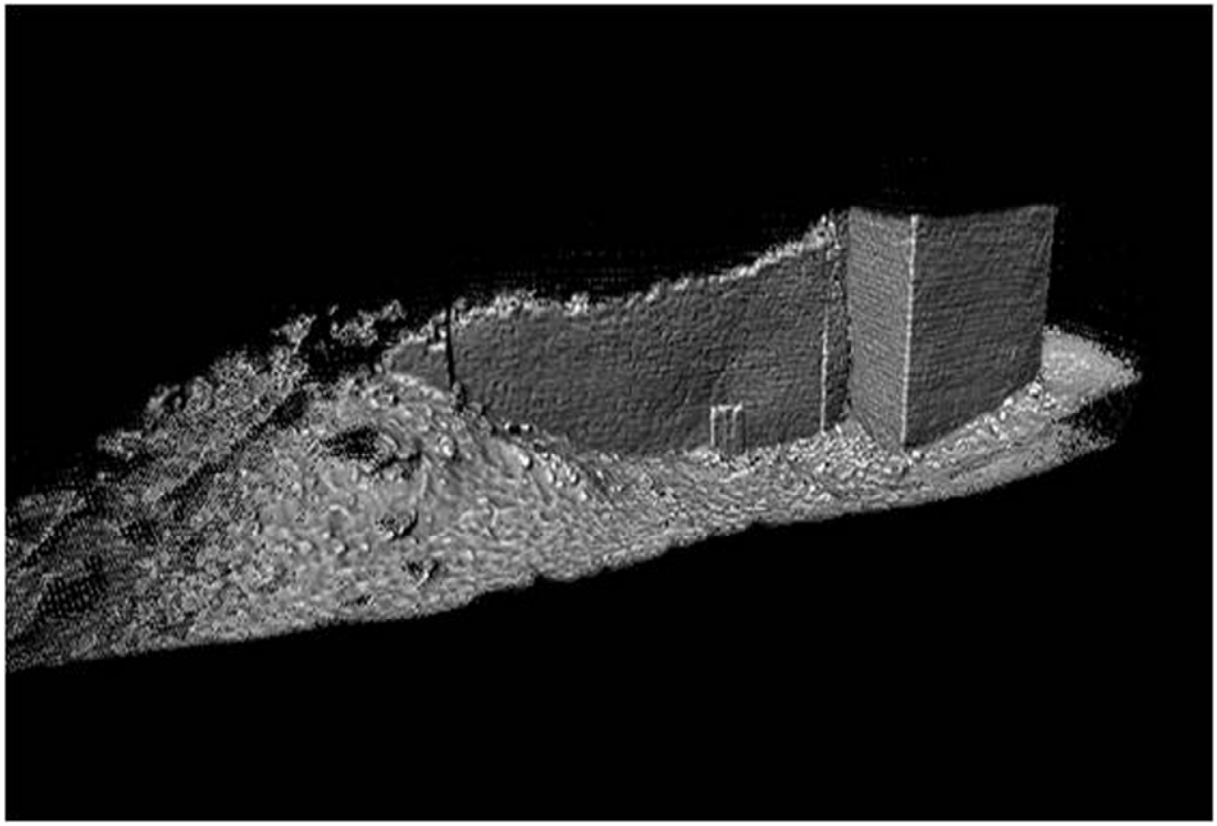

Fig. 34 - First model after 3D scan

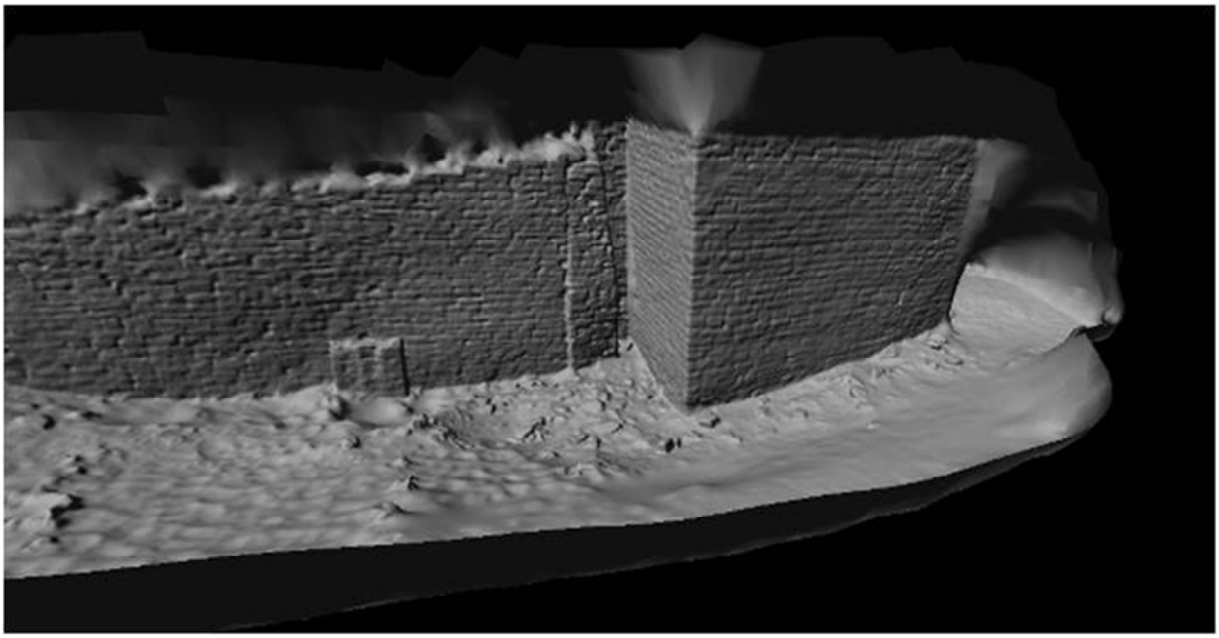

Fig. 35 - Detail of the first model after scan

Fig. 36 - Rendering of the north tower. Ortorectified image on 3D model

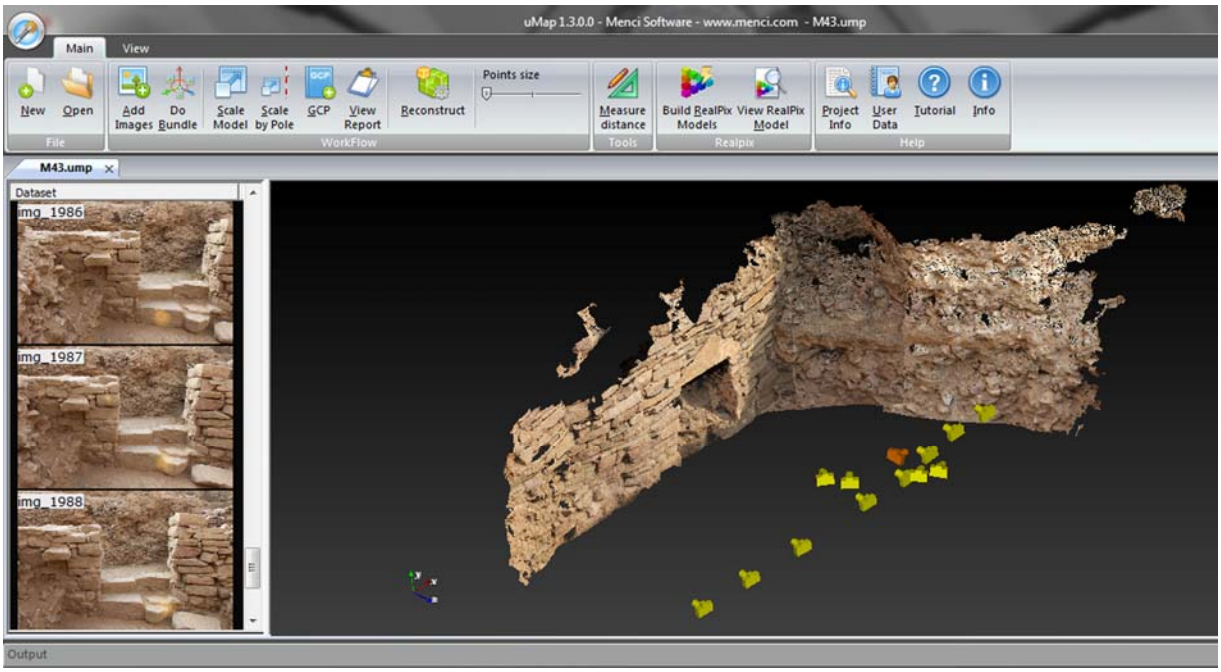


Fig. 37 - 3D reconstruction of wall 43 with shooting positions

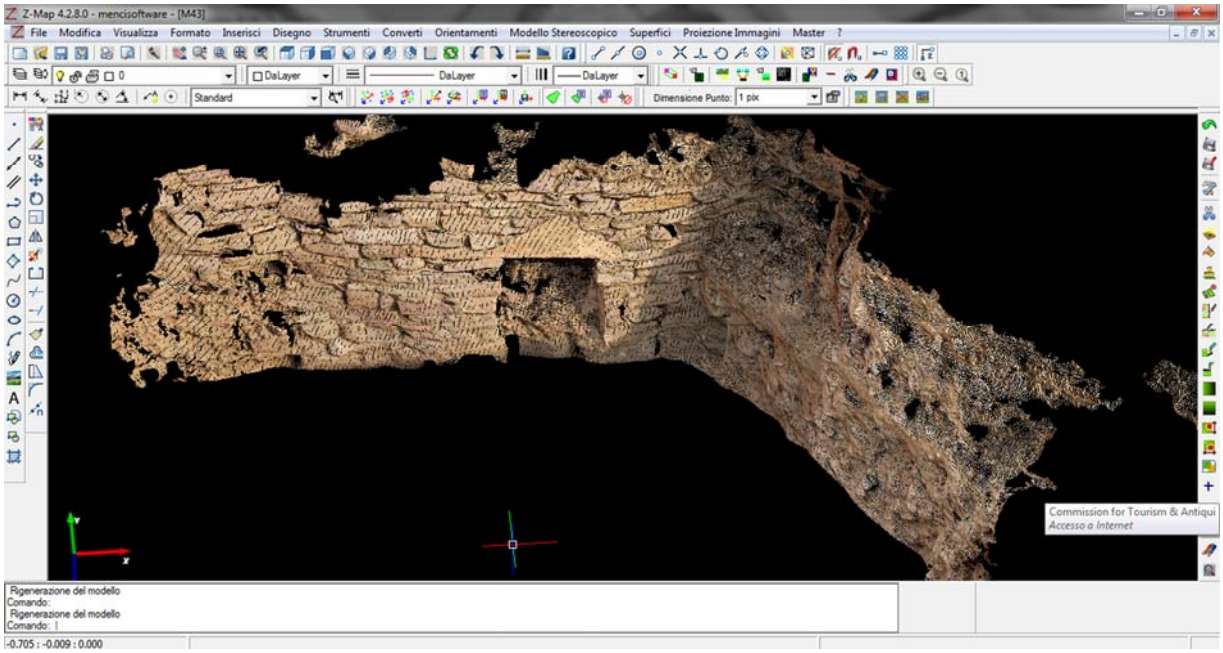


Fig. 38 - Points cloud generated with RGB data

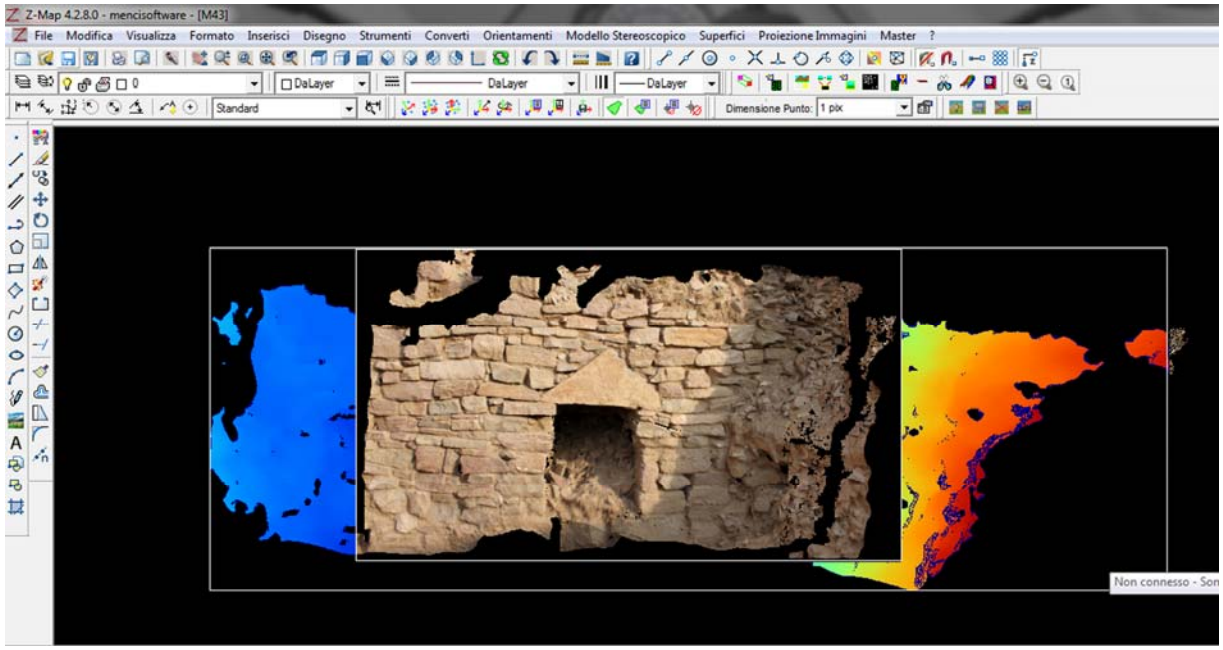


Fig. 39 - Digital Elevation Model of wall 43 with generated scaled ortophoto

Fig. 40 - Wall M10 points cloud with RGB values. Preliminary elaboration

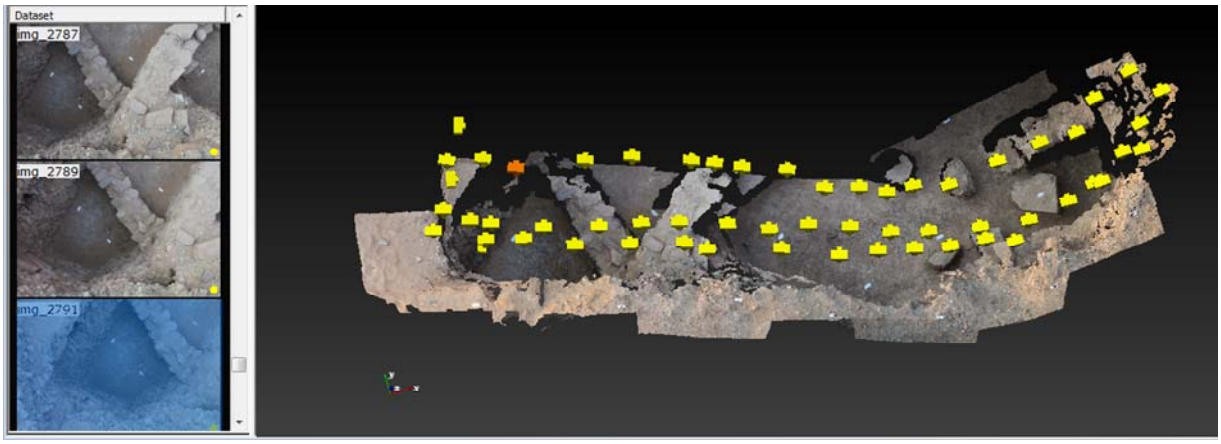


Fig. 41 - North part of sector A 3D reconstruction from digital images, top view

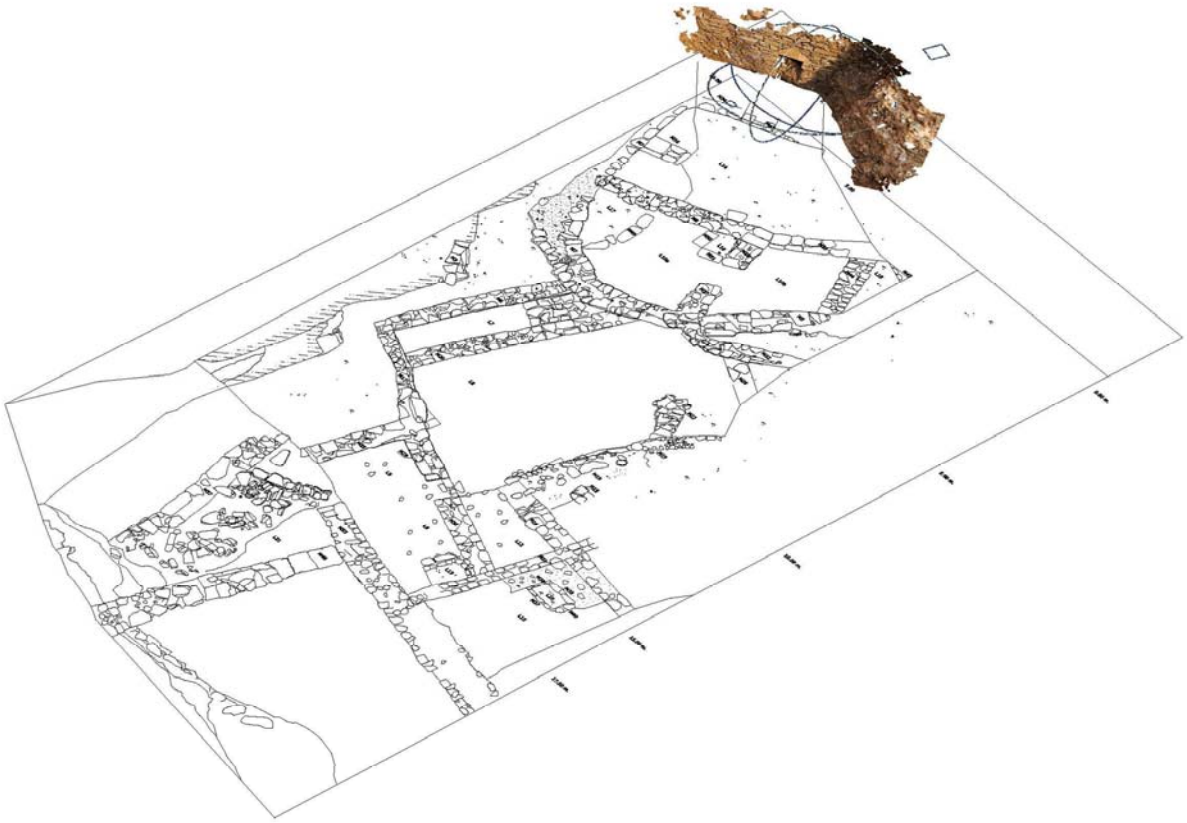

Fig. 42 - General plan of sector A with 3D model of wall 43