

Ulrich Bellwald
Ba'ja Survey Project, Miami University
intrmeem@go.com.jo

Ulrich Bellwald

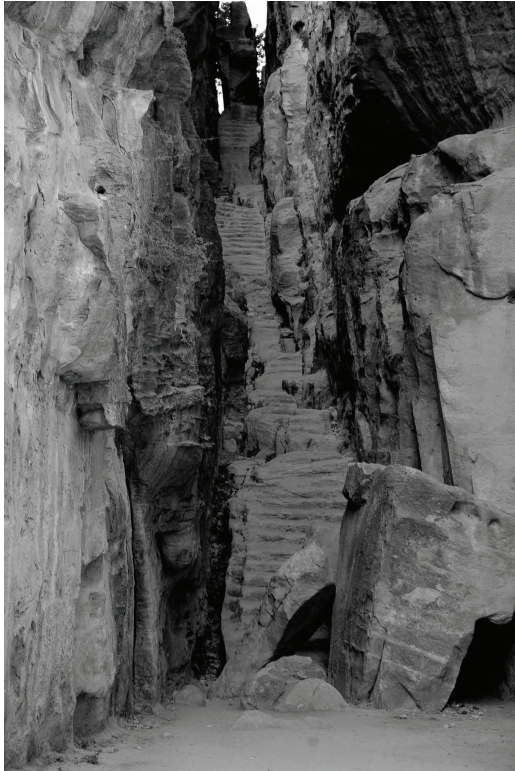
Wādī 'Agalāt Winery: A Model for Long-Term Planning and Investment in Agriculture in the Petra Area

A Question at the Beginning

Have you ever asked yourself where the monumental, rock-cut staircase at the western end of Little Petra is leading (FIG. 1)? When I first visited Little Petra in 1991, I was told by my archaeologist friends that it was the rear entry used by the traders from Petra to receive the caravan leaders. Years later, when I climbed up this staircase, I reached a narrow passage and then another staircase leading down. At the bottom of this staircase, I found myself in a wādī bed and decided to follow it downstream. After around 400 m, I reached its lower end and realized that its outlet into Wādī Bayḍa was an extremely narrow drop-off with a width of only 1.2 m and a height of 19 m (FIGS. 2–3). There was absolutely no rear access to Little Petra from this side, and the monumental staircase at the western end of Sīq al Bārid must have been built for completely different reasons!

Introduction

The discovery of the Wādī 'Agalāt Winery was a side benefit of my research of Petra's hydraulic system. In 2001, surveying the runoff water retention systems built by the Nabataeans in the Bayḍa area, mainly inside Little Petra, I climbed along a very narrow fault leading from the main Plaza inside Sīq al Bārid, parallel to its southern cliff westwards. It led me again into the wādī bed at the bottom of the previously mentioned staircase at the end of Sīq al Bārid. During my survey on this visit, I recorded several water installations and a well preserved, partially still backfilled and not fully cleaned wine press at the eastern end of the wādī. By asking people from the Amarin village, I learned that the name of this wādī was Wādī 'Agalāt. As my research focus at that time was not yet on wine production, I did not proceed with further research in Wādī 'Agalāt. So the western wine press was first



1. View of the monumental staircase hewn into the bedrock at the western end of Little Petra (U. Bellwald).

published by Zeyad al Salameen (2004: 176) in 2004. From 2010–2017, I conducted more and intensified surveys in Wādī ‘Agalāt which revealed the existence of an extended winery occupying its full extension from the western inlet to the eastern outlet and from the northern to the southern cliffs. In 2007, I entered into a co-operation with the Ba‘ja Survey Project of the University of Miami, directed by David Graf, in order to integrate my private research about Nabataean wine production into a more extended and comprehensive research project. During the “3rd International Conference on Petra and the Nabataean Culture,” David Graf presented the general research results and reflections of the project, hence for these aspects I refer to his contribution in this volume. My



2. View from the outlet of Wādī ‘Agalāt down to Wādī Bayḍa. The drop-off has a height of 19 m (U. Bellwald).



3. View onto the very narrow drop-off from Wādī ‘Agalāt into Wādī Bayḍa. It has a width of only 1.2 m (U. Bellwald).

contribution will present the Wādī ‘Agalāt Winery as one of the most elaborate models of agriculture through its terracing of the Petra area, and furthermore it bears witness to long-term planning and investment in the field of agricultural production. The presentation of the preliminary results of the Wādī ‘Agalāt Winery Project presented here is an interim report, providing insight into an archaeological work in progress, including a prospectus for future work.

The Location of Wādī ‘Agalāt

Wādī ‘Agalāt is located to the west of Sīq al Bārid or Little Petra. It is a “deadlock”-wādī with no walkable entrance or exit. It is almost oriented west-east, its lowest section sharply diverting south in direction to the drop-off into Wādī Bayḍa. Its upstream end lies at a height of 1,097 m, its outlet at 1,074 m. The level of Bayḍa below the drop-off is at 1,055 m. The entire length of Wādī

‘Agalāt measures 1.19 km, its width differs from a maximum of 130 m to a minimum of 10 m. The topography of Wādī ‘Agalāt is characterized by two extended pans at the western and the eastern end and a meandering wādī bed in-between with alternating widths (FIG. 4).

The Results of the Surveys 2010–2017

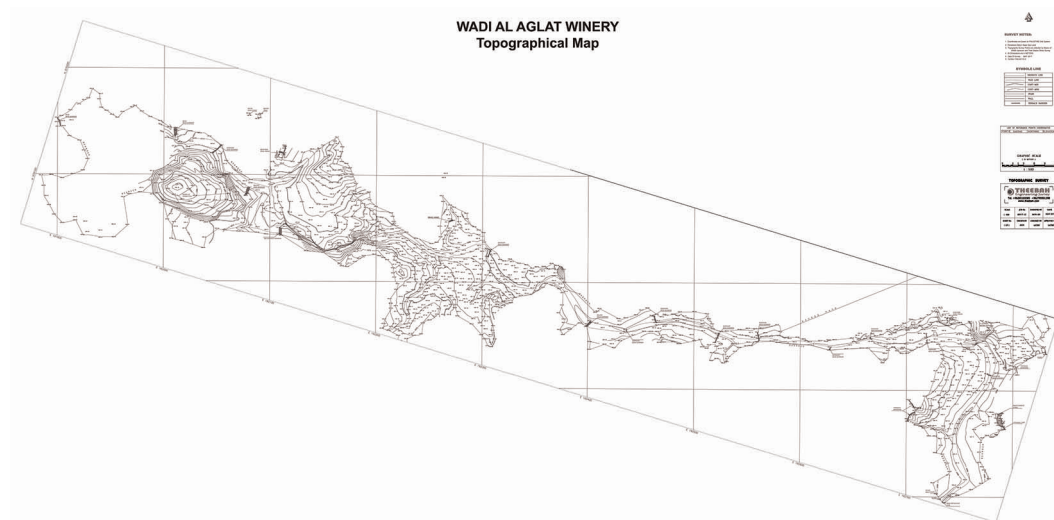
In the course of field work from 2010–2016, all the visible archaeological remains in Wādī ‘Agalāt were meticulously documented by photographs, drawings, and GPS-localization. In May 2017, the entire area of Wādī ‘Agalāt was mapped and all visible archaeological remains were recorded in the topographical contour-line map in the scale of 1:500 (FIG. 5). The details of the main archaeological elements were mapped in the scale 1:50. The field work and the mapping from 2010–2017 revealed the existence of an extended



4. Satellite view showing the location of Wādī ‘Agalāt with the course of the wādī bed highlighted in black. The dots at the upstream and downstream end of the wādī bed indicate the highest and the lowest points. The isolated dot west of Bayḍa Neolithic Village indicates the bottom of the drop-off between Wādī ‘Agalāt and Wādī Bayḍa. The grey surface highlights the extension of the former winery (extract from Google Earth; key by U. Bellwald).

winery occupying the full extension of Wādī ‘Agalāt from the western upstream end to the eastern outlet and from the northern to the southern cliffs. In an initial step for the set-up of Wādī ‘Agalāt Winery,

the outlet of the wādī bed into Wādī Bayḍa was completely barred by a retention dam of solid masonry with a height of 4.9 m, a width from 98 cm to 170 cm and a thickness of 69 cm (Fig. 6). The blocks of the masonry



5. Topographical map of Wādī ‘Agalāt (original scale 1:500) showing the location of all archaeological remains recorded (drawing by Theebah, ‘Ammān).



6. View onto the crest of the retention dam closing the drop-off towards Wādī Bayḍa (U. Bellwald).
7. Frontal view at the niche sanctuary chiseled out of the western cliff flanking the dam (U. Bellwald).

were accurately embedded in grey hydraulic lime mortar in order to prevent any water from running off. In the western cliff, the dam is flanked by a niche sanctuary framed by pilasters and an altar with three footings for the insertion of betyloi, both directly hewn into the bedrock (FIGS. 7–8). My research on the hydraulic infrastructure of Petra has revealed that almost all solid dam constructions, either flash-flood retention dams, diversion dams, or storage dams were





8. View from north onto the altar with three footings for the insertion of Betyloi, chiseled out of the western cliff flanking the dam (U. Bellwald).

accompanied by niche sanctuaries (Bellwald 2003: 81–4; 2008: 76–86). It may be assumed that the niche sanctuaries accompanying dams or aqueduct bridges were installed with the aim of asking selected gods or goddesses to prevent the construction from being damaged by natural disasters. That no other hydraulic structure in the entire Petra area is accompanied by a niche sanctuary and an altar at the main dam at the outlet of Wādī ‘Agalāt into Wādī Bayḍa demonstrates how much care was invested in the set-up of this specific winery. By holding back the material dissolved by winter rains from the rock formations surrounding the wādī, the construction of the dam led to the natural deposition of the soil sediments required for the growing of the vines. By identifying

the human intervention in the construction of the main retention dam of Wādī ‘Agalāt, its actual topography proves to be a completely artificial, man-made landscape. In its original form, the wādī bed was much steeper and narrower and there were no farmable surfaces along its banks.

Upon the completion of the accumulation of upstream sediments from the main retention dam, the course of Wādī ‘Agalāt was further terraced for facilitating the planting of vines. A sequence of 17 wādī barriers was built along the course of the wādī bed, upstream from the main retention dam. A wādī barrier is a facility built for containing runoff water and for reducing its outflow velocity. Furthermore, barriers have the duty to increase the upstream surface



9. View of the well preserved northern section of the downstream face of the main wādī barriers at the northern foot of the rock outcrop bearing the ruins of the farmstead. The frontal view shows well the typical construction method of wādī barriers, well-dressed ashlar blocks set up as dry masonry without mortar (U. Bellwald).

10. View from north onto the well preserved section of the same wādī barriers (U. Bellwald).



level by building up sediments. In order to withstand the water pressure from upstream, barriers are constructed in dry masonry, without any mortar in the joints, allowing the water to seep through the voids. Based on their location, outlet, and dimensions, three categories of wādī barriers can



11. View from west of the stratigraphy of the sediments built up upstream from the main wādī barriers shown here above, exposed by erosion after the partial collapse of the construction. Below the scale the ruins of some older buildings may be detected (U. Bellwald).



12. Panoramic view from north into the pan at the upstream end of Wādī ‘Agalāt by the wādī barrier built at the outlet of Wādī ‘Agalāt. From this pan the Nabataeans were not only able to accumulate the required fertile soil covering the former rock surface, but also created a vast plane surface for establishing the vineyard (U. Bellwald).

be distinguished in Wadi ‘Agalāt. The two main wādī barriers had an original height of approximately 3 m and a thickness of up to 2.5 m. They are located at the inlet and the outlet of the extended wide pan at its western upstream end and led to the accumulation of huge sediments, creating an extended, even area for cultivation (FIGS. 9–12). They still stand nowadays to a height of 2.5 m, but have partially collapsed with the result that the runoff water in wintertime has locally washed out the accumulated sediments to

the original surface of the bedrock. Such recent erosion allows an impressive “x-ray” insight into the stratigraphy of the sediments. The most impressive stratigraphic profile can be seen at the foot of the rock outcrop bearing the ruins of the farmstead (FIG. 11). Ruins of masonry at the bottom of the profile prove that Wādī ‘Agalāt was used by humans even before the installation of the winery. Originally, the three major wādī barriers had almost the same dimensions as the main wādī barriers, but they were not



13–14. View of the downstream face of two well preserved average wādī barriers in the central section of Wādī ‘Agalāt. The photographs show that the abutments of the construction touch the bottom of the cliffs. The dry masonry of these wide barriers with limited height has been erected with the same well-dressed ashlar blocks as in the main and major wādī barriers (U. Bellwald).

erected for accumulating huge, extended sediments, but for taming the outflow speed of the runoff water. They are all located in steep, curvy sections of the wādī bed. Two of them are located immediately downstream from the rock outcrop bearing the ruins of the farmstead where the wādī bed has the course of the sharp S.

Along the sections of the wādī bed with a limited width and a rather gentle slope, a sequence of 12 average wādī barriers was built. These barriers had a height of about 1.2 m; their width depended on the width of the wādī bed, as they completely closed it from the northern to the southern cliff. The thickness varies from 1 to 1.5 m (Figs. 13–14). As the main and the major wādī barriers, the average ones were built with well-dressed ashlar blocks of local sandstone. The sequence of the average wādī barriers changed the course of the wādī bed

into a stepped cascade with a gentle slope, reducing the outflow velocity of the runoff water tremendously in order to protect the vines from being damaged by erosion of the fertile soil. As the average terrace barriers used both cliffs as their abutments, they closed the wādī bed over its complete cross-section, hence the gently outflowing runoff water reached all rows of vines planted on both embankments.

In the wide areas at the upstream and downstream ends of Wādī ‘Agalāt, the slopes reaching up to the bottom of the flanking cliffs have steeper slopes compared to the lower areas built up by artificial sedimentation due to the construction of the wādī barriers. In order to secure the plants in these higher locations from being washed down, terrace barriers were built. Terrace Barriers are also constructions in dry masonry, erected along slopes like contour lines in order to decrease



15. In steeper areas where runnels risked sluicing out the terraces, they were reinforced by terrace barriers of which six have already been detected and surveyed (U. Bellwald).



16. One of the most thrilling discoveries were the still very visible artificially modeled terraces worked out by simply stepping the ground with rakes or similar tools along which the vines were planted. Instead of vines, nowadays Mediterranean onions are growing on the terraces (U. Bellwald).

the gradient by dividing the slope into a sequence of stepped terraces. The sediments accumulated upstream of the terrace barrier absorbed a great part of the runoff water and stored it, fostering agricultural production. Furthermore, terrace barriers stabilize the soil and hence prevent surface erosion. During the various surveys, three sets of terrace barriers were recorded with a total of six single walls. In future seasons of the project, it is likely that more such terrace barriers will be discovered, as some of them may have been buried by debris washed down during winter floods. One buried terrace barrier was recently exposed in an angle of the western cliff close to the outlet of the wādī bed into Wādī Bayḍa (FIG. 15). All the visible and recorded terrace barriers were not built with well-dressed ashlar blocks, but with flat sandstone hunks collected from the surface in the area where they were erected. Between the terrace barriers, and in areas with a

very gentle slope, the ground was prepared for planting the vines by simply terracing the soil with rakes or similar tools. Due to the very remote location of Wādī 'Agalāt, a great number of these ground terraces are preserved and still visible today (FIG. 16).

Two huge wine presses in the wide eastern and western pans of the wādī allowed efficient processing of the grape harvest. The eastern wine press is located at the inlet from the narrow central section of the wādī into the wide eastern pan; it is inserted into a rock terrace at the bottom of the northern cliff. As it is occasionally used by Bedouins as a drinking trough for goats, it has partially been cleaned, but nevertheless the original bottom of all its basins is not yet visible. The eastern wine press consists of an extended, square treading platform which was also used as a pressing basin. From the treading platform, the must flowed through a valve into the rectangular filter basin, from where another valve conducted it into the

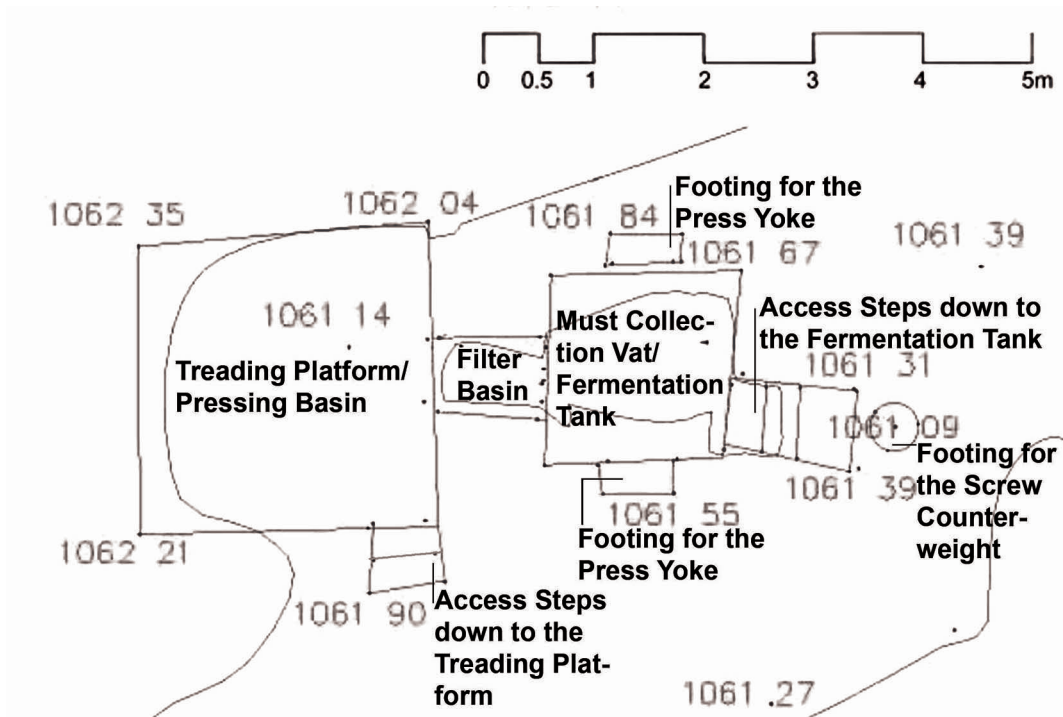
fermentation tank. Two sets of stairs gave access to the bottom of the treading platform and the fermentation vat. Absolutely exceptional are the well preserved footings of the wooden press construction on both sides of the fermentation vat and on the eastern side of its access stair. The two rectangular indentations on both sides of the fermentation tank were made for anchoring the yoke keeping the long press beam in its position, whereas the circular cut in front of the stair was used as a foundation for the counterweight of the wooden screw for pulling the beam down (FIGS. 17–18). These footings hence allow a rather precise reconstruction of the wooden press mechanism (FIGS. 19–20). The dimensions of the almost square fermentation vat are 1.65 x 1.75 m; its depth from the bottom to the inlet valve from the filter basin may be estimated to 1.8 m. Therefore the fermentation vat had a capacity per pressing process of 4,331 L.



17. View from east onto the eastern wine press with a treading and pressing basin, a filter basin, a must collection, and a fermentation vat (U. Bellwald).

The western wine press is located on the northern slope above the wādī bed, opposite the hilltop with the ruins of the farmstead. From its various single elements, only the huge square treading platform/filter basin is actually visible; all the other basins and installations are still completely buried (FIGS. 21–22). Similar to the eastern press, the western one also has footings for the anchorage of the wooden press mechanism. As both wine presses in Wādī ‘Aḡalāt have huge and deep treading platforms where the grapes were crushed by foot, the must could be stored together with the skins and the stems of the grapes for a while before being conducted into the filter basin. By such a procedure the must was able to absorb the dye from the skins and hence got a red color. It is therefore most probable that the Wādī ‘Aḡalāt Winery produced mainly red wine.

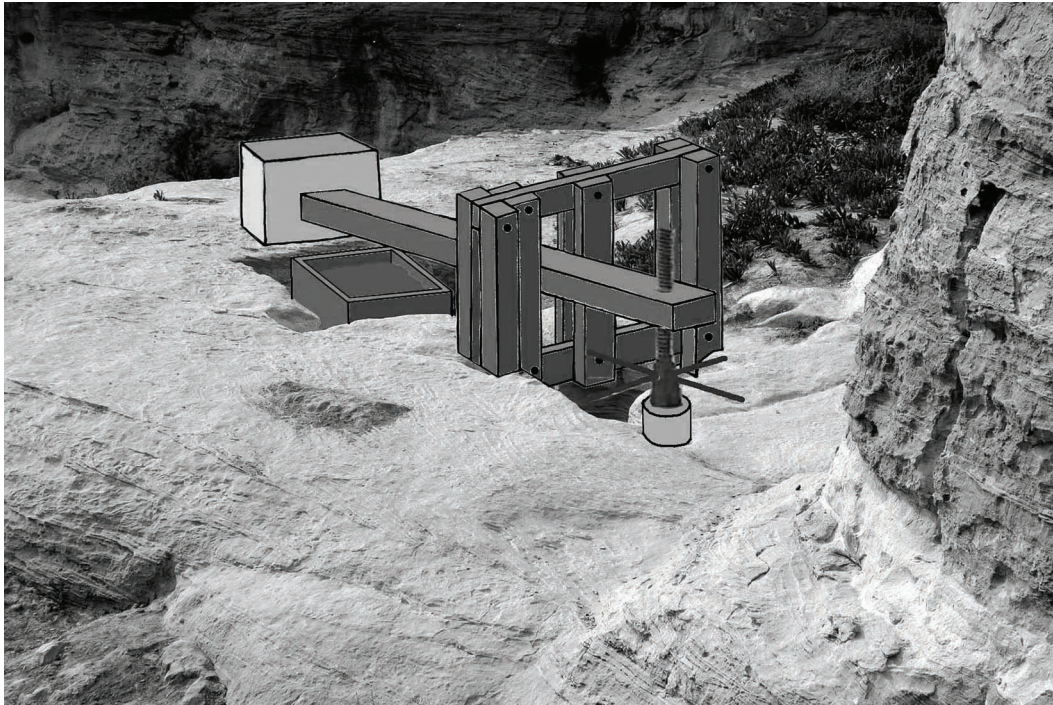
Hydraulic installations in the close neighborhood of both wine presses assured a sufficient supply of runoff water for the needs of the wine making process. The most impressive such installation is a retention dam located at the eastern embankment of the wādī bed south of the eastern wine press. It closes the western section of a long and narrow fault parallel to Sīq al Bārid. The dam is 3 m wide and still stands up to a height of 2 m, but originally it was at least 1 m higher. Its masonry is 60 cm thick and set up with well-dressed ashlar blocks, fully embedded in grey hydraulic mortar (FIG. 23). The



18. Plan of the eastern wine press with the keys to its single elements (Plan: Theebah; key: U. Bellwald).



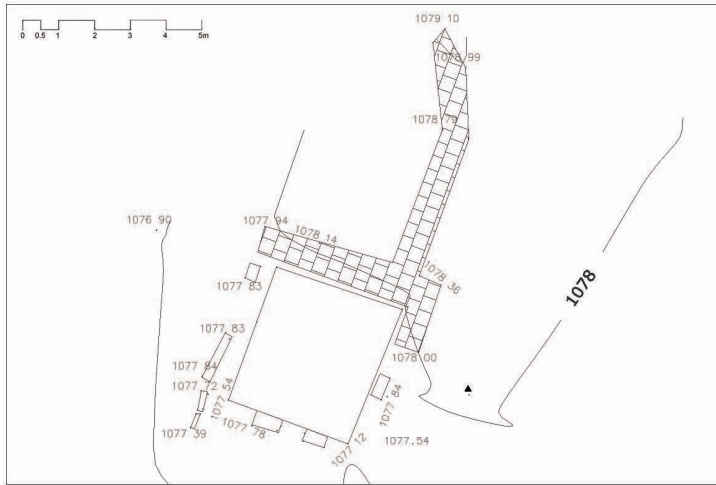
19. View from southeast at the eastern wine press (U. Bellwald).



20. The same view showing a reconstruction of the wooden construction for the press with the yoke, the press beam and the screw-counterweight mechanism for pulling it down (U. Bellwald).



21. View from north onto the western wine press with an extended treading and pressing basin, surrounded by footings for anchoring the wooden press construction. The filter basin, the must collection, and fermentation vat are still buried (U. Bellwald).



22. Plan of the western wine press (drawing by Theebah).



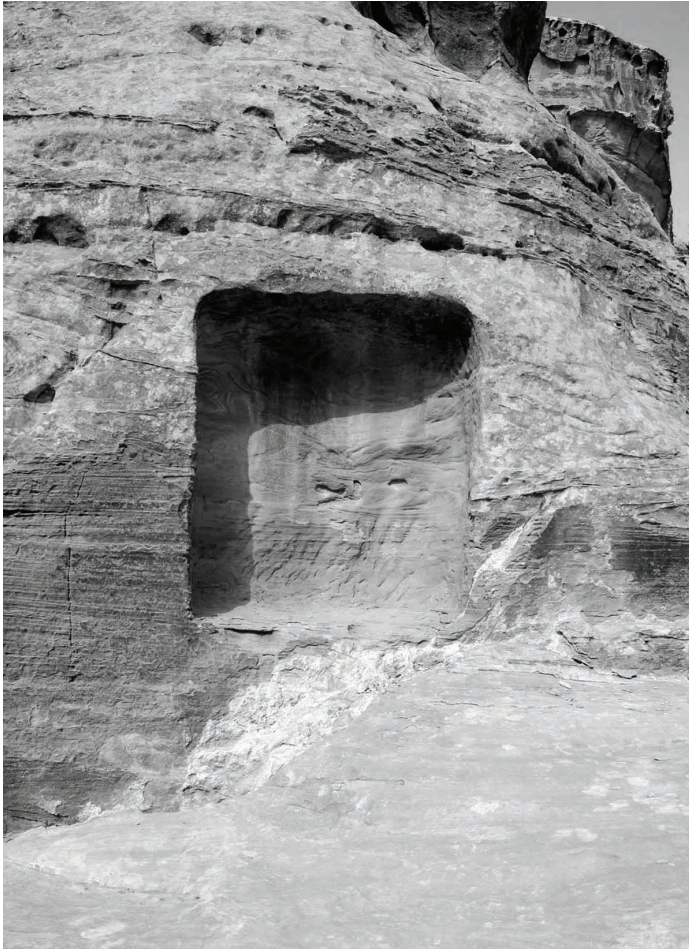
23. The retention dam for storing runoff water south of the eastern wine press. It closes a long and narrow fault running parallel to Sīq al Bārid (U. Bellwald).



24. View from west at the rock outcrop at the northern abutment of the dam with the stair winding up to its crest in an elegant S-shaped line (U. Bellwald).



25. Cistern hewn into the bedrock at the foot of the northern cliff above the western wine press (U. Bellwald).



26. Niche sanctuary located to the west of the cistern (U. Bellwald).



27. Panoramic view from north over the wide, even uppermost part of Wādī ‘Agalāt. The ruins of the farmstead are located on the hilltop framed by trees. At the bottom of the hill the ruins of one of the main wādī barriers may be seen (U. Bellwald).

extended catchment basin upstream of the dam had a length of approximately 400 m, hence it allowed for the storage of at least 2500 m³ of water. To give access to the water reserve in the catchment basin, a stair was hewn into the rock outcrop at the northern

abutment of the dam. It winds up to the crest of the dam in an elegant S-shaped line (FIG. 24). On a rock outcrop opposite the eastern wine press, the partially eroded remains of a working platform with a cistern and a hand washing basin are preserved. At the



28. Close view from north at the rock outcrop with the ruins of the farmstead on its hilltop (U. Bellwald).



29. View from west onto the ground of the hilltop with blocks from the collapsed walls scattered across the surface. Among the blocks scattered on the surface, a well preserved door-jam may be detected (U. Bellwald).

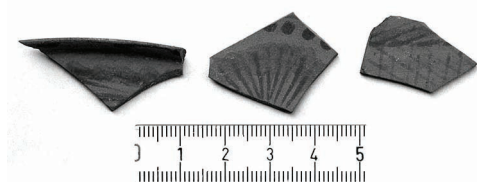
foot of the northern cliff above the western wine press, a huge cistern is hewn into the bedrock, accompanied by a great niche sanctuary some meters further westwards (FIGS. 25–26).

On top of a hill overlooking the wide, even uppermost part of Wādī ‘Agalāt, the ruins of a large farmstead could be identified, which most probably served as the administrative and logistic center of the winery. Actually only small sections of walls may be detected on the ground, therefore no attempt of an even schematic reconstruction may be given, but as the blocks from the collapsed walls are spread all over the entire hilltop, it may be assumed that the building occupied the full plateau (FIGS. 27–29).

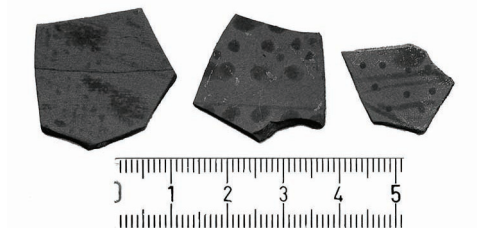
Dating the Wādī ‘Agalāt Winery

As no excavations have been undertaken in Wādī ‘Agalāt, all attempts to date its construction time and the period of use

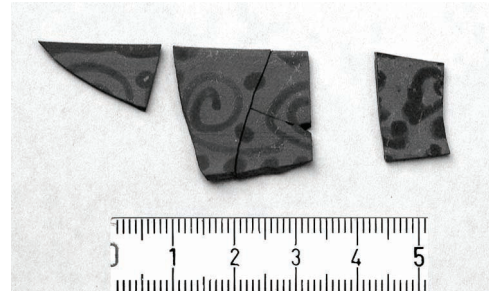
can only be based on pottery sherds that were collected from the surface around the wine presses and inside the ruins of the farmstead. Interestingly, the pottery results are the same for all three locations. Based on the chronology of the Nabataean fine



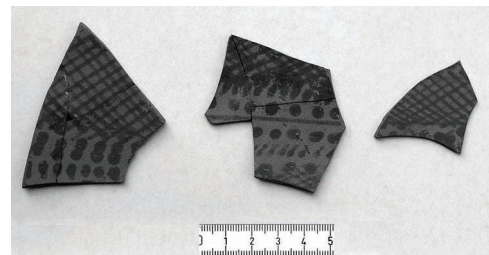
30. Fragments of painted fine ware bowls of sub phase 2b, dated to the last quarter of the 1st c. BC (U. Bellwald).



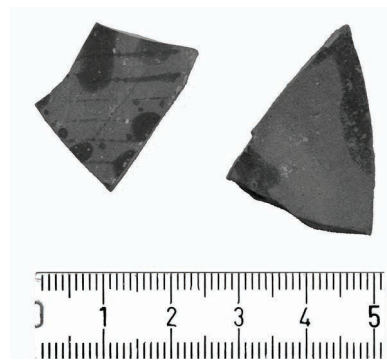
31. Fragments of painted fine ware bowls of sub phase 2c, dated to AD 0–20 (U. Bellwald).



33. Fragments of painted fine ware bowls of sub phase 3b, dated to AD 70–100 (U. Bellwald).



32. Fragments of painted fine ware bowls of sub phase 3a, dated to AD 20–70 (U. Bellwald).



34. Fragments of painted fine ware bowls of sub phase 3c and 4, dated to the 3rd c. AD and the first half of the 4th c. AD (U. Bellwald).



35. Satellite view showing the entire area of Bayḍa and Wādī ‘Aḡalāt with the marking of the most important elements connected with wine production:

(1) Wine presses in the Wādī ‘Aḡalāt Winery; (2) Wādī ‘Aḡalāt retention dam for storing runoff water during winter rains for irrigation in summer time; (3) Maintenance stairs giving access to the catchment basin behind dam 2; (4) Main retention dam closing the outlet of Wādī ‘Aḡalāt into Wādī Bayḍa; (5) Sequence of average wādī barriers in Wādī ‘Aḡalāt for damming up the runoff water to the height of the vines; (6) Staircase connecting Little Petra with Wādī ‘Aḡalāt; (7) Little Petra; (8) Visitors parking for Little Petra; (9) Intersection to Little Petra from the main road–Umm Ṣayḥūn Waste Water Treatment Plant–Wādī ‘Arabāh; (10) Neolithic settlement of Wādī Bayḍa; (11) Wine presses in the eastern and southern Wādī Bayḍa area; (12) Main cistern for the water supply of the wine presses; (13) Farmstead of the Wādī ‘Aḡalāt Winery; (14) Mansion excavated by the American Center of Oriental Research; (15) Cisterns to the vaulted rock chamber; (16) Terrace barriers in Wādī Bayḍa (satellite view courtesy of D. Comer; key by U. Bellwald).

ware pottery established by S.G. Schmid, the earliest sherds represent sub-phase 2a, dated to the third quarter of the 1st c. BC. Only a few sherds from this phase have been found. Many more of the collected sherds represent sub-phase 2b, dated to the last quarter of the 1st c. BC (FIG. 30). The largest number of sherds represent the sub-phases 2c–3b, which can be dated to the full extent of the 1st c. AD (FIGS. 31–33). Only very few sherds represent the sub-phases 3c and 4, dating to the 3rd c. AD and the first half of the 4th c. AD (FIG. 34, Schmid 1996;

1997; 2000). Absolutely no sherds dating to a period after the earthquake of AD 363 were found. The unpainted fine ware and the coarse ware sherds confirm this dating (Gerber 1994; 1997). It may therefore be proposed that the Wādī ‘Aḡalāt Winery was established in the third quarter of the 1st c. AD and had its prime period of production in the 1st c. AD. From the 2nd c. AD to the middle of the 4th c. AD, the winery was still under operation, but most probably on a more modest level. The winery in Wādī ‘Aḡalāt was abandoned after the earthquake

of AD 363, which destroyed, at least partially, the wādī and terrace barriers and led to the complete collapse of the farmstead.

Conclusion

Without any doubt, it can be stated that the winery in Wādī 'Agalāt, as presented here, is one of the most elaborate models of agriculture through its terracing of the Petra area. Furthermore, it bears witness of a long-term planning and investment in the field of agricultural production. Preliminary estimations have shown that the accumulation of sediments upstream from the main dam and the main and major wādī barriers took around 30 years. The entire surface for the cultivation of vines, resulting from the terracing of the wādī bed, ultimately covered an area of 5 ha, which equals an annual yield of around 30,000 L of wine, based on the numbers given by Lucius Junius Moderatus Columella (AD 4–70) in *De Re Rustica* (3.3.2–3, 9.2; written ca. AD 64). To answer the question asked at the beginning of my contribution, it must be highlighted that the winery in Wādī 'Agalāt is exclusively accessible from Little Petra. Hence the monumental, rock-cut stair-case at its western end was uniquely built to provide access to the winery. Therefore, it is obvious that the winery and the rock-cut tri- and biclinia in Little Petra have to be seen as one unit (FIG. 35). This makes it very improbable to consider Little Petra as the office suburb for the traders from Petra, but it might have served as a highly sophisticated banquet area for wine tasting, promotion, and selling. The cooperation of the Wādī 'Agalāt Winery Project with the Ba'ja Survey Project of the University of Miami, directed by David Graf, has allowed us to shed new light on the wine production of the Nabataeans and its socio-economic aspects. As the wine production is concentrated in the Bayḍa-Ba'ja area, and considering the long-term planning and investment into undertakings

like the set-up of the Wādī 'Agalāt winery, it is likely that wine production was a royal monopoly with a governmental director as superintendent of the wines, equal to the "Praepositus Vinorum" of the Roman emperors (Schwinden 1996: 49–60). His offices and his residence could well have been in the luxurious mansion Patricia and Pierre Bikai excavated on the elongated rock outcrop just to the East of Sīq al Bārid (Bikai *et al.* 2008).

Future Research

In 2020, we plan to execute a certain number of soundings in the area of the wine presses, upstream in the main, major, and average wādī barriers and in the farmstead. More trenches will be opened in the area of the well preserved terraces where the vines were planted. Hopefully, these soundings will provide us with sufficient organic material, with remains of vines (roots, branches, stems, grape pips), allowing us to engage in extended archaeobotanical research in order to get information about the species of vines planted in the Wādī 'Agalāt winery. Maybe at the end, we will even be able to determine the region from which the vines were originally imported. For these investigations, we will cooperate with the archaeobotanical institute of Zurich University under the direction of Dr. Cristiane Jacquat. For the determination of the origin of the vines, we will cooperate with the archaeological institute of the University L'Orientale at Naples under the direction of Prof. Romolo Loreto. For the soil analysis, our expert will be Prof. Bernhard Lucke from the Friedrich-Alexander University at Erlangen-Tuebingen.

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