Azraq al-Šišan. ʻAyn Sawda reservoir project. Report of the fieldwork led from the 13th to the 31st of May 2014

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Azraq al-Šišan

`Ayn Sawda reservoir project

Report of the fieldwork led from the 13th to the 31st of May 2014

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Introduction

Partly located in the Azraq Wetland Reserve, the `Ayn Sawda reservoir is part of the Azraq al-Šišān historical heritage that the inhabitants record as a pleasure, fishing and swimming place. From the beginning of the 80's, the Azraq oasis underwent important environmental changes linked to the excessive pumping in the water table for agricultural purposes. Following the decrease of the water level in the whole oasis and the progressive drying of the `Ayn Sawda spring (drying up in 1993), the archaeological remains of the reservoir and its close nearby appeared, making the archaeological works possible (and necessary) (**Fig.1**).

In 1981, a team of the DoAJ, led by Dr. Ghazi Bisheh[1], has led a first project which major result has been the identification of carved basalt blocks, discovered in the reservoir, next to the platform which is located on the eastern side of the structure.

In 1997, an american team composed of Richard P. Watson, an anthropologist, and Wesley Burnett, a geographer, led archaeological soundings on very specified zones of the reservoir. The three soundings they have done allowed them to identify, on the N/W corner, a channel crossing the northern wall of the reservoir and the foundations of the wall in the two other sectors. Their results have been published in 2001 in an article[2], sadly poorly documented.

Finally, in 2004, a project led by Claude Vibert-Guigue (CNRS) has begunon request of the DoAJ. Five fieldwork missions (2004, 2007-2010) have taken place with a clear objective: to carry out surface excavations next to the platform of the reservoir in order to identify and to secure the carved blocks that could be discovered and that be added to the ones discovered by the DoAJ. 69 blocks with bas-reliefs have been uncovered[3]. The necessary evolution of the project into an architectural study of the reservoir and the blocks has nevertheless quickly appeared.

That is the reason why in 2013, still on request of the DoAJ, a relay mission has been implemented between the CNRS (Cl. Vibert-Guigue) and the Ifpo Amman (L. Abu-Azizeh, architect) with the aim of launching a new study project of the Azraq `Ayn Sawda reservoir[4].

In 2014, the first fieldwork mission of the new Ifpo « Azraq AynSawda Reservoir Project » has been led by L. Abu-Azizeh (architect, Ifpo-Amman) and her team composed of an architect (A. Stavy) and two archaeologists (Dr. J. Bonnéric, Ifpo Beyrouth and Dr. B. Couturaud, ArScAn Paris). The fieldwork, from the 13th of May until 31st of May, was based on an archaeological part (excavations) and an architectural part (sanitary assessment, 3D modelling…) described below.

1 Bisheh G., 1986.
2 Watson R.P. & Burnett G.W., 2001.
3 The fieldworks reports are available in the DoAJ, Amman, 2004 and 2007 to 2010.
4 The fieldwork report is available in the DoAJ, Amman.

1. Objectives 2014

The assessment done after the relay mission in 2013 showed three analysis scales necessary to our study. The first one concerns the reservoir itself; the second one concerns the extensions of the walls identified outside the reservoir; the third one concerns the carved blocks discovered in the reservoir, next to the platform.
In the frame of our first fieldwork mission in 2014, we have decided to concentrate our work on the reservoir (analysis scale 1) and the carved blocks (analysis scale 3) and to work with the base of four major themes that guided our work in Azraq.

1.1. Theme 1: archaeological soundings

The archaeological works on the `Ayn Sawda reservoir are a few. An American team, organized by R. P. Watson and G. W. Burnett, led to one single campaign, in 1997, and one single article. It focused on three zones: the N/W corner of the reservoir, a part of the N wall (section 15 of our system) and a part of the E wall (section 5 of our system). A French mission, led by Cl. Vibert-Guigue took place between 2004 and 2010. It was mainly about the uncovering of carved blocks next to the platform, inside the reservoir (**Fig.2**). The available documentation related to the results of these two missions is quite brief in terms of stratigraphy, archaeological levels description or excavation plans accurate and with dimensions.
The aim of our first fieldwork mission was to obtain information related to the nature and the function of the reservoir, but also to get indications related to the dating of the reservoir. The exact nature of this large pool is unknown: water reservoir for agricultural purposes, separation system for natural water and salted water, entertainment place? To understand how it is organized is a major issue to identify or precise its function.
Furthermore, concerning the building period of the reservoir, the architectural shape of the buttresses and the presence of the carved blocks (which bas-reliefs are very certainly Umayyad) are the main elements which led to date the reservoir to the Umayyad period. But, nothing allowed to exclude the hypothesis of an oldest structure reused (roman or byzantine) or proved in a definitive way the relationship between the carved blocks and the reservoir. The nature itself of the site makes the dating more complex as the reservoir is characterized by the accumulation of natural clay layers containing very little material.
For our project, it seemed interesting to us to work on the N/W corner of the reservoir, were R. P. Watson and G. W. Burnett led their excavation, in order to complete the documentation and to identify the two construction phases and the wall going to the west as explained in their article. Furthermore, this location is very important as there is a channel that could be either a water supply channel or an evacuation channel.
Then, the excavations aimed to define the relationship between the reservoir and the large circular structure located north of the N/E corner of the reservoir. Stone alignments, understood as a double faced wall, allowed supposing the existence of a wall, or a channel, linking the two structures. We planned to make some soundings

against the N wall of the reservoir and the south part of the circular structure in order to identify potential connections with the masonries.
Finally, it seemed important to work on the platform and to complete the data of Cl. Vibert-Guigue, especially at the northern extremity (interior side) of the platform where he identified wooden elements. We wanted to locate these elements, to document them, to precise their role in the foundation itself and to get a sample for wood identification and dating ^{14}C.

1.2. Theme 2: topography

Until now, only schematic plans of the `Ayn Sawda reservoir were available. There are five plans: L. W. B. Rees has done one in 1929[5], A. Musil a second one in 1978[6], D. L. Kennedy a third one in 1982[7], R. P. Watson et G. W. Burnett a fourth one in 1998[8] and Cl. Vibert-Guigue a last one used in his excavations reports since 2008[9] (**Fig.3**). No one of these plans has been realized from a topographic survey of the site and as a consequence remains approximate plans.
In 2013, during the relay mission, we have produced the first plan of the reservoir elaborated from a total station survey, a precise and accurate plan of the structures (**Fig.2**). Nevertheless, even if this plan constitutes a major graphic support for our work, it needs to be completed on three levels.
The first point, that seems to be the most important, would be to inscribe this plan in a georeferenced system known, as the UTM for example. Actually, no topographic point with coordinates to which we could have referred seemed to be known in 2013, neither by the teams of the Wetland Reserve of the DoAJ team.
The second point would aim to complete the survey in the non-surveyed zones in 2013 (mostly the walls west and south), particularly to clarify the levels of each visible part of the reservoir. That would give us the possibility to study the reservoir in its full dimension, especially in comparing the levels. The comparison of the levels of the two channels known (on the N/W corner and on the wall E) would be, for example, rich in information about their function (supply channel, evacuation, overflow, etc.)
The third point, related to the first one, will be – once a geodesic reference identified – to implement in the reserve a minimum of three topographic points with known coordinates which would allow a more simple and efficient use of total station, as well for our own project as for the other archaeological missions and the RSCN.

1.3. Theme 3: sanitary assessment of the reservoir

The reservoir is at the same time inside and outside the Wetland Reserve. In the Reserve, the north wall, the northern part of the east wall and the platform are part of the touristic trail proposed to the visitors. The structures suffer from three main threats: the impacts (visitors, buffaloes of the Reserve), the drying up of the soils

5 Rees, 1929.
6 Musil, 1978.
7 Kennedy and al., 1982.
8 Watson R.P. & Burnett G.W., 2001.
9 The fieldwork report is available in the DoAJ, Amman.

and the vegetation. The meeting of these three phenomena increases the damages, particularly visible, on the masonries. Despite the many restorations conducted by the DoAJ in the 80's and daily by the RSCN, the general estate of the reservoir continues to degrade, making the situation more and more dangerous foe the structure itself ans for the visitors.
Outside the Reserve, the still visible wall remains are located on private lands, non-closed. The invisible parts are either already destroyed or under new constructions. The major threats, for the visible masonries, are the lootings and the destruction as these zones are accessible to everybody.
One of our objectives was then to do an sanitary assessment of all the visible parts of the reservoir combining at the same time an architectural description, a description of the pathologies visible on the masonries and a full photographic report. Such an assessment constitutes the necessary base for the preparation of a protection and restoration plan of the reservoir, defining priorities and emergencies. Discussions with the DoAJ and the RSCN will be then necessary.

1.4. Theme 4: carved blocks and methodology implementation for documentation

The carved blocks of the `Ayn Sawda reservoir, discovered between 1981 and 2013, are now shown in Qala't Azraq. Only 10 of the 106 blocks are stored in Irbid, in the Yarmouk University. The specificity of these basalt blocks is their shape, often surprising, which present tenons and mortise on one of their faces as well as on the four faces. Only 62 blocks presents a bas-reliefs drawing on their main face, representing human beings, animals and vegetation or even more complex scenes (**Fig.4**).
In the frame of his project led between 2004 and 2010, Cl. Vibert-Guigue focused mainly on the bas-reliefs, leaving on one side the five other faces and the non-decorated blocks. Despite his work, it seems that the comprehension of these basalt blocks is still uncertain: the role, the organization, the disposition and the function of each block still need to be defined.
Following the relay mission of 2013, it seemed clear to us that the pursuit of the study of the 106 blocks will need to consider the 6 faces of each block, especially as they should present stone cutting details or even wear details. In this perspective, the first phase of our work was clear: we have to document each block carefully. For this, we based our work on a new technology, the photogrammetry, allowing us to create 3D models of each element. The major interest of such a technique is the accuracy and the virtual handling. Our objectives, on a long term scale, are to create a full 3D documentation (and so 2D and pictures too) and to use it for testing virtual reconstructions (without the weight problem of the blocks) and real reconstructions thanks to 3D printings of small-scale models.
In the frame of our mission in May 2014, we plan to test and to implement an efficient methodology for the creation of the 3D models in order then to have the elements to estimate the efficiency and the return of such a method.

II. Results 2014

2.1. Theme 1: archaeological soundings

The results of May 2014 campaign are richer than expected, in spite of the short duration of the campaign. Indeed, if the stratigraphy is not, as expected, very informative (no soil or circulation layer and many non-anthropogenic layers), and if the archaeological material is quasi absent, the study of construction's techniques authorized progress in the site's knowledge, in particular regarding the dating of the reservoir and its functioning.

2014 campaign concerned mainly several small soundings to check, punctually, some precise information. Extensive excavation was not undertaken this year. The objective was to complete the lacunar documentation of the previous expeditions and to answer some questions concerning the construction techniques and the nature of some structures (**Fig.5**). Two new areas were excavated. The first one concerned the circular structure (M01, A area), situated in the N/E of the reservoir and aimed to understand the construction and foundation system of that stepped structure, to determine the function of the place and to check its connection with wall M02 appearing on the surface between the stepped structure and the reservoir (E area). A sector was implanted in the N/E angle of the reservoir, made of walls M03 and M04 (sector B), in order to determine if the wall situated between the circular wall M02 and the reservoir was connected with it, and if the buttress 10.4e was constructed at the same time than wall M04 to which it was appended, or added later. The excavation revealed a very interesting system of reinforcement of the wall and the foundation of the walls M03 and M04 in their E and N part. In order to compare those foundations with the ones of the wall M03 in its W part, another sector has been opened, widening a previous excavation made by the American team (sector G). Moreover, in order to document the previous excavations, soundings were held in two other sectors. The platform (sector C) was the subject of three soundings in order to understand and document more specifically the foundations of this work. The N/W angle of the reservoir and its canal (sector D) was excavated again after the investigations by the American team (1998) and two soundings were held in order to study the chronology of the construction, a hypothetic widening of the reservoir to the W and the foundations of the wall M03, corresponding to the N wall of the reservoir.

2.1.1. The archaeological soundings led in 2014

2.1.1.1. Sector A

The excavation of the sector A was held from the 14th to the 22nd of May. The sounding, implanted on the round wall interpreted as a tree pot by the previous mission[10], measures approximately 6 x 4 m and is oriented N/S (**Fig.5**). The presence of the wall divides the sector into two areas, A south outside the wall and A north inside. The aim

10 2009 excavation report.

of the sounding was the study of the structure by observing its foundations and the archaeological layers adjoining, and the seeking of a junction with a wall located on the surface, halfway to the N/E angle of the reservoir[11] (**Fig.6**).

The circular wall (M01) measures 2,40 m wide in its higher part. It has been restored recently, especially on its inner face where one course of small blocks has been added above the upper course (**Fig.7**). On each face, it presents two benches of 20 to 30 cm high and 15 to 20 cm wide. Those benches correspond to three courses of blocks: the lower level is made of big blocks roughly carved, almost flat on the upper surface; then come big rectangular blocks; finally, the upper course is made of small rectangular blocks. On the outer face of the wall, and more particularly where we implanted the sounding, the benches are covered with an important mass of white lime mortar, very compact though powdery on the surface (US A-13). This mortar can be seen on other parts of the wall, but in smaller quantity and only on the outer face (**Fig.8**).

The foundations are not in the same state of preservation on the two faces, for reasons linked with the nature of the sediments. Indeed, and as we will describe it later, they are much more compact in the S area than in the N one. Consequently, we were able to observe some few places where the courses are visibly collapsed. Despite this state of disrepair and the absence of cement, the situation of the foundations was studied (**Fig.9**). They consist in a trench wider than the wall, about 40 cm on the outer face and around 20 cm on the inner one[12]. It is composed of medium size blocks and compact cement, white to grey (US A-04 in the S area, US A-10 in the N area). Unfortunately, the base of the trench was not reached and the excavations had to be stopped prematurely: in the N area because of the powdery layers that were about to provoke the collapse of the blocks[13]; on the S area because we reached the level of the water (**Fig.2**, **Fig.10a and Fig.10b**). In the actual state of the excavation, we can only attest a minimal depth of 1,30 m. Finally, it has to be noticed that on this trench was set a course of small flat stones, in the possible intention to set up a raft.

Concerning the sediments on each side of the wall, we were able to notice that they are not strictly the same ones. In the inner part on the circular wall, the filling is clayey but mostly ashy (**Fig.4**): was the area submitted to fire? Or were the ashes of the 2009 fire intentionally put here? The stratigraphy shows a first layer of light grey ashes, very powdery, 30 cm thick (US A-01), then a more clayey layer, dark grey, still very ashy but a little bit more compact (US A-05). From time to time occur thin layers of organic material or decomposed roots or cane (US A-06, A-08 et A-09). Only two sherds were recovered.

Outside the wall, in the S area, the nature of the sediments is also clayey, but does not present any traces of ashes (**Fig.11**). Under the surface layer (US A-02) is a sterile clayey layer, white to beige, relatively compact and slightly humid (US A-03). This layer measures about 40 cm thick, and lies on an equally clayey layer, but black (US A-12). It has to be noticed that the limit between those two layers is more or less horizontal.

11 This wall has been excavated in sector E (cf. p.17) ; see also the excavation of the N/E angle of the reservoir in sector B (p.10).

12 On this side, because of the poor state of preservation, this measure has to be relativized.

13 In order to protect the wall and the blocks about to collapse, we put some bags against the foundations during the backfilling.

Inside this black layer is a level of stones (US A-07). It would be delicate to assume here that there is a circulation level or even a floor, as the stones are not organized as a reel flat level, and are not strictly present on the whole excavated surface. Anyway, this level has been cut by the foundation trench. If it corresponds to an occupation level, it is previous to the circular wall. Under this layer lies a black earthy layer, a little less homogeneous, filled with small pebbles and few coals (US A-11). In this layer was found many fragments of a single broken ceramic[14].

To conclude, this sector has brought information concerning the structure of the circular wall, without answering the question of its function, despite the impressive deepness of its foundation trench. Moreover, no connection was established with the wall located S, nor any trench or sign of tearing out. It seems that this circular wall was conceived in an independent way.

2.1.1.2. Sector B

The two soundings of sector B, situated in the N/E corner of the reservoir, aim a double objective. B1 sounding, placed against the exterior face of the northern wall of the reservoir concerned the connection between the wall M02 – a N/E-S/W orientated wall, situated between the northern circular structure (M01) and the reservoir -, and the northern wall of the reservoir (M03), but also to determine if it is a wall or a canal. B2 sounding, situated against the eastern wall of the reservoir and the circular buttress 10-4e (in the N/E corner of the reservoir) questioned the connection between these elements in the aim of understanding if the buttress was built after the construction of the reservoir or if both were built together.

B1 sounding

The sounding B1 is a small sounding (2.5 x 1.4 m) situated at the end of the N wall of the reservoir (M03), against its exterior face. It was placed in the axis of wall M02 (two part of the wall appearing in surface) to check its connection with the reservoir. We didn't enlarge this sounding to the 10-4e buttress because of wood posts which must have disturbed the stratigraphy.

B1 sounding revealed that wall M02 did not join the northern wall of the reservoir (M03) and was not a link between it and the circular N structure. Even if the stratigraphy is disturbed in this sounding, nothing indicates a wall's presence and no lifting indication appears. However this sounding revealed a consolidation of the base of the wall in the N/E corner of the reservoir. The system is study more clearly in sounding B2, where the stratigraphy is intact.

Under a thin surface layer (US B1-00) then a layer (US B1-01) not very thick (between 15 and 40 cm) and composed with a friable grayish brown earth, containing cobbles and modern materiel (glass), was discovered a mortar layer (US B1-02) particularly hard covering stones placed against the base of the wall (**Fig.12**, **Fig.13**). This mortar, white on the surface but whitish grey, is composed of chipped stone (particularly dense) and gravel. From the base of the upper course, the mortar is going to the N following a light

14 We kept one number for the modern surface even though we observed different layers observed while digging, C03, C04, C05 and C06.

slope (alt. sup. max. 10.15 ; alt. sup. min. 9.91). The end of this mortar slope was not discovered because the layer is going in the N section. In its E part, the layer is more degraded. The mortar layer is wider than the consolidations large stones it recovers. The medium-module (between 40 and 50 cm) stones are placed against the first course of the wall inside a grey mortar, particularly hard and compact, containing gravel, a lot of lime nodules and charcoals. The stones and the mortar layer, about 30 cm thick, are situated on a clayey layer. This layer is grayish brown, very crumbly (US B1-04) and without anthropogenic object. It was excavated on 50 cm. The mortar was removed in the N half of the sounding to expose this probably natural layer, where it didn't not covered the stones.

The stratigraphy was disturbed in the central part of the sounding because of a pit (US B1-6) dug for the cement post. The base of the post, pinky gravely cement, is place deeply in the soil (about 80 x 60 cm and 60 cm of depth). The post could be a relic of enclosure posts for a face appearing on photography by D.L. Kennedy. This picture seems to represent the enclosure of the N part of the reservoir.

The pit destroyed the stones belt against the wall over a width of 50 to 60 cm. Its removal let see the base of the wall. It is composed of 3 courses on its outer face but of 2 on its inner face (**Fig.13**). The middle-module stones are well squared off. The base of the wall is placed in a foundation trench excavated only on a small width and length (**Fig.14**). The pit for the cement post was enlarged and the sounding (50 x 140 cm) extended to the N, to the section. The N wall (M03) is founded like the N part of E wall of the reservoir (sounding B2). The N wall is founded differently in the E (sounding B1) and the O (G sector). In B1, the superior part of the mortar is altered because of the pit, but visible in the section. The lower part is similar to the black and gravelly mortar of B2 foundation. The foundation was excavated only of about 50 cm. The trench, like in B2, was dug in the crumbly clayey layer (US B1-4).

B2 Sounding

The sounding B2 is also small (1,80 x 1,50 m). It is situated at the northern extremity of the E wall of the reservoir (M04), against the outer face of the wall and in the south corner of the circular buttress (10-4e) which is situated in the N/E corner of the reservoir. The sounding shows a clamping of the face of the buttress inside the outer face of the wall, like in other buttresses of the reservoir. This is particularly interesting because it points out a global conception of the construction of the corner of the reservoir. This sounding also revealed information about the technical conception of the reservoir in this place. A particularly complex system of consolidation of the wall, unexpected, was discovered.

Under a grayish brown crumbly earth with cobbles thin (between 20 and 40 cm) layer (US B2-01) appeared a layer (US B2-02), very hard and whitish grey mortar(**Fig.15**, **Fig.16**, **Fig.17**). As in B1 sounding, the layer is lightly inclined (alt. sup. max. 10,09 ; alt. sup. inf. 9,73), from the wall and on almost 1,40 m length to the E. The mortar, very compact, is composed with gravel and a lot of chipped stones. The layer is very thin at the W part (4 cm) because it's covering large-module rough-stones placed in another mortar (US B1-03), and thicker (until 20 cm) in the E part witch cover clayey

layer (US B1-04). As in B1, the stones are placed against the outer face of the wall, in B2 the E wall (M04). However, while the south part of the consolidation belt was constituted of one stones alignment, the northern part shows two layered alignments. The upper alignment is composed of badly square off rough-stones, random placed but the inferior alignment presents oblong stones, better squared off, and placed perpendicularly to the wall and in the same alignment each other (**Fig.18**). The stones are average 60 cm long. Contrary to the oblong stones of the platform's bench, the belts stones are relatively spaced each other, smaller rough-stones being placed between them.

The consolidation stones are placed in a very solid mortar but different from the mortar of the upper layer (US B2-02). The second one ((US B2-03) is very hard and dense, grey, with lime nodules, charcoal and gravel. The excavation of this layer was difficult because of the solidity of the mortar. The layer, that is to say mortar and large stones, is one a slity layer (US B2-04), and another mortar (US B2-05). The slity layer is the layer inside which was dig the foundation pit and on which was built de consolidation system. Like in B1, the slity layer is grayish brown. With a hard surface, the layer is however friable, even if some parts inside remain hard. This layer is very deep and was excavated on 1 m. The foundation trench (**Fig.19**), dig inside this layer, is known only by its E face and its size is unknown. The trench is not very large comparing to the face of the wall: it is larger under the buttress (20 cm) than under the wall (8 cm). The mortar (US B2-05), dark grey, almost black during its excavation and on the surface, is crumblier than the previous ones and contains a lot of gravel (**Fig.20**). The trench is almost 90 cm deep and its width decreases slowly. Its maximal inferior altitude is 8,86 m. In the foundation, the stones are similar to wall's stones in module and material, but are different in many points (**Fig. 21**). The stones of the foundation are not well squared off, the courses are less regular, and the facing is irregular.

Under the buttress, a mortar layer (US B2-06) covers the foundation trench. The mortar (10 cm thick) is similar to the one (US B2-02) covering the stones belt and its mortar (US B2-03). White in surface but whitish grey, hard and compact the mortar contains gravel and a lot of chipped stones, like mortar (US B2-02). This layer didn't appear under the wall, in the part excavated.

The E wall of the reservoir is preserved on 3 courses of middle-module dressed stones measuring an average size comprised between 20 and 35 cm, some of them measuring until 58 cm. The two lower courses, excavated this year, are well built comparatively to the upper one, restored by the RSNC. The same holds true for the circular buttress. The joint between the inferior and the middle courses is covered by a lime distemper, 6 cm wide and 1 cm thick (**Fig.22**). At the south end of the sounding there is also a vertical joint. Both of them present basalt gravel inlay: each gravel is placed sideway on two lines. A joint, very white but not very well preserved could be the same kind of joint. It is situated between the facing of the E wall (M04) and the buttress (10-4e).

If these two elements are not linked, the excavation shows a clamping of the buttress and the wall facings, pointing out a contemporaneity in their construction. The facing stones of the buttress's middle course get lightly into the wall facing while the buttress's stone of the inferior course. This technique of buttress's clamping was highlight in other

buttress case on the reservoir.
This sounding, despite its small size, has been in fact very interesting regarding the construction and consolidation techniques. The wall was built on a mortar foundation, relatively deep but not very large comparing to the wall. It was after conscientiously strengthen with large-module rough-stones and very solid mortar, and protected – with a mortar slope, which hydraulic nature must be determine, and with a lime distemper on some joints.

2.1.1.3. Sector C

The excavation of the sector C was held from the 20th the 27th of May. The objective of the three soundings was the study of the platform set on the E wall of the reservoir. One sounding was implanted on each side of the platform, and a third one on the S/W angle (Fig.5). Each one of them revealed different archaeological and stratigraphical situations; consequently, we will present each sounding separately.

Sounding C1

The sounding C1 measures 2 x 2 m from the platform (M05) and is located on its E side, against the bench situated between the buttresses 8-8e and 8-7e. The main objective was to obtain a first sketch of the nature of the layers outside the reservoir, never excavated. Down the bench, covered by mortar (US C-20) is a bank of mortar, extremely compact, white to grey, constituted of small stones and thick of 60 cm approximately at the end of the excavations (US C-19) (**Fig.23**). Unfortunately, due to time reasons, we were not able to reach the base of this bank or to excavate it; therefore, we ignore the nature of the foundation on the E side of the platform.
The stratigraphy of the layers excavated in this sector turned out to be more complex than expected, because they seemed to be deeply disturbed. In the E part of the sounding, caught in the section, there is a pile of blocks, which seems to go deeper (**Fig.24**). They might have been pushed against the platform by a bulldozer during the settlement of the reserve and the setting of circulation areas. That would also explain why no blocks are resting against the bank of the platform's foundation, which would normally be the case if we were dealing with a collapse.
The small dimensions of this sounding did not allow an interpretation of the layers excavated, but only the observation (**Fig.25**). A first remark concerns a trench dug along the foundation bench, deep of 30 cm approximately. This trench is recent because it has been excavated in the modern layer, thick of 40 cm (US C-01[15]) in which we recovered plastic and modern glass. The layers excavated below are earthy and/or clayey, locally organized in bedding, distinguishable only by the color. There are three main layers: a first one, under the surface layer, mainly clayey, heterogeneous, relatively loose and filled with modern roots and punctually stones (US C-07); a brown earthy layer in which we stopped the excavations (US C-18); an extremely compact dark green clayey layer, resting against the cement and filled with chipped stones (US C-17).

15 2004 and 2007 excavations reports.

Sounding C2

This sounding was held on the inside of the reservoir, on the foot of the triangular buttress 8-7i. The aim was to excavate, understand and document the installation of wooden planks and stakes in the foundation, previously observed but poorly documented[16] (**Fig.26**). Initially, the sounding was measuring 2,50 x 1 m, but was quickly shortened: in the S/E angle of the sounding was discovered a pile of blocks, visibly intentionally put there in order to protect the wooden element discovered. We decided to keep there this fragile protection, and work only in the N part of the sounding, on a surface measuring approximately 1,50 x 1 m. The surface layer corresponds to the end of the previous excavations held here.

The smallness of the sounding and the willingness to finish the work in order not to leave the wooden installation in the air did not allow the understanding of the whole installation, but at least allowed its preservation. We hope, for the next excavation, to excavate more the area and to be able to set a protection protocol for the preservation of the wood during the excavation. Thus, the results presented here have to be considered as preliminary; they will be completed by further observations. For the moment, we were able to establish that the foundation bench lies on a foundation trench constituted of mid-size stones[17] and compact white to grey mortar (US C-26) (**Fig.27**). The edges of this trench seem to be maintained by planks deeply pushed in the ground, in a slanting way, and covered by white lime mortar (US C-15). The planks measure 15 to 20 cm wide, around 5 cm thick, and continue deeper. In front of the planks were the stakes, with a diameter of about 10 cm.

Under the surface layer (US C-02), we were able to observe the presence of two pits, probably modern (**Fig.28**). They were dug in a brown to black earth (US C-10) lying on a clayey orangey layer (US C-16). Under it rests a thin sandy layer, filled with small shells and pebbles (US C-13), than a black layer, filled with chipped stones and small fragments of wood around the planks (US C-14). Those two last layers are strictly horizontal. It seems that they pass under the foundation trench.

Sounding C3

This sounding measures 1 x 1,30 m, and is located on the foot of the bench situated between the buttresses 8-1i and 8-2i. This bench is the last one in the S on the W part of the platform. The N and S section of the sounding correspond to those made by the previous sounding, not entirely documented[18]. The objective was hence to observe the foundation previously excavated.

The situation of the foundations here is different, as there is not any wooden installation with planks and stakes. On the other side, we were able to observe, under the bench of the platform, the setting of two levels of foundation, each one identically composed of small stones and white to grey cement, very compact, as what was excavated in the sector A, but with smaller stones (**Fig.29**). The upper level is 60 cm thick (US C-24),

16 Those that we were able to see during the excavation look more, in dimension, to the ones found in the foundation trench below the circular wall in sector A (cf. p.8). It will have to be confirmed during the next excavation.

17 2009 excavation report.

18 Watson & Burnett 2001, p. 75.

the lower one 50 cm thick (US C-25). Both look like they correspond to one single event. Moreover, the limit between the two corresponds more or less to a change in the archaeological layers, with a thin layer of orange clay (US C-21). The lower part corresponds to a clayey black layer (US C-09), similar to the one excavated in the S area of the sector A (US A-12). The layer against the upper part is earthier and very heterogeneous (US C-08): could it be an accumulation of earth? Consequently, we could interpret the first level as being dug in the black clay (US C-09) and, in a second time, another level of foundation would have been raised from that level, maintained by brought earth. On top of the heterogeneous brown earth is a thick light green layer, clayey (US C-22), previously excavated. The excavation stopped on a level of small stones, more or less flat (US C-23), which seems to run under the foundation. No material was found in this sounding.

Those three soundings aimed at documenting the building techniques of the platform. It turned out that the situation looks complex and that the construction of this element of the reservoir had probably to adapt to environmental constraints, probably linked to different nature of the soil from one end to the other of the platform. Those results will conduct to a systematic exploration of the platform the next campaign, in order to observe the whole foundation and layers.

2.1.1.4. Sector D

Sector D is situated in the N/W corner of the reservoir. This place was excavated before by an American team, in 1997. However it was necessary to enlarge the excavations and to conduct some deeper soundings to complete the documentation, concerning the stratigraphy and the hypothetic extension of the reservoir to the W. The entire part excavated by previous team, recovered by trashes (**Fig. 30**) was clean again (**Fig. 31**), with the exception of the N/W extremity of the ancient sounding, on which a trees grown up. The cleaning allow a drawing more complete of the N end of W wall (M08), of W end of N wall (M03) and canal inside it. The excavation revealed a circular buttress at the end of N wall (**Fig.32**, **Fig.33**), contradicting the R. P. Watson and G. W. Burnett hypothesis that the wall extended to the W. It also allows precision concerning the walls' construction and the stratigraphy, even though interrogation remains.
In this area, situated outside the reserve, the ruins were partially destroyed by fire and stones pulled out, probably where the American team left. The stones of the N/W internal corner, as the stones framing the sluice and the stones of the inner face of N wall were intentionally removed or destroyed by trash fires. The stones we found were replaced randomly inside the sounding during the backfilling at the end of the excavation.

<u>Sounding D1</u>

The sounding D1 is the extension to the E of one of the Americans' soundings (**Fig.33**, **Fig.34**, **Fig.35**). Measuring 1 x 2 m, it is perpendicular to the N wall (M03). It was covered over more than 50 cm thick, by modern trash (US D1-00, D1-01, D1-02), however more

trash was added on the sounding after the American excavations. These layers (cf. descriptions in US listing) contain glass, modern porcelain, cloth and plastic. Under these layers, two layers that nature, anthropogenic or not, is not clear, have been discovered. The upper layer (US D1-03), about 30 cm thick, is greenish brown and compact. It contains and chipped stones. The lower one (US D1-04) is green, more compact and contains a lot of gravel and chipped stone. It was excavated more than 30 cm thick but we did not reached its end (alt. inf. at the end of excavations: 10,30 m). No artefact was discovered in these two layers. This is maybe an indication of geologic deposits. Besides, the N wall's foundations seem constructed in US D1-04. This is less clear for US D1-03 (on US D1-4), going against the foundations. This layer could be a deposit placed against the foundations for leveling the area or protecting the foundations.
The sounding allows equally the analysis of foundation system of the N wall (M03) in its W part, and comparison with other parts of this wall. The foundation, about 50 cm thick, is constituted of middle-module rough-stones in a grey mortar with lime nodules (**Fig.35**, **Fig.36**). There are maybe two layers of mortar, but it is difficult to assert it because of the weak visibility of the foundations (around 70 cm). The analysis of the sample will confirm or infirm this difference of nature. As a precaution two US were created. The superior one (US D1-06), around 20 cm height, is a light grey mortar, more whitish than the inferior one (US D1-07) which is a greenish brownish grey mortar. In these two layers, the lime nodules are very numerous, texture is crumbly, and there is gravel. The color's difference, which is the reason of the hypothesis of two mortars, is insufficient to assert the difference of nature and could be the result of the difference of exposure to the atmosphere. The whole of the foundation is cover by a thin layer of mortar, white, particularly hard, containing numerous chipped stones and compact textured (US D1-05). There is the same system in other part of the wall (B and G area).

Sounding D2

A sounding was open in the N/W corner of the reservoir, near the outer face of the W wall (**Fig.37**). The aim was, originally, to examine the chronology of the construction between N and W walls. This sounding authorized the extension to the W of the American excavations, leading to the discovery of a circular buttress in the corner of the reservoir. R. P. Watson and G. W. Burnett observed two points during the excavation of the corner: the extension of the N wall to W and the absence of chaining between W and N walls. These elements have to be analyzed in detail. It appeared that, if the N wall extends well to the W, its extension is interrupted by a circular buttress. The W limit of the reservoir is still the known one (M08). The excavation of the N/W corner on its outer face showed that the foundation was probably communal to the two walls. It is an indication of synchrony in the conception, even if the two walls are not linked (**Fig.38**). The limited duration of the excavation did not allow guaranteeing the uniqueness of the foundation by complete excavation. However the mortar covering the foundations, appearing in many points of the construction of N and W walls is the same.
The whole area was covered by modern trash (US D2-01) but the different steps were not distinguished (one US only). Under this layer (around 30 cm thick) composed of different deposits of gravel and earth, containing glass, plastic, etc., were discovered

the buttress C18-1, a layer of mortar (US D2-02) recovering probably the foundation of the walls, and a layer of which the origin, natural or anthropogenic, must be determine (US D2-03). The mortar (US D2-02) is similar to mortar covering other foundations of the N wall (M03; soundings D1, G1 and G2): whitish grey, containing chipped stones, and characterize by a compact and hard texture. Against this mortar and then probably against the foundations, is present the same layer than in D1: a greenish grey earth layer, compact, containing chipped stones and gravel. It is difficult to determine if the foundation trench was dig in this layer or if the latter is an anthropogenic deposit for leveling or protecting.

2.1.1.5. Sector E

The sector E was excavated from the 17th to the 21st of May. It corresponds to the study of the wall oriented N/S, from which the E and W faces were localized on the surface, halfway between the N/E angle of the reservoir[19] and the circular wall[20] (**Fig.39**). Two soundings were carried out, a first one (E1) measuring 2 x 1,50 m, on the E face of the wall – approximately 50 cm inside the wall and about 1 m on the outer face –, and a second one on what appeared to be the remains of the E face of this wall, located few meters S of the circular wall (E2) (**Fig.5**). In this last case, the work consisted in a surface cleaning.

The excavation of the sounding E1 has quickly revealed that the stones (M02) were not the E face of a wall, but an alignment of blocks (**Fig.40**). Aside a small remain of white mortar (US E-07), no traces of mortar or coating were discovered. The sounding E2, on another hand, did not confirm the presence of a wall, but of few stones, in an approximate N/S axis. It is hence not a wall, which was confirmed by the excavation of the circular wall (M01) in the sector A which did not revealed any connection with the supposed wall[21]. It has to be added that the few stones in E2 were resting about 25 cm lower than the ones in E1.

Under the surface layer, which was obviously submitted to fire (US E-01 on the E part of the stones, US E-03 on the W one), occurs the same situation on each side of the stones. First a clayey layer, white to beige, more compact on the W side (US E-08) than on the E one (US E-02) (**Fig.41**). Under lies a thin layer of green clay, 10 cm thick, filled with small pebbles (US E-04). This layer passes under the stones. More precisely, the stones seem to rest on this layer. On the W side, it is slightly higher - about 10 cm - revealing hence a little slope. Under this layer lies another one, as clayey, but dark grey, 10 cm thick (US E-05). Underneath is the white to beige clayey layer again (US E-06). Finally, it has to be noticed that no material, antic or modern, was found in this sounding[22].

19 Sector B (cf. p.10).
20 Sector A (cf. p.8).
21 We did not dismantle the formwork in the exterior of the foundation.
22 « *Batardeau (définition) : f. m. latin Pulvinus, Italien Steccato, eng. Waterstop, All. Damm in Wasser. Est, dans une rivière ou autre lieu aquatique où l'on veut fonder, une double enceinte faite avec pieux, pals, planches, traverses, moises, contrevents, etc. que l'on remplit de terre glaise, pour empêcher l'eau d'y entrer, et dont on épuise celle qui y était, afin de découvrir le bon fonds, et mettre les maçons en état d'établir les fondations solidement* ». Charles François Roland le Virloys, 1770.

The study of this sector has allowed to precise that the stones do not correspond to a wall; it is an alignment of stones, cut in its actual state of preservation in its N part as in its S one, probably disrupted by the modern planning of the reserve. It is parallel to another alignment that was not excavated this year. It is neither a wall nor a channel. It could be an enclosure, but we still have to understand why there are two of them. The green layer, visibly installed in order to serve as a base for the stones, is really interesting as it testifies some sort of planning. It could be interesting, for later excavations, to enlarge the sector in order to understand at least how those stones were installed. Indeed, no traces of slope or foundation trench were detected, and it is hard to imagine that they were able to stand still without any help. A wider excavation could maybe be able to precise this point.

2.1.1.6. Sector G

Two small soundings (1 x 4,40 m) were open in the sector G, in the W part of N wall (**Fig.42**). The sounding G1 is perpendicular to the S face of the wall and the sounding G2 is situated, on the same axis, against the N face of the wall. The aim was to examine the foundation system in the W part of the N wall to compare the techniques with E part. The foundations were partially appearing because this part of the wall was excavated, without publication and fill back in, by R. P. Watson and G. W. Burnett in 1997. The section was also cleaned in the S part of sounding G1.

Soundings G1 and G2

Because of the deep excavation of several meters on both sides of the wall and because of the non-publication of the excavations, the stratigraphy against the wall is not very well known in this part. The connection is lost more than 70 cm high from the surface, and more than 80 cm high form the preserved top of the wall. We pursued the excavation around 70 cm and it showed homogeneity in the layer with the upper part appearing in the cleaned S G1 section (not connected to the wall but parallel to the facing). The grey, crumbly earth situated under the foundation is similar to the earth in S section (about 1,40 m; **Fig.43**) and in section W and E (about 70 cm). It seems that the foundation trench was dug in this grey layer (US G1-01). However, it is surprising that the grey layer is upper than the top of the foundations (alt. sup. of the foundations 10,21 *vs* alt. sup. of the layer 10,42) in G1. The surface of this layer is situated at the middle of the first course of the wall (alt. sup. of the wall 10,51). It means that most of half the inferior course was not visible what is surprising for a wall with three courses maximum (only one is preserved in that place). However, this area was disturbed by the American excavation and by construction around. The excavated grey earth could have be deposit nearby and flatten down or leveled, raising the height of US G1-01. It is possible that the addition of identical earth is not visible in a 1 m length section (same texture and same color). Moreover, in G2 sounding, the layer is only few cm upper than the wall.
If the stratigraphic results in this sounding are relatively poor, the study of the foundation is more informative. The foundation in sector G is totally different from the N/E corner of the reservoir, even if it is supporting a wall constructed in one phase (no break in the

wall). Wide (2,50 m) and deep (92 cm), the foundation present a straight profile (**Fig.44**, **Fig.45**), contrary to the convex profile of the N/E corner's foundation (cf. sector B). The N face of the foundation is larger in relation to the wall than the S face: the first one is 50 cm wide and the second one 12 cm wide.
In sounding G2, on the exterior face of N wall, the mortar formwork is well preserved and was not destroy by the previous expedition (**Fig.45, Fig.46**). Whitish grey in surface, the mortar is grey, friable and contains gravel (US G2-03). Another type of mortar (US G2-02) is situated on the foundation, directly under the inferior course of the wall (**Fig. 47**). This mortar is similar to others discovered in sectors B and D, under the N wall: whitish grey, white on the surface, it contains gravel and a lot of chipped stones and it is characterized by a compact and hard texture.

In the S sounding (G1), the mortar formwork largely disappeared. The foundation's stones, middle-module and not well squared off, was then visible. The stones are placed irregularly. Two superposed layers appear, as if the stones were placed in two steps. The two stones' layers are separated by a layer of mortar with chipped stones (US G1-04), similar to the mortar placed between the inferior course of the wall and the foundation (US G1-02). It could be a construction technique aimed at protects the foundations from the water and the humidity.

2.1.2. Preliminary conclusions: construction, phases and dating

The main informations collected from the excavations led in May 2014 concern the building techniques and the chronology of the reservoir building. We will focus at first on the architectural aspects and then on the archaeological aspects related to the phases and the dating of the reservoir, to the stratigraphy and to the material uncovered.

2.1.2.1. The architecture

The `Ayn Sawda reservoir covers an area of around 62200 m^2. Its perimeter is delimited by a long wall of 990 m built in basalt blocks masonry that we have sub-divided into many walls sections for the study (M3 to M8, **Fig.5**). Some buttresses, semi-circular, triangular or rectangular, are present on the interior and exterior faces of the wall.
It is a basalt construction, due to the large presence in the area of basalt stones thanks to the geology of the region and more especially to the basalt slide going down into Jordan from southern Syria and the Hauran region. The wall is constituted of two visible elements: the facing stones and the internal filling. The facing stones are made of basalt blocks cut with a diamond shape at the back (five faces blocks from which only one face is cut in its integrality) which dimensions are varying (the detail will be presented in the final report). The internal filling of the wall, which constitutes the core of the masonry, is composed of rubble stones of small and medium sizes, gravels and mortar.
Thanks to the observations we have led on the field, two main axes appeared.

<u>The reservoir: one single construction phase?</u>
During our survey along the wall, we have identified some clear constructive connections between the buttresses and the wall that let us think that they have been built in one

single phase. Indeed, additionally to the systematic interruption of the stone facing of the wall on the buttresses location, the major part of the buttresses still visible on the reservoir present facing blocks which are penetrating into the wall masonry. This phenomenon can be seen on more than one stone row, on one stone row or only on one point of the buttresses. Nevertheless, it is a recurring observation and in some cases, it is even enriched by specific stone setting details which suggest quite clearly one single construction phase (**Fig.48**). If we follow the hypothesis of the previous scholars, and if we admit that these buttresses are typical of the Umayyad architecture, then we could conclude that the reservoir itself is datable to Umayyad period.

It is important too to mention that the absence of buttresses chaining to the wall was observed by some scholars who saw in this detail the proof of a multi-phase construction (roman/byzantine then Umayyad). From our point of view, it is the absence of the wall's stone facing where the buttresses are located – and so the continuity of the internal filling of the wall and buttresses – that plays the chaining role and gives to the wall the sufficient resistance and cohesion against the solicitations. We have to keep in mind that we are most probably not facing a high construction. The penetration of the buttresses' stone facing into the wall's stone facing is a supplementary proof of the absence, from the origin, of any stone facing on the buttresses location. About this particular point, it is interesting to note the restoration made on the buttress 12-5e, on the N wall (M3), where the wall's stone facing has been reconstructed where the buttress is located. The actual situation is that the buttress is falling apart from the wall (**Fig.49**).

Nevertheless, in sector D, a situation previously described by Watson et Burnett seems to contradict this hypothesis. Actually, the wall M3 (oriented W/E) present a continuous stone facing on its south face, on which comes the wall M8 (oriented N/S) whose internal rubble stone filling seems to stop clearly in front of the stone facing of M3 (**Fig.33**). This situation, only there observed, could be explained by the presence of the channel specific features in the direct vicinity, even it still needs to be demonstrated.

<u>The reservoir foundations</u>

The major interest of the archaeological soundings led during the fieldwork is the uncovering and the documentation of the foundations of the reservoir and of the circular structure, on five of the studied areas (A, B, C, D, G).

In the sector A, we have reached the foundations in the two soundings, north and south. On the north side, the three cut basalt rows are lying on top of more irregular rows of big rubble stones founded on a mortar and rubble stone complex which base has not been reached for security reason as the wall was falling down (end of the excavation 9,00 m). On the south side, the water table has been reached in the sounding at 8,28 m, stopping our work. The organization of the foundation is similar to the one observed on the north side, a complex of rubble stones and mortars overhanging the stone facing of the lower visible basalt row. The specificity, on the south side, is the presence of a mortar glacis on top of the cut basalt rows (**Fig.8, Fig.10a and Fig.10b**).

In the sector B, the foundation base has been reached in the sounding B2only at 8,85 m. In this sounding, three cut basalt rows (between 10,50 m and 9,58 m) have been uncovered. Founded on a massive complex of rubble stone and mortar, in small

overhanging compared to the wall face, the wall facing was visible only on one row and a half. Indeed, long stone slabs were lying on a mortar bed on top of the foundation and were covered by a second very hard mortar (10,00 m). They were abutted to the stone facing of wall M4. The removal of these stone slabs allow us to observe the perfect stone cutting of the wall's stone facing and the presence of a joint with basalt fragments (displayed in fish bone shape) on top of the joints on the three facing rows. In the sounding B1, the presence of similar slabs and mortar layers has been observed and the highest level of the foundation has been seen on a similar level 9,56 m. Even if the south face of M3 has not been excavated, it is interesting to notice that the highest level of the foundations (mortar layer and small basalt stones under the cut facing stone) reaches 9,88 m, which correspond to the base of the intermediary row seen in sounding B1 and B2 (**Fig.13, Fig.16 and Fig.17**).
In the sector D, the foundation has been observed in one zone only, on the south face of wall M3. Composed of quite big rubble stones and mortar, it appears at 11,03 m and it base is at 10,53 m (**Fig.35**).
In the sector G, which had been already excavated by the American team in 1997, the cleaning of the faces north and south of wall M3 allowed us to observe the same type of foundations than in sector D. The foundation appears at 10,21 m and its bas is at 9,30 m. Composed of big rubble stones and mortar, it is overhanging compared to the wall face and the foundation trench has been clearly identified on the north side (**Fig.45**).
Finally, in the sector C, excavated in three zones (C1, C2, and C3) three different situations have been observed. In C1, on the east face of the platform, a bench made of basalt slabs has been identified at 10,02 m, under which is present massive mortar element whose base has not been reached before the end of the excavation (8,89 m) (**Fig.25**).
In C2 and C3, on the west face of the platform, the basalt benches have been observed respectively at 9,66 m and 9,82 m. In C2, the wooden elements (pillars and boards) identified reach the base of the benches and seem to be set in a mortar. Their base has not been reached before the end of the excavation (7,90 m) (**Fig.27** and **Fig.28**). In C3, two level foundations have been observed at 9,18 m and 8,61 m. Composed of mortar and rubble stones, they are step shaped and present a large overhang compared to the face of the bench. The base of the foundation has been observed at 6,98 m and the water appeared at around 7,90 m (**Fig.29**).

An important diversity has been observed and the major question is now to understand if it is related to different construction phases or to specific technical requirements. From our observations made during the excavations and the sanitary assessment of the reservoir, it seems that the diversity observed on the foundations is more related to technical needs. About this, it is particularly interesting to notice the specifities observed on the platform. The presence of wooden elements in C2, previously interpreted as foundations by Cl. Vibert-Guigue, seems on the contrary to be the negative of the foundation that is its formwork. Indeed, the position of the elements, in front of the platform construction (the pillars in particular), and the wood dimensions (the boards under the benches are only 4 cm thick) seem to be more related to a *batardeau* than to a foundation itself. This impression seems reinforced by three elements: the first one is

the presence of mortar in between the boards, the second one is the nature of the soil very different from C1 and C3 (more sand, no black earth) and finally the third one is the absence, at the top of the boards, of a wooden charge repartition system. It is then preferable to apprehend this technical solution as a solution guided by the geologic nature of the soil at this precise location: weakness linked to the wadi coming from the east? Likewise, in the sector B, the presence of the big slabs at the base of the wall could be related to a soil weakness.
In the perspective of précising our hypothesis, each mortar identified has been sampled. The aim is double. First, the analysis of the composition of the mortars could allow us to understand in a better way the technical role of each element and secondly, the comparison with documented mortars form similar constructions could help us to precise the dating of the reservoir. We hope to be able to do these analyses in Jordan.

2.1.2.2. Stratigraphy

The time devoted to this first campaign was relatively short, and needed precise objectives, architectural and archaeological. In order to reach the maximum amount of data related to the nature of the sediments, the material, the archaeological context and the architectural situation, we decided to privilege the number of sectors rather than their dimension. At the end of the campaign, twelve soundings were opened in different places of the reservoir, even out of it in its N part in order to explore the circular wall M01 (Fig.5). This accumulation of soundings has, of course, allowed various interesting data. Moreover, it allowed the documentation of many areas that were previously excavated. On another hand, from a purely stratigraphic point of view, we can regret the absence of analysis and interpretations, despite the numerous observations made. Indeed, if the archaeological layers were observed and documented in every sounding opened, the smallness of most of them could not allow interpretations, complicating the analogy between the different sectors. Nevertheless, before further explorations, we can already make some remarks.

<u>Nature of the layers</u>
In every sounding, it has to be noticed that the main nature of the layers excavated is clayey. This is not a surprise, giving the humid character of the excavated area. Nevertheless, it is not the only one. For instance, we could notice that the sounding C1, out of the reservoir, revealed earthy layer deep down. We will have to analyze those different layers in order to understand the natural or human nature of the sediments that will allow a better comprehension of the diverse phases of planning of the reservoir.

<u>Green clayey layer</u>
In three different sectors was excavated a layer of clay, green and very compact, composed of stones or chipped stones. In the sector C, more specifically in the sounding C1, this layer made of small pebbles covers the mortar bank down the bench. In the sector D, this layer is on a flat level and corresponds either to a natural level or to a level functioning with the foundation of the N/W angle of the reservoir. Finally, in the

sector E, a thin layer of dark green clay filled with small pebbles is used as a bed for the stone alignment M02. In the three cases, without any possible interpretations, we could make the hypothesis of a same desire to level, isolate or ensure a solid base during the construction of the reservoir.

Black clayey layer

In the areas A south and C3, the same stratigraphic situation was observed: a black clayey layer covered by a layer of the same kind, only white to beige, slightly orange in C3. Beyond the color, the nature of the layers is the same. In both cases, the black layer seems associated to a level of stones, and the limit between the two layers is horizontal. On another hand, the situation is not the same: the sector A corresponds to the circular wall M01 and the sounding C3 to the SW angle of the platform. In the first case, the observation was made in the outer part of the wall, at the level 9,34 m; in the second case, in the inner part of the reservoir, at the level 8,64 m. The same situation was noticed in the reservoir, in a place where an artificial section was made by a bulldozer, giving as a limit for the layers the level 9,15 m. Does this limit correspond to the maximum level of the water during the spring time? We must find an answer to this phenomenon, and try to seek out the other places where this configuration is visible.

Situation of the platform

As mentioned earlier in the architectural section[23], the platform of the reservoir offers three different situations in the three soundings where it was studied in sector C. On the outside, the results of the excavations were not as conclusive as expected, though they revealed a stratigraphic situation richer than in other places. The smallness of the sounding did not allow the understanding of the layers nor the disturbance due to modern planning of the reserve. On the inside, the sounding revealed layers in context, horizontal, filled with small shells and chipped stones that can be related to proto-historical periods. In the sounding C3, nothing like this was observed. Locally, around the platform, those three soundings showed different situations, putting in evidence the various settings of the area, antic and modern. In order to understand this structure on the E wall of the reservoir as well as the stratigraphic changes – and also the architectural ones –, we must plan an extensive excavation, allowing a simultaneous exploration of the layers, the wall and the foundations.

Situation of the reservoir

Except the sector D, the soundings opened on each side of the reservoir wall offered the same situation of clayey earth, white or beige, filled with small pebbles. Those soundings were never deep, but still they don't attest major ruptures visible in the construction of the reservoir.

Archaeological material

The last remark concerns the poorness of the material collected, antic or modern. This absence has to be questioned, though it can be relativized given that we are dealing

23 See p.21.

with a reservoir and not an inhabited area, but that has still to be examined at least around the platform, when we think about the previous excavations that delivered numerous objects (beads, bracelets, metal objects) and sherds [24].

2.1.2.3. Ceramic

The ceramic discovered during our fieldwork, and most probably by the other archaeological missions, doesn't come from stratigraphic context as interesting as floors or circulation levels. Nevertheless, it has been found in very poor quantity and no diagnostic potsherd has been discovered. A first observation allowed us to date some of the potsherds (sector A south, US11) from the Byzantino-Umayyad time (**Fig.50**). The sherds concerned are handle pieces and can't be dated more precisely as the ceramic from the late byzantine time and the early Umayyad period are quite similar. We established some contacts with the DoAJ, especially with Ahmad Lash, in order to access to the material collected during the previous works led by Cl. Vibert-Guigue. This material, coming from the surface excavations next to the platform, seems to be more interesting that what we found this year. Some diagnostic sherds and some bracelets pieces could undoubtedly give us a more precise dating.
If we still don't have any specific element to date the reservoir form the Umayyad period, the recurrence of indications pointing to this period is notable: the buttresses are characteristic from the Umayyad period, no construction break indicating many building phases has been identified, the ceramic seems to indicate the late byzantine time and the early Umayyad period, the mortars discovered in sector B could be similar to mortars identified in Qusayr `Amra (information from Wisam Esaid, DoAJ Azraq) the Umayyad bath built at al-Walid time.

2.2. Theme 2: topography

2.2.1. Levels implementation on the reservoir

Despite the first research led at the Royal Center of Geography in Amman, no geodesic point in the Wetland Reserve had been identified before the fieldwork in May 2014. On site, we asked again to the responsibles of the DoAJ and the RSCN, but without any result. Actually, it seems that geographers implemented a point at the beginning of the 80's, next to the Ecolodge Azraq (RSCN) but nobody in Azraq knows its coordinates. In parallel, we realized that all the archaeological missions working in the Reserve or in Azraq are using GPS, easier and less expensive than total stations. But even so, the accuracy is not as precise as total station, especially for the altitudes.
As we were not equipped with a GPS this year, we implemented an arbitrary reference point A-REF (z=10,00 m) located on the first exterior step of the circular structure (M1) located north of the reservoir. From this reference, three other points have been installed: B-REF (z=10,56 m) on the E wall of the reservoir (M4, next to sector B), C-REF (z=10,91 m) on the triangular buttress immediately north of the platform (9-1i, next to sector C) and D-REF (z=11,22 m) on a stone of the channel in sector D. It allowed us to

24 2004 and 2007 to 2010 excavation reports.

measure the levels on the whole reservoir, inside and outside the Wetland Reserve and so to compare the different zones of the reservoir and our excavations sectors (**Fig.51**).

2.2.2. Levels: a necessary analysis tool

The first aspect that seems interesting is the levels comparison of the top stone row of the reservoir and the foundations levels that have been observed during the excavations or the architectural observation. Not very reliable for the top stone row in the much restored zones, the precise study of the stone rows levels could give us information on the rows horizontality and give us indications on the topography at the construction time. From this point of view, the study of the foundations levels identified would allow us to precise our hypothesis and conclusions. On another side, the important variations observed on the foundations (9,18 m in C3 ; 9,52 m in C2 ; 9,56 m in B1 ; 11,03 in D) could give us information about the function or the organization of the reservoir. These analyses are in progress (**Fig.51**).

The second aspect that seems fundamental is the levels comparison of the specific features of the reservoir, such as the channels. Indeed, the excavations on the N/W corner of the reservoir where the American worked and the topographic study of the reservoir showed an important level difference between the channel located on the N/W corner of the reservoir (sector D) and the channel located on the south of the platform in sector F (M6). The N/W channel is built with a very elaborated technique which combines basalt slabs on the ground, facing stone perfectly cut ans some specific features like buttresses in the masonry. Four of the facing blocks (only one is missing actually) and two of the slabs are cut with a rebate measuring around 5 x 5 cm, creating a double closing system which could have been used with wooden panels. A slight slope is visible on the slabs as the external slab is at 10,85 m while the internal slab is at 10,80 m (**Fig.52**). The channel F, south of the platform, is very different form the constructive point of view. Indeed, this is a channel with a coated base and with irregular side faces. His conservation state is not as good as the N/W channel but we can observe clearly a a slope (from the interior 10,05 m to the exterior 10,00 m of the reservoir) and a funnel shape which narrows on the exterior side of the channel. No closing system has been observed (**Fig.53**).

The levels question is crucial, particularly for a structure designed for containing water. The comparison of the channels levels shows a difference of around 75 cm between the N/W corner, which is higher, and the sector F, which is lower. It is very interesting too to notice that, in the sector D, the highest level of the foundations of wall M3 is at 10,80 m and that it corresponds exactly to the top of the platform in sector C. This important difference makes us think that the reservoir, if it is real function is to be a reservoir, doesn't work as a unique entity but that two different parts were visible: a zone to the west, relatively flat and on a hard ground (Plan of Rees **Fig.2**), in which water supplying was assured by the N/W channel; and a zone to the east, with a more important topography (cf. top level of the foundations in sector C for example) and a swamp ground, in which surfaces `Ayn Sawda spring which was controlled by the channel of sector F. In this case, the channel F could be interpreted as a water flow channel. Only an accurate geologic study would allow confirming these hypotheses.

2.3. Theme 3: sanitary assessment of the reservoir

To draw up a sanitary assessment of the reservoir, the wall has been divided in 21 sections. Each section is recognizable by an important change either of visibility (wall visible, wall invisible or destroyed) or of construction (presence of specific features, foundation levels changes, etc.) (**Fig.54**).
A standard form has been created and filled systematically for each section defined. It includes graphic elements (plan and schematic sections of the section) and descriptive elements which concerns general informations (section length, wall width, presence or absence of buttresses), related to the architecture itself (number of stone rows visible, rows height, presence or absence of mortars or coats, stone layout, etc.) but also the pathologies observed and their probable origin. We have distinguished the interior from the exterior of the reservoir. Systematic pictures have been shot for each section: three general views of the section from each extremity of the section, one to three pictures of each buttress according to the access possibility, detailed pictures of the specific features and pictures of each pathology visible in the section. The 21 forms will be presented in the final report and will constitute the base of our work for the elaboration of the restoration and protection plan.

2.3.1. Files assessment: some general remarks

On the 21 sections defined, 19 concerns the reservoir itself, the section 20 concerns the elements between the N/E corner of the reservoir and the circular structure (sector E) and the section 21 concerns the circular structure (sector A).
Sections 1,3,14, 16 and 19 are zones where the reservoir's wall is not visible (**Fig.54**). In the section 1, the shape of the wall is very clear on the ground but the architecture is covered with earth. In the section 3, the wall is present too but covered by a car track created by the RSCN to access to the east of the Reserve. The section 14 is occupied by one of the RSCN office buildings, built on a concrete slab, by a dense vegetation and 4x4 tracks for the rangers of the RSCN. The section 16, at the junction between the inside and the outside of the Reserve, presents probably a stone row under the earth but nothing is visible. A concrete threshold is on top of the supposed wall location where the fence of the Wetland Reserve is located. Finally, the section 19, outside the Reserve, is the longest one as it groups the west wall and the south wall of the reservoir. It presents a lot of lootings and as a consequence the zones were the wall is visible (sometimes one face, sometimes two faces) are more and more numerous (clear increase of lootings between 2013 and 2014) in the accessible zones.
All the other sections are referring to zones where the architecture of the reservoir is visible, at least partially. Some sections, as section 2 and section 17, present only one visible stone row while sections 8 and 9 present four stone rows at least. Even if it is clearly visible that the architecture of the wall is in a bad general estate, it is possible to distinguish three main zones.
The zone I - which includes sections 2 to 7, 13 and 15 – is a relatively privileged zone as it is inside the Wetland Reserve but outside the zone accessible to visitors (**Fig.54**). The wall has been only a few or not modified and thanks to the absence of restorations, it

appears in its original estate. Only the vegetation is very dense and covers some parts (sections 4 and 6 mostly).
The zone II – which includes sections 8 to 12 and 21 – is part of the visitor trail that the tourists have to take while they visit the Reserve (**Fig.54**). The access to the wall is located at the W extremity of section 12, in front of the observation spot overlooking the reservoir, and the exit is located on the platform (section 8) where a wooden bridge lead the visitors to a second observation spot. Very restored, this zone underwent important modifications and doesn't present much original parts, especially on the higher stone rows which have been systematically restored. Generally speaking, we observe important disturbances on the wall, which seem related to the quality of the restoration done, to the impacts of visitors and animals and to the drying up of the soils for the zones next to the platform. Numerous facing stones are falling down, the connections wall/buttresses are endangered and big cracks appeared on the platform.
The zone III – which includes sections 17 and 18 – is outside the Wetland Reserve, on a private land non-closed (**Fig.57**). Here, the conservation estate of the wall – its existence even – is clearly in danger. The threats are much more dangerous than inside the Reserve as a lot of lootings are happening in this area. Looking for gold, the looters dig holes in the wall, next to wall and even under the wall. They destroy if necessary and in any case the wall is weakened as the holes are not backfilled of course. The second threat is the consideration of the place as a garbage area. If the thickness of the garbage can sometimes constitutes a protection layer on the remains (almost 1 m garbage excavated in sector D on the zone where the American team excavated in 1997 without backfilling), the fires to eliminate them are a real danger as it breaks the stones.

2.3.2. Proposition of a protection and restoration plan of the `Ayn Sawda reservoir.

As we have seen above, the general estate of the reservoir is quite bad for many reasons which are differing according to the location of the elements. It is then important to draw up a protection and restoration plan which takes into account this essential data.

<u>Inside the Wetland Reserve</u>
For what concerns the zone I (sections 2 to 17, 13 and 15), the wall estate will remain stable as soon as the facing stone blocks will remain partly buried into the earth. So there is no real need to intervene on a general scale. But nevertheless, we recommend some punctual interventions:

- *Control and regular care of the vegetation next to the wall* (the entire zone is concerned). Indeed, the damages caused by the trees roots and the reeds need be taken into account as it provokes facing stone falling and joints explosions. The roots penetration into the visible wall faces and in the subterranean parts need to be limited.
- *Dismantling and removal of the concrete elements installed on the wall* (section 4). The installation of these elements has been done after a partial dismantling or even the breaking of the top stone row of the wall. The lack of care and

use make them dangerous for the masonries, particularly because of the steel reinforcement bars which are rusting. *The creation and the installation of new elements of this type needs to be forbidden on the reservoir wall.*

- *Backfilling of the bordering zones of the wall* (sections 5 and 15). In these sections, there are important damages on the wall, related to old excavations which were not backfilled. Since then, the wall is isolated from the natural ground and trenches are present in between. We can observe now stones falling and stones swinging, garbage concentration, fire traces and even damages and blocks falling in the foundation and lower rows of the wall. *Every excavation led on the reservoir needs to be backfilled immediately.*
- Punctual restoration of stone facing (sections 5, 6, 7 and 15) in the zones where damages have been observed. As much as possible, the restoration should be done with the original blocks, the bed layer needs to be cleaned and the block needs to be built with a hybrid mortar. The mortar will have to be brushed with an hard brush on all its visible parts.
- *New ranger and car tracks or repair of the actual tracks:* it is a necessity to continue to raise the tracks in order to have on top of the wall, and if possible to locate them next to the wall in order to limit the damages on the masonries (the entire zone is concerned and more particularly sections 3 and 15).

For what concerns the zone I (sections 8 to 12), the emergency is clear as this zone is part of the visitor trail in the Reserve. The two main causes of the damages are, as we have seen above, related to the impacts (human, animals, restorations not strong enough) and to the hydrologic conditions of Azraq, particularly the drying up of the soils in the Wetland Reserve. Even they have to be treated separately, as the technics and the ways to solve them are very different, it is nevertheless possible to make two general recommendations that seem to be necessary before any other intervention:

- Purge, control *and regular care of the vegetation next to the wall. This task need to be particularly followed on the zones 8, 9 and 10 in order to limit the subterranean damages due to the roots development. The roots purge has to be done with caution and the holes created by their removal will have to be filled with earth.*
- *Purge of recent mortars, removal of the unstable stone facing blocks and restoration with a hybrid mortar.* On the entire top stone row of zone II, we observe damages related to the bad cohesion of the facing blocks with the internal filling of the wall: stones swinging, stones falling and restoration mistakes (blocks used at the wrong place). We recommend to purge the recent mortars, to remove the unstable blocks and to prepare a bed layer important enough to recreate the cohesion between the stone facing blocks rebuilt with a hybrid mortar and the internal filling composed of rubble stones and mortar. More specifically, in the buttresses nearby, we recommend to remove the remove the facing blocks (built during the restorations) that separate the internal filling of the buttress from the walls one: it concerns mainly the section 12 were the buttresses are clearly weakened.

For what concerns the problems related to the impacts, two possibilities seems conceivable:

- The first one is to change the visitor trail of the Reserve. Planning it north of the north wall of the reservoir, on the already existing track, the access on the wall could be limited to one point only: the access to the observation spot (west extremity of section 12). Nevertheless, this implies some modifications on the wooden bridge leading from the platform to the second observatory spot.
- The second one, which implies more important financial needs, could be to cover the wall with a wooden trail equipped with lifelines on each side. This structure should be independent from the wall in order to limit the impacts on the wall and to allow a removal without consequence for the reservoir if necessary. The restoration works of the top stone row should be done before its installation.

Discussions with the RSCN and the manager of the Wetland Reserve will be necessary in order to define the more adapted solution.

For what concerns the problems related to the drying up of the soils, it is mostly on the sections 8 and 9 that they are visible, on the interior face of the reservoir. As we have seen above[25], the platform of the reservoir is built on a masonry massif. The wooden elements (pillars and boards) identified in C2 (but neither in C1 or C3) are most probably the indication of the operating mode used during the construction of the foundations (*batardeau*) and are indicating the presence, in this specific zone, of water in important quantity in the soils (wadi coming from the east, soil composition more sandy). This impression is reinforced by the presence in section 9 of an important shear crack in the masonry, indication of a punctual imbalance. Before any intervention, it seems necessary to continue the excavations along the platform, going to the N and to the S of sounding C2, to know the exact limit of the concerned area and to have a better knowledge of the ground composition. The back filling of the excavations will be necessary and a geotechnical study led by specialists will be necessary before any intervention which could be more important (injections to strengthen the soils for example).

<u>Outside the Wetland Reserve</u>

Two zones can be distinguished. The first one - which corresponds to the zone III to which is added a first part of the W wall - between the Wetland Reserve fence and the north façade of the buildings covering the W wall, needs to be closed by a fence as soon as possible in order to limit or even to avoid lootings and garbage spots.

The second zone, which is between the S facade of the constructions covering the W wall and the S/E corner of the reservoir, is more complex. Even if some stones faces are visible in many locations, it is clear that the wall is partially covered by new constructions or plantations and as a consequence most probably destroyed in some parts. It seems difficult to advocate a long term protection and the best that can be done now is to excavate and document quickly, particularly on the S/W and S/E corners.

25 See page p.21.

2.4. Theme 4: carved blocks and methodology implementation for documentation

The work done during the fieldwork in 2014 has been shared out on two days and aimed to define the bases of our future work. It has been divided into two phases.

2.4.1. To list and to photograph the blocks

The first phase of our work was to list the blocks stored in Qala't Azraq (cf. Appendix 2) and to photograph their main face. This step, compulsory as we didn't have these documents, constitutes the base of a database catalog that will allow us to study the block in an accurate way. The photographs have been taken with a reflex digital camera Nikon, lent by the Ifpo, and a three worksite spots installation to get a good lighting.
The main conclusion of this work, and especially from the photographs, is that the blocks need a full cleaning. Indeed, the accumulation of dust in the exhibition room is very important and doesn't allow distinguishing the bas-reliefs in a correct way. For our fieldwork this year, in the frame of saving time, we proceeded to a surface cleaning with a soft brush of each block before to photograph them. It allowed us to notice that, under the dust, most of the blocks still present earth or vegetation traces giving them their brown/beige color while it is basalt blocks! Beyond the problem that it creates for the photography, it is clear that the blocks are not highlighted form a touristic point of view (**Fig.55**).
Attention: we have noticed this year that two blocks indicated on the plan given by Cl. Vibert-guigue in 2013 are missing in the exhibition room. It is the block 21 (snake), which was already missing in 2013 in our records, and the block 44 (elephant), which was present in May 2013. It is a necessity to find them and to apply measures to avoid any future disappearance (**Fig.56**).
On request of Wisam Esaid, responsible of the DoAJ in Azraq, we will give him a copy of the list and pictures of the blocks in order to keep a copy in Azraq. The surveillance of the blocks will be done on this base.

2.4.2. To model the blocks

The second phase of our work was to implement a methodology to create 3D models of the blocks. The 3D modelling of the blocks presents a double interest. The first one is to produce virtual models, easily manipulable without any weight or size constraint. The second one is to create a realistic documentation (photo rendering) scaled that allows to obtain orthophotos of each face of the block (ideal base for precise drawings).
Thanks to previous modelling experiences using the photogrammetry technique, we decided to work with this technique and, thanks to the financial support of the CNRS, we bought the educative license of the Agisoft software ©Photoscan.
Because of time issues, we did our tests on two blocks only: the block 41 (representing a senmurv) and the block 22 (decorated with a fish) that we choose for their different stone cutting aspects (**Fig.57**).
The photogrammetry principle is based on the immobility of the elements and the numerous points of view to reconstruct the volumes. In the frame of block modelling,

the problem is that it is not possible to photograph the six faces without moving the block at one point in order to photograph the face on which it was lying. We established the following method:

- To mark the block with a minimum of one reference point on each lateral face, halfway up of the 4 faces concerned;
- To photograph the block in two sessions – session 1 with the decorated face on the top and session 2 with the back face on the top – covering each time the reference points zones;
- To create the two models on ©Photoscan;
- To merge the two models on ©Photoscan thanks to the common reference points.

We followed this method, with one single difference: on the block 41 we have put 8 reference points, on the block 22 we have put 4 reference points.
The photographs have been taken with the worksite spots light.
The results are very positive as we succeed and created the 3D models of blocks 41 and 22 (**Fig.58**). We validated so the first step of the work and extract from the 3D models the orthophotos of each face (**Fig.59 and Fig.60**).
The assessment that we have done after these two days' work is very positive. In the perspective of continuing the works in 2015, it is important to notice that the cleaning of the blocks is a compulsory requirement before any work and that a fourth worksite spot should be added for the lighting. About the photogrammetry, it is very important to keep in mind that the 106 blocks will require a long time of work and that it is not possible to plan it in one single campaign (for 1 block, except cleaning time: 1h for the photographs + 30 min to validate the pictures taken on site and around 6h to 8h to create the 3D model + 2h to extract the orthophotos of the faces).

2.5. Participation to a meeting with the local communities by the DoAJ, the 28th of May 2014

We have been invited by Ahmad Lash, DoAJ Amman, to participate on the 28th of May 2014 to a meeting with the local communities of Azraq, hold in the visitor center of the Wetland Reserve. This meeting aimed to put in contact the representatives of the local communities and the archaeological missions working in the Azraq region. About fifteen responsibles of Azraq were present, of which the governor and the mayor, and five archaeological missions were present: April Nowell and Carlos Cordova who work in the Wetland Reserve on `Ayn Sawda, Gary Rollefson who worked for a long time on `Ayn Sawda and who is working now further east (Wisad pools and Maitland), Peter Ackermann who is leading a survey project in the eastern desert of Azraq (safaitic inscriptions), the Italian team who is working on the restoration of Qusayr `Amra frescoes and our mission « Azraq Ayn Sawda Reservoir Project ». Each team presented its project with a PowerPoint and a 10-15 min speech in English. L. Abu-Azizeh presented the mission project in Arabic. This meeting was interesting at many levels. First, it was the occasion to present our work, even if in a very short way, to the representatives of the Azraq local communities; then it allowed us to identify the interest showed to each prject; and finally it was the opportunity to meet all the archaeologists working in the area.

III. Objectives 2015

3.1. Theme 1: archaeological excavations and surveys

In 2015, the archaeological work will have to focus on the continuation of some soundings, the implementation of new excavations areas and surveys outside the strict limit of the reservoir.

First of all, the excavations next to the platform will have to continue. The sounding located on the N/W corner of the platform needs to be extended as the base of the wooden system was not reached in 2014. Moreover the platform area appeared more interesting than we supposed form the previous works. Indeed, the three soundings showed different building techniques on the same architectural element. It seems necessary to identify these techniques and to understand why they have been used. Finally, the channel in sector F, south of the platform, needs to be studied more precisely and some excavations need to be done on its close vicinity. On the northern side of the platform, a specific feature has been identified by R. P. Watson and G. W. Burnett and Cl. Vibert-Guigue. It needs further investigation as we don't have enough elements to understand it.

Some new excavations will need to be led, especially on the S/W corner of the reservoir. Actually, on the plans of Rees and Musil is represented a specific feature. On Musil's plan, it is even similar to the detail on the N/W corner. The discoveries made this year in the N/W corner showed a circular buttress, different from what is on the plans, the S/W corner would present a similar buttress? The S/W corner has been identified in 2013 and 2014 but its conservation estate is difficult to apprehend as an olive tree plantation is now next to it. Additionally, a channel is present on Musil's plan in the western wall, and it could be interesting to check the presence of such a channel and to see if it is a water supply, water flow or evacuation channel. It will probably be difficult to determine its precise location which can be under new buildings or on a private land. In the two cases, an archaeological investigation needs to be led quickly, before any destruction.

Finally, an archaeological survey needs to be led to the east of the reservoir, along the wall identified in 2013 in the southern area of the reservoir. It would be interesting to locate it precisely, to identify its connection with the reservoir and to check if some structures appear in the zone between the reservoir and this wall leading to the east, especially if we are dealing with an agricultural purpose structure.

3.2. Theme 2: topography

Taking into account the progress of the project, it is necessary to integrate as soon as possible the plans and the levels into a georeferenced system. The ideal scenario would be to identify, before the fieldwork in 2015, a geodesic point known with coordinates from which we could adjust our topographical surveys. Now that we know the existence of such a point next to the Ecolodge Azraq, we hope it will be easier to

find its coordinates. In case we fail, we will come to Azraq with a GPS (either a manual GPS or the DGPS of the Ifpo) and a specific methodology will be implemented in order to reduce the potential errors during the reference point installation.
The aim will be to install three reference points in the Wetland Reserve (which locations will need to be decided with the RSCN and the DoAJ) and to survey some characteristic points of the reservoir that will allow us to integrate our surveys into the georeferenced system. We will take profit of this work to complete the survey of the zones outside the Reserve.

3.3. Theme 3: restoration and development

The recommendations established after the sanitary assessment during the fieldwork are numerous and it seems important to us to identify the priorities and the processes and persons concerned to implement the works.

- Vegetation management: needs to be done by the RSNC as soon as possible. This work has to be spread over the whole year, with a permanent watch by the teams on site;
- To close the property outside the Reserve: the process has to be engaged by the DoAJ. The best would be to contact as soon as possible the land owner in order to plan the installation of a fence in 2015;
- Dismantling and removal of the concrete elements built on the reservoir wall: needs to be done by the RSCN before the fieldwork 2015. It is about one spot in section 4.
- Back filling with earth of the zones close to the wall: needs to be done by the RSCN and the « AzraqAynSawda Project » during the next fieldwork in 2015. The RSCN will need to supply the vehicles to take the earth on the southern part of the Reserve and the bags in which it will be transported. « AzraqAynSawda Project » will supply the workers and the material needed (shovel, pickaxe) to fill the bags and to install the earth on site (sections 5 and 15 mostly).
- Restoration of the faces of the superior row of stone: taking into account the importance of the work for the sections 8 to 12, it would be necessary to plan a full fieldwork time for this project. At first, the fieldwork mission of 2015 could be the occasion to work on the stone faces of sections 5 and 15 before to proceed to the backfilling and so to begin the training of a 3-4 workers team, in the perspective of the following mission.
- Intervention in zone II: despite the emergency of the intervention, it seems clear that discussions with the RSCN and the DoAJ are necessary before any decision. If we don't have the opportunity to clarify the intention of every part before the next fieldwork mission in 2015, then the mission will be the occasion to decide, to establish a financial plan and to define a program if the funds allow it.

About the development of the remains, we wish in 2015 to focus on the exhibition room where the blocks are stored in Qala't Azraq as it is described below. Nevertheless, we wish to be able to launch the discussions with the RSCN and the DoAJ about the real

needs of the Wetland Reserve in order to begin to think together on the projects we could propose (panels, small-scale models of the blocks, etc.).

3.4. Theme 4: blocks presented in the Qala't Azraq

The bases of the methodology needed to obtain 3D models of the blocks has been confirmed during the fieldwork in May 2014, but the remaining work to carry out is important and concerns three axes.

3.4.1. Implementation of a database of the blocks presented in Qala't Azraq

The implementation of a database which will integrate the blocks stored in Qala't Azraq, seems to be necessary to the study of the blocks uncovered in the reservoir. In this work frame, three tasks need to be led:

- The blocks cleaning: necessary step before any photography. The cleaning of the six faces will be done with water and a soft brush, keeping in mind that some blocks may presents some mortars remains that will need to be conserved;
- The 3D modelling with use of photogrammetry: the pictures will be realized, after the blocks cleaning, inside the exhibition room using a 4 worksite's spots lighting. A quick verification with ©Photoscan will be done on site in order to check the pictures. The end of the process will be done outside of Qala't Azraq and if possible with two computers, to save time;
- The bringing to Qala't Azraq of the blocks with redans located in the blocks parking next to the platform, in the Wetland Reserve. From the inventory done by Cl. Vibert-Guigue, only six blocks may be concerned. We would then integrate them into the 3D modelling process, as well as the similar blocks stored in Qala't Azraq.

Aside this work, we plan to start again the inventory of the blocks parking in order to integrate all the blocks to the database and to standardize the numbering. For the simple blocks (without redans or bas-reliefs), a manual survey and some pictures will be done on site.

3.4.2. The 3D printing of the blocks presented in Qala't Azraq

The 3D modelling that we propose will aim to create a reliable documentation and to facilitate the block handling and will be a necessary step to 3D printing. Actually, we plan to do some 3D printing tests in order to get small-scale models, easily replicable and manipulable. It would allow us to validate "physically" the reconstruction hypothesis that we will elaborate from the virtual handling with the 3D models.

To implement such a project, we have contacts with a technical Highschool in France which owns a 3D printer and is looking for multi-disciplinary projects for the students (technology, history, geography). Our project seems to be interesting to them and we hope we will be able to collaborate in 2014-2015 and then to print the first small-scale models in 2015.

3.4.3. Development and presentation in the exhibition room of Qala't Azraq

After having spent two days in the exhibition room of Qala't Azraq where the blocks are stored, it seemed that the lighting of the room is not sufficient and that the blocks installation is not adapted. The visitors coming in this room give a look to the blocks and to the panels without reading them, and go away without having understood neither the origin of the blocks or their unicity.

We think that it is possible, at little cost and before to propose a complete museographic project, to improve the quality of this room and to create a richer visit from a touristic point of view. In this perspective, we would like to propose our help, technical and financial, to the DoAJ and to begin from 2015 the implementation of the following improvements:

- Reorganization of the blocks highlighting the blocks that presents bas-reliefs – and take profit of the necessary cleaning for the study to expose them in good conditions;
- Reinforce the lighting system, focusing on the blocks with bas-reliefs and the panels;
- To work on the panels integrating an update of the datas, location plans (visitors don't understand that these blocks are not coming from Qala't Azraq), large print texts and if possible translated in three languages (French, English and Arabic);
- To begin the discussions with the DoAJ for the implantation of a more ambitious project.

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Bibliography

Bisheh G., *Remarks concerning recent discoveries on the Umayyads*, ADAJ 30, 1986, p. 7-55.
Kennedy D. L., Riley D. N. and Stein A., *1982 Archaeological Explorations on the Roman Frontier in Northeast Jordan : the Roman and Byzantine Military Installations and Road Network on the Ground and from the Air*, BAR International Series134, Oxford:BritishArchaeological Reports.
Musil A., Arabia Deserta : A Topographical Itinerary, Oriental Explorations and Studies No 2, 1978.
Rees L.W.B., *The Transjordan Desert*, Antiquity vol.3 No 12, 1929, p. 389-407.
Vibert-Guigue Cl., *Découverte de nouveaux blocs sculptés à Ayn es-Sawda (Azraq al-Shishan) Jordanie*, ADAJ 50, 2006, p. 326-349.
Vibert-Guigue C., *Le réservoir monumental de l'oasis d'Azraq ash-Shishan et la découverte de blocs sculptés : un défi écologique, technique et iconographique,* actes ICHAJ, 11e conférence internationale sur l'Histoire et l'Archéologie de la Jordanie, Changes and challenges, Paris, 7-12 juin 2010, SHAJ XI, 2012.
Watson R.P. and Burnett G.W., *On the origins of Azraq's "Roman wall"*, Near Eastern Archaeology 64, 2001, p. 72-79.

Illustrations

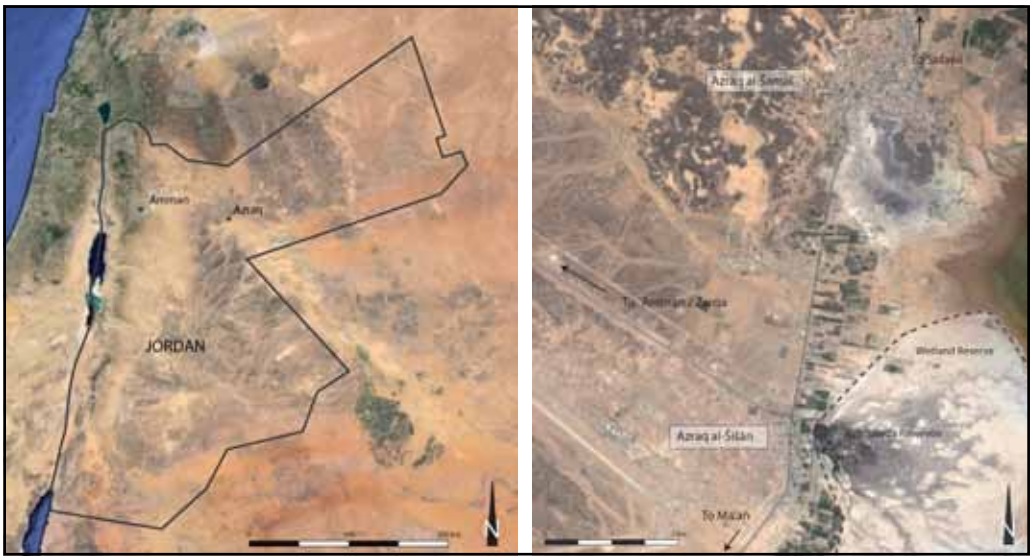


Fig.1: Location maps of Azraq's region and Azraq `Ayn Sawda area (satellite images from ©Google Earth).

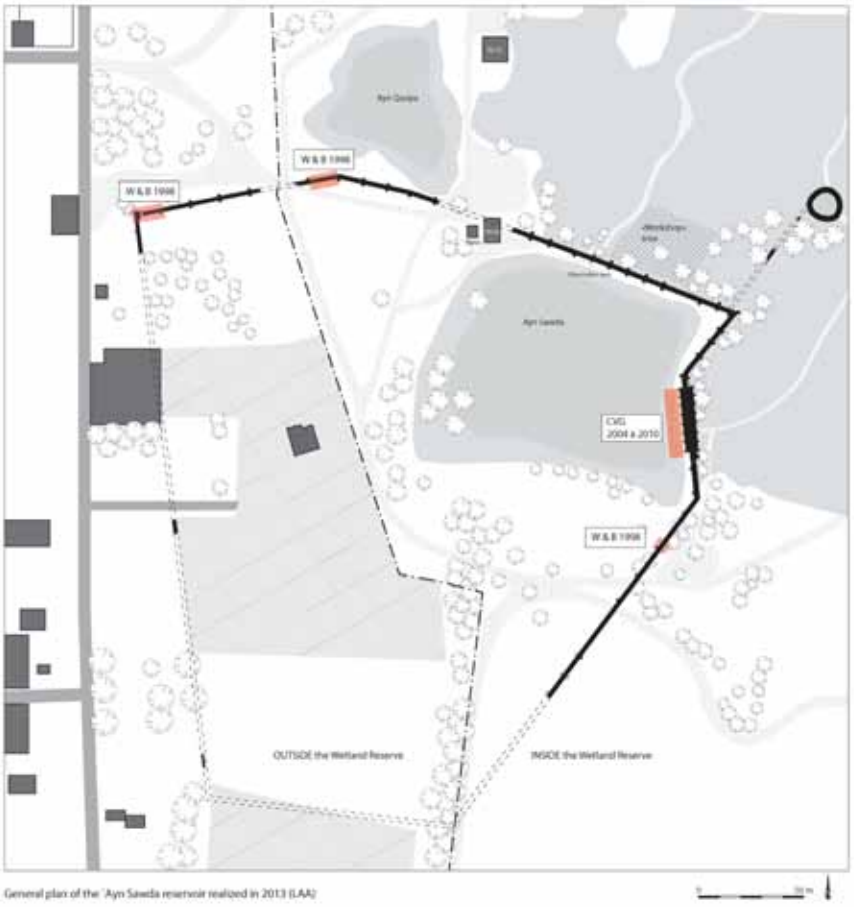


Fig.2: General plan of the reservoir indicating the former excavations project (LAA, 2013).

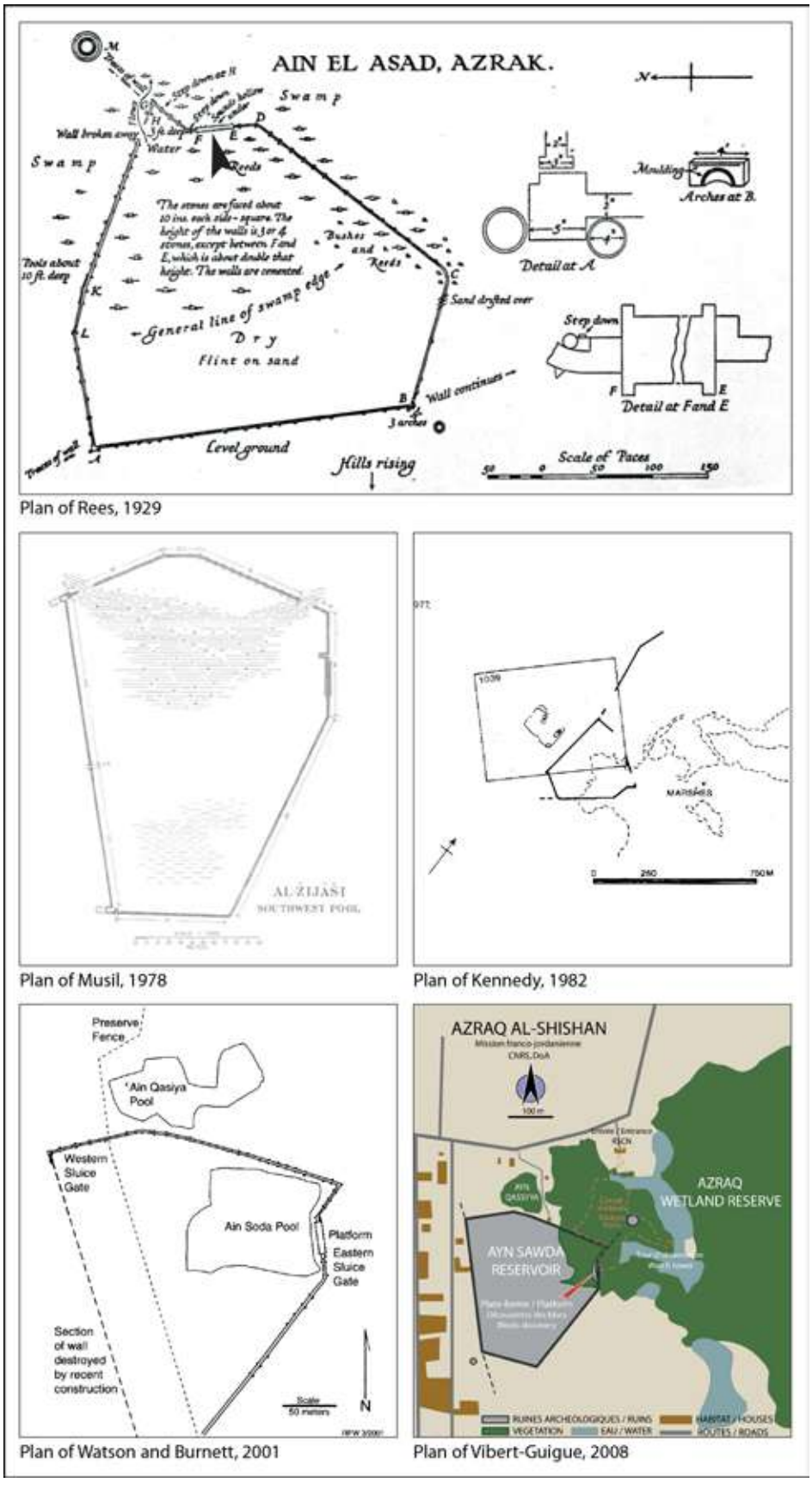


Fig.3: Available plans of the `Ayn Sawda reservoir until 2013.

Fig.4: Example of some carved blocks uncovered in the reservoir until 2013 (AS and LAA 2014).

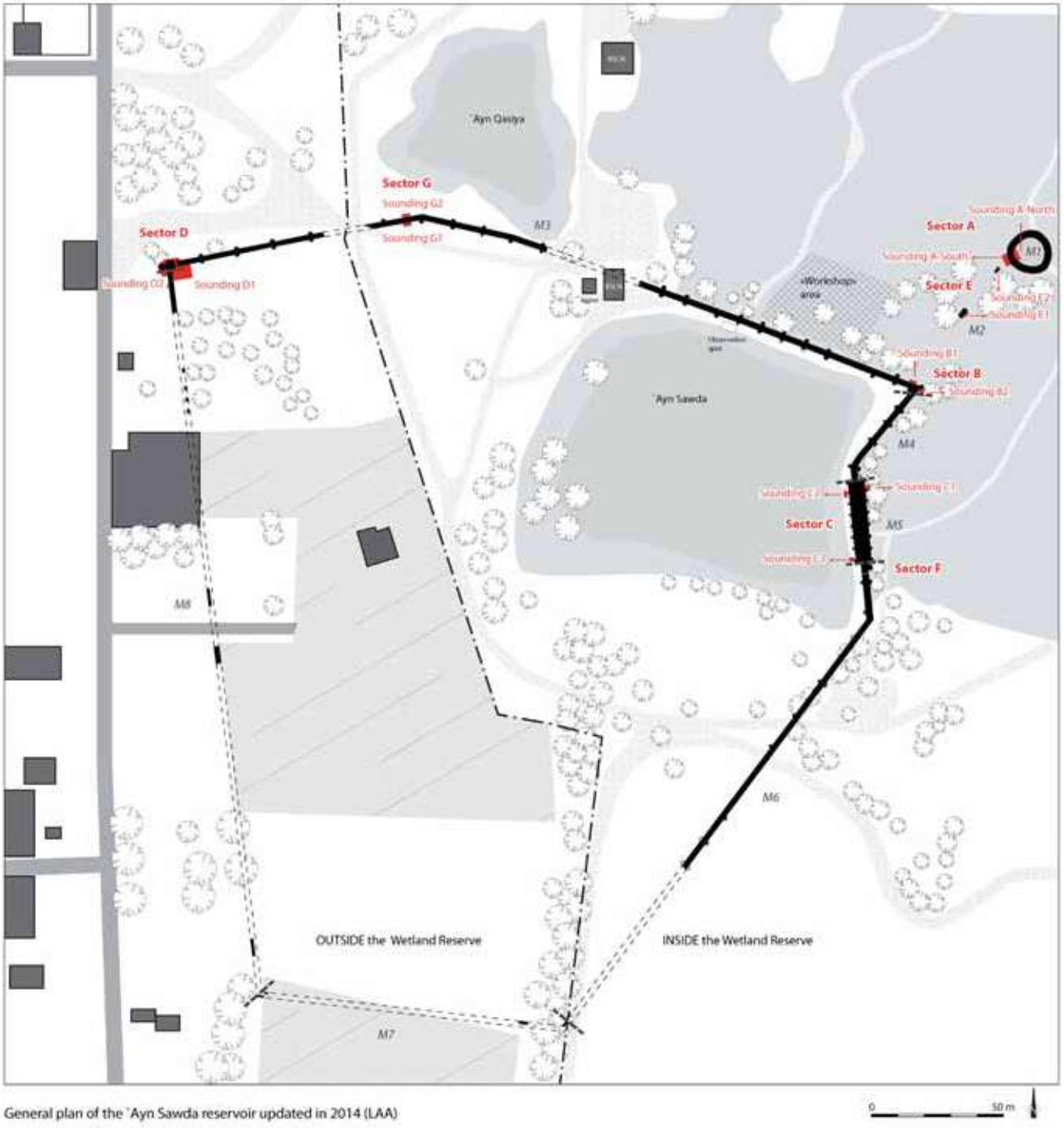


Fig.5: Location of the archaeological soundings led in 2014 (LAA 2014).

Fig.6: General view of the wall M1 in sector A. Looking to the west (BC 2014).

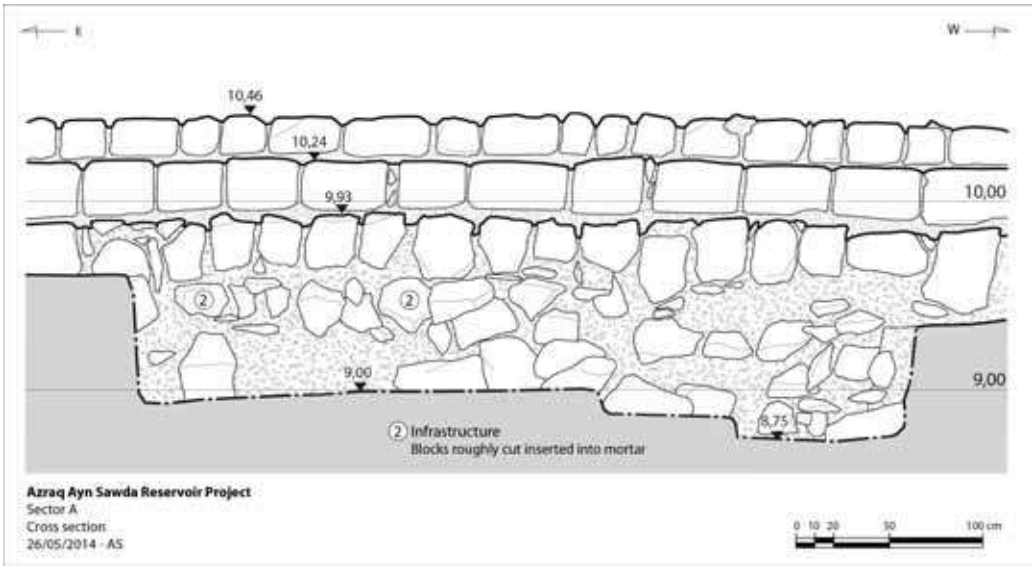


Fig.7: Facade of the wall M1 in sounding A north (AS 2014).

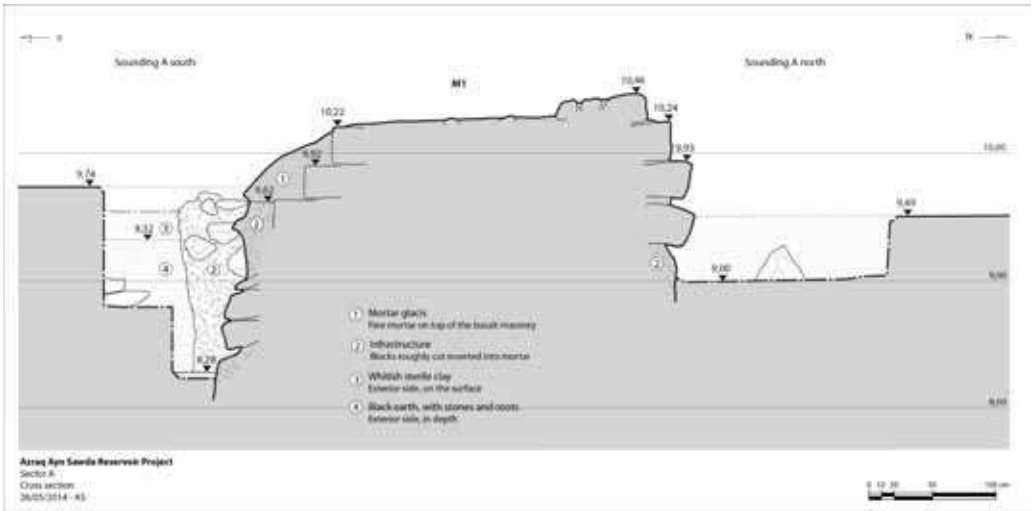


Fig.8: Cross section of soundings A north and A south (AS 2014).

Fig.9: View of the three stone rows and the foundations of circular wall M1. Looking to the south (BC 2014).

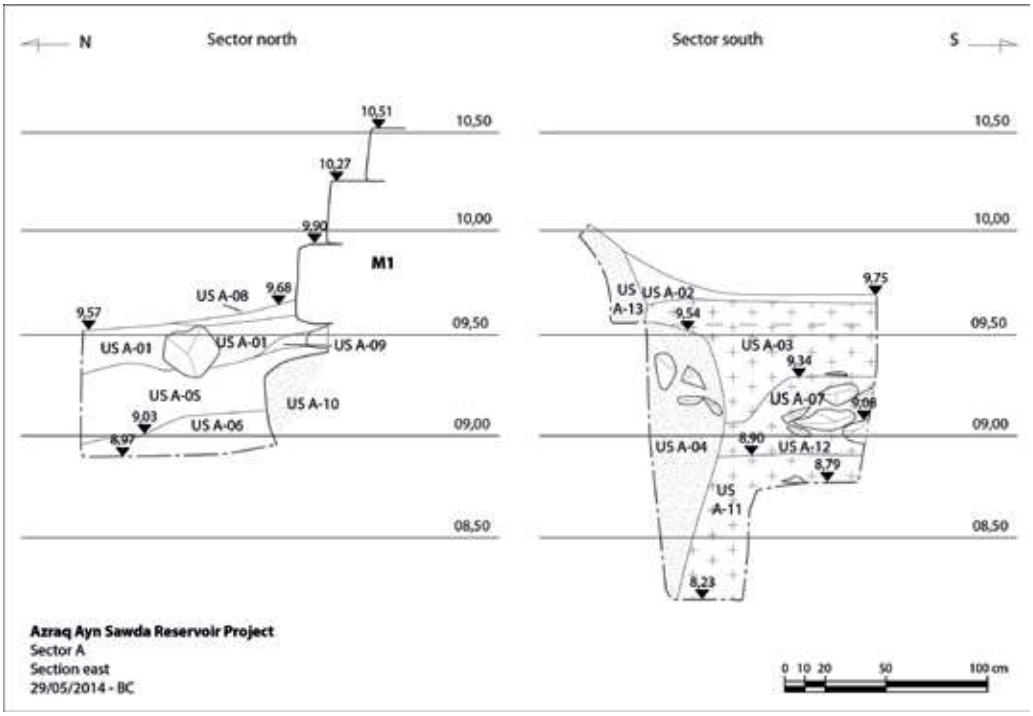


Fig.10a: Sections E of A south and A north (BC 2014).

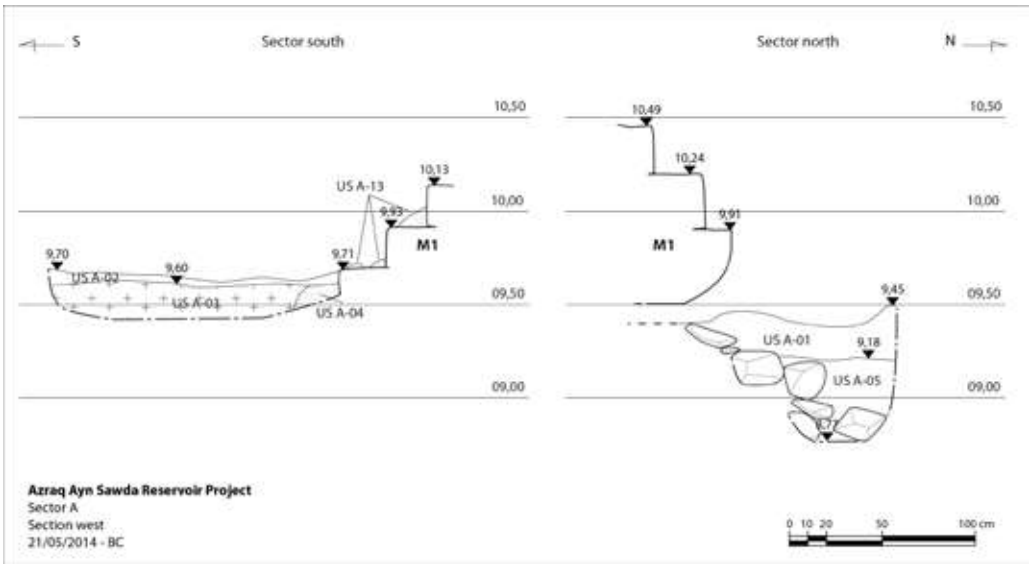


Fig.10b: Sections W of A south and A north (BC 2014).

Fig.11: View of sounding A south. First plan: the deep sounding stopped by the water. On the left: the mortar glacis on the basalt rows of the exterior face of M1. Looking to the N/W (BC 2014).

Fig.12: General view of sounding B1 after having reached the mortar glacis (JB 2014).

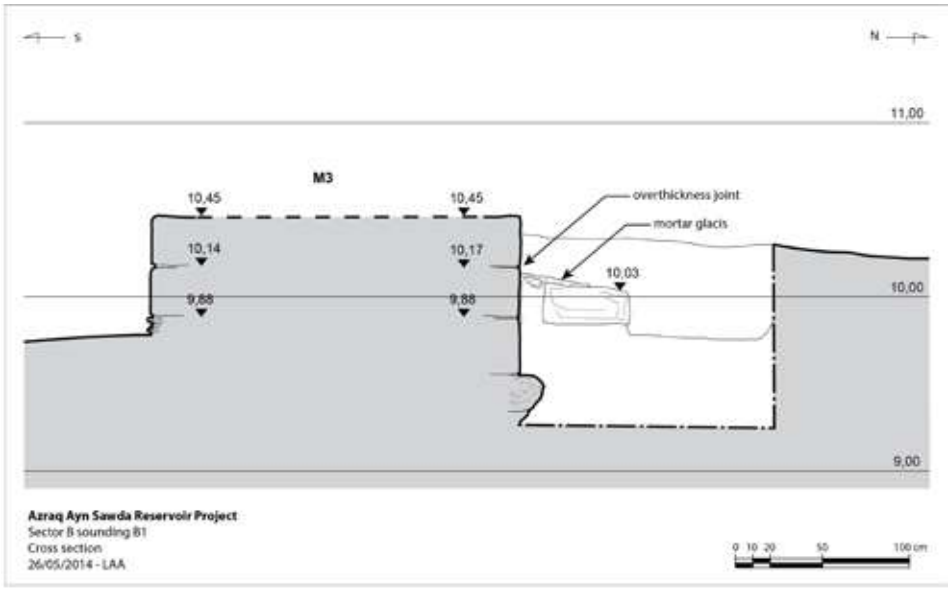


Fig.13: Cross section of sounding B1 (LAA 2014).

Fig.14: View of sounding B1 after having reached the foundation level (JB 2014).

Fig.15: View of sounding B2 after having reached the mortar glacis (JB 2014).

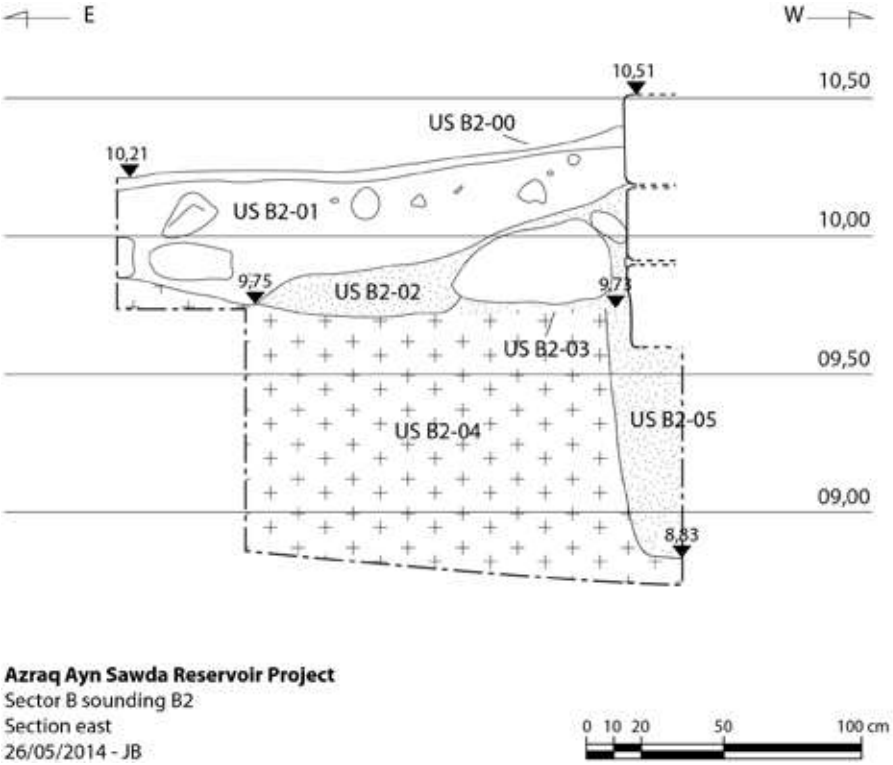


Fig.16: Section east of sounding B2 (JB 2014).

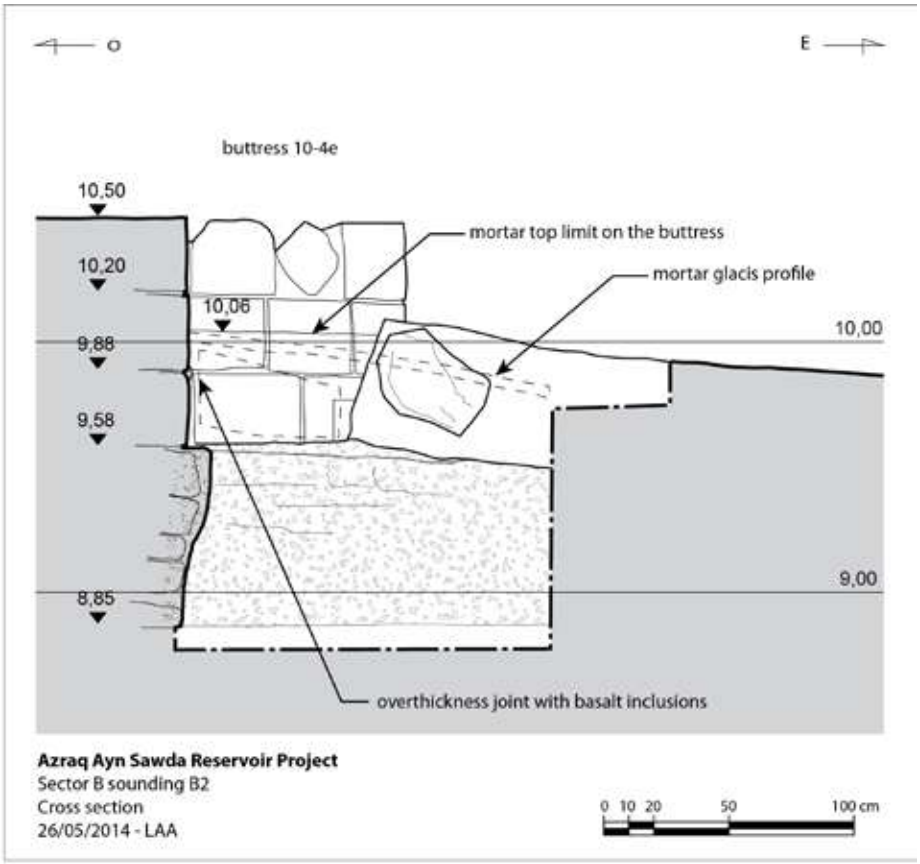


Fig.17: Cross section looking north of sounding B2 (LAA 2014).

Fig.18: View of the slabs appeared under the mortar glacis in B2 (JB 2014).

Fig.19: General view of B2 looking to the foundation system (JB 2014).

Fig.20: Detail of the foundation in B2 under wall M4 (JB 2014).

Fig.21: Detail of the foundation under wall M4 in B2 after having removed the mortar (JB 2014).

Fig.22: Detail of the overthickness joint with the basalt inclusions (JB 2014).

Fig.23: Mortar glacis next to the basalt benches of the platform, sounding C1. Looking to the west (BC 2014).

Fig.24: Basalt blocks in the east section of sounding C1 related either to a wall collapse or to the recent Reserve laying out. Looking to the east (BC 2014).

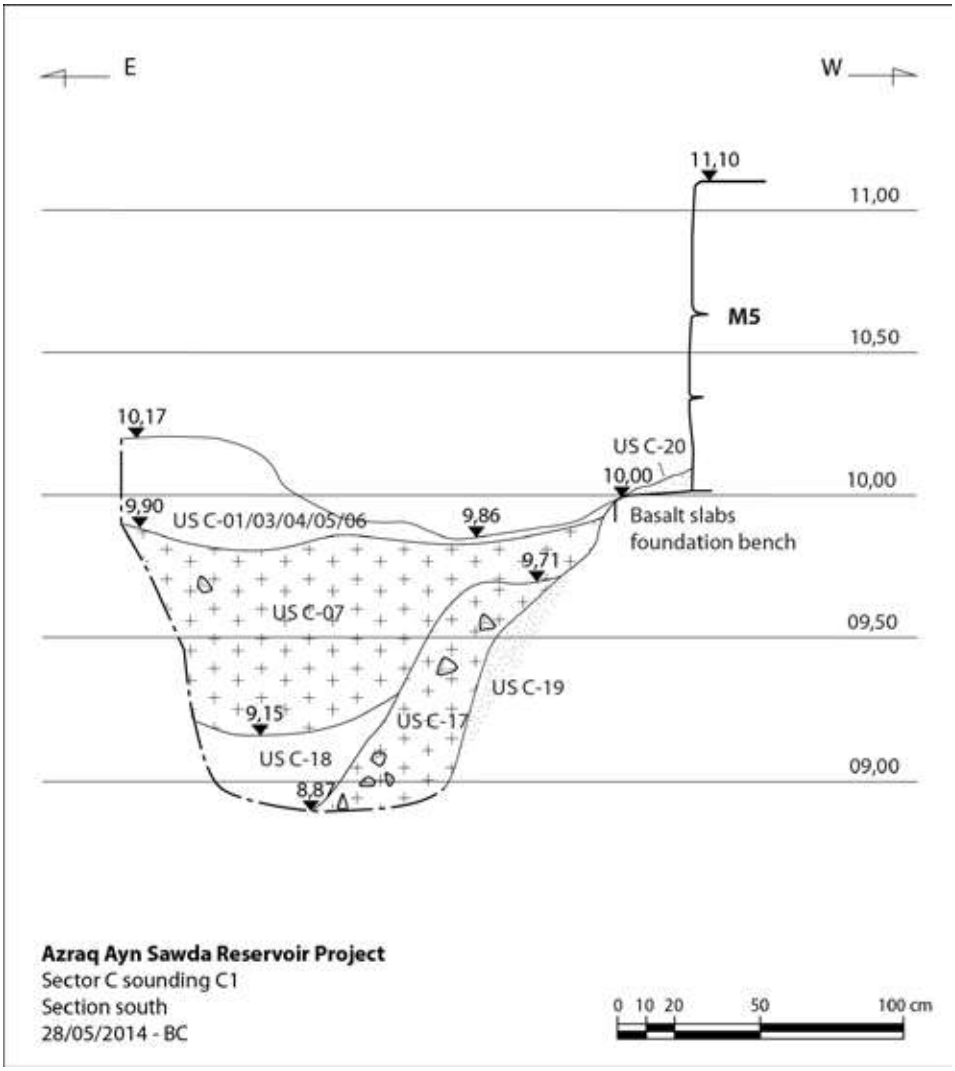


Fig.25: Section south of sounding C1 (BC 2014).

Fig.26: Wooden elements (pillars and boards) under the basalt bench of the platform, in sounding C2. Looking to the east (BC 2014).

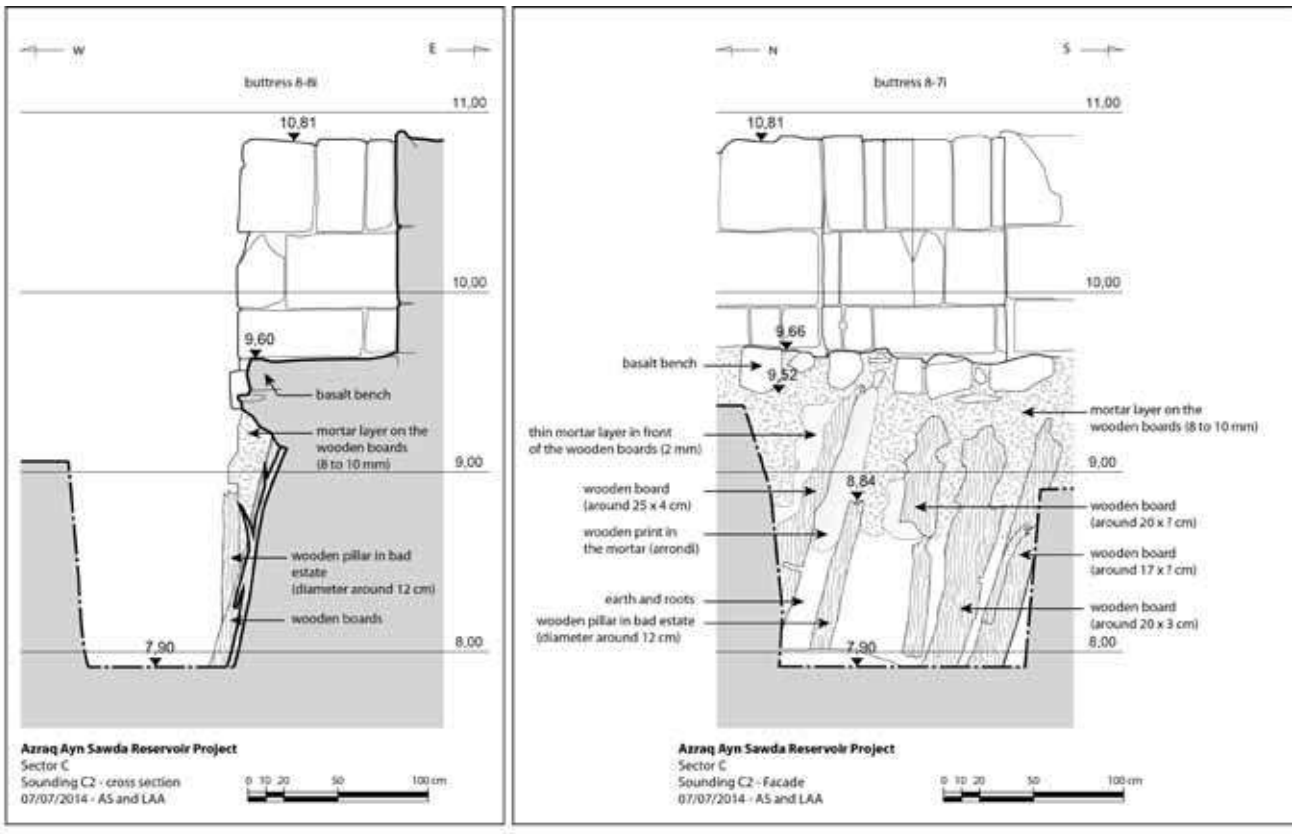


Fig.27: Cross section and facade of sounding C2 (AS and LAA 2014).

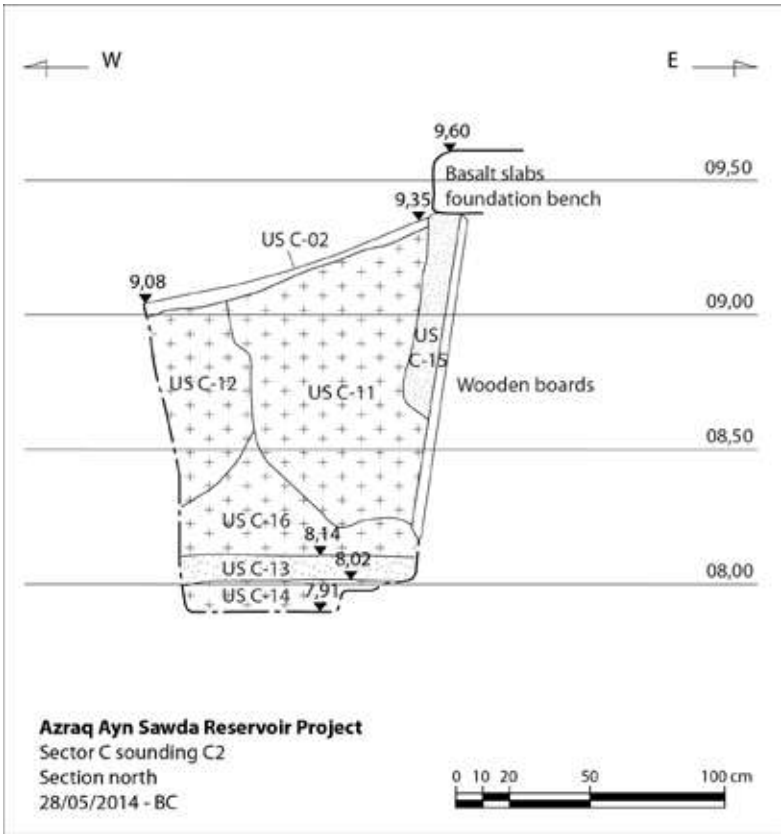


Fig.28: Section north of sounding C2 (BC 2014).

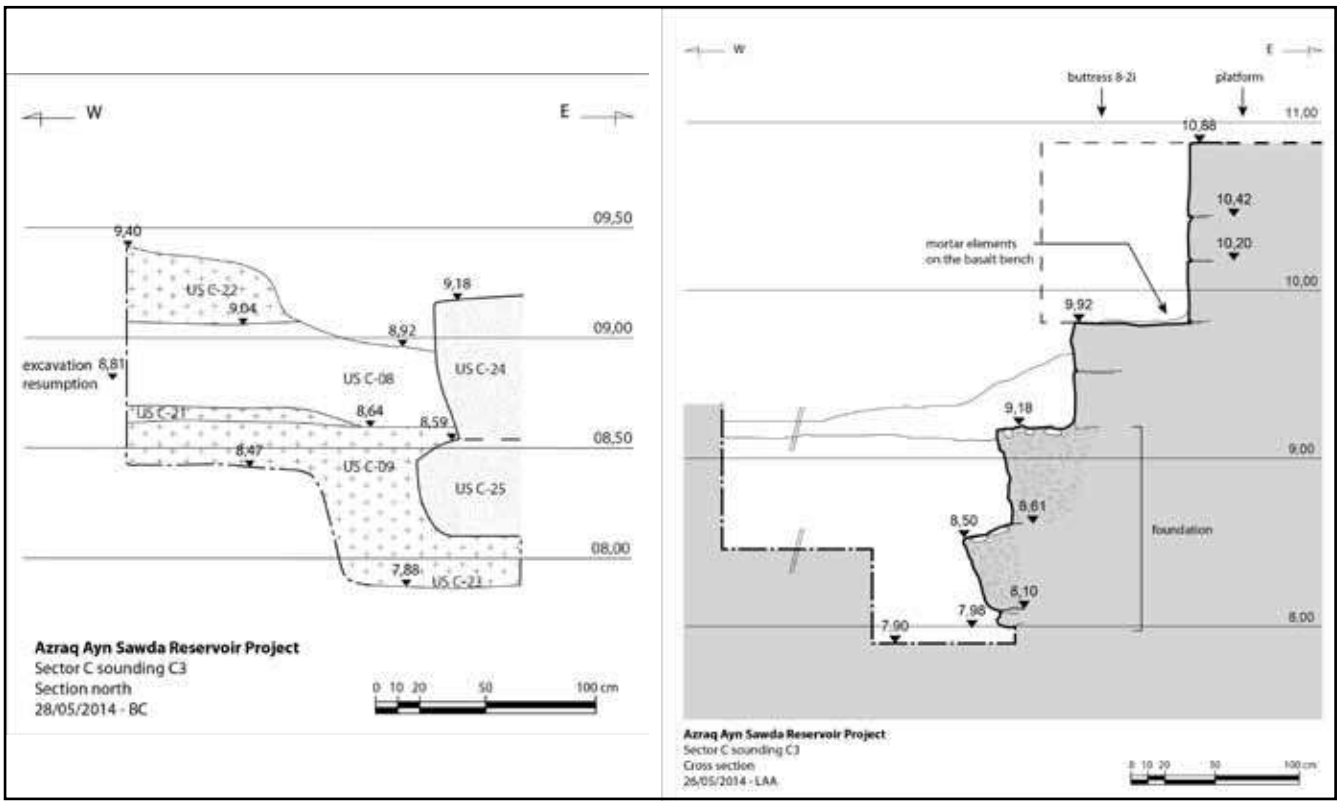


Fig.29: Section north of sounding C3 (BC and LAA 2014).

Fig.30: General view of sector D before the excavations (JB 2014).

Fig.31: General view of sector D during the excavations, the channel is visible (JB 2014).

Fig.32: View of buttress 18-1, in sector D, uncovered on the west extremity of wall M3 (JB 2014).

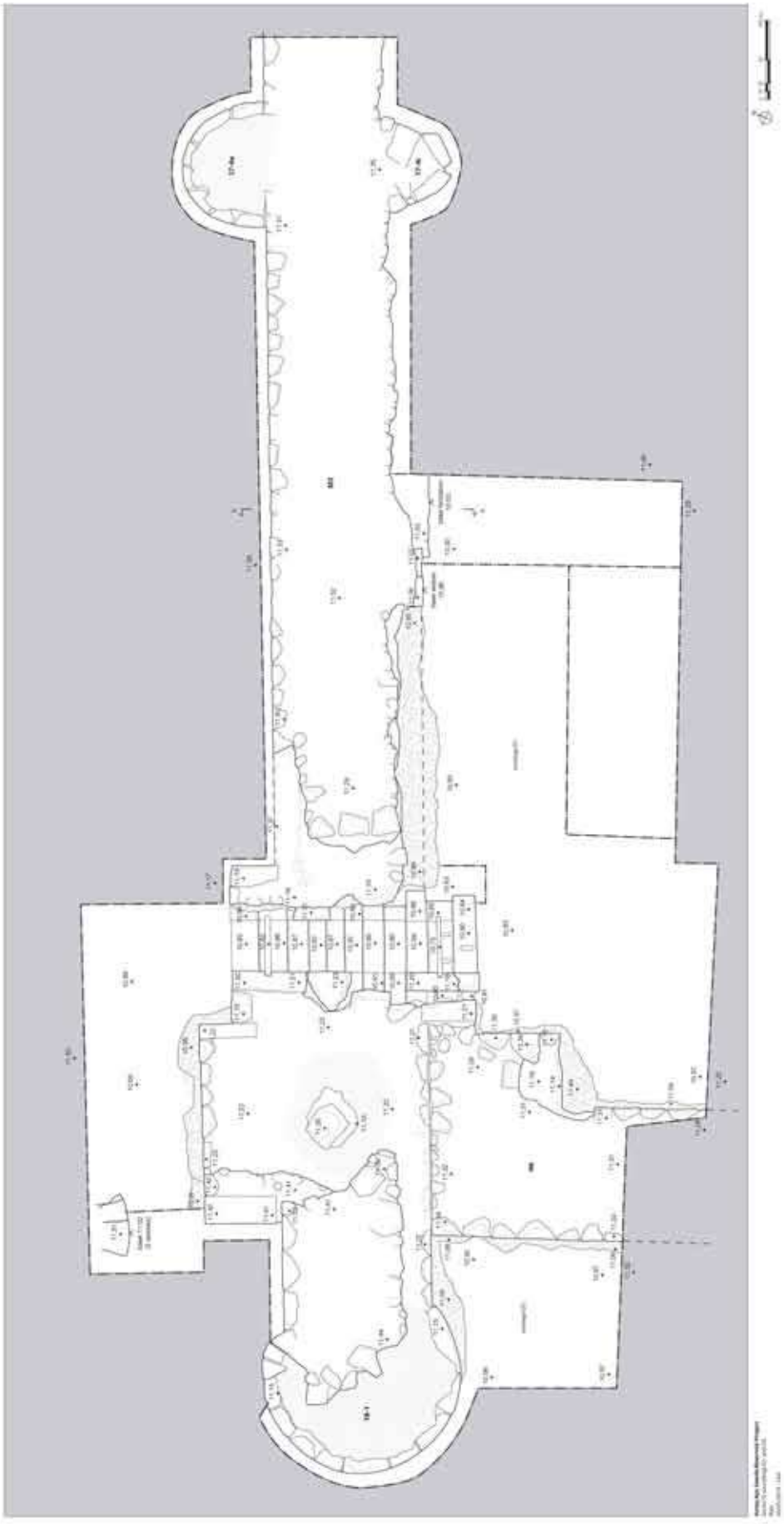


Fig.33: Plan of sector D - the north is on the left (LAA 2014).

Fig.34: General view at the end of the excavation, looking to the north (JB 2014).

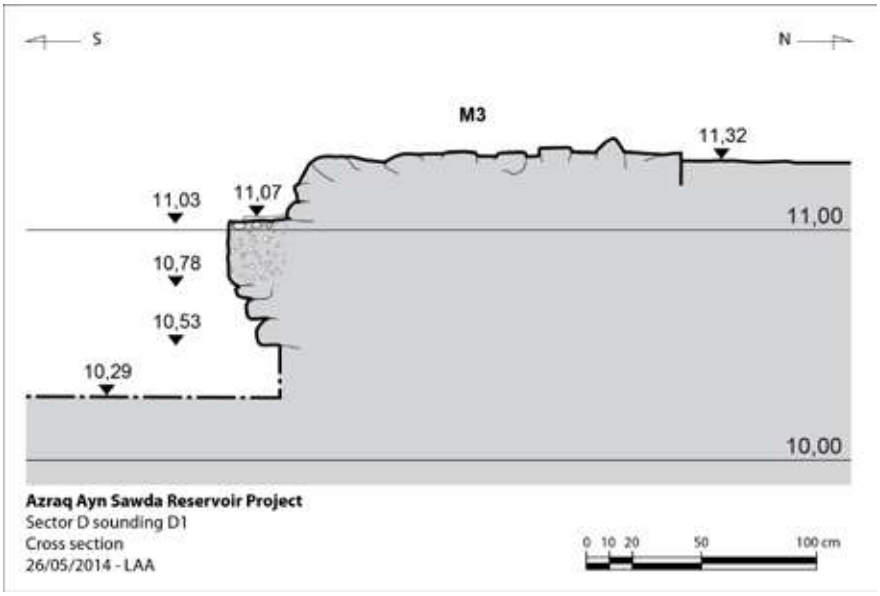


Fig.35: Cross section of wall M3 in sector D, looking to the west (LAA 2014).

Fig.36: Detail of M3 foundation in sector D (JB 2014).

Fig.37: Detail of sounding D2 (JB 2014).

Fig.38: Detail of the connection between walls M3 (in front) and M8 (on the right) in sounding D2 (JB 2014).

Fig.39: Location of sounding E1 on each side of the stone alignment M2, before the excavations. Looking to the S/W (BC 2014).

Fig.40: The stones of alignment M2 in sounding E1 (BC 2014).

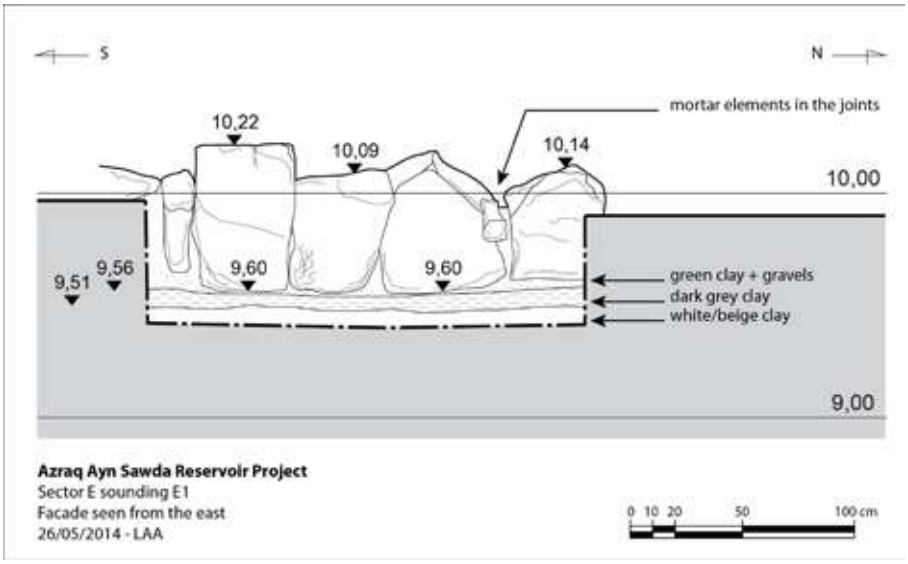


Fig.41: East elevation of M2 in sounding E1 (LAA 2014).

Fig.42: General view of sector G before the excavations (JB 2014).

Fig.43: Detail of sounding G1, south of wall M3. Looking to the south (JB 2014).

Fig.44: Detail of sounding G1, south of wall M3. Looking to the north (JB 2014).

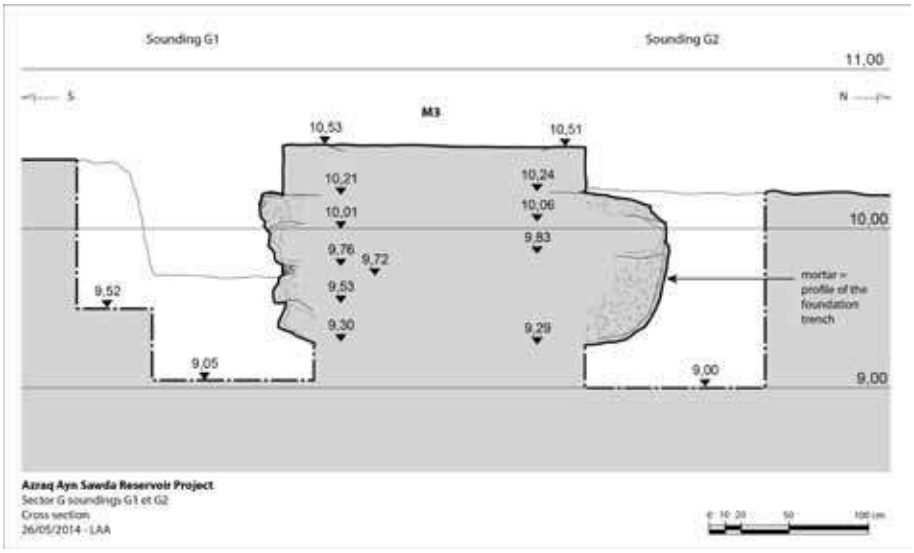


Fig.45: Cross section of soundings G1 and G2 (JB 2014).

Fig.46: Detail of the mortar in sounding G2 (JB 2014).

Fig.47: Detail of the different layers of the foundation in sounding G2 (JB 2014).

Fig.48: Detail of buttress 4-1i and its connection with wall M6 (AS 2014).

Fig.49: Detail of the restored buttress 12-4e with the continued facing of wall M3 (AS 2014).

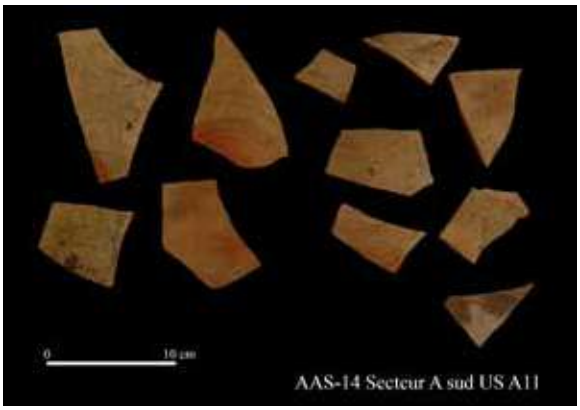
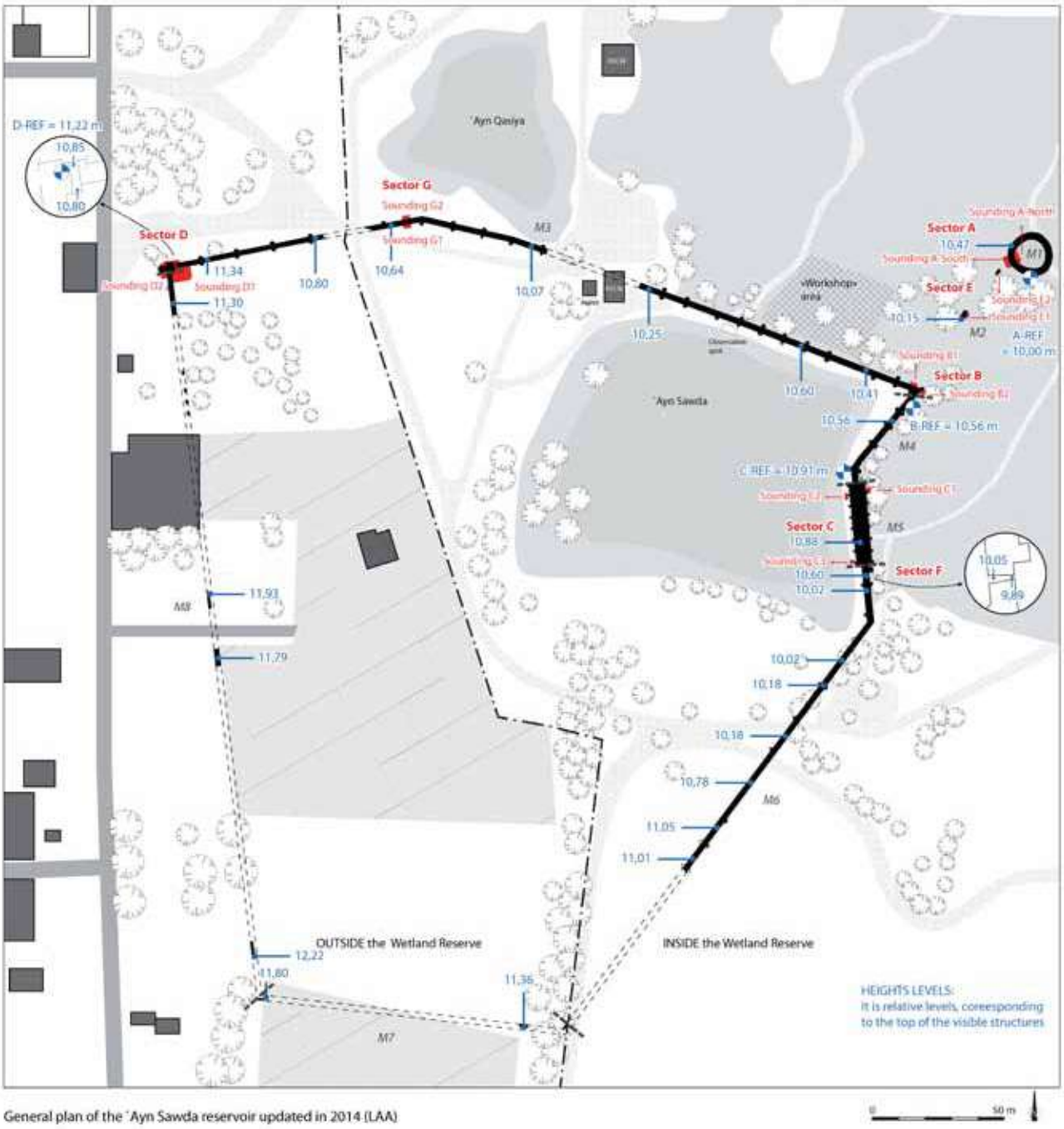


Fig.50: Ceramic sherds uncovered in sector A (BC 2014).



General plan of the 'Ayn Sawda reservoir updated in 2014 (LAA)

Fig.51: General plan of the reservoir with levels and sectors indications (LAA 2014).

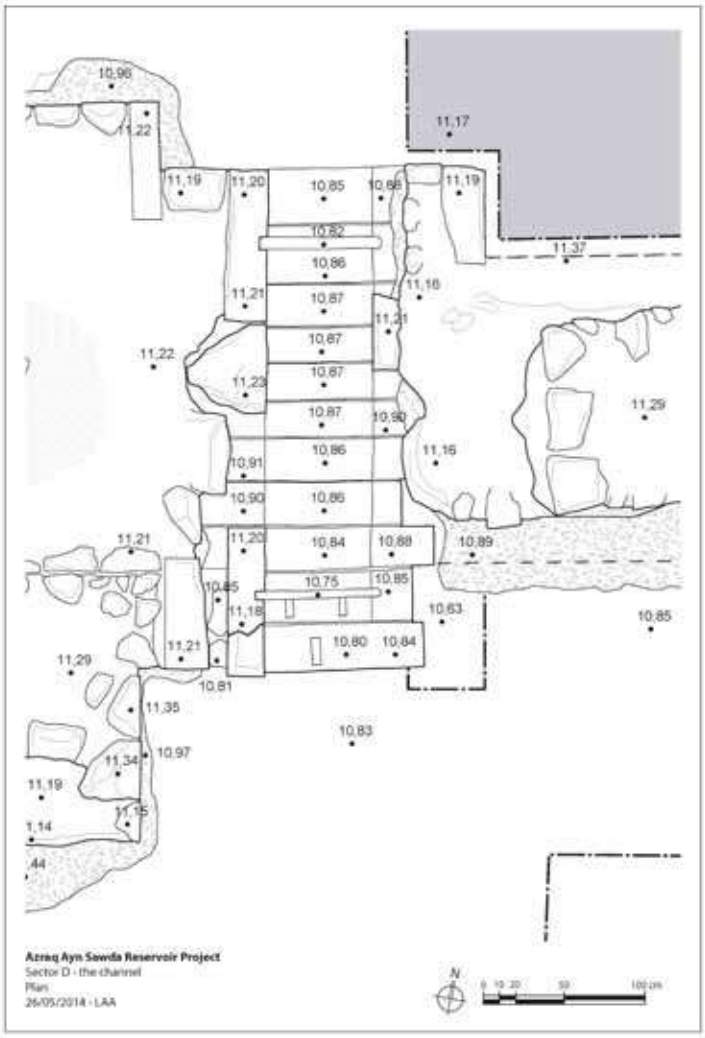


Fig.52: Detail of the channel in sector D (LAA 2014).

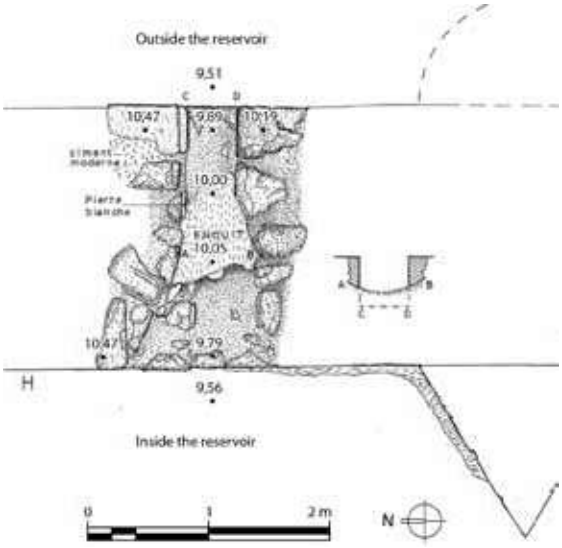
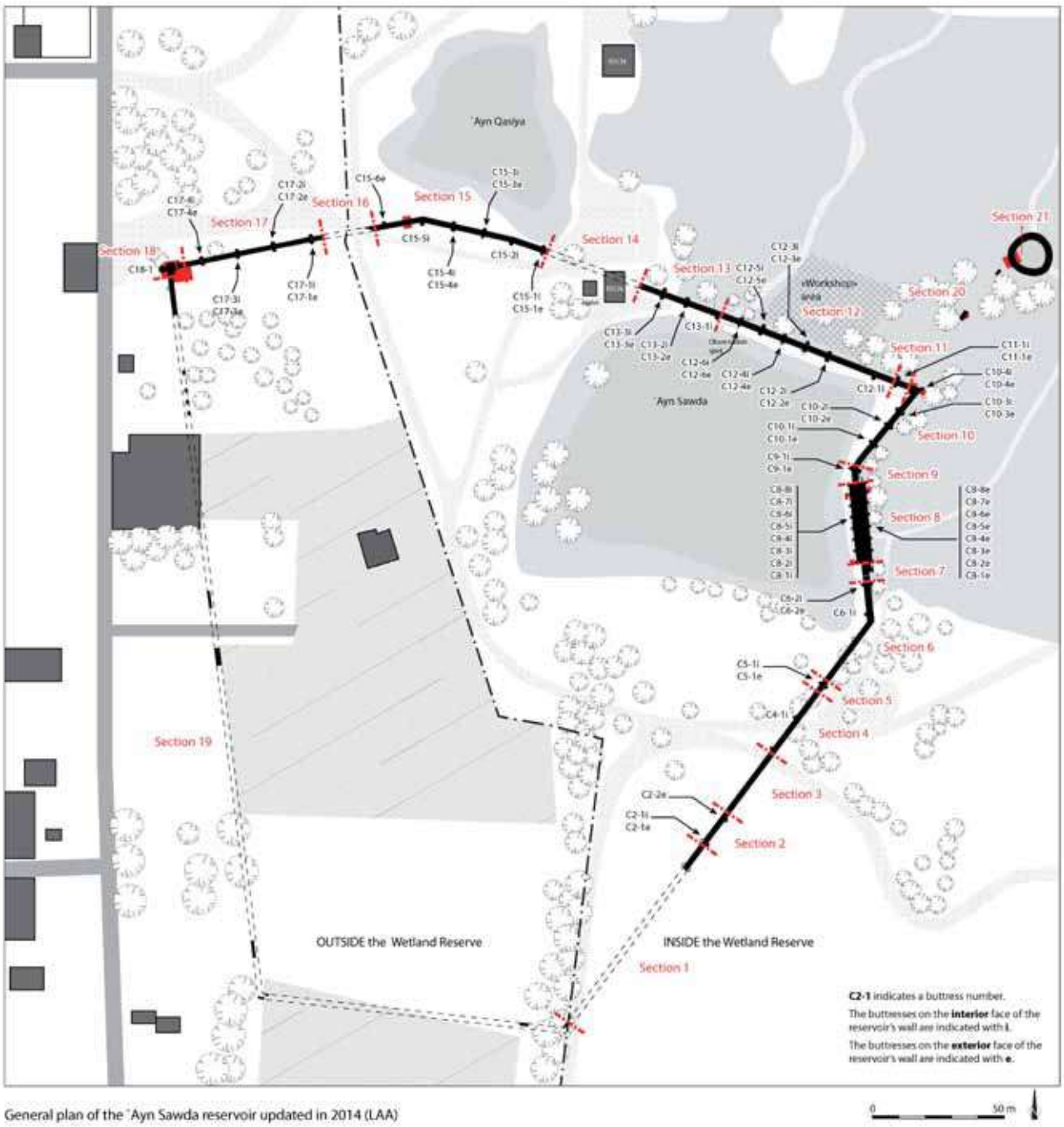


Fig.53: Detail of the channel in sector F, drawing of Cl. Vibert-Guigue (excavation report 2009), with level complements (LAA 2014).



General plan of the `Ayn Sawda reservoir updated in 2014 (LAA)

Fig.54: General plan of the reservoir with the sections locations and buttresses numbering (LAA 2014).

Fig.55: Methodology elements on block 62 (AS and LAA 2014).

Fig.56: The two disapeared blocks 44 and 21 (LAA 2013).

Fig.57: Blocks 22 and 41 used as test for the 3D modelling (AS and LAA 2014).

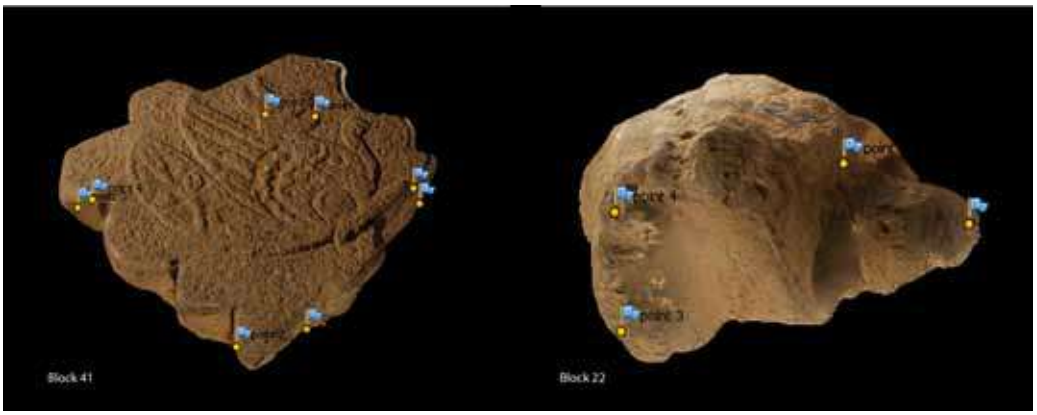


Fig.58: Blocks 22 and 41 under photogrammetry process (AS and LAA 2014).

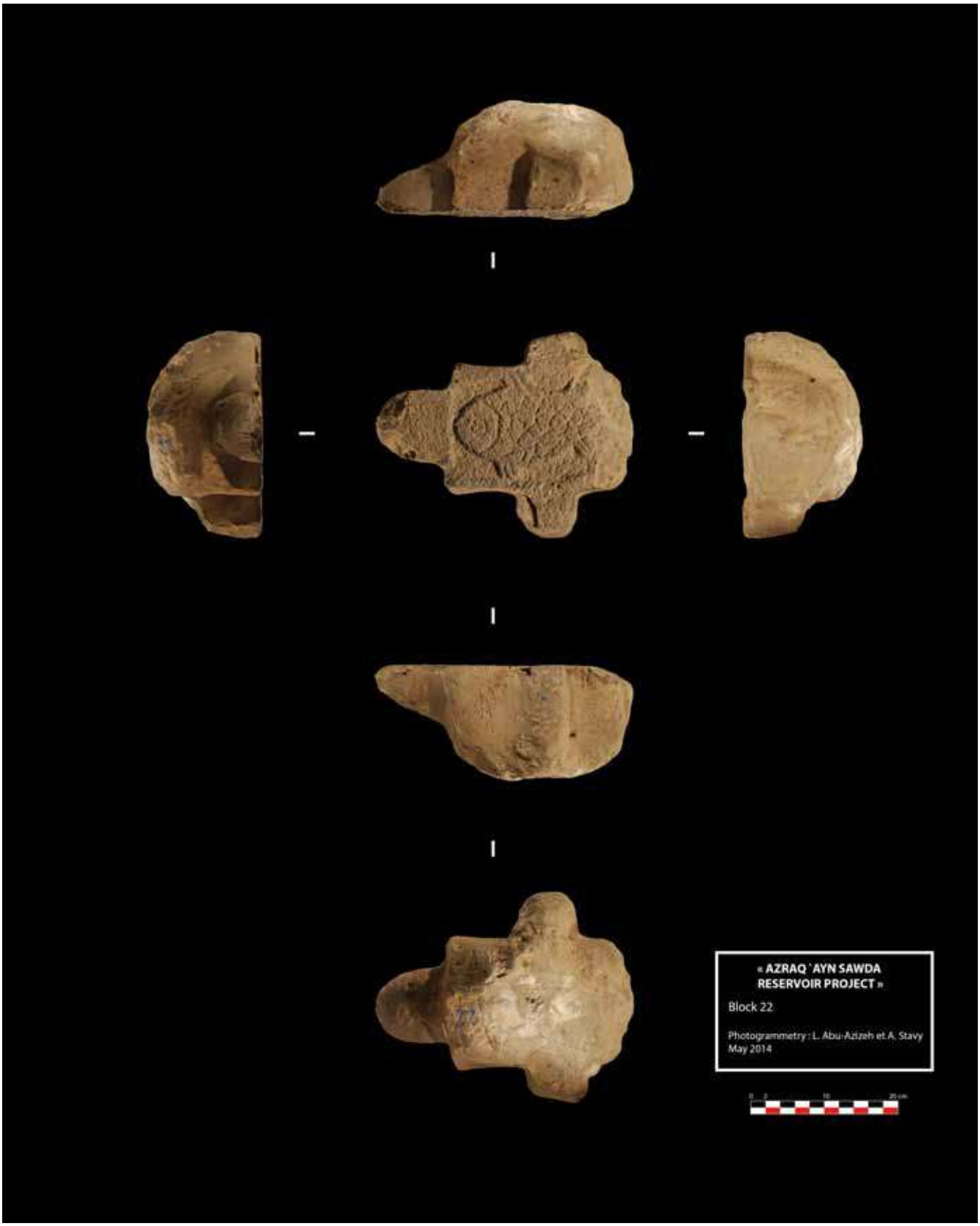


Fig.59: Block 22 orthophotos after the photogrammetry process (AS and LAA 2014).

Fig.60: Block 41 orthophotos after the photogrammetry process (AS and LAA 2014).

Appendix

Appendix 1: stratigraphic units (US) by excavations sector

Sector A

- US A-01. Surface layer, N area, ashy, powdery, light grey; alt. sup. 9,57; alt. inf. 9,18; on US A-05 and A-09; under US A-08; against M01.
- US A-02. Surface layer, S area, black earth, relatively loose; alt. sup. 9,95; alt. inf. 9,60; on US A-03; against M01.
- US A-03. Clay, S area, white to beige, very compact; alt. sup. 9,71; alt. inf. 9,08; on US A-07; under US A-02; cut by US A-04.
- US A-04. M01 foundation trench, S area, composed by stones and cement; alt. sup. 9,61; alt. inf. 8,23 (end of excavations); under M01; cuts US A-03, A-11 and A-12.
- US A-05. Clay, N area, very ashy, dark grey; alt. sup. 9,50; alt. inf. 8,77 (end of excavations); on US A-06; under US A-01 and A-09; cut by US A-10.
- US A-06. Black earth, N area, constituted of humus, roots and decomposed wood; alt. sup. 9,17; alt. inf. 8,96 (end of excavations); under US A-05; cut by US A-10.
- US A-07. Possible stone level, caught in US A-12; alt. sup. 9,32; alt. inf. 8,94.
- US A-08. Black earth, N area, composed of humus, roots and decomposed wood; alt. sup. 9,68; alt. inf. 9,60; on US A-01; against M01.
- US A-09. Black earth, N area, composed of humus, roots and decomposed wood; alt. sup. 9,55; alt. inf. 9,43; under US A-01; on US A-05 and A-10.
- US A-10. M01 foundation trench, N area, composed by stones and cement; alt. sup. 9,41; alt. inf. 8,98 (end of excavations); under M01; cuts US A-05 and A-06.
- US A-11. Black clayey earth, S area, few pebbles; alt. sup. 8,90; alt. inf. 8,23 (end of excavations); under US A-07; cut by US A-04.
- US A-12. Black earth, S area, composed by many stones (level?) and roots, relatively loose; alt. sup. 9,34; alt. inf. 8,90; under US A-03; on US A-11; cut by US A-04.
- US A-13. White mortar on the outer face of M01, very compact, powdery on the surface; alt. sup. 10,22; alt. inf. 9,56; under US A-02; against M01.

Sector B

B1

- US B1-00. Surface layer, brown earth, with vegetal deposits and cobbles; alt. sup. max. 10,40; alt. sup. min. 10,32; alt. inf. max. 10,35; alt. inf. min. 10,28; on US001; against M03.
- US B1-01. Earth, grayish brown color, friable, with cobbles and modern material, friable texture, heterogeneous; alt. sup. max. 10,35; alt. sup. min. 10,28; alt. inf. max. 10,15; alt. inf. min. 9,91; under US B1-0; on US B1-2; against M03.
- US B1-02. Mortar layer, whitish grey, but white on the surface, with gravel and

a lot of chipped stones, compact and very hard texture; alt. sup. max. 10,15; alt. sup. min. 9,91; alt. inf. max. 10,02; alt. inf. min. 9,85; under US B1-1; on US B1-3 and US B1-4; against M03.

- US B1-03. Mortar, grey color, with gravel, a lot of lime nodules and charcoal, with large-module rough-stones against wall M03, compact and very hard texture; alt. sup. max. 10,02; alt. sup. min. 10; alt. inf. max. 9,79; alt. inf. min. 9,74; under US B1-2; on US B1-4 et US B1-5; against M03.
- US B1-04. Clayey layer, grayish brown color, very friable texture; alt. sup. max. 9,87; alt. sup. min. 9,83; alt. inf. (end of excavations) 9,28; under US B1-2 and US B1-3; against US B1-5.
- US B1-05. Mortar, dark grey, black on the surface, color, very friable texture; alt. sup. max. 9,75; alt. inf. (end of excavation) 9,28.
- US B1-06. Filling of modern post, brown earth, cement, stones; alt. sup. 10,32; alt. inf. 9,74; cutting US B1-2, US B1-3, US B1-4 and US B1-5; against M03.

B2

- US B2-00. Surface layer, brown earth, with vegetal deposits and cobbles; alt. sup. max. 10,49; alt. sup. min. 10,08; alt. inf. max. 10,43; alt. inf. min. 10,04; on US B2-1; against M04.
- US B2-01. Earth, grayish brown color, friable, with cobbles and modern material, friable texture, heterogeneous; alt. sup. max. 10,43; alt. sup. min. 10,04; alt. inf. max 10,09; alt. inf. min. 9,73; under US B2-0; on US B2-2 et US B2-3; against M04.
- US B2-02. Mortar layer, whitish grey, but white on the surface, with gravel and a lot of chipped stones, compact and very hard texture; alt. sup. max. 10,09; alt. sup. min. 9,73; alt. inf. max. 10,03; alt. inf. min. 9,69; under US B2-1; on US B2-3 et US B2-4; against M04.
- US B2-03. Mortar, grey color, with gravel, a lot of lime nodules and charcoal, with large-module rough-stones against wall M04, compact and very hard texture; alt. sup. max. 10,04; alt. sup. min. 9,78; alt. inf. max. 9,72; alt. inf. min. 9,69; under US B2-2; on US B2-4 and US B2-5; against M04.
- US B2-04. Clayey layer, grayish brown color, very friable texture; alt. sup. max. 9,83; alt. sup. min. 9,73; alt. inf. (end of excavations) 8,77; under US B2-2 and US B2-3; against US B2-5.
- US B2-05. Mortar, dark grey, black on the surface, very friable texture; alt. sup. max. 9,58; alt. sup. min. 9,59; alt. inf. max. 8,86; alt. inf. min. 9,92.
- US B2-06. Mortar layer, whitish grey, but white on the surface, with gravel and a lot of chipped stones, compact and very hard texture; alt. sup. max. 9,60; alt. sup. min. 9,70; alt. inf. max. 9,57; alt. inf. min. 9,58; under US B2-3; on US B2-5; against 10.4e and M04.

Sector C

- US C-01. Surface layer, sounding C1; mixed with US C-03, C-04, C-05 and C-06; alt. sup. 10,17; alt. inf. 9,82; on US C-07; against M05.

- US C-02. Surface layer, sounding C2; alt. sup. max. 9,35; alt. sup. min. 9,08; alt. inf. max. 9,33; alt. inf. min. 9,04; on US C-11 and C-12; against US C-15.
- US C-03. Roots and decomposed humus, sounding C1; mixed with US C-01, C-04, C-05 and C-06; alt. sup. 10,17; alt. inf. 9,82; on US C-07; against M05.
- US C-04. Disturbed layers, sounding C1, mix of earth and clay, roots and stones, plastic; mixed with US C-01, C-03, C-05 and C-06; alt. sup. 10,17; alt. inf. 9,82; on US C-07; against M05.
- US C-05. White to light grey clay, sounding C1, very heterogeneous; mixed with US C-01, C-03, C-04 and C-06; alt. sup. 10,17; alt. inf. 9,82; on US C-07; against M05.
- US C-06. Beige to yellow clay, sounding C1; mixed with US C-01, C-03, C-04 and C-05; alt. sup. 10,17; alt. inf. 9,82; on US C-07; against M05.
- US C-07. Clay, dark grey, sounding C1; alt. sup. 9,82; alt. inf. 9,15; on US C-17 and C-18; under US C-01, C-03, C-04 and C-05.
- US C-08. Surface layer, sounding C3; alt. sup. 9,04; alt. inf. 8,64; on US C-09 and C-21; under US C-22; cut by US C-24.
- US C-09. Black earth, sounding C3; alt. sup. 8,64; alt. inf. 7,88; on US C-08 and C-21; under US C-22; cut by US C-24.
- US C-10. Black earth, sounding C2; alt. sup. 9,20; alt. inf. 8,45; on US C-16; under US C-02.
- US C-11. Green clay, sounding C2, possible filling of a pit; alt. sup. 9,33; alt. inf. 8,19; under US C-02; cuts US C-12 and C-16; against US C-15.
- US C-12. White clay, sounding C2, possible filling of a pit; alt. sup. 9,08; alt. inf. 8,30; under US C-02; cuts US C-16; cut by US C-11.
- US C-13. Sandy layer, sounding C2, shells; alt. sup. 8,14; alt. inf. 8,02; under US C-16; on US C-14.
- US C-14. Black clay, sounding C2; alt. sup. 8,02; alt. inf. 7,91 (end of excavations); under US C-13.
- US C-15. Lime on the wooden planks, sounding C2; alt. sup. 9,40; alt. inf. 8,65.
- US C-16. Orange clay, sounding C2; alt. sup. 8,58; alt. inf. 8,14; on US C-13; cut by US C-11 and C-12.
- US C-17. Very compact green clay, sounding C1, stones; alt. sup. 9,71; alt. inf. 8,87 (end of excavations); on US C-19; under US C-07 and C-08.
- US C-18. Earth, slightly clayey, brown, sounding C1, very heterogeneous; alt. sup. 9,30; alt. inf. 8,87 (end of excavations); on US C-17; under US C-07.
- US C-19. Mortar, sounding C1, few pebbles; alt. sup. 10,00; alt. inf. 8,91 (end of excavations); under US C-17.
- US C-20. Mortar on the foundation bench, sounding C1, pebbles; alt. sup. 10,10; alt. inf. 10,00; against M05.
- US C-21. Beige to orange clay, sounding C3; alt. sup. 8,71; alt. inf. 8,64; on US C-09; under US C-08.
- US C-22. Green clay, sounding C3, not excavated; alt. sup. 9,28; alt. inf. 9,04; on US C-08.
- US C-23. Level of stone (?), sounding C3; alt. sup. 7,88; under US C-09.

- US C-24. Upper foundation level, sounding C3, made of stone and mortar, very dense; alt. sup. 9,18; alt. inf. 8,61; on US C-25; cuts US C-08.
- US C-25. Lower foundation level, sounding C3, made of stone and mortar, very dense; alt. sup. 8,61; alt. inf. 8,08; under US C-24; cuts US C-09.
- US C-26. Foundation trench, sounding C2, earth, mortar and stones; alt. sup. 9,35; under M05.

Sector D

D1

- US D1-00. Surface layer, brown color, with cobbles and gravel, very friable; alt. sup. max. 11,40; alt. sup. min. 11,30; alt. inf. max. 11,31; alt. inf. min. 11,28; on US D1-1.
- US D1-01. Modern deposits, light brown color, with stones, gravel, cement, glass and modern porcelain, texture relatively compact; alt. sup. max. 11,30; alt. sup. min. 11,28; alt. inf. max. 11,26; alt. inf. min. 10,95; under US D1-0; on US D1-2.
- US D1-02. Modern deposits, light brown color, with cobbles, compact texture; alt. sup. max. 11,28; alt. sup. min. 10,95; alt. inf. max. 10,99; alt. inf. min. 10,93; under US D1-1; on US D1-3 and M08.
- US D1-03. Layer whose nature (natural or anthropogenic) has to be determined, greenish brown color, with gravel and chipped stones, compact texture; alt. sup. max. 10,99; alt. sup. min. 10,93; alt. inf. max. 10,65; alt. inf. min. 10,61; under US D1-2; against wall M08 foundations.
- US D1-04. Clayey layer whose nature (natural or anthropogenic) has to be determined, light green, with a great amount of chipped stones of different sizes, very compact texture; alt. sup. max. 10,65; alt. sup. min. 10,61; alt. inf. (end of excavations) 10,30; under US D1-3; against wall M08 foundations.
- US D1-05. Mortar layer, white color, with a lot of chipped stones, compact and hard texture; on US D1-6.
- US D1-06. Mortar, whitish grey color, with a lot of lime nodules and gravel, friable texture; alt. sup. max. 11,04.; alt. inf. 10,53.; equivalent to US D1-7 (?); under US D1-5.
- US D1-07. Mortar, greenish grey-brown color, with a lot lime nodules and gravel, friable texture; alt. sup. max. 10,04.; alt. inf. 10,53; equivalent to US D1-6 (?).

D2

- US D2-01. Surface layer, modern deposits, light brown color, with cobbles, gravel, stones, glass, plastic, fabric, friable texture; alt. sup. max. 11,32; alt. sup. min. 11,30; alt. inf. max. 11,23; alt. inf. min. 10,97; on the buttress C18-1, M08, US D2-2 and US D2-3.
- US D2-02. Mortar layer covering the foundation, whitish grey color, with chipped stones, hard and compact texture; alt. sup. max. 11,10; alt. sup. min. 11,02; under US D2-1; against buttress C18-1 and wall M08.
- US D2-03. Layer whose nature (natural or anthropogenic) has to be

determined, greenish brown color, with gravel and chipped stones, compact texture; alt. sup. max. 11,02; alt. sup. min. 10,97; alt. inf. (end of excavations) 10,94; under US D2-1; against the foundation of M08.

Sector E

- US E-01. Surface layer, E part, E1 sounding; alt. sup. max. 10,16; alt. inf. max. 10,04; on US E-02; against M02.
- US E-02. White to beige clay, E part, E1 sounding; alt. sup. max. 10,16; alt. inf. 9,60; on US E-04; under US E-01; against M02.
- US E-03. Surface layer, W part, E1 sounding; alt. sup. 10,17; alt. inf. 10,14; on US E-08.
- US E-04. Green clay and pebbles, E1 sounding; alt. sup. 9,66; alt. inf. 9,56; on US E-05; under M02 and US E-02.
- US E-05. Dark grey clay, E1 sounding; alt. sup. 9,56; alt. inf. 9,50; on US E-06; under US E-04.
- US E-06. Compact clay, white to beige, E1 sounding; alt. sup. 9,50; alt. inf. 9,41 (end of excavations); under US E-05.
- US E-07. White mortar between the stones of M02, E1 sounding; alt. sup. 9,91.
- US E-08. White to beige clay, W part, E1 sounding; alt. sup. 10,14; alt. inf. 9,61; on US E-04; under US E-03.

Sector G

G1

- US G1-01. Grey earth, friable; alt. sup. 10,42; alt. inf. (end of excavations) 9,05; against US G1-2-US G1-4 and M03.
- US G1-02. Mortar layer, whitish grey but white on the surface, gravel and numerous chipped stones, compact and hard texture; alt. sup. 10,21; alt. inf. 10,17; on US G1-3; under M03.
- US G1-03. Mortar, grey (grayish white on the surface), friable, with gravel; alt. sup. 10,17; alt. inf. 9,76; under US G1-2; on US G1-4.
- US G1-04. Mortar, whitish grey but white on the surface, gravel and numerous chipped stones, compact and hard texture; alt. sup. 9,76; alt. inf. 9,72; on US G1-3; under US G1-5.
- US G1-05. Mortar, grey (grayish white on the surface), friable, with gravel; alt. sup. 9,71; alt. inf. 9,30; under US G1-4.

G2

- US G2-01. Grey earth, friable; alt. sup. 10,23; alt. inf. (end of excavations) 9,00; against US G1-2- US G1-4 and M03.
- US G2-02. Mortar layer, whitish grey but white on the surface, gravel and numerous chipped stones, compact and very hard texture; alt. sup. 10,24; alt. inf. 10,16; on US G1-3; under M03.
- US G2-03. Mortar, grey (grayish white on the surface), friable, with gravel; alt. sup. 10,16; alt. inf. 9,29; under US G1-2.

Appendix 2: List of the carved blocks discovered in the `AynSawda reservoir and stored in Qala't Azraq

In **black** are the blocks stored in Qala't Azraq;
In **red** are the disappeared blocks;
In *black* are the blocks stored at the Yarmouk University in Irbid.

Block number	Block shape	Details	Quantity	Bending	Break and missing part	Bas-reliefs	Peripheral frame	Year of discovery	Discovered by
1	Random	with mortise and tenons	on 4 faces	yes ?	yes			1981	DoAJ
2	Random	with mortise and tenons	on 4 faces		yes			1981	DoAJ
3	Squared				yes	Sun		1981	DoAJ
4	Rectangular					Man with large trousers	yes	1981	DoAJ
5	Rectangular	with mortise and tenons	on 2 faces			Fight of 2 animals with a palm tree in the middle		1981	DoAJ
6	Squared	cut on one face				Vase with pomegranate		1981	DoAJ
7	Radial	with mortise and tenons	on 4 faces	yes		Animal, gazelle like		1981	DoAJ
8	Rectangular			yes ?	yes	Vase with pomegranate		1981	DoAJ
9	Rectangular	with tenon	on 1 face		a few	Woman		1981	DoAJ
10	Radial	with mortise and tenons	on 1 face	yes	yes	Gazelles with scarf and fire		1981	DoAJ
11	Squared	with mortise and tenons	on 2 faces			2 animals (?)	yes	1981	DoAJ
12	Radial	with mortise and tenons	on 4 faces	yes		Lion (?)		1981	DoAJ
13	Radial	with mortise and tenons	on 1 face	yes		2 birds facing itself		1981	DoAJ
14	Rectangular	with tenon	on 1 face					1981	DoAJ
15	Radial	with mortise and tenons	on 4 faces	yes		Fish		1981	DoAJ
16	Radial	with mortise and tenons	on 4 faces	yes		Winged horse		1981	DoAJ
17	Rectangular					Geometric elements		1981	DoAJ
18	Rectangular					Geometric elements in a circle		1981	DoAJ
19	Squared					Bird		1981	DoAJ
20	Radial	with mortise and tenons	on 1 face	yes		Donkey		1981	DoAJ
21	Random	with mortise and tenons	on 2 faces			Snake	yes	1981	DoAJ
22	Rectangular	with mortise and tenons	on 3 faces		yes	Fish	yes	1981	DoAJ
23	Radial	with mortise and tenons	on 4 faces	yes		Bull (?)		1981	DoAJ
24	*Rectangular*	*avec excroissance*	*on 1 face*		*yes*	*Wading bird*	*yes*	*1981*	*DoAJ*
25	*Radial*	*with mortise and tenons*	*on 4 faces*	*yes*		*Bird ?*		*1981*	*DoAJ*
26	*Radial*	*with mortise and tenons*	*on 1 face*	*yes*		*Senmurv*		*1981*	*DoAJ*
27	*Radial*	*with mortise and tenons*	*on 4 faces*	*yes*		*Fish*		*1981*	*DoAJ*
28	*Radial*	*with mortise and tenons*	*on 4 faces*	*yes*		*Leopard ?*		*1981*	*DoAJ*
29	*Squared*	*with mortise and tenons*	*on 1 face*		*?*	*tree or vegetal*	*yes*	*1981*	*DoAJ*
30	*Radial*	*with mortise and tenons*	*on 4 faces*	*yes*	*yes*	*Winged horse*		*1981*	*DoAJ*

31	*Radial*	*with mortise and tenons*	*on 4 faces*	*yes*		*Leopard ?*		*1981*	*DoAJ*
32	*Random*					*Dog ?*	*yes*	*1981*	*DoAJ*
33	*Rectangular*				*?*	*tree or vegetal*	*yes*	*1981*	*DoAJ*
34	*Squared*	*cut on one face*				*Vase with pomegranate*		*1981*	*DoAJ*
35	Random	with mortise and tenons	on 3 faces	?	yes	Man on a horse, fighting with an animal and a spear		1981 ?	?
36	?	?	?	?	?	?	?	?	?
37	Pyramidal	with mortise and tenons	on 1 face		yes			2004	Cl. VG
38	Rectangular	with mortise and tenons	on 3 faces	yes on 1 face	yes			2004	Cl. VG
39	Rectangular	with tenon	on 1 face					2004	Cl. VG
40	Radial	with mortise and tenons	on 4 faces	yes	yes	Fish		2004	Cl. VG
41	Radial	with mortise and tenons	on 4 faces	yes		Senmurv		2004	Cl. VG
42	Radial	with mortise and tenons	on 1 face	yes		Deer		2004	Cl. VG
43	Squared	cut on one face				Vase with pomegranate		2004	Cl. VG
44	Radial	with mortise and tenons	on 4 faces	yes	yes	Elephant		2004	Cl. VG
45	Rectangular	with mortise and tenons	on 3 faces		yes			2004	Cl. VG
46	Radial	with mortise and tenons	on 1 face	yes		Man on a horse		2004	Cl. VG
47	Radial	with mortise and tenons	on 4 faces	yes		Leopard ?		2004	Cl. VG
48	Radial	with mortise and tenons	on 4 faces	yes		Deer		2004	Cl. VG
49	Pyramidal	with mortise and tenons	on 2 faces		yes			2004	Cl. VG
50	Radial	with mortise and tenons	on 4 faces	yes		See horse		2004	Cl. VG
51	Random	with mortise and tenons	on 2 faces			Scorpion	yes	2004	Cl. VG
52	Radial	with mortise and tenons	on 4 faces	yes		Sea horse		2004	Cl. VG
53	Radial	with mortise and tenons	on 4 faces	yes		Rabbit		2004	Cl. VG
54	Radial	with mortise and tenons	on 1 face	yes		Woman with plate and jug		2004	Cl. VG
55	Fragment							2004	Cl. VG
56	Fragment							2004	Cl. VG
57	Rectangular	with notch	on 1 face					2004	Cl. VG
58	Squared	with mortise and tenons	on 4 faces					2004	Cl. VG
59	Radial	with mortise and tenons	on 1 face	yes		Cock after a dog		2004	Cl. VG
60	Random	with mortise and tenons	on 4 faces		yes			2004	Cl. VG
61	Squared	with notch	on 2 faces					2004	Cl. VG
62	Radial	with mortise and tenons	on 4 faces	yes		Siren		2004	Cl. VG
63	Rectangular	with mortise and tenons	on 1 face					2004	Cl. VG
64	Radial	with mortise and tenons	on 1 face	yes		2 gazelles facing each other with a tree in the middle		2004	Cl. VG
65	Rectangular	with mortise and tenons	on 4 faces		yes	Man with beard and stick	yes	2004	Cl. VG
66	Rectangular	with mortise and tenons	on 1 face					2004	Cl. VG
67	Rectangular	with mortise and tenons	on 2 faces					2004	Cl. VG
68	Random	with bending	on 1 face	yes				2004	Cl. VG
69	Rectangular	with mortise and tenons	on 4 faces					2007	Cl. VG
70	Rectangular	with mortise and tenons	on 1 face		yes			2007	Cl. VG

71	Radial	with mortise and tenons	on 4 faces	yes		Winged horse		2007	Cl. VG
72	Random	with mortise and tenons	on 3 faces		yes			2007	Cl. VG
73	Radial	with mortise and tenons	on 2 faces	yes	yes	Eagle		2007	Cl. VG
74	Random	with mortise and tenons	on 1 face	yes ?				2007	Cl. VG
75	circulaire	with mortise and tenons		yes	yes			2007	Cl. VG
76	Squared				yes			2007	Cl. VG
77	Random	with mortise and tenons	on 2 faces		yes			2007	Cl. VG
78	Rectangular	with mortise and tenons	on 2 faces	yes				2007	Cl. VG
79	Fragment							2007	Cl. VG
80	Rectangular			yes		Vase with pomegranate		2007	Cl. VG
81	Squared	with mortise and tenons	on 4 faces		yes	Mens and animals around a central circle	yes	2007	Cl. VG
82	Rectangular	with mortise and tenons	on 1 face		yes			2007	Cl. VG
83	Fragment							2007	Cl. VG
84	Radial	with mortise and tenons	on 1 face	yes		Senmurv		2007	Cl. VG
85	Fragment							2007	Cl. VG
86	Rectangular	with notch	on 2 faces		yes			2008	Cl. VG
87	Rectangular	with mortise and tenons	on 3 faces	yes ?		Vase with pomegranate		2008	RSCN
88	Radial	with mortise and tenons	on 4 faces	yes		Sea peacock ?		2008	RSCN
89	Squared	with mortise and tenons	on 4 faces		yes			2008	Cl. VG
90	Rectangular	with mortise and tenons	on 2 faces		yes	2 dogs running after a gazelle ?		2008	Cl. VG
91	Octogonal							2008	Cl. VG
92	Rectangular	with notch	on 2 faces					2008	Cl. VG
93	Squared	with notch	on 2 faces					2008	Cl. VG
94	Random	with mortise and tenons	on 2 faces			Fish	yes	2008	Cl. VG
95	Random	avec face biaise	on 1 face					2008	Cl. VG
96	Pyramidal	with mortise and tenons	on 2 faces		yes			2008	Cl. VG
97	Pyramidal	with mortise and tenons	on 2 faces		yes			2008	Cl. VG
98	Squared	with mortise and tenons	on 4 faces		yes	2 lamas facing each other with a tree in the middle	yes	2008	Cl. VG
99	Fragment							2008	Cl. VG
100	Fragment							2008	Cl. VG
101	Fragment							2009	Cl. VG
102	circulaire	with mortise and tenons		yes	yes	Eagle catching a deer/ gazelle		2009	RSCN
103	Rectangular	with mortise and tenons	on 1 face					2010	Cl. VG
104	Rectangular	avec excroissance	on 1 face		yes			2010	Cl. VG
105	Rectangular	with mortise and tenons	on 2 faces		yes	Sea winged horse	yes	2010	Cl. VG
106	Radial	with mortise and tenons	on 4 faces	yes	yes	Gazelle with scarf and fire		2013	RSCN