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In memory of Dave Hopkins,
Androna draughtsman

Responding to Byzantine Environments: Then and Now

Environment is a flexible term. My paper refers mostly to the natural environment, with a brief introductory reference to the built environment as being the traditional concern of Classical archaeology, of which Byzantine archaeology is considered a branch. Hence the plural »environments« of my title. »Then« relates to what the Byzantines themselves knew, as reflected in their own words and images (e. g. **figs 3. 27**). »Now« refers to what we know, particularly equipped as we are with our modern »tool box« – making use of, for example, archaeozoology[1] and metallurgical study (e. g. **figs 4. 31**). Unsurprisingly, we know much more than they did, but we do not know everything that they knew. We do not have all the facts.

Specifically, my paper is concerned with two aspects of the natural environment to which the Byzantines responded with regard to exploitation of natural resources, namely by farming and by mining. By chance, the two cases considered here by way of example are geographically situated within the same region (**fig. 1**) and are limited to the Early Byzantine period which has produced more abundant archaeological evidence than succeeding periods. But our modern investigation here begins at two different ends of these subjects: one (farming) is explored at the site of the environmental exploitation, the other (mining) is approached by way of the product of the environmental resource exploited. The agricultural site in question is Androna situated in a semi-arid zone of northern Syria (gov. Hama) (**fig. 2**), while investigated metal objects, now widely scattered, lead us to the mining area of the Taurus Mountains, further to the West, in southeast Turkey (**figs 1. 33**). Again, by chance, there are two modern agencies available to further supply the tool box. In the latter case, it is the Turkish Mining Authority[2], in the former it is ICARDA, the International Centre for Agricultural Research in Dry Areas[3], situated outside Aleppo, ancient Beroea (**fig. 2**). Although, as stated above, Byzantine archaeology is considered a branch of Classical archaeology, in both cases explored here there was a considerable methodological input from Ancient Near Eastern archaeologists, namely Tony Wilkinson, Carrie Hritz and Aslihan Yener (see below).

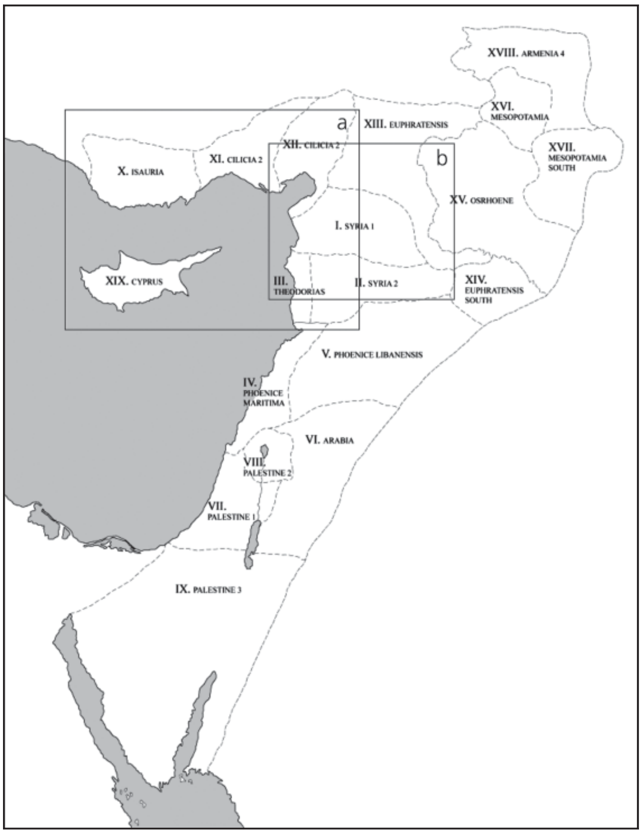


Fig. 1 Map of Diocese of the East, with mining and farming areas discussed here indicated. – (Drawing A. Wilkins).

Part I: a farming environment

To start with farming at Androna, we refer again to the »then« image just cited above, that of the water lifting wheel which appears in a pavement mosaic dated to AD 469 on the main street (*cardo*) at Apamea (gov. Hama), the capital of the province of Syria Secunda, not far from Androna[4] (**fig. 3a**). Although schematic in presentation, it unmistakably corresponds to the *norias* (**fig. 3b**) still functioning at nearby Epiphaneia (modern Hama, **fig. 2**)[5]. These were, and are still, used in this region for irrigation: the water lifted from the

1 See Kroll; Tiere, especially 89-114 for the area discussed here.
2 Yener, Mines 156 ann. 2.
3 www.icarda.cgiar.org/ (30.11.2016). One section of their research portfolio is devoted to Integrated Water and Land Management.
4 Dulière, Mosaïques 26-27. 35-39; pls XXII-XXIII.
5 Kamash, Archaeologies of Water 18-23.

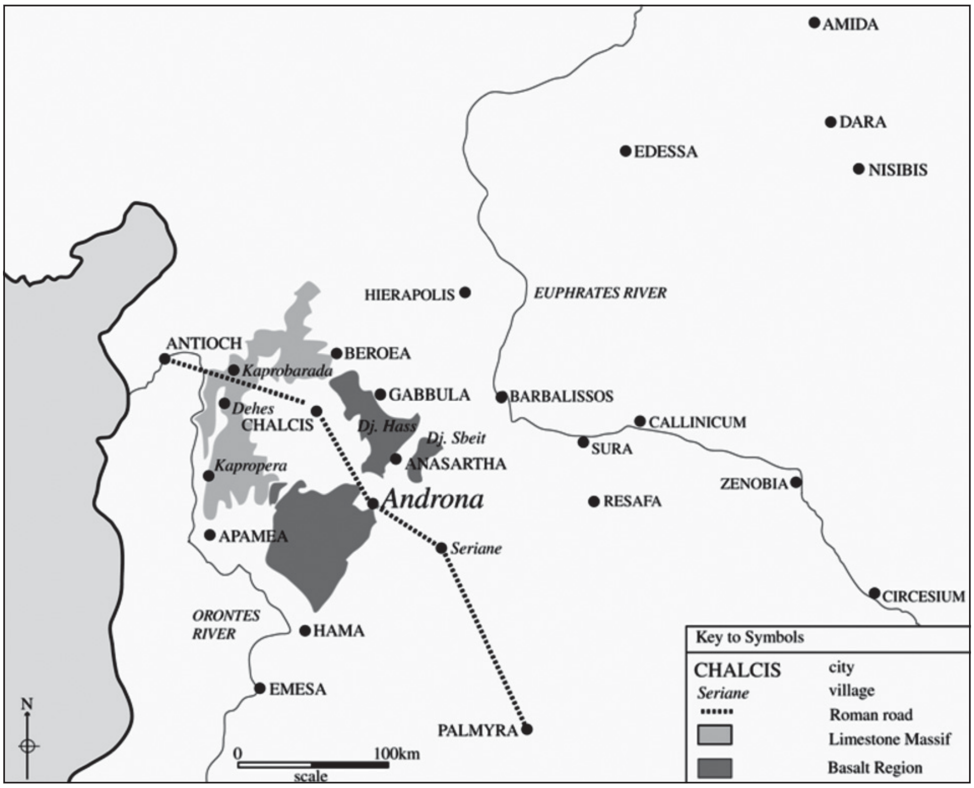


Fig. 2 Detail of **fig. 1**, showing farming area. – (Drawing T. Papaioannou),


Fig. 3 **a** Irrigation water wheel illustrated in mosaic pavement on the *cardo* of Apamea, AD 469; **b** Hama, *noria.* – (a after Dulière, Mosaïques pl. XXII; b photo M. Mango).

Orontes River by the buckets attached to the wheel is emptied into the channel above and behind the wheel and delivered to nearby fields. A central theme of Part I of this paper is the importance of irrigation to farming in a semi-arid zone such as that of Androna, which is located midway between the Orontes and the Euphrates rivers and on a dry steppe which extends to Resafa (gov. Ar-Raqqah/SYR; **fig. 2**). The introductory »now« image cited above is an example of modern archaeozoological study by Priscilla Lange of animal bones excavated at Androna (**fig. 4**; see below). Part of a total of 2170 identifiable bones found together, the 45 pictured in **figure 4** are among the 24% classified as pig (**fig. 21a**). Each bone is identified as one of over 200 pig body parts and its age of death is estimated (**fig. 21b**). Each bone can also be (approximately) radiocarbon dated and DNA analysis can indicate its possible geographical origins. Butchering marks on the bones indicate how they were used (**fig. 22**). The study concludes that these pigs were reared at Androna. They required water, mud and shade provided by irrigation installed at Androna. These pig bones hold the key, I believe, to understanding the dynamic of the farming responsible for the prosperity of the site itself.

As briefly stated above, Byzantine archaeology is considered a branch of Classical archaeology which for long was concerned primarily with the built environment which it surveyed, excavated and studied. Looking back to the Byzantines themselves who inhabited our geographical area, we see that their built environment was, for example, celebrated in the *De aedificiis* of Procopius and by the rhetoricians of Antioch and Gaza[6]. The *Expositio totius mundi et gentium* calls Edessa a *civitas splendida* and Berytus a *civitas … deliciosa*. It praises the *tetrapylon* of Caesarea, the harbour at Seleucia and the circuses at Laodicea, Tyre and other cities[7]. Urban structures were also classified in the »Laws or Customs in Palestine«, a system of building regulations compiled by Julian of Ascalon[8]. The built environment is portrayed in mosaics and paintings which illustrate both entire cities as collections of buildings surrounded by a wall, as at Umm er-Rasas (gov. Amman/JOR), or as individual monuments displayed in solitary panels, as near Hama (**fig. 5**, top left); elsewhere, people are shown animating city streets and occupying buildings, as near Antioch (prov. Hatay/TR) (**fig. 6**)[9]. The other concern of archaeology, the natural environment, is described by Procopius as a great force that could challenge engineers to divert rivers at Antioch and Edessa[10], but it is also celebrated for its abundant resources. Libanius praises the fish available at Antioch, from the sea (consumed by the rich), from the lake (by the poor) and from the river (by both)[11]. The *Expositio totius mundi et gentium* names Scythopolis and seven other cities as renowned for their textiles made with cultivated flax or fished murex dye, and which also produced wheat, wine, oil, dates and pistachios. Cilicia produced much wine while Ascalon and Gaza exported »*vinum optimum*«. Cyprus built ships because it had timber, copper, iron, pitch and cloth for sails and rigging[12]. Important for the exploitation of the natural environment were Roman and later agricultural handbooks (see below)[13]. Regarding imagery of the natural environment, the Byzantines followed earlier Roman pictorial rhetoric which celebrated the celestial, terrestrial and maritime spheres, so they continued to portray the earth, the sea, the seasons, the months, agricultural calendars and other images of the rural economy[14]. The farm itself is represented as a productive unit in floor mosaics near Tyre (gov. South/RL), where in AD 576 the staff of two estates records their rural activities on the floor of the local church (**fig. 7**)[15]. At Sawran 2 km outside Hama, what might be another farming estate appears to represent itself by way of its products, in this case catfish, spiced wine and cheese, the latter two images labelled *konditon* and *tyrion* are shown circulating in transport amphorae (**fig. 5**)[16]. Other mosaics show amphorae likewise transported by water in a boat, near Apamea, and by land on a camel, in Palestine[17].

Fig. 4 Pig bones excavated in the Byzantine bath at Androna (built *c.* AD 560). – (Photo P. Lange).

The built and natural environments at Androna

Turning from »then« to »now«, we see that archaeological exploration at Androna has encompassed these two types of environment: that is, the subject of investigation of the site shifted from the built to the natural environment in the course of three projects spread over a century. To start with H. C. Butler's mission in 1905, part of Princeton University's survey of Syria which was firmly focussed on buildings. His team had four members[18] who, at Androna, working to a very high professional standard, planned, drew sections or elevations of and photographed individual buildings, i.e. the large *kastron*, the bath, the so-called »*praetorium*« and »cathedral«, another eight churches and one reservoir. And, they located, copied and photographed nearly 40 Greek inscriptions[19]. Their mission account states that »…after lunch of the second day we left«[20]. All this detailed work done in

6 See Mango, Monumentality 241-245. 254-256. 259. – Buildings in the Diocese of the East are included mostly in Books 2 and 5.
7 Epos. mundi 157-166.
8 Saliou, Traité.
9 In the church of St. Stephen: Piccirillo, Mosaics of Jordan figs 345. 347-357. – In the church at Tayybat al-Imam: Zaqzuq, Hama 238-240 figs 14-16. 23. – In the villa at Daphne: Levi, Antioch pl. LXXIX.
10 De aedificiis 2, 7, 1-11 (Edessa); 10, 6-9 (Antioch).
11 Festugière, Antioche 35. 58.
12 Epos. mundi 162-165. 177. 206-207.
13 On Varro, Cato, etc., see below and Decker, Tilling 263-271.
14 The subject of a current DPhil thesis by E. Montgomerie at Oxford.
15 Baratte, Catalogue 132-145.
16 Zaqzuq, Hama 240-242 fig. 31.
17 Near Apamea: Decker, Food figs 4-5. – Near Kissufim: Cohen, Kissufim on cover.
18 In addition to Butler himself, these included W. K. Prentice and E. Littmann, epigraphists, and the geographer, R. Garrett; see Butler, Architecture.
19 Butler, Architecture 47-63.
20 Butler/Norris/Stroever, Geography 52-53.

Fig. 5 Local production of catfish (top centre), cheese (row 2 left) and spiced wine (bottom right), the latter two transported in amphorae illustrated in a mosaic of an estate at Sawran near Epiphanea (Hama). – (After Zaqzuq, Hama 254 fig. 31).

Fig. 6 Street scenes of Daphne (?), topographical border mosaic pavement, *c.* AD 500, in the triclinium of the Yakto villa outside Antioch; private bath of Ardaburius in the centre. – (After Kondoleon, Antioch 148 fig. 2).

less than 48 hours. But in placing the individual buildings into the site setting, they produced a diagrammatic plan of the centre surrounded by one of its two circuit walls (**fig. 8**) which, conceptually and stylistically, recalls the topographical borders at Antioch and Daphne (**fig. 6**).

The following stage of work at Androna, moving from the built to the natural environment, took place in the 1930s during a survey carried out by R. Mouterde and A. Poidebard, published as the »Limes of Chalcis«[21]. Using aerial photography (**fig. 9**), they studied the geographical context of North

21 Mouterde / Poidebard, Limes esp. 61-63. 174.

Fig. 7 Vintaging, hunting, pastoral and other rural scenes on mosaic pavement, AD 576, in the church of St Christopher at Qabr Hiram near Tyre. – (After Donceel-Voûte, Les pavements 413 fig. 403).

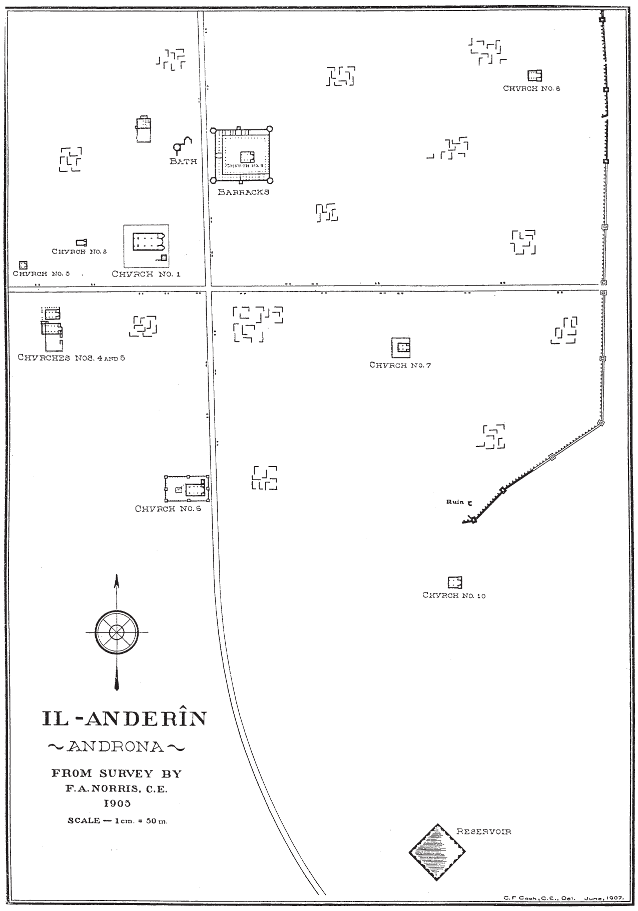


Fig. 8 Androna, partial site plan recorded 1905. – (After Butler, Architecture pl. 2).

Central Syria, linking sites to the Antonine Itinerary of the late 3rd century, within which Androna is identified as a *mansio* or staging post on the route between Palmyra and Chalcis (**fig. 2**). They also noted the area's semi-arid condition (250-300 mm annual rainfall) and the ancient irrigational systems installed there which they linked to perceived military activities following the Persian sack of Antioch in 540[22].

The next and present stage of investigation at Androna, started in 1997 and continuing still, comprises Syrian, German and British teams, initially directed by Abdurrazzaq Zaqzuq, Christine Strube and myself, respectively, which have engaged with both the built and natural environments. The latter being the principal aim of the archaeologists from Oxford, namely water management. The first stage of the new international project (1997-2004) was devoted to excavation in the centre of the site of three important public buildings: the *kastron* of 558/559 and the Byzantine bath (*loutron*) of *c.* 560, both identified epigraphically as built by one Thomas, and the Umayyad bath (Butler's »*praetorium*«), excavated respectively by the German, British and Syrian teams[23]. Concerning the built environment of the site, we followed in Butler's footsteps, correcting his observations and conclusions as we went along. The Byzantine public bath (built by Thomas) was revealed as a large building (*c.* 25 m × 40 m) (**fig. 16**) ambitiously decorated with costly materials (including wall mosaics and 19 types of marble and other decorative stones, all identified by Olga Karagiorgou) and displaying at least two verse inscriptions carved in relief. Although Androna has been recently confirmed epigraphically as a *kome*[24], the size, architecture and quality of Thomas' buildings suggest urban aspirations, of the type illustrated in the mosaics cited above, namely the street scenes at Antioch/Daphne, which include, in fact, the private bath (*pribaton*) of Ardaburius, thus labelled (**fig. 6**)[25].

In seeking an explanation for the prosperity and material display evidenced in the bath that Thomas built, the Oxford team considered its settlement context, namely the size and character of the entire site, viewed as a fortified conglomerate filled with buildings (as, again, illustrated in the mosaic pavements cited above)[26]. While it would probably take a century to excavate all of Androna, there are other tools available for this study, particularly given the local conditions of a lack of vegetation and of deposits of fine soil loosely distributed over collapsed structures eventually abandoned. The tools are those of elevated vertical imaging that reveals the site more clearly than does the topographical plan drawn up in 1997 prior to excavation (**fig. 10**) or even Butler's diagram (**fig. 8**) which recalls Antioch mosaics. Already in the 1930s the potential of this perspective is revealed in Poidebard's aerial photographs (**fig. 9**)[27], and improves spectacularly with satellite images, of which the Corona satellite images of the 1960s (**fig. 14**) are preferred in this region, up to the release this past decade of the relevant Google Earth coverage in Syria (**fig. 11;** see also **fig. 25**)[28], while the kite photographs taken by our architect Richard Anderson, in 1998-2003, provide closer views. These distant elevated views are complemented by geophysical survey on the ground of what still lies beneath, as that carried out by magnetometry on unexcavated features at Androna by Alex Johnson in 2006. These included a row of eight cement kilns revealed in a slag-covered field by the southeast reservoir, and the reservoir's outlet channel (**fig. 19**)[29]. Thus, optical observation of the site at

22 Pp. 3-23. 229-240. – See Mango, Baths 78-79. – Mango, Environment 284-285. – Mango, Expansion 121-122.

23 Strube, Vorbericht. – Strube, Setting. – Strube, Androna. – From 2004, excavation by the German and Syrian teams has been extended to two houses, two site gates, the two sets of circuit walls and in 2010 the area around the »cathedral«.

24 Salame-Sarkis, Syria 322-325.

25 Lassus, Yakto. While both the Ardaburius and Thomas baths were built with private funds, the latter was open to the public, as stated epigraphically, see Mango, Environment 248-249.

26 See annotation 9.

27 Mouterde/Poidebard, Limes pls. CX-CXIII. – On Poidebard's use of aerial photography see Bauzou, Antoine Poidebard 71-78. – On the Aerial Photographic Archive for Archaeology in the Middle East (currently with 66 000 items), see www.flickr.com/photos/APAAME/ collections [30.11.2016] and Kennedy/Bewley, Archives.

28 On the use of Google Earth in Saudi Arabia, see Kennedy/Bishop, Google Earth. – Kennedy, Works of Old Men.

29 For survey by magnetometer conducted at Androna by A. Johnson, see Mango, Landscape Study 2007, 80-81. – On geophysical surveying in general, Greene, Archaeology 46-50 and Gaffney, Detecting Trends.

Fig. 9 Androna, view of site, aerial photograph taken in the 1930s. – (After Mouterde/Poidebard, Limes pl. CXI).

Fig. 10 Androna, site plan recorded 1997. – (After Strube, Vorbericht 27 fig. 2).

Fig. 11 Androna, view of site, Google Earth satellite image, 2006. – (After Strube, Al Andarin 2 table 1).

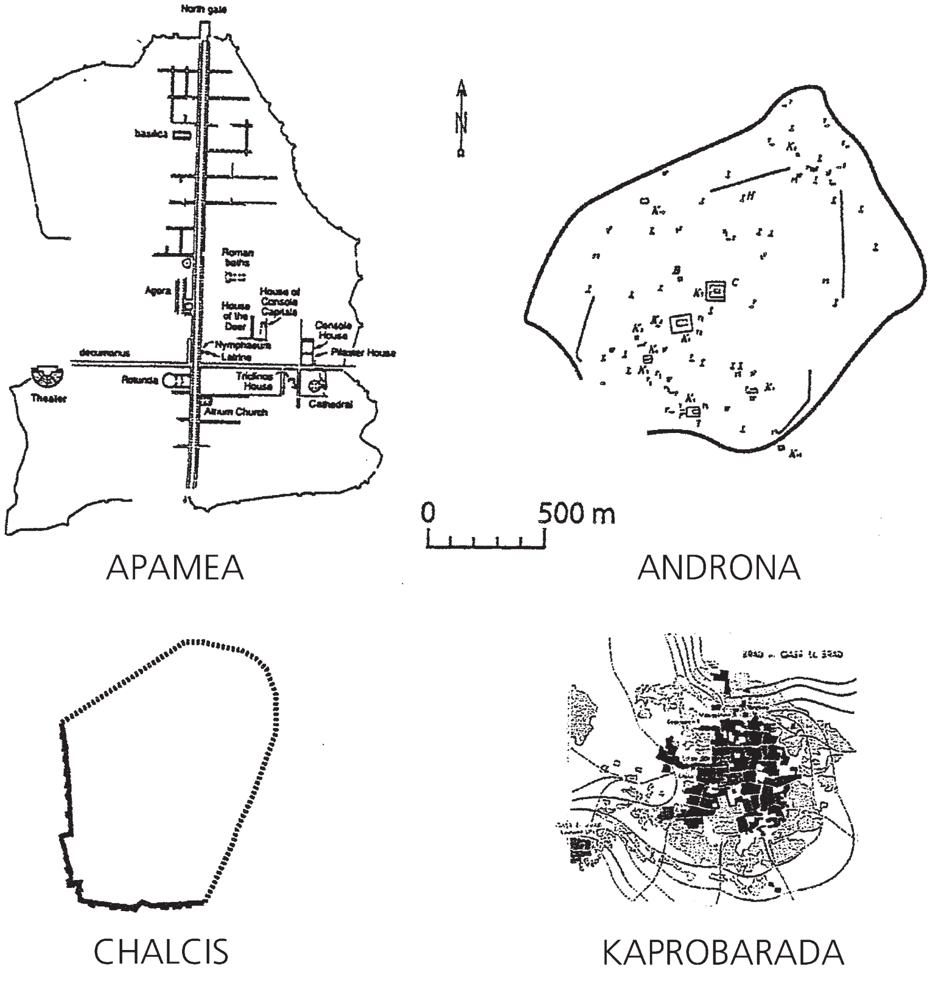


Fig. 12 Comparative site plans: two *poleis* (Apamea, Chalcis) and two *komai* (Androna, Kaprobarada). – (Layout M. Whiting).

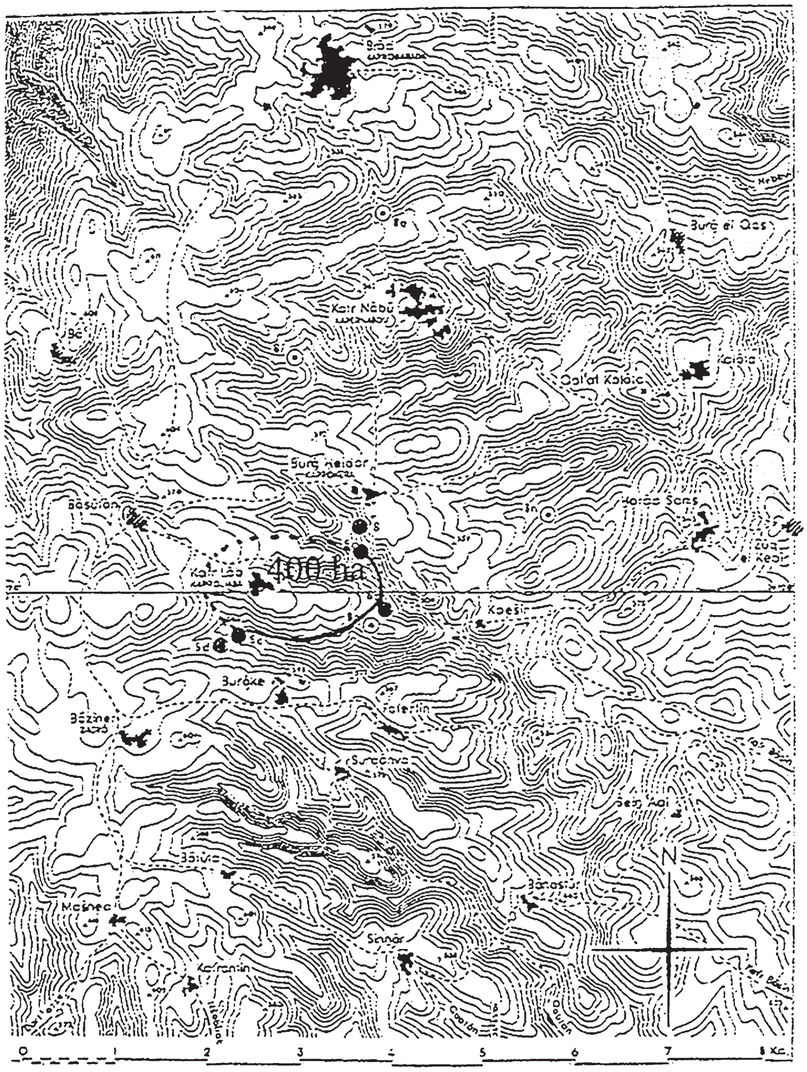


Fig. 13 Kaproliaba (village of 7.5 ha) surrounded by territory of *c.* 400 ha, designated by boundary stones of AD 297. – (After Tchalenko, Villages fig. 1).

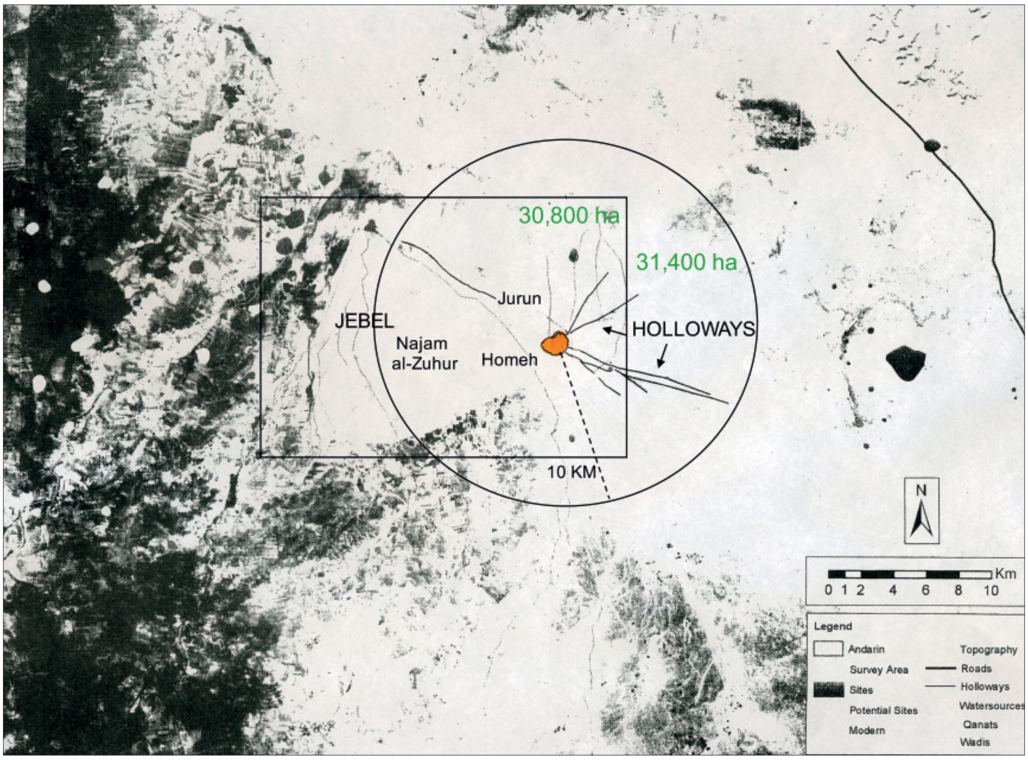


Fig. 14 Androna, holloways detected in Corona satellite image by C. Hritz. Circle added and overlapping rectangle enclosing Oxford's landscape study area. – (© U.S. Geological Survey, Earth Resources Observation and Science [EROS] Center).

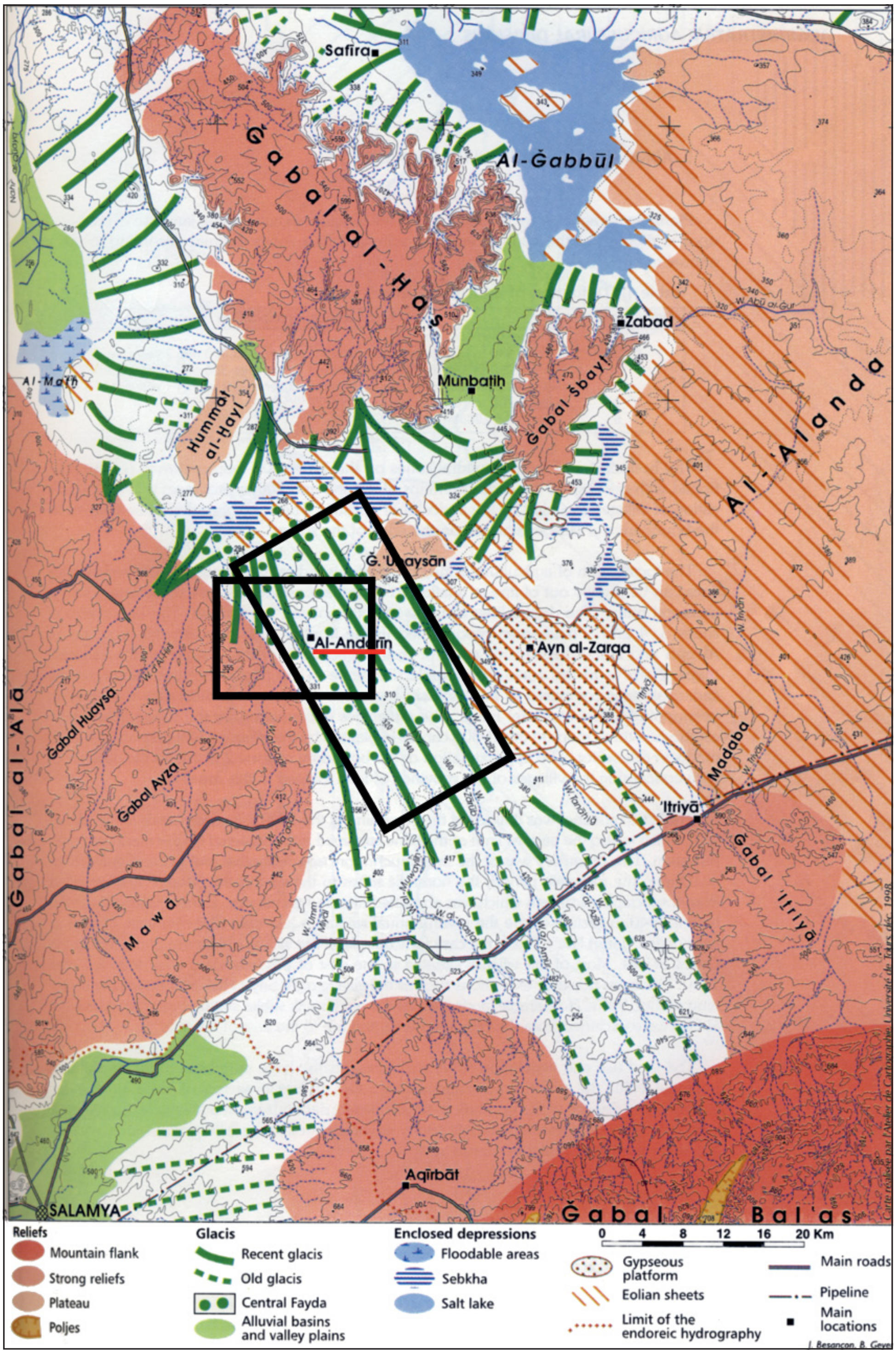


Fig. 15 Geological map of North Central Syria. Large rectangle added around limestone soil (60 000 ha) of Androna area; smaller rectangle added for Oxford's landscape study area (30 800 ha). – (Map after Jaubert et al., Arid Margins map 5; assembled by M. Mango).

several levels (of satellite, aerial, kite, geophysical) is possible; with the aerial and kite views possibly also oblique.

The German team's topographical plan (**fig. 10**) revealed that the site occupies a surprising area of 160 ha, while the Google Earth image (**fig. 11**) clarifies the picture already suggested in the 1930s (**fig. 9**) of a densely built site. So sharp is the recent image that very approximate counting using a grid suggests 1300 units of occupation probably on two levels, hence a possible total of 2600 units[30]. Comparisons made with other sites, including cities and villages in the region, are revealing. For example, Androna, a *kome*, is, at 160 ha, twice the size of the nearby *polis* of Chalcis (gov. Aleppo / SYR), at *c.* 80 ha. By contrast, a large *kome* in the Limestone Massif, Kaprobarada (gov. Aleppo, **fig. 2**), is *c.* 40 ha (**fig. 12**) and

30 For calculations about size, population and territory, see Mango, Expansion tables 1-4. On this and the following considerations see ibidem 98 tables 1-2.

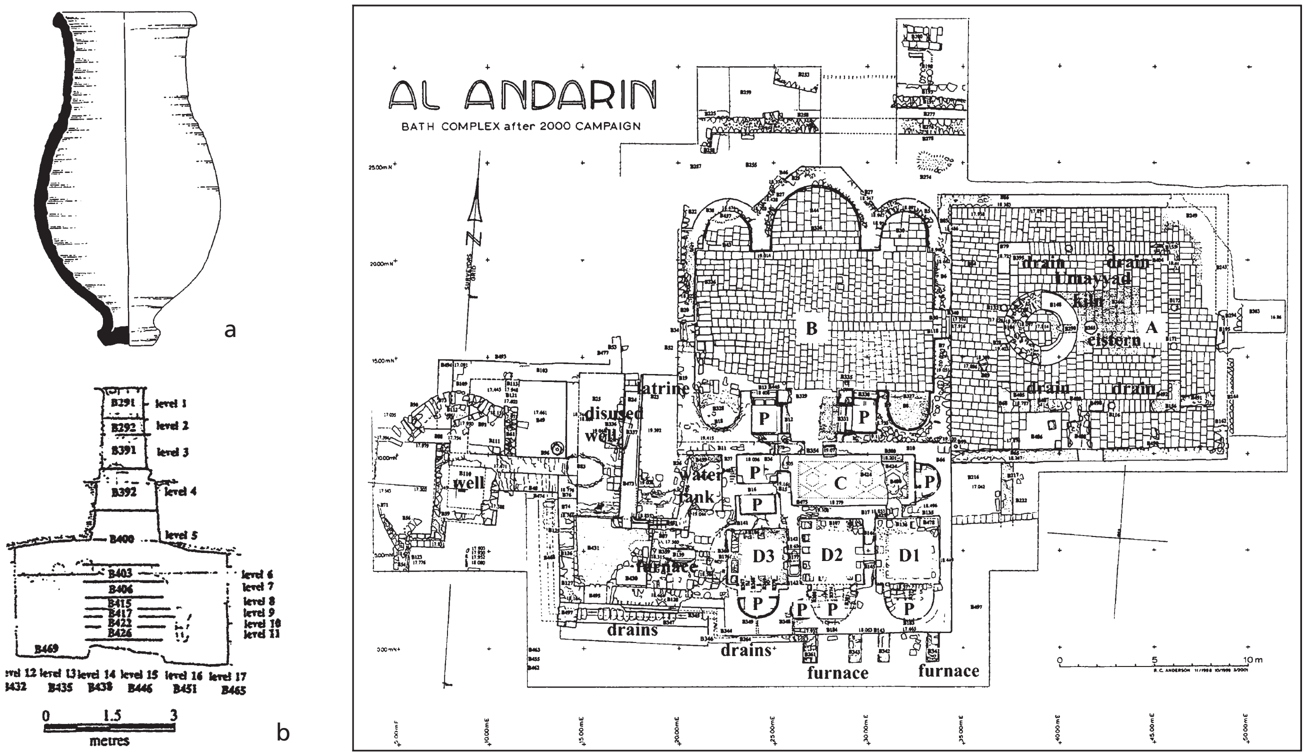


Fig. 16 Androna, bath built by Thomas in *c.* AD 560. **A** entrance court. – **B** *frigidarium.* – **C** *tepidarium.* – **D1-D3** *caldarium.* – **P** pool. – Also indicated: well, disused well, latrine, water tank, furnaces, drains, cistern, Umayyad period kiln. – **a** water lifting jar (H 33 cm) excavated in bath. – **b** Section of cistern (*c.* 7 m deep) in entrance court (**A**), with daily excavation levels indicated. – (Main plan and b R. C. Anderson; a drawing F. Hopkins).

a small one, Kaproliaba, merely 7.5 ha (**fig. 13**)[31]. Further interpretations of this information concern the population of the residential units, as they may feature in papyrus documents in Egypt and Palestine relating to entire houses, or individual »rooms« as counted in the Limestone Massif. Did one room contain four or six or even eight individuals? We also have the census of Apamea to consider[32]. To calculate maximum site population, I used the figure offered by Ancient Near Eastern archaeology (that used by D. Baird for the Late Roman period in his Konya plain survey[33]) of 100 inhabitants per ha, giving in Androna's case 16 000. The next question to address, moving from the built to the natural environment, is that of the sustaining area needed for the population. The Ancient Near Eastern specialists suggest that 100 ha outside is needed for every ha inside, or one ha per mouth to feed. Other evidence is provided from Egyptian documents and boundary stones set up during the cadastral survey of AD 297 in the Limestone Massif as to the amount of land belonging to or used by a particular site, e. g. Kaproliaba, the village of 7.5 ha (see above), with a territory of *c.* 400 ha (**fig. 13**)[34]. Again, Ancient Near Eastern archaeology provides a useful indicator, in this case the evidence of holloways, the paths followed daily by men, animals and carts to go out to the fields or work stations. Their length can indicate the extent of land worked around a site[35]. Carrie Hritz identified on a Corona satellite image such marks extending 10 km at Androna (**fig. 14**), enclosing an area of over 31 000 ha, nearly twice the required minimum sustaining area of 16 000 ha[36].

Of course, not all this land was necessarily cultivated. This depends on the character of the soil and the number of other settlements competing for its use. For the answer to these questions we turn to the »tool box« provided by the recent Syrian-French survey of the Arid Margins, to which ICARDA contributed its expertise. The general Arid Margins map illustrates the overall geology of the region studied (**fig. 15**). The part marked by the large rectangle is described in the project's preliminary publication as »The great central plain … covered with limestone silts suitable for cereal cultivation«. The Arid Margins project, therefore, identified the area surrounding Androna as choice agricultural land and also stated that the irrigation systems installed there are of Late Roman date, according to the project's pottery finds. It also indicated that Androna was the single large settlement of this plain and is situated at its centre[37]. This entire area of choice

31 Mango, Expansion 95 table 1 fig. 3.
32 Mango, Expansion 98 tables 1-2.
33 Baird, Settlement Expansion 238.
34 Mango, Expansion 103 tables 3-4.
35 See Wilkinson, Hollows and http://oi-archive.uchicago.edu/OI/PROJ/MASS/Mass.htm (3.11.2017).
36 See Mango, Expansion 103 with ann. 41-42.
37 Jaubert et al., Arid Margins 6. 9. 16-34; maps 5. 13. – See also Decker, Tilling 189-193. – Rousset, Qanāts.

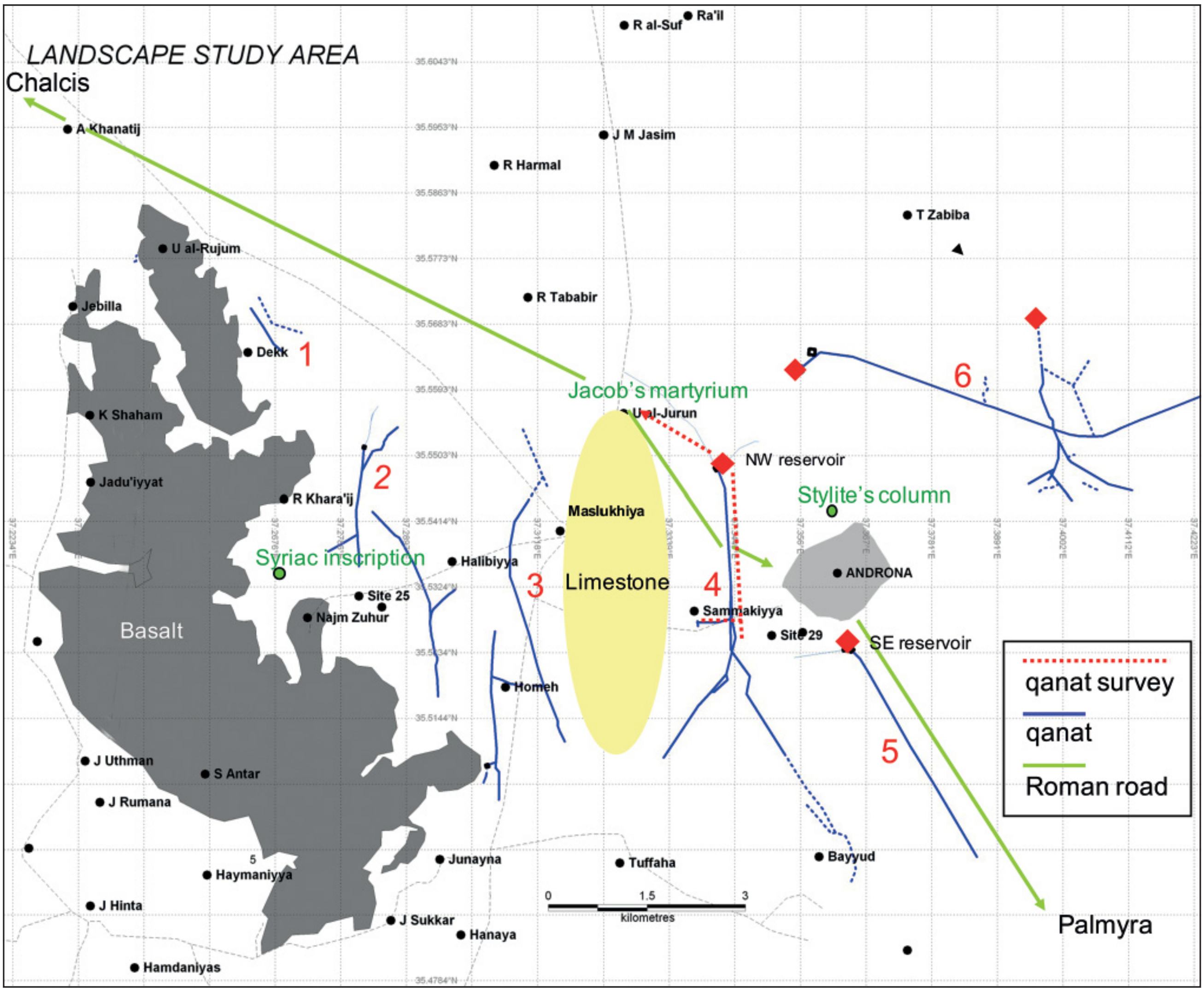


Fig. 17 Androna, landscape study area showing six qanat systems, nos. 1-6. – (Map compiled by L. Schachner and T. Papaioannou).

land is 60 000 ha, nearly twice the 31 000 ha of the Androna holloways circle, at the top of which lies another important agricultural commodity, namely salt deposits (see below). Imposed upon the large rectangle is another box (**fig. 15**) that encloses the area of Oxford's landscape study at Androna started in 2004[38]. At 30 800 ha it is slightly smaller than the holloways circle which is centred on Androna itself (**fig. 14**). Our landscape study area is centred to the west to include specific strategic areas (e. g. the basalt jabal) and sites (e. g. Abu Khanatij). Before we proceed to consider whether our landscape study area of 300 km² with 250-300 mm annual rainfall could sustain a population at Androna of 16 000, we should look to the example of an arid site in the Negev in southern Palestine, namely Sede Boqer (Southern distr. / IL) where a 200 km² area with 100 mm annual rainfall could only support possibly up to 400 people[39]. The difference between these two scenarios is, of course, irrigation.

Water sources in the semi-arid environment of Androna: wells, cisterns, qanats

Within Androna, our excavation of the Byzantine bath (**fig. 16,** lower left) – launched by Amanda Claridge[40] – demonstrated a reliance on well and cistern water. The water of the well to the West was lifted in jars by a water wheel *saqiya* operated by a beast such as a donkey, a variant on the Orontes water wheel seen above in the mosaic at Apamea (**fig. 3**). The water was then conveyed to one or more tanks positioned above the eight cold, warm and hot pools of the

38 Mango, Landscape Study 2005. – Mango, Landscape Study 2006. – Mango, Landscape Study 2007. – Mango, Environment 271-278 figs 32-46. – Mango, Expansion 108-115. – Mango, Landscape Study 2011.

39 Mango, Expansion 105 with ann. 62.

40 Other excavators of the bath include Cassian Hall, Antonietta Lerz, Anne McCabe, Maria Parani and Nigel Pollard. Our architect Richard Anderson was assisted at both the baths and reservoirs by, successively, Tassos Papacostas, Jonathan Bardill and Lukas Schachner.

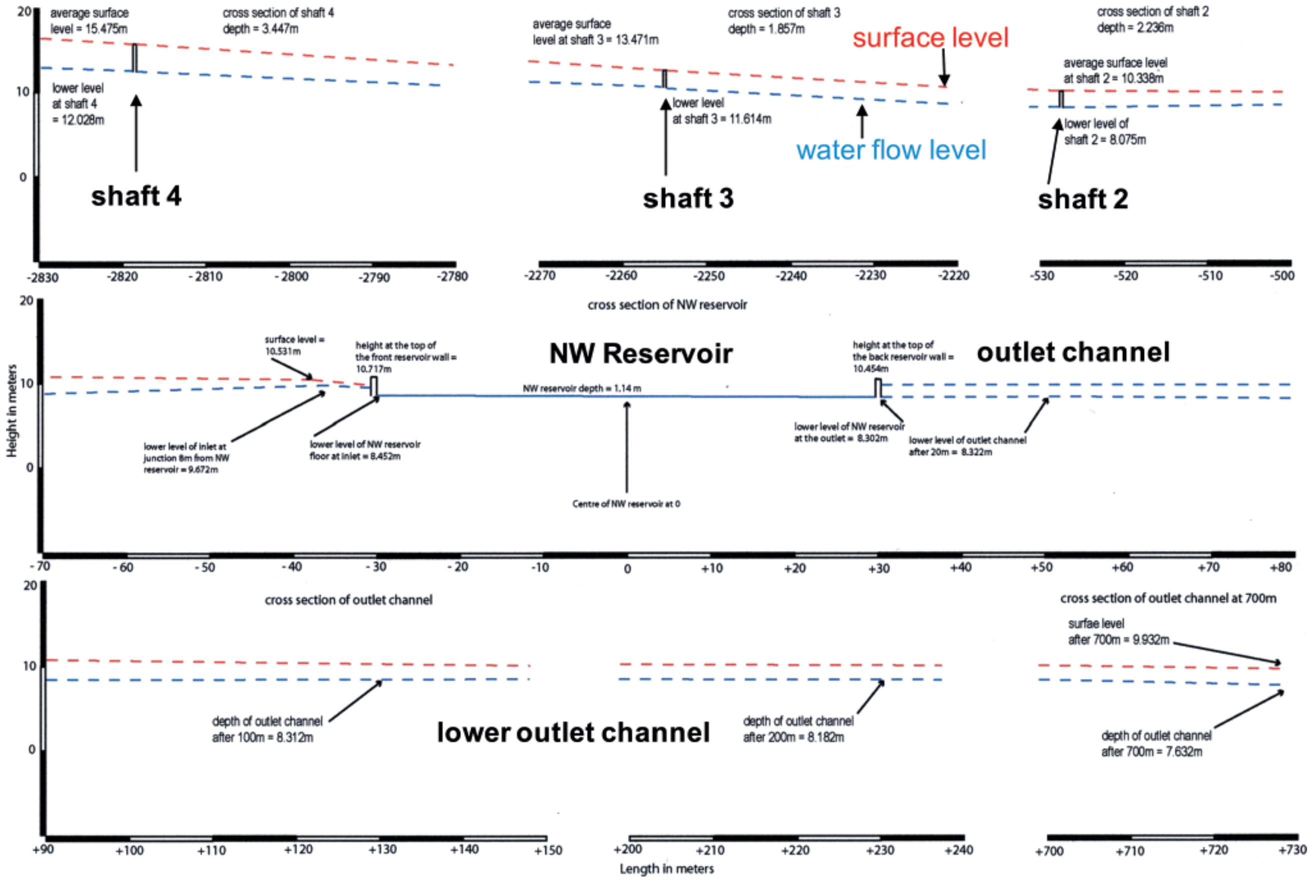


Fig. 18 Androna, qanat 4's survey of water flow including shafts 2-4 and northwest reservoir (see **fig. 17**). – (Image L. Schachner and B. Magee).

bath (**fig. 16, P**). The used water was drained away in two directions, some of it flushing the latrine outside the west door of the *frigidarium* (**fig. 16, B**) on the way to a disused well, 11 m deep. A cistern, *c.* 7 m deep, at the front of the bath (**fig. 16, A. b**) was fed by rainwater collected from the peristyle roof of the entrance court and provided drinking water[41]. Excavation of the bath provided datable artefactual material (e. g. **figs 16a. 24a-b**; classified and studied by Nigel Pollard[42]) used to establish a chronological framework, for building and site, and a range of organic material (**figs 4. 22**) relating to the environment (and likewise datable by radiocarbon analysis).

Agricultural irrigation in the area around Androna was provided by a third water source, namely qanats, installed in some numbers throughout Syria, the Near East, North Africa, exported from there to Spain, and originating apparently in ancient Persia[43]. The qanat could be described as a subterranean aqueduct. The mouths of the shafts are visible from above in a straight line on the surface and gave access for cleaning operations to keep water flowing. There are six qanat systems in the near vicinity of Androna, including at least four attached reservoirs (**fig. 17, 1-6**). Since initial study of these qanats by Andrew Wilson, 1998-1999[44], we have had time to explore only one of them in any detail (**fig. 17, 4**), which is that installed nearest to Androna and thus possibly the earliest. The survey, conducted in 2006 by Lukas Schachner and Bryan Magee, covered the main part of the qanat, leading from shaft 4 (**figs 17-18**) up to its reservoir to the Northwest of the site. The planned section illustrates the long-distance flow up to and through the very shallow reservoir and out through a double outlet channel of which the lower level continued for a distance of nearly a kilometre (**fig. 18**) in the direction of a site (modern Umm al-Jurun) marked by an imperial boundary inscription set up in the names of Justinian and Theodora, hence AD 527-548. It mentions the Martyr Jacob and probably belongs to a single collapsed large building nearby, undoubtedly his martyrium (**fig. 17**)[45]. Opposite Androna, at Sammaqiyya (**fig. 23**, shaft

41 On the bath see Mango, Excavations 1999, 309-314 figs 3-16 (pools); 17 (drainage channels); 18 (disused well); 19. – Mango, Excavation 2000 figs 2 (entrance court); 3-7 (furnace); 8-12 (water tank); 13 (water channels); 14-15 (well); 16-17. – Mango, Baths 73-75 figs 3-5 (cistern); 6-7. – Mango, Environment 248-254 figs 3-13.

42 Agnes Vokaer has also studied the Syrian Brittle Ware, see Mango, Environment 253-254 with ann. 45-46. – Other finds have been registered and/or studied by Olga Karagiorgou (marble), Natalija Ristovska (glass, metalwork), Maria Parani and Priscilla Lange (limestone carving).

43 Lightfoot, Qanat 324. – Kamash, Archaeologies of Water 33-37. – For the area of Androna see Rousset, Qanāts.

44 Assisted by Michael Decker and Tyler Bell; see Mango, Excavations 1998.

45 Mango, Environment 273-274 figs 32-34. – Mango, Expansion fig. 19a-e.

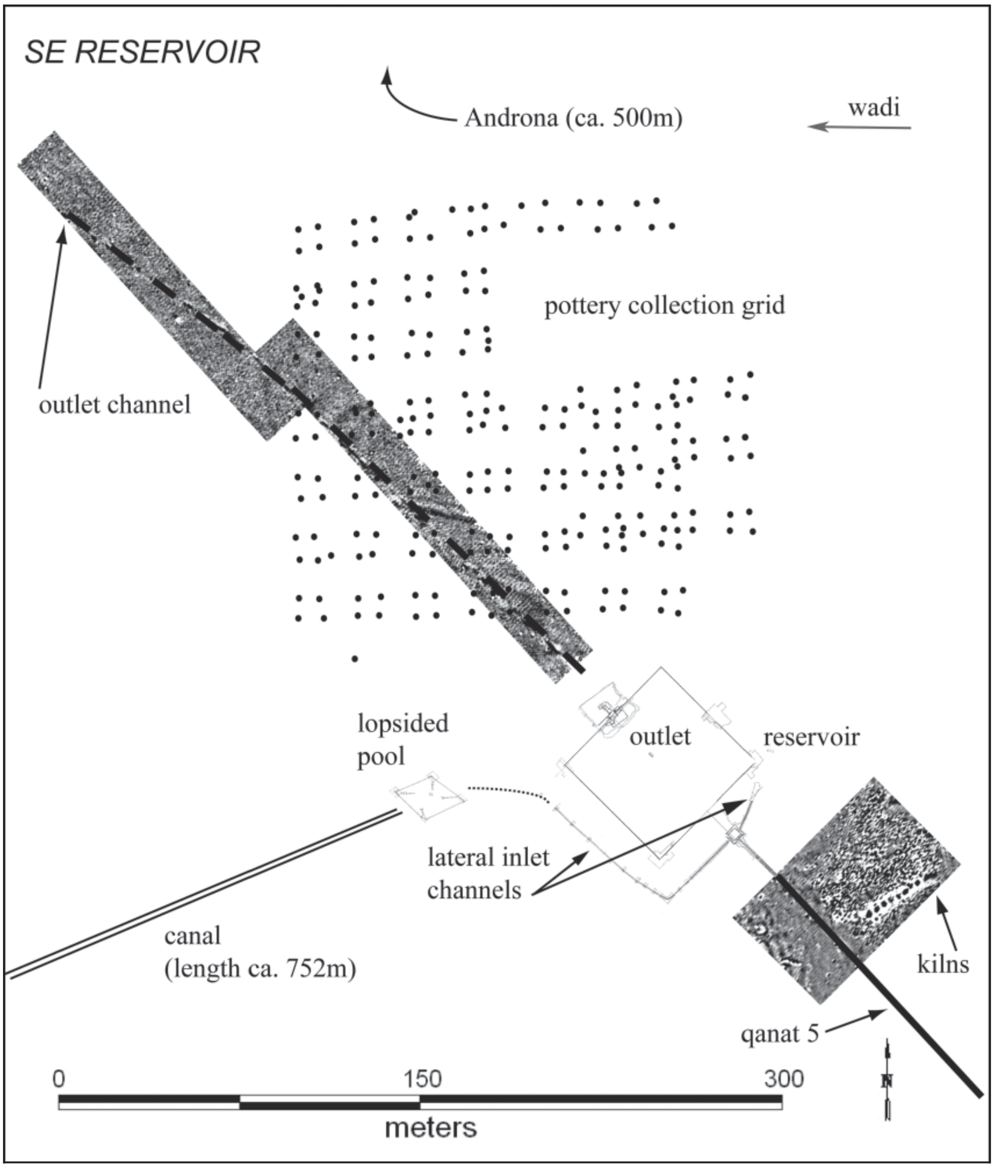
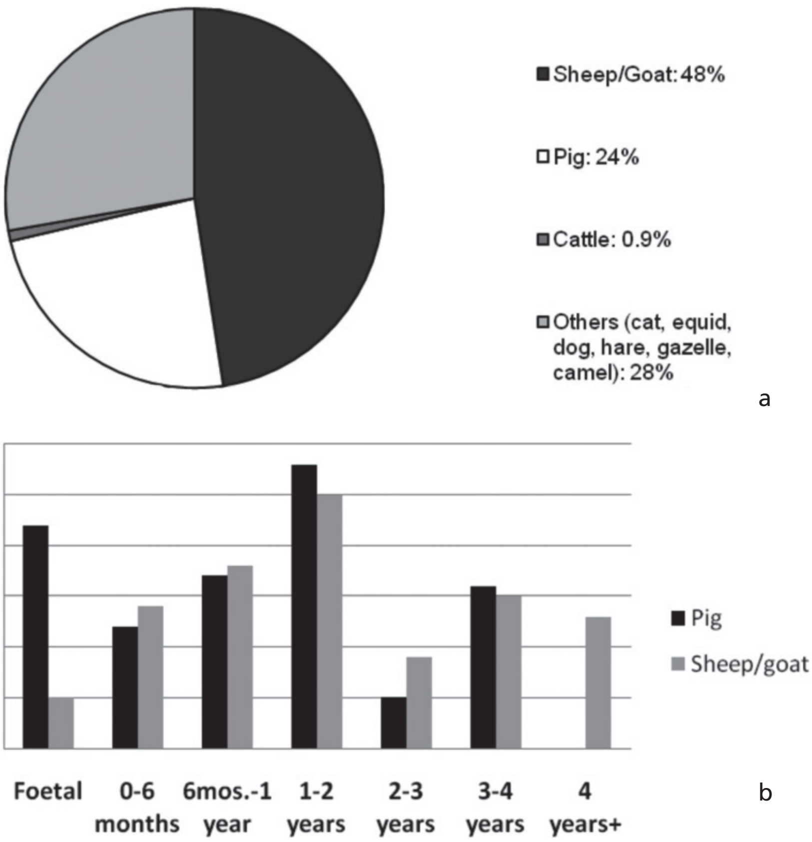


Fig. 19 Androna, qanat 5's southeast reservoir. – (Plan R. C. Anderson [excavated areas], A. Johnson [geophysical survey], L. Schachner [GPS plotting], K. Mohammed, S. Randell, J. Stockbridge [pottery grid], R. Hoyland [qanat GPS], Mouterde/Poidebard, Limes pl. CXII.2 [canal], T. Papaioannou [compilation]).

Fig. 20 Androna, southeast reservoir, excavated corner. – (Photo M. Mango).

Fig. 21 Androna, graphs illustrating percentages of animal bones excavated in Byzantine bath cistern (total number of idenitfiable bone: 2170). – **a** species. – **b** age of death. – (Images P. Lange).



1. 3; **fig. 18**, shaft 3), qanat 4 has a short east-west branch, also surveyed[46].

We have explored the northwest reservoir and that to the southeast, belonging to qanat 5 (**figs 17. 19-20**), regarding size including depth, masonry and operational details. They are both complex structures. Both measure 61 m a side, equivalent to 200 Roman feet and are shallow, being only 2.5-3 m deep. Both are built of limestone masonry with a surprising degree of ornamentation, namely large niches with flanking carved colonnettes alternating with columns supported on engaged bases[47]. The northwest reservoir lacks the niches but had a large relief of Jonah and the Whale decorating the outlet wall[48]. Indications for dating the construction of the southeast reservoir were obtained from a sample of cement containing charcoal removed from the floor of the reservoir which was radiocarbon dated to 6th-7th century. We are awaiting confirmation of the general dating of building and abandonment of the southeast reservoir from further radiocarbon dates obtained from olive pits used as fuel in cement kilns, located by magnetometry in 2006 and excavated in 2010 (**fig. 19**) by Antonietta Lerz and Stuart Randall; see below. On the other side, the reservoir has lost all traces of its outlet, but this too was picked up further out by magnetometry in 2006[49] (**fig. 19**). Following the recommendation of Tony Wilkinson, we collected pottery near the reservoir (**fig. 19, grid**), presumably deposited in irrigated areas together with fertilizing manure[50]. The finewares among the 600-odd sherds collected were exclusively Late Roman, indicating the period of use.

Use of irrigation systems

What did these irrigation systems provide? Most directly there may have been fish bred within the southeast reservoir, used as a *vivarium*, for which a series of recesses were provided at the base of the wall (**fig. 20**)[51]. The fish, most likely freshwater catfish, as known at other Roman and Late Roman sites, may have been intended for salting and export. Salt, noted above on **figure 15**, is available in abundance nearby, as was catfish, particularly associated with the area of Apamea and illustrated on the mosaic near Hama cited above (**figs 2. 5**)[52]. In addition to catfish bones, those of sea fish, such as bream and mullet were also excavated in the Byzantine bath at Androna[53].

Other excavated finds, mostly from the bath, relating to environmental conditions include 2170 animal bones classi-

46 For the survey see Mango, Landscape Study 2007, 79-80. – Mango, Baths 76 fig. 9 (masonry in shaft). – Mango, Environment 262-263. – And for the survey of the short east-west branch see also Mango, Environment fig. 18.
47 Mango, Environment 265-266 figs 22-24.
48 Mango, Environment 266-268 figs 26-27. – Mango, Expansion fig. 7b.
49 Both features recorded by Alex Johnson, see Mango, Landscape Study 2007, 80.
50 On which see Wilkinson, Sherd-Sampling.
51 Mango, Fishing.
52 On the catfish of the area of Apamea / Hama, see Horden / Purcell, Corrupting Sea 195.
53 Identified by Caroline Cartwright.

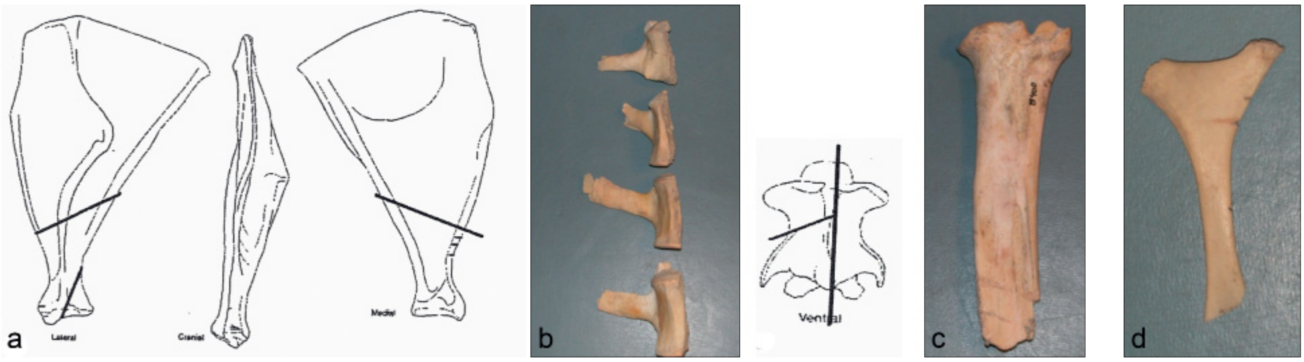


Fig. 22 Androna, sheep/goat and pig bones with marks of butchering. **a** pig scapula showing intensive chopping for smaller portions of meat. – **b** sheep/goat vertebrae chopped through middle to cut carcass in two. – **c** sheep/goat radius with chop marks. – **d** sheep/goat tongue bone with cut marks to separate it from the head or separate the tongue meat. – (Photos, drawings and descriptions P. Lange).

biscuit *(bucellatum)*	2 days
bread	1 day
wine	1 day × 2 *xestai*
sour wine (*acetum*)	2 days × 2 *xestai*
salted pork (*laridum*)	1 day × 1 ℔
mutton	2 days × 1 ℔

Tab. 1 Military rations issued AD 360 at Hierapolis (Membij), northwest of Androna; see **fig. 2**. – (After Cod. Theod. 7. 4. 6).

fied by Priscilla Lange[54] (**figs 4. 21. 22**) as well as sampled plant material processed by flotation[55], and identified by Mark Robinson. Among these are several things that would have benefitted from irrigation, such as coniferous and deciduous wood, bread wheat and durum wheat (there is also much organic evidence of grain processing) and olive pits. While the barley, also recovered, would have grown without irrigation in the semi-arid conditions, wheat would not. Evidence of cultivation and processing is also provided by the various mills used for grain and olives, and other farming equipment we have recorded in large numbers within our landscape study area (**figs 24c-f; 26d-e**)[56]; see below.

Most of the well preserved animal bones, identified and studied by Priscilla Lange, were excavated in the bath's cistern (**fig. 16, A. b**) where they were thrown, together with a variety of material, after the bath had been converted to industrial activities; on which see below. That the animals were foetal or slaughtered young (**figs 4. 21b**) indicates they were bred locally and not imported. Signs of butchery on sheep, goat and pig bones, demonstrate that they were slaughtered for meat (**fig. 22**). One graph (**fig. 21a**) illustrates the percentage of species, the most striking of which is the high number of pigs, namely 24 % as against the combined total of 48 % for sheep and goat. While the latter two are considered eastern Mediterranean meat, pig is more commonly associated with the West, in particular Italy, Spain and southern France[57]. In fact, pig is most often seen as natively prohibited meat in parts of the East, with the exception in the Roman period of cosmopolitan cities, such as Apamea where it is found[58], but not in villages of the Levant[59].

Evidence for the role of the meat at Androna and elsewhere in the period relies on modern excavation and archaeozoological identification, combined with a variety of ancient written sources. Thus we know from the latter that the pork of 30 000 pigs was distributed as part of the *annona civica* in Rome in AD 452, that pork also formed an essential part of the *annona* in Constantinople and was associated with the Roman army, which imported pigs to military sites abroad[60]. Most relevant to Androna, I would suggest, is the part salted pork (*laridum*) played in the military rations (*annona militaris*), as issued nearby at Hierapolis in AD 360 (**tab. 1**)[61]. I have suggested that pigs raised, butchered and salted at Androna were intended for sale to the army for rations[62]. The army in question, I would maintain, was that stationed on the Euphrates nearby (**fig. 2**). I have taken as a module the Legio IV Parthica, which moved from Circesium (gov. Deir er-Zor) to Beroea (modern Aleppo) in 582-602 and theoretically numbered 1000 men, so that certain calculations can be made (with the help of Varro and other Roman agricultural writers) as to the amount of pork and numbers of pigs required and as to the conditions and provisions needed for such animals at Androna[63]. Foremost among provisions indicated is for water, mud and shade. These would be facilitated by irrigation, water delivered directly by qanat and shade provided by watered

54 Lange in Mango, Environment 270 fig. 31 and in Mango, Expansion 108. 116-117 table 6 fig. 16.
55 Carried out by Jenny Emmitt.
56 We recorded a total of *c.* 140 in 2005 and 2010. The larger of two houses excavated at Androna contains a large press, Strube, Androna 235 fig. 34. – On flour mills, see Moritz, Grain-mills. – On wine and oil presses, see Frankel, Presses. – And on rollers, see White, Farm Equipment 15 fig. 1.
57 King, Diet. – Mango, Expansion 116-117.
58 Gautier, La faune 357.
59 e.g., at Déhès, Sodini et al., Déhès 303. – See also Mango, Expansion 116 with ann. 94.
60 Barnish, Pigs 157-185. – King, Animals and the Roman Army. – van der Veen, Luxury. – Kroll, Tiere 102-103.
61 Cod. Theod. 7. 4. 6. – Mango, Expansion 116 with ann. 91.
62 Mango, Environment 282. – Mango, Expansion 116-117 fig. 16.
63 For calculations, see Mango, Expansion table 6. 117. 119.

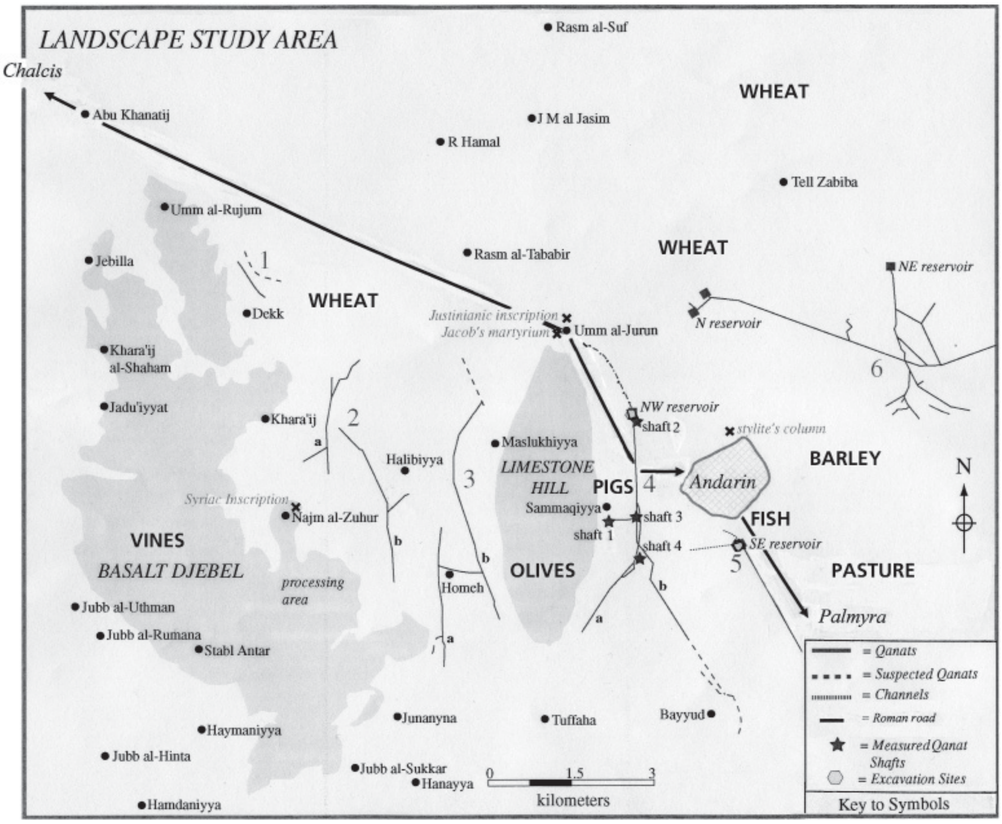


Fig. 23 Androna, landscape study map showing postulated areas of specific agricultural production. – (Map compiled by L. Schachner and T. Papaioannou; annotated by M. Mango).

trees, such as olives. Alternatively, sties could have provided shade, as did those excavated at Settefinestre, Italy[64], which bear resemblance to a rectilinear structure at Sammaqiyya close to Androna's west gate which appears to be watered by the east-west branch of qanat 4. Salt, of course, was locally available in abundance to preserve the pork, see above.

Similar calculations as to locations and quantities of agricultural produce at Androna can be made on the basis of information from ancient sources, the modern study of the effects of irrigation, but starting particularly with the geological configuration of the land around Androna which is partly basalt and partly limestone, as seen in **figure 23**. Limestone is beneficial both to certain plants such as olive trees and for excavating qanats[65]. These qanats, and the local limestone silts, described above (**fig. 15**), are both suitable to wheat cultivation[66], while the basalt jabal or hill provides water sources for qanats at its base and its elevated contours are covered with terracing for vines on its surface (**fig. 25**)[67]. The unirrigated area to the East of Androna may have continued to support barley and provide pasture land. It can be briefly stated here that the conditions of space, irrigated climate and soil would have existed to supply the population of Androna, the Legio IV Parthica and a commercial export market with sufficient amounts of wheat, wine and olive oil[68]. In fact, the export market for Androna's wine is explicitly attested in a pre-Islamic Arabic source[69]. Wine, olive oil, salted fish, etc. could have been transported from Androna in transport amphoras of the type excavated in the Byzantine bath (**fig. 24a-b**)[70].

As part of its original role as a *mansio* in the Antonine Itinerary, Androna provided horses[71] and already enjoyed good communications with the military provisioning centre at Chalcis (**fig. 2**) which acted as a crossroads between Antioch and Mesopotamia, the focus of Persian aggression. Fodder of barley could be grown in the original semi-arid conditions of Androna as could the vines planted on the basalt jabal on bench terraces (**figs 23. 25**) trapping rain water which supplied its renowned wine. With Palmyra's decrease in importance as an international trade artery from the late 3rd century, Androna may have decided to invest in irrigation and expand agriculturally. The plausible circumstances for such a change are detailed in Joshua the Stylite's account of the war in Mesopotamia AD 502-506 and its details of provisioning of wheat[72]. Androna was ideally placed to meet the demand.

64 Carandini, Settefinestre 2 figs 279-284.
65 Tchalenko, Villages I 60-63. 68-70. – Lightfoot, Qanat 327-329. – Kamash, Archaeologies of Water 34. 181.
66 Wheat requires irrigation in a semi-arid area. On the soil here, Jaubert et al., Arid Margins 16-34.
67 Lightfoot, Qanat 328-329. – For terracing, see Kamash, Archaeologies of Water 38-39 and below.
68 For calculations, see Mango, Expansion 117. 119-120; Tables 5. 7-8.
69 ʿAmr Ibn Kulthum, Muʾallaqa, see Mouterde/Poidebard, Limes 61-63. 174.
70 Mango, Environment 253 with ann. 45.
71 Jones, Later Roman Empire 831-833.
72 Pollard, Soldiers 69-81. 222-225. 285-303. – Ps.-Josua Stylites, Chron. 61. 66. 88. 95. – Mango, Expansion 116-118.

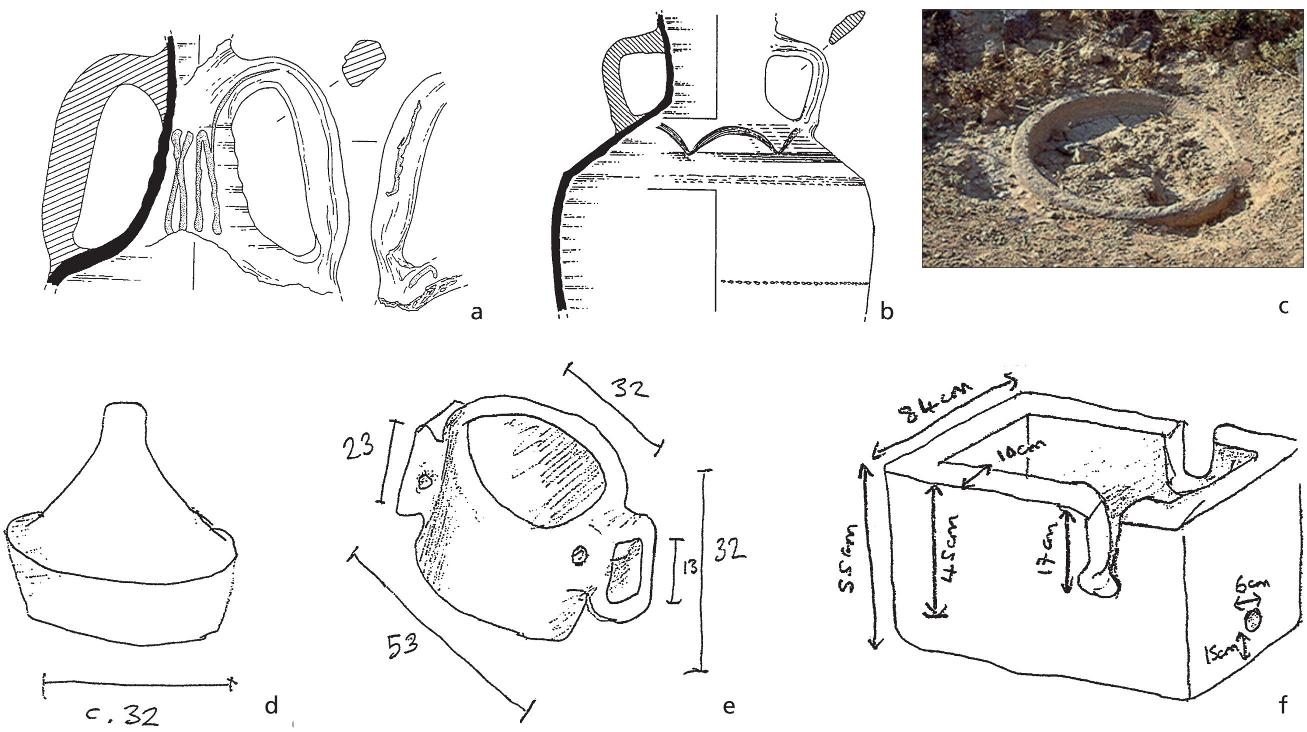


Fig. 24 Androna and landscape study area. **a-b** Byzantine bath, transport amphoras. – **c** Stabl Antar, oil mill (D 124 cm). – **d** Hamaniyya, trough (W 113 cm). – **e-f** Abu Khanatij, two parts of grain mills. – (a-b drawings D. Hopkins; c photo M. Mango; d-f drawings R. Razzall).

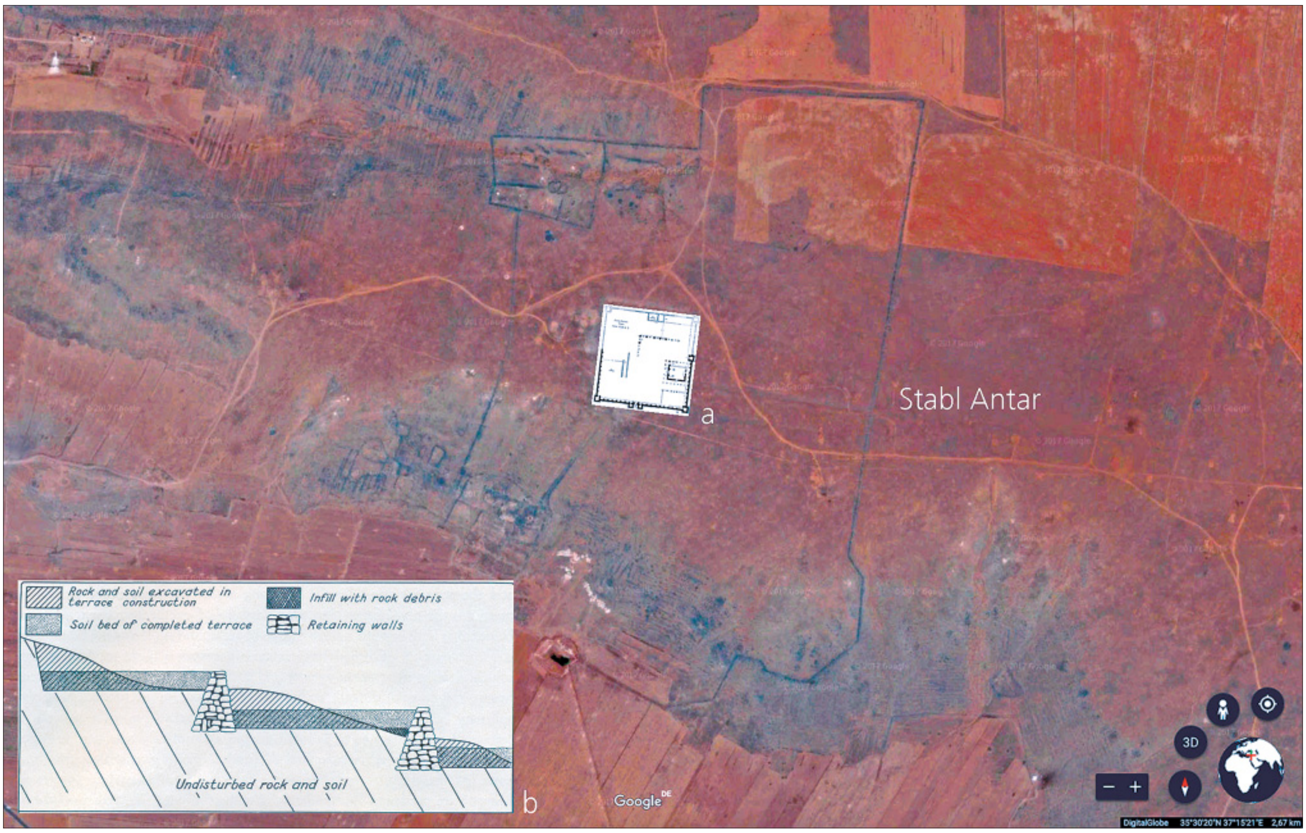


Fig. 25 Androna, landscape study area, basalt jabal, Stabl Antar, farm built AD 577/578, surrounded by bench terraces. – **a** Central buildings planned by H. C. Butler. – **b** Drawing of terraces in Lebanon. – (Main image © Google Earth 2017; a after Butler, Architecture pl. IX; b after Lewis, Lebanon 3 fig. 2).

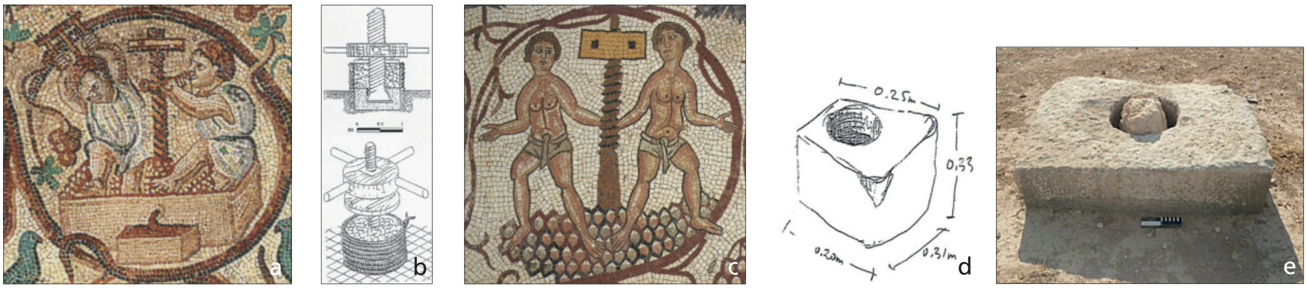


Fig. 26 Wine screw presses. – **a** mosaic pavement near Tyre of AD 576 (detail of **fig. 7**). – **b** Reconstruction drawing. – **c** mosaic pavement at Mt Nebo of AD 577. – **d-e** Blocks possibly used as sockets, from d Abu Khanatij (W 126 cm) and d Sammaqiyya. – (a see **fig. 7**; b after Frankel, Introduction 18 fig. 5; c after Piccirillo, Mosaics of Jordan 158 fig. 206; d drawing A. McCabe; e photo M. Mango).

Areas of agricultural activity surrounding Androna

Our excavations, survey and geophysical work on the irrigation systems outside Androna were complemented by our landscape study, 2004-2006, 2010, in the surrounding area (**fig. 23**), as originally planned by Michael Decker and Carrie Hritz. There, we recorded remains of buildings (by Sarah Leppard, Simon Greenslade), as well as *c.* 320 loose architectural pieces and agricultural equipment (by Anne McCabe, Rosie Razzall, Sarah Waidler; see, e.g. **figs 24c-f; 26d-e**), and collected pottery (organized by James Stockbridge[73], see, e.g. collection grid **figure 19;** 2005 pottery sorted by Theo Papaioannou). We also had interviews with today's farmers at eleven sites, conducted by Robert Hoyland, Khalid Mohammed and Lukas Schachner. In the first stage of work, 2004-2006, we pursued evidence in the limestone area on the east side, including four prominent sites, Umm al-Jurun, Sammaqiyya, Homeh and Najm al-Zuhur. The first three are immediately to the North, East and West of the limestone hill near Androna itself, while the fourth site is on an east edge of the basalt jabal. Qanat 4 runs to Umm al-Jurun (to the Justinianic boundary stone; **fig. 17**) and has an east-west branch which extends to what may be pigsties at Sammaqiyya. Homeh lies at the juncture of three branches of qanat 3. Najm is close to qanat 2 and to plantations on the basalt jabal. Altogether we investigated these and nine other sites and off-site activity areas (e.g. the two reservoirs of qanat 6, etc.)[74]. Later, in 2010[75], we concentrated on the jabal and its bench terraces, one focus of work being Stabl Antar (south of Najm, **figs 17. 23**), identified as a farm by Michael Decker[76] and dated epigraphically to 577/578, the site where Butler went when he departed from Androna in 1905 (**fig. 25**). There he planned only a central walled area which included a church and other collapsed structures (**fig. 25a**)[77]. During our season, we explored also the surrounding parts of the site, recording a storehouse, cisterns, a water channel and a road, some of this cited by Lauffray (see annotation 77). We systematically collected pottery, which included Late Roman finewares and Syrian Brittle Ware, and examined – plus in one area measured – remains of bench terraces of the type recorded elsewhere in the general region (e.g. in Lebanon, **fig. 25b**)[78]. At Stabl Antar, and at sites to the South (e.g. Hamdaniyya) and to the North (Abu Khanatij) of the jabal, we recorded loose agricultural finds such as mills, vats and troughs (**fig. 24c-f**). We particularly looked there and elsewhere for the stone sockets for the wooden screw presses, illustrated in mosaics in our general region (**fig. 26**)[79].

Chronology of irrigation at Androna

While epigraphy, radiocarbon analysis and pottery evidence suggests a general dating of the installation and use of the qanats in the vicinity of Androna to be the $6^{th}/7^{th}$ centuries (see above), preliminary indications from optically stimulated luminescence (OSL) and radiocarbon dating may document the silting of the southeast reservoir, no longer kept clean by bottom-feeding catfish, to the $8^{th}/9^{th}$ centuries. An element from the period of abandonment of the reservoir itself appears to be the small, poorly built pool constructed at its northwest corner (»lopsided pool« in **fig. 19**). This shallow pool, of roughly one third the size in area of the reservoir itself, was fed water still supplied by the qanat which was diverted from the main reservoir by means of a lateral channel[80]. The silting of the southeast (and northwest) reservoirs probably marked the end of large scale irrigated farming at Androna. A similar process of abandonment is observed in the Byzantine bath which was turned over to industrial activ-

73 Carried out in 2010 by Margot Arthur, Tim Ramsey, Paul Razzall, and Isobel Whitting.
74 Mango, Environment 271-278 figs 42-45. – Mango, Expansion 108-115; for agricultural equipment see figs 14b-c; 15a-b. d-e; 18b-d; 19c-e; 20b.
75 Mango, Landscape Study 2011.
76 Decker, Towers 512-515. – Decker, Tilling 63.
77 Butler, Architecture 63-64 pl. IX. – See also J. Lauffray in Mouterde/Poidebard, Limes 174-175.
78 Mango, Landscape Study 2011, 65. – The terraces on the jabal featured basalt bolders in the retaining walls.
79 Frankel, Presses 82-84 figs 13 B. A; 14 B. A. – Decker, Tilling 141-144.
80 On dating the qanats in the general area of Androna, see Rousset, Qanāts 241. 245-250. 250-267. – The small pool was excavated by Robert Hoyland, Simon Greenslade, Sarah Leppard, Antonietta Lerz and Stuart Randall (Mango, Landscape Study 2006, 46-47 fig. p. 47 nos. 2-3. – Mango, Landscape Study 2011, 64). – Other excavation of the reservoirs carried out by Anne McCabe, Katherine Blythe and Paul Clark.

ities represented by a large kiln built beside the cistern at the entrance of the building and by a metal workshop installed in the *tepidarium* (fig. 16, A. C), being studied by Chris Salter. A new bath built downhill in the Umayyad period, influenced architecturally by the Byzantine bath and making use of lintels and other blocks with Byzantine inscriptions on its floor and in its walls, also utilized the Byzantine bath's well water[81].

To conclude Part I of this paper, we make a final observation about farming sites. Above we compared Androna with other cities and villages on the basis of size (fig. 12) and population. In theory we might also consider a comparison at the level of management and communications with various imperial domains, particularly those situated in the general area of Androna (fig. 2): the domains of Hormisdas near Kaprobarada in the limestone massif (figs 12-13), and, northeast and southeast, respectively, of Androna at/near Taroutia Emporon (opposite Kapropera) and Meshrife/Ruhaiyeh (opposite Apamea). These domains are known almost exclusively epigraphically by name and/or general location, but have not been investigated as such on the ground[82].

Part II: a mining environment

To turn now to our second subject, mining. As stated at the start, Byzantine mining is best approached through its products. The tool box needed to examine these products is full and allows us to identify precisely the metals worked, how they were formed and the origin of their material. As an example of metallurgical study (by Peter Northover), the »now« image (fig. 28a) is a microphotograph (×500) view of a sample cut from a Byzantine object of hammered copper (99.08 % pure) which, in the 9th-11th century, had been heated (to above 232°C) to receive a thin coating of tin (2-3 µm thick). This process was/is used both »then« (called *ganotos* = polished) and »now« (called wipe-tinning); the tin is seen above as a tiny silver line[83]. Compared with Byzantine farming, Byzantine mining is a neglected subject and, compared with pottery, its products are rarely discussed by archaeologists, aside from numismatists. But, if we turn for a »then« image to the illustrated government administrative handbook, the *Notitia Dignitatum* compiled in *c.* AD 408 (fig. 27)[84], we see unsurprisingly that metal was of primary interest to the Byzantines themselves. The page devoted to the *Magister officiorum* of the Eastern Empire (fig. 27a) illustrates the weapons and armour manufactured at the 15 state *fabricae* under his auspices[85]. On another page (fig. 27b) are shown coins, state jewellery such as official belt buckles, silver plate and other objects all made from the precious metals at mints overseen by the *Comes sacrarum largitionum* of the Eastern Empire[86]. Elsewhere appear precious metal objects in the care of the *Castrensis sacri palatii*[87].

In these few pictures we see several types of metals – iron, copper, gold and silver – formed in a variety of ways. In characterizing metalwork, one can distinguish between technology and stylistic technique. Roughly stated, working hammered sheet metal, for example the copper in figure 28a, is a primitive or simple technology[88] but can be worked very effectively by advanced technique, as seen in the (very pure) silver repoussé work in figure 28b[89]. Equally, casting alloyed metal, represented here by the gilded Hippodrome horses of Constantinople now in Venice (fig. 28c), is an advanced or complex technology requiring highly specialized expertise and materials, and employing in this case advanced technique[90], but it can also be used to produce objects of simplified technique[91]. In other words, multiple combinations of material, type, style and size are possible. Compared to pottery and glass work, for example, metal artefacts are infinitely diverse and for study can be approached in a variety of ways. And, of course, they are infinitely recyclable which reduces the number of survivals in the archaeological record. Similarly, Byzantine numismatists think that their metal has been infinitely and officially recycled so that the investigation of mining in the Byzantine period may not be of direct interest to them[92].

Circulation of state-produced silver plate

Sadly, few of the objects produced by the *Magister officiorum* (fig. 27a), i. e. weapons and armour, survive, although some have been excavated at Sardis, a major iron-working centre which had a Late Roman state weapons *fabrica*[93]. But, study of earlier Roman military remains and related medieval Byzantine texts provide comparative data[94] for the Early Byzantine

81 Mango, Expansion 122. – Strube, Environment 228-229 figs 27-28.
82 Mango, Environment 257.
83 Mango, Significance 225-226. – Northover, Copper 226-227.
84 For the text, see Not. dign., on its date, see Jones, Later Roman Empire 1451. – The illustrations reproduced here (figs 27a-b) are those of the Oxford manuscript, Ms. Canon. Misc. lat. 378 of AD 1436, which is judged to be of reliable iconography, see Berger, Notitia Dignitatum 13-16.
85 Berger, Notitia Dignitatum 58-63 figs 13. 59. – On the fabricae, see Jones, Later Roman Empire 834-836.
86 Berger, Notitia Dignitatum 67-73 figs 15. 57. – On the state use of precious metals, see Jones, Later Roman Empire 838-839.
87 Berger, Notitia Dignitatum 80-84 figs 18. 62.
88 Of the vessels of hammered sheet metal excavated at Sardis, the great majority were Early Byzantine and most of those analysed were of pure copper, as used in the Bronze Age, Waldbaum, Sardis 87-98. 176.
89 Mango/Bennett, Sevso Treasure 194-239; esp. 201-203. 206-210. – Sherlock, Silver.
90 Leoni, Casting. – Oddy/Vlad/Meeks, Gilding.
91 Brown, Bronze and Pewter 26-39.
92 Hendy, Administration of Mints.
93 Waldbaum, Sardis 8-9. 29-40.
94 An article (Fulford/Sim/Doig, Ferrous Armour) on the production of Roman armour, first to third c., calculated that 12-16 million metal plates (a combination of iron and bronze) for the cuirasses alone were needed for the 300 000-400 000 men serving in the army. For the Byzantine Cretan expedition in 911 (Haldon, Theory and Practice 208. 285 with ann. 165), a total of 800 000 arrows and 13 000 heavy infantry spears (*menaulia*) were required. Provisioning on these scales required dependable metal sources. See also Kolias, Waffen.

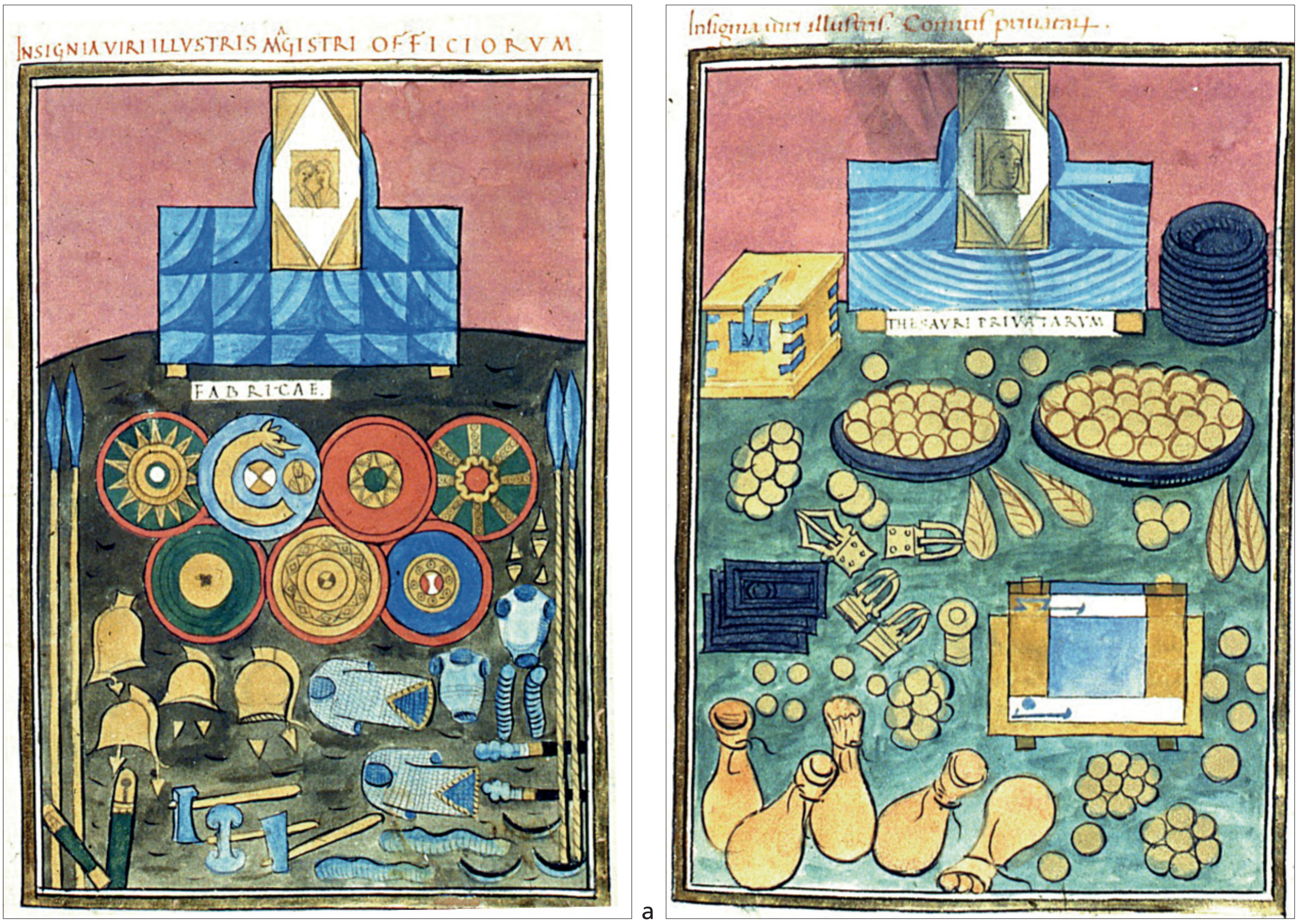


Fig. 27 Metal production in state *fabricae* illustrated in the *Magister dignitatum,* composed *c.* AD 408; manuscript of AD 1436. – **a** Weapons and armour under the *Magister officiorum.* – **b** Precious metal coin, insignia and plate under the *Comes sacrarum largitionum.* – (Photos Bodleian Library, Ms. Canon. Misc. lat. 378 f. 141r [a] und 144r [b]).

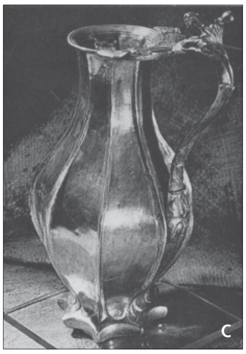
Fig. 28 Technology versus technique. – **a** Primitive technology. Hammered sheet metal, copper with tinning: Byzantine polycandelon, Ashmolean Museum, Oxford. – **b** Advanced technique. Hammered sheet metal, repoussé silver: amphora, Sevso Treasure. – **c** Advanced technology. Cast copper alloy: gilded horse, San Marco, Venice. – (a microphotograph [×500] P. Northover; b photo M. Mango; c after Olivetti/Kunstbuch Berlin [eds], Die Pferde von San Marco [Berlin 1982] 8).

period, much as the metallurgical literature preserved in the earlier texts of Pliny the Elder and the medieval Theophilus bracket and compensate for a Byzantine void[95]. Given this scarcity of surviving Byzantine military metalwork, we shall instead discuss another group mentioned above, namely silver objects, most of those considered here being state-produced

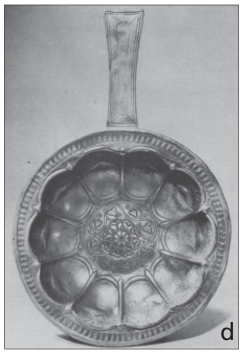
95 For Pliny see Bailey, Pliny's Chapters and for Theophilus, Theophilus, De diversis artibus.

a

b



c

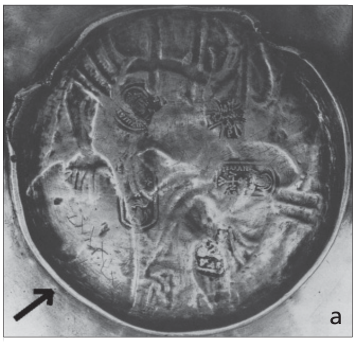


d

AD 550-565

AD 641-651

AD 582-602



a

Sogdian

[Property of] the
ruler of Buchara
Dazoj

b

A
C
B

A [Property] of Theodore
B 1/2 lb. 2 oz. 10 gr

C 

d

The washing set (*cherniboxeston*)
including this [piece]
8 lbs., 1 oz., 20 sc

e

f

f

f

Indiction IIII

e +ΕΥΧΗΕΠΠΕΛΑΓΙΟΥΒΑCΙΑΝΟΥΚΕΜΕΛΙΟΝΤΟΥΑΓΙΟΥCΕΡΓΙΟΥ
ΚΩΜΙCΚΑΠΠΕΡΚΟΡΑΩΝ +

+ Vow of Pelagius Basianou: Treasure of St. Sergios
of the village of Kaper Koraon +

f +ΥΠΕΡΕΥΧΗCΠΕΛΑΓΙΟΥΚΑΙCΩCΑΝΝΑC
ΚΑΙΤΩΝΤΕΚΝΩΝΑΥΤΩΝΑΜΗΝ

+ In fulfillment of a vow of Pelagius and Sosanna
and their children. Amen. +

Fig. 29 Six pieces of silver plate (**a-b** plates. – **c-d** washing set [*cherniboxeston*]. – **e-f** church chalice and paten [*diskopoterion*]) bearing combinations of dated control stamps, formal inscriptions, and graffiti, found in three geographical areas: **a-b** North Russia via Central Asia. – **c-d** Central Europe. – **e-f** Syrian village. – Metal of **a, c, e** traced to three mining areas. – (a-d after Dodd, Silver Stamps nos. 16. 30. 31. 36. 76; drawings M. Mango; e-f photos and inscriptions after Mango, Silver from Early Byzantium nos. 3. 5).

under the *Comes sacrarum largitionum* (fig. 27b), which have been scientifically investigated in detail.

In addition to the information obtained by scientific analysis to be considered below, we shall first note the integral verbal information that the silver objects themselves provide which pertains to the cultural environment in which they were made and used. This type of information is illustrated by the six objects seen in figure 29[96], namely the diverse inscriptions which include dated state control stamps on five of them (fig. 29a-d. f)[97], weight inscriptions on two (fig. 29b. d)[98], which in one case includes an identifying statement (»this is a handwashing set«) applying to two objects (fig. 29c-d)[99], ownership graffiti on another two (fig. 29a-b)[100], – all these placed on the reverse surface – and, finally, formal decoratively executed dedicatory inscriptions on the main obverse surface of another two (fig. 29e-f)[101]. These six objects can be seen to form three groups according to their find contexts in combination with the inscribed information. The chalice and paten (fig. 29e-f) were donated by Pelagius, his wife Sosanna and their children to the village church of Kaper Koraon which is in northern Syria (fig. 30), in the late 6th/early 7th century. The paten (fig. 29f) bears state control stamps which number two (dated »indiction IIII«) and differs stylistically from the unstamped chalice (fig. 29e) which was made, undoubtedly, by a private silversmith[102]. Both objects of the handwashing set (fig. 29c-d) bear state control stamps which, as also on figure 29a-b, number five and the weight inscription on the basin includes both objects[103]. This set was discovered outside the empire in central Europe at Malaya Pereshchepina (fig. 30) in what Joachim Werner suggested[104] was the burial of Kuvrat, Kagan of the Bulgars, together with a wealth of material including other Byzantine silver artefacts. The final two objects (fig. 29a-b), both with imperial control stamps and both found separately in the Urals in north Russia (fig. 30), were taken there, it is suggested, by Volga Bulgars in the 9th-10th century from Central Asia where the objects were originally transported, probably by Byzantine merchants in the 6th-7th century for use as an export currency. One merchant may have been Theodore, the name in the genitive inscribed on the plate with a central cross (fig. 29b). The other (fig. 29a), decorated with what has been described as Aphrodite in the tent of Anchises, bears a Sogdian inscription designating its owner as »Dazoj, ruler of Buchara«[105]. So these three sets of objects circulated to very different environments (fig. 30) – one went first, to the commercial hub of Central Asia and then to North Russia, the second went, possibly by diplomatic gift, to barbarian Europe, and the third travelled to a village church within the Empire, and as we shall see, not far from where the objects were made of metal mined nearby. Three of the individual objects (fig. 29a. c. f) were included in the analyses considered below which established the source of their metal.

Detecting production stages of silver plate

Although coin was recycled by the state, and copper and iron by local copper and iron smiths (the latter type operating in the *tepidarium* of the Androna bath during the Umayyad period, as mentioned above, fig. 16 C), silver objects were valued and protected by their owners and so often survive made of unmixed metal which can be provenanced. The first specimen to consider (fig. 31) is of very sophisticated workmanship of the 4th century, being facetted in surface and decorated with 120 tiny graduated panels each incised, gilded and inlaid in niello[106]. These illustrate circus scenes with *bestiarii*. What is of interest here is that the object is made of 13 separate parts, each of the five tested revealed a different combination of metals[107]. The silver used in the period was typically very pure and soft (normally above modern Sterling levels of 91 %) and needed to be strengthened by the addition of copper which varies in amount for the five pieces according to function, from 1.6 % for the body to 7.9 % for the lid, as indicated in figure 31a-b. The silver and the copper each has its own combination of trace elements and can therefore be considered separately (fig. 31c). Six different methods of compositional analysis detect different elements, the lowest number of elements obtained by X-ray fluorescence (XRF), being the basic three, silver, gold and copper. Other methods (indicated on fig. 31d) include neutron activation analysis (NAA), inductively coupled plasma spectrometry (ICP-MS), atomic absorption spectroscopy (AAS) and lead isotope analysis (LIA)[108].

Pieter Meyers, formerly of the Metropolitan Museum of Art in New York and now in the Los Angeles County Museum of Art, has made creative use of these different methods in order to detect particular stages of Byzantine silver production and to provenance the metal itself, in other words to lead us ultimately to the mines exploited[109]. Neutron activation analysis is the only method to detect both iridium and gold (fig. 31d, NAA: Ir, Au), which, he pointed out, because they are unaltered by any manufacturing process, can be used to form geological groups. These he detected in a large number of Early Byzantine silver objects many of which are

96 On which see Dodd, Silver Stamps nos. 16. 30-31. 76. 98. – And Mango, Silver from Early Byzantium no. 3.
97 On Byzantine control stamps, most of which are imperial and dated, see Dodd, Silver Stamps.
98 Scratched in the first case and dotted in the second which is considered a type executed by a craftsman, see Mango/Bennett, Sevso Treasure 36-54.
99 Effenberger et al., Silbergefäße nos. 10-11.
100 Effenberger et al., Silbergefäße no. 9. – Dodd, Silver Stamps no. 76.
101 Mango, Silver from Early Byzantium nos. 3. 5.
102 Mango, Silver from Early Byzantium nos. 3. 5.
103 Effenberger et al., Silbergefäße nos. 10-11.
104 Werner, Grabfund. – Kazanski/Sodini, l'art »nomade«.
105 Leščenko, Serebra. – Darkevič, Metall. – Effenberger et al., Silbergefäße 35-36. – Mango, Archaeological Context 218-226.
106 Mango/Bennett, Sevso Treasure 267-318.
107 Mango/Bennett, Sevso Treasure 277-279.
108 On these, and others such as the »streak« method, see Meyers, Sion Treasure.
109 See discussion Meyers, Sion Treasure 169-177 and results, 178-189.

Fig. 30 Map of findspots of Byzantine silver sampled for lead isotope analysis. – (Drawing H. Baron, after A. Wilkins).

precisely dated by state control stamps, in use between 498 and 685 and illustrated above (fig. 29). He thus constructed a chronology of exploitation, that traced the move from one mining area to another, presumably following exhaustion of resources, although these areas could not yet be identified geographically. To the common question as to what distinguished stamped from unstamped silver, he answered that the silver itself was equally pure in both cases, but the copper alloyed to silver to strengthen it was less pure in its trace elements (fig. 31c) in unstamped objects. This discovery related to the early stages of preparation of the metal, possibly within the mining region, before transportation to manufacturing centres. A third investigation he conducted, was carrying out lead isotope analysis on five silver objects in the Hermitage (including fig. 29a. c) and the Metropolitan Museum. This is the most effective means of tracing the metal to its mine, but in this case the figures obtained were not immediately referred to a databank.

Identifying mines exploited

This pilot project of Byzantine lead isotope analysis was subsequently enlarged in the course of investigations carried out by Ancient Near Eastern archaeologist Aslihan Yener, who was in search of the tin first used to create the bronze of the Bronze Age. Relying on data available from the Turkish Mining Authority, she focused on the Taurus Mountains (figs 32. 33c) whose polymetallic mines include tin sources. In the course of archaeological inspection of the area, she repeatedly encountered material of both the Late Roman and Byzantine periods, particularly pottery from surrounding mining settlements, but also within the mines radiocarbon dated wood such as a shovel handle and ladder (AD 700-850; AD 777 ± 55)[110]. She then decided to add samples of Byzantine silver to her programme of lead isotope analysis, which came then to include four hexagrams of Heraclius and twenty-two objects mostly dated by control stamps[111], as well as the five

110 Yener, Mines 157.

111 Yener, Mines 156 with ann. 8. – Mango, Tracking Byzantine Silver.

analyzed by P. Meyers[112]. Their resulting assignment to a mining area among the 15 in the Eastern Mediterranean (**fig. 32**), was made on the basis of comparison with more than 1000 isotopic measurements of artefacts, ores and slag[113]. The Byzantine samples are overwhelmingly linked to Asia Minor, either to the Black Sea in the North (**fig. 32**) or the Taurus in the South (**figs 32-33**). Among the objects illustrated in **figure 29**, three were included in the analyses and their metal sources identified as follows: **figure 29a**, one plate found in North Russia, was made of Black Sea silver, **figure 29c**, the ewer found in Ukraine, was made of Taurus Mt. silver, while **figure 29f**, the church paten, belongs to a group identified as the »Eastern Artefact 2 Group« whose metal is thought to originate in mines to the North of Antioch (in the Amuk area, prov. Hatay/TR) whose ores and slag were not sampled[114]. Both Black Sea and Taurus silver were apparently shipped to Constantinople for coin and stamped silver production, and Taurus silver was apparently also worked locally at Antioch and Tarsus (see below).

Because of its tin deposits, the Taurus was the area investigated in detail by Aslihan Yener, particularly the Bolkardağ mining district (prov. Niğde and Mersin/TR) with its archaeological sites and metallurgical installations (**fig. 33b**)[115]. The Taurus Mountains formed the backdrop to the *Notitia Dignitatum* page for the *Comes Isauriae* (**fig. 33a**)[116]. In the Late Roman period this region as illustrated in **figure 33c** was literally a hive of metallurgical activity, which extended beyond the mining area and Isauria to encompass Antioch, the capital of the East, and Cyprus. The Taurus has 800 mines of iron, copper, lead, tin, gold and silver and other silver mines existed north of Antioch (at Amuk)[117] and copper mines in Cyprus[118]. State weapons factories, under the *Magister officiorum* (**fig. 27a**), produced lances at Irenopolis and shields, arms and cavalry armour at Antioch where ceremonial armour was also manufactured[119]. Also at Antioch, *largitio* silver plate, produced under the *Comes sacrarum largitionum* (**fig. 27b**), was made in the 4th century and stamped silver produced for sale in the 7th century as it was also at Tarsus in the 6th and 7th centuries[120]. The Antioch mint produced precious metal coin in the 4th century and thereafter copper. In 608-610 Heraclius' rebel coinage was minted at Cilician Alexandria and Salamis in Cyprus. When the Antioch mint closed in 610 following Persian occupation, new mints opened 615-617 at Seleucia Isauriae, then at Isaura Vetus 617/618. In 626-629, during Heraclius' campaign in the East, the Salamis mint again struck coins[121].

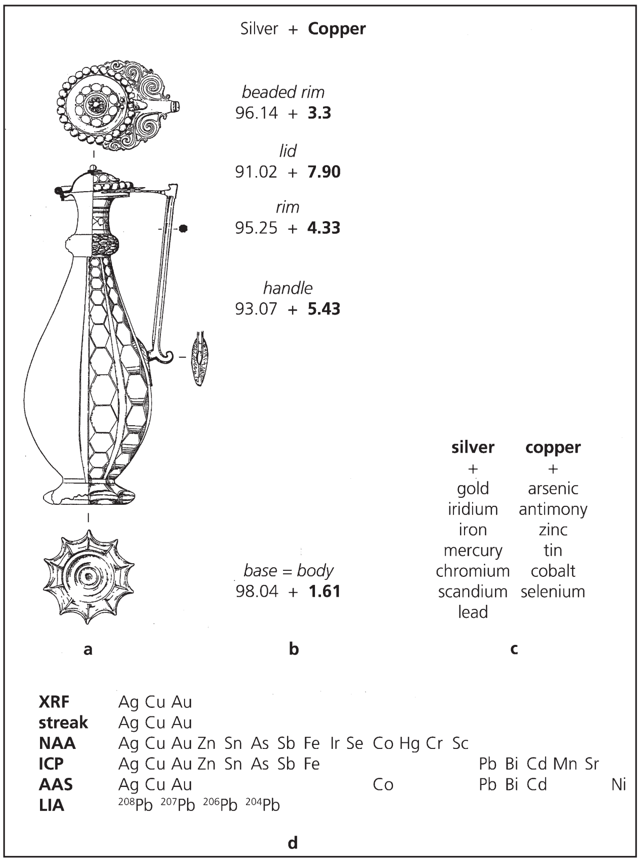


Fig. 31 **a** Silver ewer, Sevso Treasure. – **b** Chemical compositions of silver and copper indicated for five parts. – **c** Trace elements of silver and copper listed. – **d** General types of analysis listed. – (a-b after Mango/Bennett, Sevso Treasure fig. 7.5 [drawing M. Schofield]).

Finally, a footnote to the local built environment on the edge of this metallurgically developed area. Binbirkilise (prov. Karaman), the Turkish name given to the ancient site just outside the Bolkardağ area (**fig. 33c**), is composed of two modern villages, Değle and Madenşehir. Binbirkilise means literally »1001 churches«, and refers to its nearly 50 ancient buildings, including at least 30 churches, studied by William Ramsey and Gertrude Bell in 1909[122]. This megasite has been largely neglected since then but its growth might have been linked to the mining activity in the nearby Taurus, rather than merely agriculture, and deserves further investigation. The overall chronology offered by Ramsey and Bell, based on a combination of epigraphic and architectural evidence, suggests the lower area of Madenşehir (literally »metal town«) dated to the 5th-6th centuries, that upper Değle was pre-classical and then 7th century, with both experiencing a restora-

112 Meyers, Sion Treasure 180 table 3B: Hermitage.
113 Sayre et al., Anatolia 73.
114 Sayre et al., Ore 100-103.
115 Yener, Mines 157-158.
116 Berger, Notitia Dignitatum 111-124 fig. 29, where it is said, p. 123, to be »an authentic topographical motif«. I would suggest that the animal (here called a deer, but resembling more a wolf in the Oxford MS, fig. 33a) walking between mountains marks the location of the Cilician Gates.
117 Yener, Mines 157.
118 Given et al., Troodos.
119 Jones, Later Roman Empire 834.
120 Mango, Purpose. – J. Kent in Dodd, Silver Stamps 44.
121 Grierson, Byzantine Coins 39-41.
122 Ramsey/Bell, Churches viii. 3-38.

Fig. 32 Map of mining areas identified in 1000 lead isotope data of ores, slag and artefacts. – (Drawing H. Baron, after A. Wilkins).

tion period from 850-1070. And, of course, the multitude of mines and mining villages (**fig. 33b**) identified by Aslihan Yener and colleagues should also be further investigated by Byzantine archaeologists on and under the ground, looking beyond silver and to some of the other many metals, particularly tin.

Although I have concentrated here on silver objects, particularly those stamped and inscribed, to illustrate how the exploitation of the Taurus or other mines were approached by study today, I think the overwhelmingly important purpose of the exploitation of the mines in Byzantine times was, as indicated in the *Notitia Dignitatum*, to provide the metal for coinage and weapons made by the *Magister officiorum* and the *Comes sacrarum largitionum* (**fig. 27**).

Conclusion

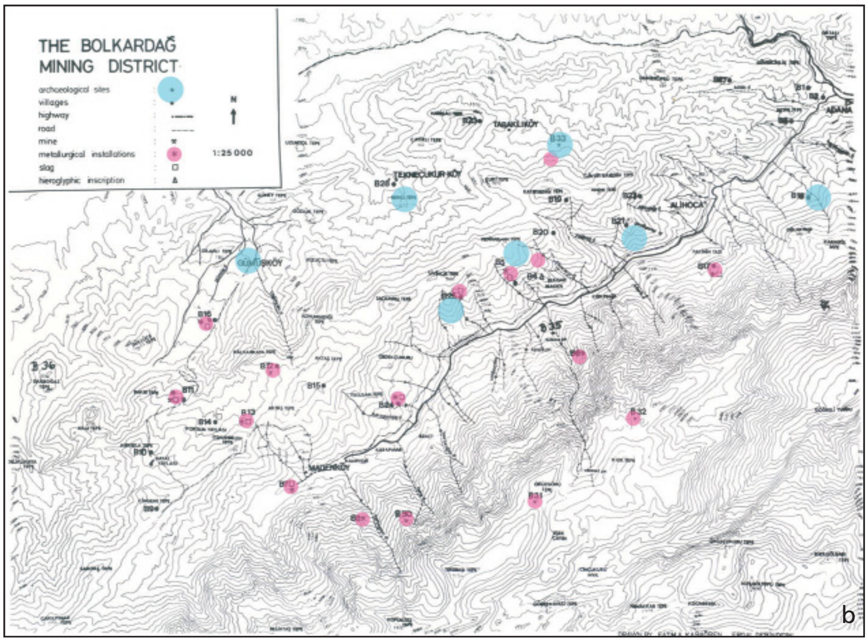
We return to the map indicating our farming and mining areas (**fig. 1**). Unlike the Google Earth image of these two areas which shows the natural environment as it is, the drawn map reminds us of the Byzantine state, its impact on the land. Its proliferating 19 provinces of the Diocese of the East suggest increasing micromanagement. Within the scenarios presented above regarding farming and mining, the state was buying and selling – buying pork from Androna to provide rations for the army on the Euphrates and selling stamped silver to Pelagius who donated it to his village church and to the hypothetical merchant Theodore who may have taken it on business to Central Asia. This is another type or level of interaction that, like the management and communications of imperial domains mentioned above, goes beyond questions of responding directly to environments and should probably be considered as much by historical study as by means of archaeology.

The paper published here, was delivered at a conference held at Mainz in November 2011. The text encompasses two subject areas in which I have worked, settlement excavation and metallurgical study. Regarding the first, our settlement excavation team had recently in 2010 met at Androna in Syria for what became a final season, two months after which erupted the violence which continues today to make further field work there impossible in the near future. For a conference held in Istanbul, November 2013, I was invited to present a paper on our Androna project. That paper was recently published[123]. The latter paper covers what became our final season in 2010 at Androna where our work first started in 1998. That latest report made in 2013 now serves as an announcement of a final general publication which our team will soon start to undertake. It carefully lists every member of the field team and the nature of the team work[124]. This last report, compared to the present discussion in the Mainz paper, is relatively concise, being only 16 pages long with only 14 illustrations.

The present text provides a specialist perspective which attempts to integrate our field work with earlier local field work (in and adjacent to Syria) of a broader range of uncovered material including mosaic pavements (**figs 3. 5-7**) illustrating relevant, mostly figural, decoration which has yet to be discovered in any abundance at Androna, but which may be found there eventually if work ever resumes in the future. A full bibliography of all published work carried out at Androna is due to appear shortly in another publication in October 2017.

123 Mango, Androna.

124 Mango, Androna, Ann. 25-26.



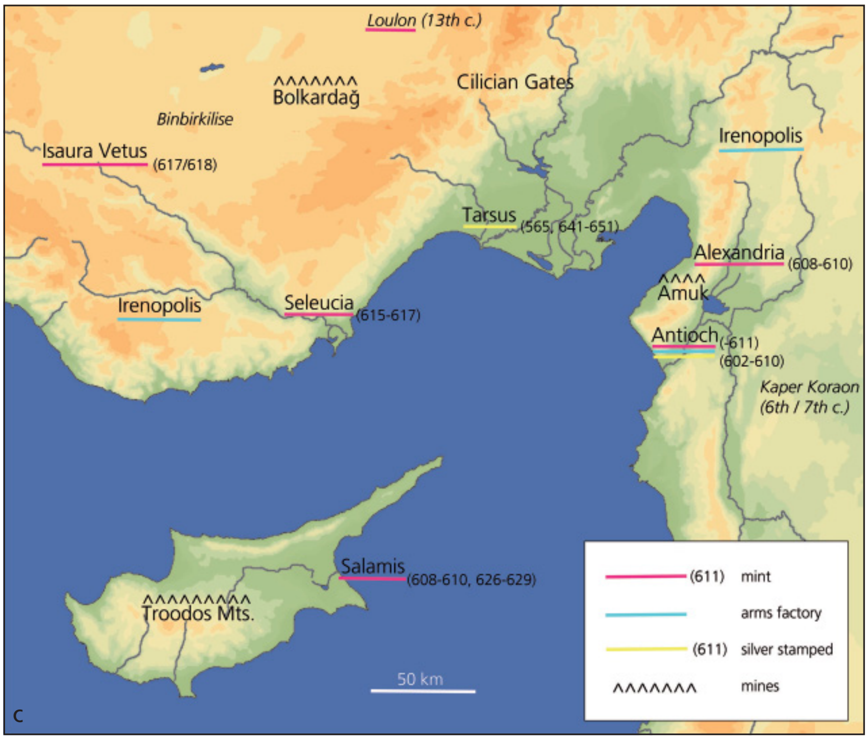


Fig. 33 The Taurus Mountains mining areas illustrated, **a** on the page of the *Comes Isauriae* in the *Notitia Dignitatum, c.* AD 408, manuscript of AD 1436. – **b** in the Bolkardağ area investigated by A. Yener. – **c** general map of mining area, including Antioch and Cyprus and indicating mines, weapons factories and mints. – (a photo Bodleian Library, Ms. Canon. Misc. lat. 378 f. 114v; b after Yener, Mines fig. 2, with additions by A. Wilkins; c map by H. Baron, annotated by A. Wilkins).

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Zusammenfassung / Summary

Reaktionen auf byzantinische Umwelten – heute und damals

Der Vortrag, auf dem dieser Beitrag basiert, wurde auf einer Konferenz in Mainz im November 2011 gehalten. Der Text umspannt zwei Themenbereiche, zu denen ich geforscht habe: Siedlungsarchäologie und metallurgische Studien. Der vorliegende Text nimmt eine spezialisierte Perspektive ein, die darauf abzielt, unsere Feldforschungen mit Funden und Befunden früherer Feldforschungen in Syrien und angrenzenden Regionen zu verbinden, die auch Mosaikböden (**Abb. 3. 5-7**) umfassen. Diese zeigen für unsere Fragestellungen relevante, überwiegend figurale Motive, wie sie in nennenswertem Maße für Androna noch nicht bekannt sind, aber dort durchaus noch gefunden werden könnten, falls die Forschungen in der Zukunft wieder aufgenommen werden können. Eine vollständige Bibliographie aller publizierten Arbeiten zu Androna soll im Oktober 2017 erscheinen.

Dem zweiten Thema dieses Beitrags, dem byzantinischen Bergbau, nähert sich der Text über die Produkte desselben, wenngleich nicht viele erhalten sind. Zu jenen, die es noch gibt, zählt staatlich produziertes Silbergeschirr, welches aufgrund seines hohen Wertes oft mit »verbaler Information« versehen wurde – gravierten Inschriften, Graffitiritzungen und Prüfstempeln. Diverse Wissenschaftler haben Methoden entwickelt, unterschiedliche Metalle zu analysieren und mit verschiedenen Bergbaugebieten in Verbindung zu setzen. Diese Untersuchungen erbringen sehr informative Erkenntnisse. Die jeweiligen Regionen überschneiden sich geografisch mit den im siedlungsarchäologischen Teil des Beitrags behandelten Gebieten (**Abb. 1**).

Responding to Byzantine Environments: Then and Now

The paper published here was delivered at a conference held at Mainz in November 2011. The text encompasses two subject areas in which I have worked, settlement excavation and metallurgical study. The present text provides a specialist perspective which attempts to integrate our field work with earlier local field work (in and adjacent to Syria) of a broader range of uncovered material including mosaic pavements (**figs 3, 5-7**) illustrating relevant, mostly figural, decoration which has yet to be discovered in any abundance at Androna, but which may be found there eventually if work ever resumes in the future.

Regarding the second subject of this paper, that of Byzantine mining, like Androna is located in the Near East (**fig. 1**), the text provided here opens with the statement that the subject »is best approached through its products«, although many do not survive. Those that have survived include especially state produced silver plate which, given its value, often incorporates »verbal information« in the form of engraved inscriptions, scratched graffiti and control stamps. Several scholars have developed methods of analysis of types of metal linked to identified mining areas, investigation of which reveal informative material. These areas overlap geographically with those of the archaeological discussion in this paper, as pointed out above (see **fig. 1**).