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Mapping Gordion

Gabriel H. Pizzorno and Gareth Darbyshire

Introduction

Six decades of archaeological investigation at Gordion have provided a wealth of information about ancient Anatolia, in particular regarding the Early and Middle Phrygian periods. However, with the ambitious scale of the project have come major challenges, chief among which is the recording of the spatial layout of the excavated remains: the mapping of Gordion.

The lack of accurate spatial representations of the site has consistently hindered the analysis and publication of the excavated material. A complete site map combining all excavated data was never produced, and little of the ancient architecture could be precisely located in a site-wide coordinate system. The seriousness of this situation is difficult to overestimate. Most of the records for the excavation trenches and their assemblages were ultimately linked to architectural features, many of which no longer survive. Consequently, the key data could not be located spatially with acceptable accuracy, either in absolute terms or relative to each other. The existence of specific problems associated with the mapping had long been known, and indeed some of the surveyors responsible for the maps and plans attempted remedies over the years, but no definitive solutions were ever found.

The situation reached a critical juncture in 2007, when two new initiatives required the accurate spatial referencing of Gordion's data. Brian Rose had just became co-director of the project and suggested that a phase plan of the Citadel Mound would improve the comprehension and presentation of the excavated remains. At the same time, the authors commenced the Digital Gordion project, the goal of which is to improve the accessibility and analysis of the Gordion materials through the digitization of the archived records and the creation of an online research environment (Darbyshire and Pizzorno 2009b). It rapidly became clear that this new research environment would require an accurate spatial referencing component in order to fully integrate all the data.

The present chapter documents our research into the history of mapping at Gordion, outlines our understanding of the problems, and presents the strategy we have developed for rectifying the situation. If at times our evaluation of past work seems less than kind, it is only because a frank and in-depth investigation into the problems, their magnitude, and their root causes is an inescapable first step toward finding the best solution. To illustrate the potential of our approach, we include a provisional phase plan of the key architectural units excavated on the Citadel Mound from the Early, Middle, and Late Phrygian periods—the first such plan ever produced for the site (foldout in back pocket). We also include a new site map, customized to show the features relevant to our discussion (Fig. 2.1, see color insert). These are examples of the kind of select cartography that we can now generate from the Digital Gordion geo-spatial dataset.

Approaching the Problem

Earlier attempts to comprehend and resolve the mapping problems at Gordion were too narrowly focused and consequently failed to recognize their underlying causes. The few solutions that were formulated only addressed immediate concerns, without ever confronting the core set of problems that had created the situation in the first place. One of

the greatest shortcomings of these earlier attempts was the restriction of their analytical scope solely to the maps and plans themselves. That is to say, the problems with the mapping were approached in a cartographic manner, focusing on the measuring and drawing of the plans but largely ignoring their content. In contrast, we have taken a holistic approach, one that, in addition to the cartographic aspects of the matter, also focuses on the content of the plans and the social milieu in which they were produced. Thus, while technical considerations remain a key component of our strategy, we have also taken into account other types of information: the archaeological evidence itself (structures, deposits, and artifacts); the site's topography; the operational context of the excavations (aims and methodology, personnel, organization, logistics, and scheduling); and technological details (the type, condition, and capabilities of the equipment used).

Our preliminary survey of the Gordion Archive for pertinent records included more than 2,000 maps and plans, together with ancillary materials such as excavation notebooks, surveyors' reports, and aerial and satellite imagery. Tracing and evaluating the development of mapping at Gordion over the course of 60 years is no easy task, in part because the project has outlived a number of those involved, but also because clear policies for documenting the survey work were never established. Where records exist, they are of uneven quality and scope, and the paucity of documentation means that our interpretations and working hypotheses inevitably carry some degree of speculation. Nevertheless, there is much to be learned from a series of short reports written by the surveyors themselves, and from the surveyors' logs that survive.[1] These, coupled with the maps, plans, and other documents (publications, notes, sketches, and correspondence), have allowed us to piece together a comprehensive history of mapping at Gordion.

Chronology of the Surveys and Mapping

The earliest archaeological excavations at Gordion were carried out in a single season by Gustav and Alfred Körte in 1900. Their published report includes a site map that is the first cartographic representation of Gordion's archaeology. The map presents key geographical features and trench locations, but only one of the trenches has a detailed plan in the publication (Körte and Körte 1904).

Following a hiatus of 50 years, archaeological investigations resumed in 1950 under the ægis of the University of Pennsylvania Museum of Archaeology and Anthropology (henceforth Penn Museum). The first excavation series, and the most extensive in terms of the area investigated, was directed by Rodney S. Young between 1950 and 1973.[2] Over 1,500 maps and plans were produced to document the results of the 17 seasons of digging.

The year 1974 saw only a limited survey season, directed by Keith DeVries. That autumn, Young was killed in a car accident and major excavations did not resume until 1988. In the intervening period, under the direction of DeVries and G. Kenneth Sams, work focused on the analysis of excavated material, particularly the tens of thousands of artifacts, and to a much smaller degree on the evaluation and conservation of excavated architecture (DeVries 1986, 1987a, 1988a). Surveying was only carried out in 1979 and 1980, as part of the architectural conservation program, and in 1987 in preparation for a renewed series of excavations.

Penn's second excavation series began in 1988, with Mary M. Voigt as field director, and lasted until 2006.[3] These excavations were much less extensive than Young's, but the recovery and recording of evidence was more detailed, and hundreds of maps and plans were generated. These years also witnessed a number of excavations and surveys carried out on behalf of Turkey's General Directorate for Cultural Properties and Museums. The Museum of Anatolian Civilizations, Ankara, excavated Mamaderesi Tumulus in 1988, under the direction of Melih Arslan, in cooperation with the Gordion Project (Arslan 1989, Temizsoy 1992, 1993, 1994), and in 1989 Tahsin Saatçi investigated the three Kızlarkayası tumuli (Saatçi and Kopar 1990, 1991). That same year, a general evaluation survey of Gordion's tumuli was conducted and the results plotted on the standard 1:5,000 Turkish cartographic series and on an unprojected schematic map (unpublished). Three more tumuli were dug by Remzi Yağcı in 1990 (Yağcı 1992). With the exception of thirteen small inspec-

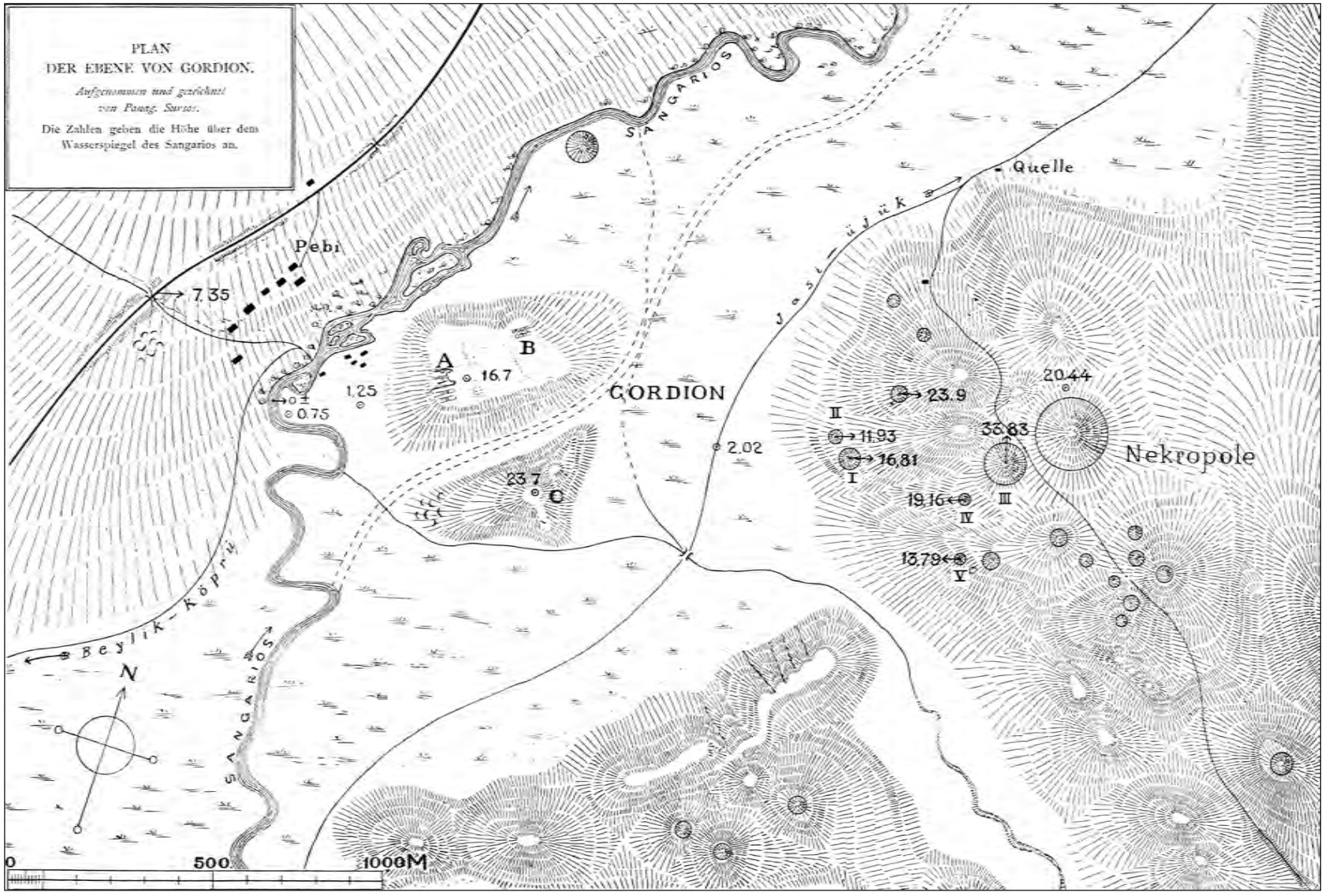

Fig. 2.2. The Körte map of Gordion, including the location of their excavation trenches on the Citadel Mound (A, B), in the Lower Town (C), and in five of the tumuli (I–V). Their vertical datum (0±) at the river Sakarya ("Sangarios") is marked directly southwest of the Citadel Mound. Also shown is the late Ottoman village of Bebi ("Pebi") and contemporary irrigation channels, springs, roads and tracks, and the railway line. Source: Körte and Körte 1904: Taf. 1.

tion trenches dug in selected areas of the site in 2007 (unpublished), no excavations have been conducted at Gordion since 2006.

As well as the excavations, other activities have generated spatial data. In 1987 and 1988 William Sumner conducted a survey of other sites in the area (the initial phase of the Gordion Regional Survey Project). The following year, a series of aerial photographs of the Citadel Mound and the Lower Town was taken by Wilson and Eleanor Myers using a balloon. In 1992 Andrew Goldman and Keith Dickey directed an intensive survey of the Outer Town, continued for another season by Goldman alone in 1995 (unpublished). A geomorphological study of Gordion and its environs was conducted by Ben Marsh between 1992 and 1995, and expanded for the Gordion Regional Survey Project directed by Lisa Kealhofer between 1996 and 2002 (Kealhofer 2005). Marsh's ongoing work has produced a number of important geomorphological and archaeological maps (Marsh 1997, 1999, 2005, and this volume). Another significant development has been the resumption, in 2007, of geophysical survey (unpublished geophysical investigations at Gordion had been conducted by E.K. Ralph in 1965). Ongoing work by Stefan Giese and Christian Hübner, of GGH GbR, has focused on the Citadel Mound, parts of the Lower and Outer Town zones, and on several of the tumuli. A second geophysics team, directed by Compton James Tucker and Joseph Nigro of the Goddard Space Flight Center, NASA, began work in 2009, focusing on the cemetery areas (Sams 2009:139–41; 2010:289–91; 2011a:462–64).

In 2008 a new survey of Middle Phrygian architecture on the Citadel Mound was initiated by Ömür Harmanşah of Brown University, and that same year a Penn team directed by Gabriel H. Pizzorno and William R. Fitts was on-site to resurvey as many extant fixed points as could be found. Most recently, in 2010, Gareth Darbyshire and John Hinchman carried out a new balloon aerial photographic survey of the Citadel Mound, Lower Town, and Northeast Ridge cemetery area. In addition, a differential Global Positioning System (dGPS) survey of the same areas, totalling more than 1,500 control points and including all extant visible architecture, was conducted by Darbyshire and Philip Sapirstein.

Mapping Gordion

The map produced by the Körte expedition of 1900 shows the contemporary relief, hydrology, vegetation, settlement, and transportation network, as well as the archaeological topography, trench locations, and elevations of selected points (Fig. 2.2). Although in many ways inaccurate, it constitutes a useful reference source for the late Ottoman landscape. Given the limitations of the Körte map and the absence of anything else that could be used, new cartography was essential at the beginning of the Penn project, and a number of basic site maps had to be produced during the first season.

Troubled Beginnings

In 1950, mapping work at Gordion was carried out by Mahmut Akok, an established Turkish archaeologist and illustrator; Edward B. Reed, a student from Princeton University; and Zihni Azım, who, like Akok, was an illustrator in Ankara. Although there are no accounts detailing the survey work that season, we have managed to reconstruct the essential sequence of events through a careful examination of the maps and plans that were produced (both draft and final versions), and the field notebooks and published reports (Young 1950, 1951).

Akok, who was the senior surveyor, spent only two weeks on-site collecting data (Young 1951:4), and produced three maps (the areas covered by these are indicated in Fig. 2.1). The first two, at a scale of 1:1,000, were based on his own survey of the areas excavated that season: the cluster of tumuli on the Northeast Ridge (1950-1; Fig. 2.3, see insert), and the Citadel Mound area, which also included the mounds of Kuş Tepe and Küçük Höyük (1950-80; Fig. 2.4, see insert).[4] The third, produced at a later date, is a 1:4,000 map of the entire site as it was then understood (1950-2; Fig. 2.5, see insert). Given the very limited time that Akok spent at Gordion, he could not have surveyed the whole area to produce the contouring on this map, and so it is likely that he also interpolated data from existing Turkish cartography (probably at 1:5,000 scale). This conjecture is supported by the fact that his survey stations are only marked on his two more detailed maps (1950-1 and 1950-80). The steps that Akok

followed for his own survey can be deduced from a careful consideration of the survey stations, sight lines, and fixed points marked on his maps (Figs. 2.3 and 2.4).

Of particular interest is the 1:4,000 map (1950-2, Fig. 2.5), which shows grid intersection markers every 1,000 m. These suggest that Akok intended to create a grid system that would cover the entire site, with intervals at 1,000, 500, 100, 50, and 10 m, as reflected also by the later configuration of the grid over the Citadel Mound (Fig. 2.6, see insert). His first survey station had surely been placed on top of Tumulus MM, because this was the highest point in the area and the site of a Turkish geodetic marker. The use of this point as the survey's planimetric datum is also suggested by Akok's sight lines from there (as shown on map 1950-1; Fig. 2.3), and by its designation as a major grid intersection on map 1950-2 (Fig. 2.5). On the Citadel Mound, Akok established and measured four fixed points (A, B, C, and D), likely marked with temporary wooden stakes, and included them on his area map 1950-80 (Fig. 2.4). These were to serve as anchors for the implementation of the site grid over this area, with each pair of points (A-B and C-D) intended to define a baseline.

After Akok's departure, Reed used this survey as the basis for a detailed 1:500 map of the Citadel Mound, on which he recorded the positions of the four trenches dug there that season. There are two versions of this map in the Gordion Archive: a draft (1950-78) and an inked version (1950-77; Fig. 2.6). These are the first maps on which the site grid was fully rendered. The framework drawn by Reed is a square grid with intervals at 10 and 50 m. The minor intervals are designated by numbers along the west-east axis (1–65) and by letters along the north-south axis (A–ZZ). The origin of coordinates is ca. 200 m northwest of the Citadel Mound, across the Sakarya River. The bottom-right corner of the map was left ungridded in order to place an inset showing a map of the entire site (although in the event this was never added).[5] It is at this juncture that the first sign of trouble emerges: referring to Akok's fixed points A-D, Reed stated on the draft version of his map that the "stake layout here has been corrected from the inaccurate state shown on Mahmut's sunprint" (handwritten note on map 1950-78).[6]

A close examination of Akok's fixed points on his 1950-80 map does indeed show a problem. The east-west (A-B) and north-south (C-D) baselines are not perpendicular and are thus an inadequate foundation for a grid (Fig. 2.7, see insert). It is unclear whether the points had been erroneously marked on the ground, improperly measured, or incorrectly drawn on the map. Furthermore, they are off from the grid intersections they were supposed to represent in Akok's theoretical site grid discussed above. This is hardly surprising, since to connect the Citadel Mound survey with the planimetric datum would have required him to measure a length of 1,500 m (the distance between the first survey station on top of Tumulus MM and the first station he established on the Citadel Mound). The accurate measurement of such a long transect would have been very time consuming given the topography and the available equipment, and was very likely never carried out.

Reed's remedy, however, was hardly without issue. It is unclear as to what data he used for his corrections, especially since, by his own admission, he did not have access to Akok's site survey at the time (cf. note 2.5). Whatever the case, while drafting map 1950-78, Reed carried out a series of inexplicable actions that were to have long-lasting repercussions. He first redesignated the 2 m contour as the zero line. He then proceeded to alter the contour in the vicinity of fixed point B, redrawing the line so that it passed through the point itself, thus making B the new vertical datum (zero for elevations) at the Citadel Mound. He subsequently relabeled all the contours on the map, subtracting 2 m from the original elevations (Fig. 2.8, see insert).

Shortly after completing this map, Reed left the site and was succeeded by Azım, who focused on drawing the excavation plans. Most of the trench plans for the Citadel Mound from 1950 include some sort of reference to the site grid, but those for the six tumuli opened that season (and for the many dug in subsequent years) were not linked to it—at best, they were only approximately positioned on the site area maps produced by Akok (1950-1 and 1950-2; Figs. 2.3 and 2.5, respectively). This is particularly unfortunate since Akok's three maps do not match each other: the mismatch is immediately noticeable for features such as the irrigation canals, roads, and tracks, but it is also

true for the contours describing the topography of the site (compare Figs. 2.3–2.5).

It would seem that Akok intended to use the same system of elevations as that employed by the Körte brothers, which took as its vertical datum the level of the Sakarya River.[7] Using the same origin point as for the planimetry (i.e., the top of Tumulus MM), Akok calculated the river's elevation above sea level and then used it as the vertical datum for his survey (Young et al. 1981, caption for fig. 1; Kohler 1995:2). He did not use this datum consistently, however, when preparing his maps.

In his general area map (1950-2; Fig. 2.5), the zero contour passes about 500 m north of the Citadel Mound and then heads north toward Yassıhöyük, not returning. By contrast, the Citadel Mound area map (1950-80; Fig. 2.4) has the same vertical datum, but the zero contour runs as far south as the area between the north end of Küçük Höyük and the eastern end of the Citadel Mound before turning east to disappear off the map. The area map of the Northeast Ridge (1950-1; Fig. 2.3) also has the same vertical datum, but the tracing of the zero contour is different from that of the general area map (1950-2; Fig. 2.5), for it runs much closer to Yassıhöyük and at one point even crosses the track that lies to the west of the village. An even more troubling attribute of this map is that contour lines are sometimes conflated, as for example with the 1 m line at the southern edge of the map, which becomes the 2 m line at the northern edge; these are not contours at all and consequently they render the entire series of intervals invalid (Fig. 2.3).[8] Lastly, as a result of Reed's adjustments, the 1:500 Citadel Mound map (1950-77; Fig. 2.6) has a different vertical datum, about 1.6 m higher, than that of the two area maps. In Reed's map the zero contour surrounds the base of the Citadel Mound, passing between it and Küçük Höyük before vanishing toward the west.

There are several likely reasons for the contour mismatches. As indicated above, Akok only surveyed two relatively small areas of the site (the end of the Northeast Ridge and the Citadel Mound); his other mapping data were presumably interpolated from already-existing maps. The need to combine these two disparate sources, compounded by the rush to produce the drawings, was probably the leading cause of errors. The immediate consequence was that most of the elevations measured in the Citadel Mound trenches took as their reference the vertical datum of the detailed Citadel Mound map (1950-77; Fig. 2.6), while the elevations measured in other areas of the site were referenced to the vertical datum of the area maps (1950-2 and 1950-80; Figs. 2.4 and 2.5, respectively).

The four maps—the three area maps by Akok (1950-1, 1950-2, and 1950-80) and Reed's map of the Citadel Mound (1950-77)—remained the foundation of every map and plan drawn at Gordion over the next half-century. Almost a decade would pass before problems with the surveying began to be noticed. It did not help that the 1950 mapping staff did not return: the chief surveyor for 1951–1953 was Dorothy H. Cox, followed by Joseph S. Last from 1955–1962, with Cox returning in 1957.[9] However, the main reason that problems went unnoticed is that until 1958 Gordion's surveyors could avoid using the site grid. Their work in these years involved mapping either previously opened trenches, or extensions to these, which only required additions to existing plans; or mapping new trenches in tumuli, for which plans could be made without any use of the site's coordinate system.

Problems Become Apparent

In 1958 the opening of new trenches in previously unexcavated areas of the Citadel Mound, and the need to incorporate these into the site map, finally brought to light the problems with the spatial referencing. Using Akok's fixed points C and D as point of departure, Last built five new ones at the intersections of the gridlines to the east of them, in order to tie the new trenches to the site grid (Last 1958–59).[10] In the process, he compared the locations of the previously excavated trenches in the 1:500 general plans, referenced using the site grid, against their actual locations on the ground. In so doing, he found significant discrepancies that he tried to correct over the next few years by remeasuring the fixed points. He assumed that the root cause of the referencing problems was the way the trenches had been incorporated into the grid, rather than the grid itself. In the end, his efforts met with little success.

In 1963, perhaps in an attempt to address this situation, Mahmut Akok was brought back to Gor-

dion. He apparently spent two months on-site, but no record of his activities remains. The other surveyor for that season was Charles K. Williams, who had previously worked with Last (Young 1964:279n1). Williams wrote a report that includes a description of some of the problems with the 1950 maps (1963). For the trenches on the west side of the Citadel Mound, he noted a discrepancy of more than 30 cm between points on the surface and those in the excavated levels. With regard to the Küçük Höyük, which had already witnessed several seasons of excavation, Williams reported that the mapped contours were inaccurate, and that the elevations did not conform with those on the Citadel Mound. As far as we can tell this was the first time that a concerted effort was made to understand and articulate some of the inconsistencies present in the site's maps.

Williams proposed a number of solutions including a full resurvey of the area and the rebuilding of the site grid. Unfortunately, none of his proposals seem to have been implemented, as the surveyors for the next two seasons, Aubrey Trik in 1965 and Joseph Shaw in 1967, focused once again on the mapping of features in existing trenches. The grid seems to have received little consideration from Trik and does not appear on any of his plans. Shaw, however, apparently tried to use it when he carried out a major update of the Citadel Mound trench plan (1967-1).[11] The fact that there are major problems with this plan suggests that Shaw was unaware of the fundamental issues besetting the site's spatial referencing system.[12]

The same focus on individual trenches continued in the next season, 1969, under Wilson W. Cummer. It was only in 1971, apparently, that he became aware of the problems with the referencing, when he was unable to tie his survey work to the site grid using several of the existing fixed points. Unable to find a solution, he decided to address the problem at the beginning of the next field season, in 1973. In his report for that year, he remarked that the accuracy of the Citadel Mound plans had deteriorated markedly since 1950, as demonstrated by the fact that he could neither correctly link his new trench plans to those from earlier seasons, nor accurately relate some of the older trench plans to each other. His efforts to resolve the situation were quickly abandoned because, in his own words, "…most of the old 1:100 plans do not show grid points or fixed points.…We dropped this job" (Cummer 1973). By the end of the season he estimated that the general degree of horizontal error on the Citadel Mound was at least 2 m. His own attempt to re-establish the site grid evidently did not meet with much success, since the problems of aligning the position of different trenches continued to be reported in later years. He did, however, produce a 1:500 Point Plan showing all the fixed points he could find and measure (1973-15).[13]

Surveying in the 1974 season was directed by John L. Miller. Upon arriving at Gordion, he checked the surveying instruments kept at the site, and reported serious problems with the transit, the wye level, and the tripods (Miller et al. 1974–2004:1–11). He concluded that the problems with the wye level could be mitigated by constant adjustments, but the transit was beyond salvage. Unfortunately, these warnings appear to have been ignored and the instruments continued to be used in later years.

Miller prepared a 1:4,000 map (1974-1) based on Akok's 1950 site area map (1950-2), on which he recorded the data from his survey of the Sakarya River channel, including twelve fixed points that he had set up along the banks (their locations were also recorded on a 1:1,000 scale map: 1974-2).[14] At the end of the season he candidly evaluated his own work: "this survey is appallingly inaccurate due to time limitations and instrument problems. Resurvey is urgently needed." Regarding Akok's survey he remarked that it was "not correct, hence [the need for] extensive fudging with [the] equally unreliable 1974 survey data and [the] resulting, highly approximate drawings" (Miller et al. 1974–2004:1–11). Clearly, by this point the magnitude of the mapping problems was impossible to ignore, but no immediate attempt was made to remedy the situation. The project was thrown into turmoil that year by Young's sudden death, and over the next decade only minimal fieldwork was carried out at Gordion. The only noteworthy surveying development during this period occurred in 1979, prompted by the need to record newly exposed walls of several Middle Phrygian structures on the Citadel Mound (Buildings P, Q, X, and Y). The project hired the architectural firm of Lightbody, Smith and Bell, who proceeded to survey the Citadel Mound for extant fixed points, managing to locate 11 in all.[15] They then attempted to rebuild

the site grid using S26-S31 as the east-west baseline, finding in the process that the "survey grid appears to be incorrectly plotted—[it] should be shifted 1 m northerly"; but how they arrived at this conclusion is not specified in their notes (Miller et al. 1974–2004:12–26).

After a 13-year hiatus, major fieldwork was resumed at Gordion in 1988, under the direction of Mary M. Voigt. To prepare for this, she and Robert H. Dyson, Jr. (then the Penn Museum's director) conducted a preliminary reconnaissance in 1987, together with architect William C.S. Remsen, who prepared an assessment of the site's mapping corpus (1987). Remsen examined previous surveyors' reports, since he mentions those for 1963 (mistakenly assigned by him to 1967) and 1973. He also reviewed the surveying equipment stored on-site, warning that the wye level "has not been cleaned or adjusted in living memory and *should not* be used" (Remsen 1987, emphasis his). In addition to his report, he surveyed the limits of the previously excavated areas on the Citadel Mound and catalogued the visible fixed points, putting this information on a 1:500 map (1987-1). He also remeasured the points on Cummer's 1973 Point Plan, which, despite some discrepancies, he found to be generally accurate.[16]

These new measurements were used in the first of the new excavation seasons the following year, but the surveyor, Keith Dickey, noticed discrepancies between Remsen's elevations and his own. Uncertain as to the nature of the problem, Dickey decided to measure all the elevations for Voigt's operations relative to a single fixed point, M10 (see foldout), for which both sets of measurements concurred.

In 1992, Remsen returned to Gordion to carry out preparatory work for Voigt's excavations the next year. He established nine new permanent fixed points on the Citadel Mound (1992a–1992i), and he began the process of rebuilding the site grid, finishing it in 1993 (Remsen 1992, 1993). The reconstructed grid retained the original's spacing and orientation by using the extant fixed points and with the addition of at least one more (1993A). Remsen selected a new horizontal origin 2.5 km south and 2 km west of the Citadel Mound so as to avoid negative coordinates, and he established a new system of absolute elevations based on the Turkish geodetic marker on top of Küçük Höyük (no. 1482, 701.59 m above mean sea level). For the 1994 season he planned to extend the grid westward to cover Voigt's Outer Town excavations, but this was never carried out.

Despite Remsen's efforts, problems with the site's referencing promptly re-emerged in the next three seasons (1995–1997), when surveyor Sean Gaukroger attempted to tie Voigt's operations in the northwestern sector of the Citadel Mound to the site grid. Gaukroger discovered discrepancies between his own survey and the earlier maps and plans, but he remained confident in the accuracy of his own work, though without explaining why (Gaukroger 1995).[17] His investigations into the inconsistencies were thwarted by problems with the theodolite kept on-site, for despite cleaning the instrument he was unable to fix the errors that occurred when measuring long distances. Another problem that he noticed when tying in Voigt's excavations was that the distance between S26 and S26N30 was only 29 m, not the 30 m it should have been. With regard to S26 he discovered that there were actually two fixed points in that general location, less than 1.5 m apart (marked as S26 and C on the phase plan, see foldout). After testing both of these against other known fixed points, he concluded that he and Remsen had not been using the same one, and that the point he himself had been using was the one that was true-to-grid.[18] Consequently he decided that it was the location of S26N30 that was erroneous, and he appears to have been satisfied with his results, though it remains unclear whether he ever corrected his measurements (Gaukroger 1996). No further work on the grid was done either in that season or in the next.

Following a hiatus between 1998 and 2000, Voigt resumed excavation on the western area of the Citadel Mound in 2001. The points set out by Gaukroger were used by Carrie Alblinger to lay out new trenches and take elevations, and an additional fixed point was built in the Citadel Mound's northwestern sector by William Collins (M.M. Voigt, pers. comm. January 12, 2010). Two other excavation projects were also carried out on the mound, directed by Brendan Burke (in 2001, 2002, 2005, and 2006) and Andrew Goldman (in 1997, 2004, and 2005), under Voigt's ægis. Although the mapping information for these seasons is limited, it does not appear that the grid was extensively used (Miller et al. 1974–2004:37–39).

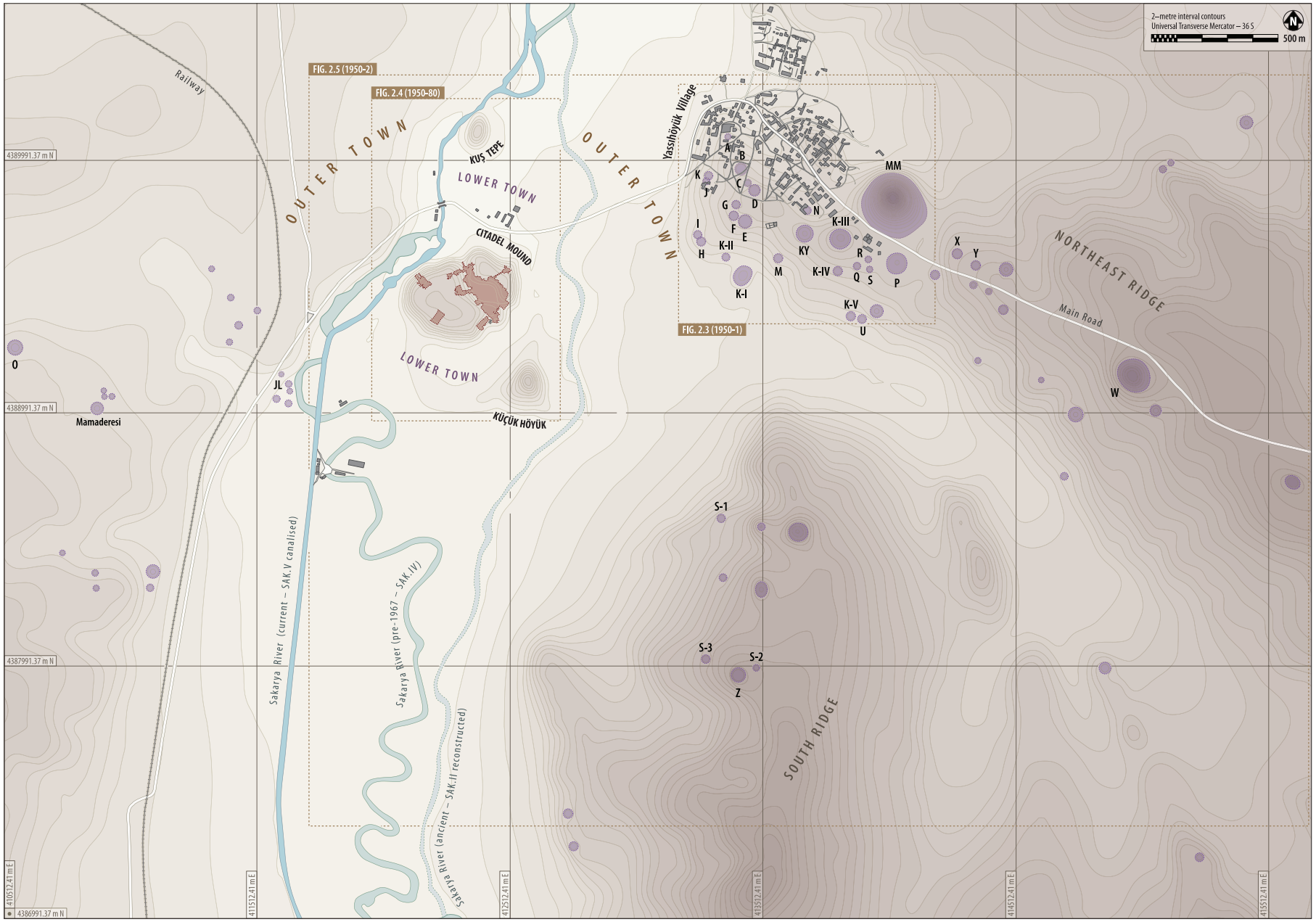

Fig. 2.1. New map of Gordion, showing select topographical and morphological components of the site, including: zones, tumuli (purple), the main excavation areas on the Citadel Mound (maroon), and the modern village of Yassıhöyük. The extents of the maps shown in Figures 2.3, 2.4, and 2.5 are also indicated. Source: G.H. Pizzorno and G. Darbyshire.

PLATE 1: FIG. 2.1

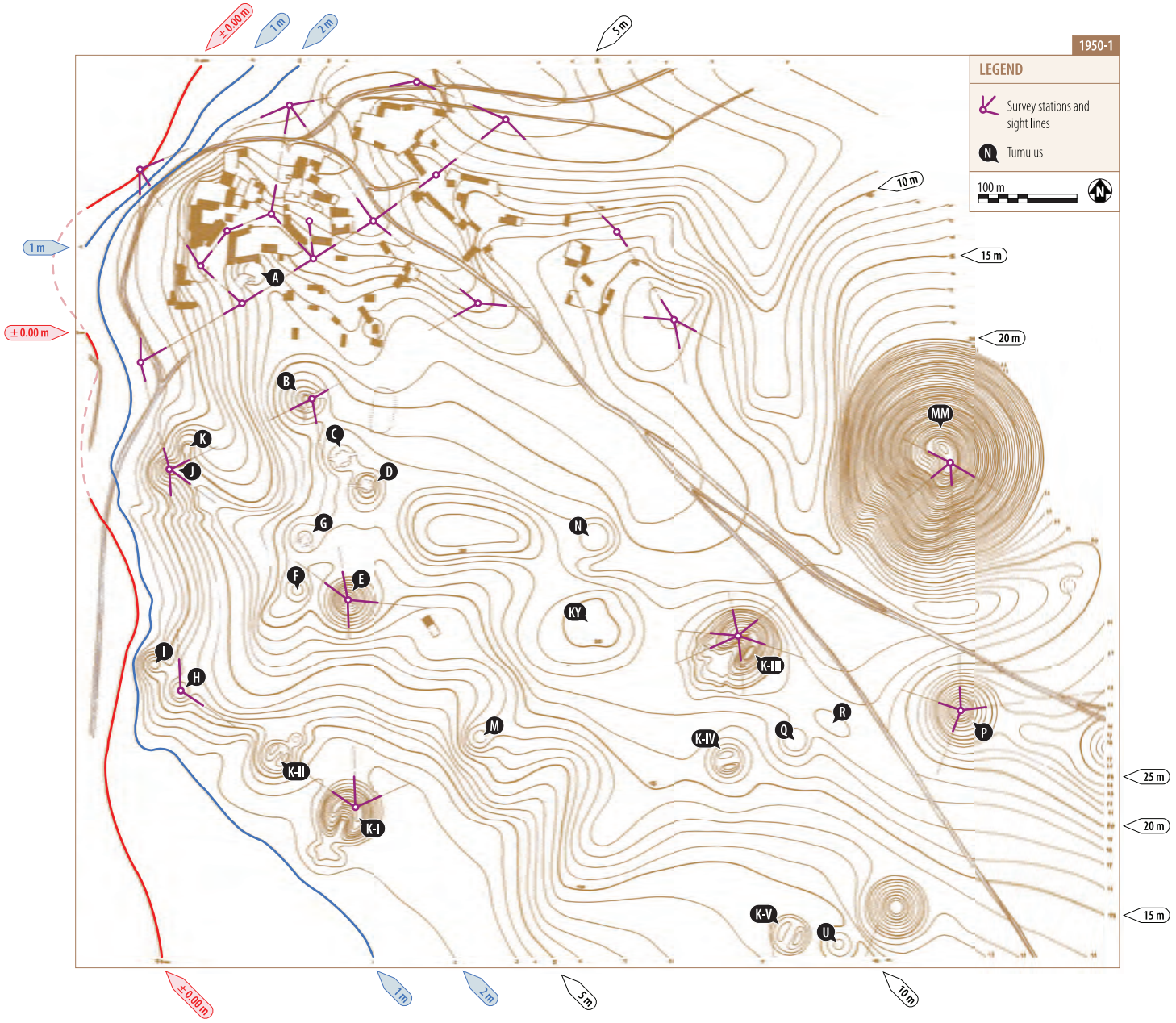

Fig. 2.3. Annotated version of Akok's map of the cluster of tumuli in the vicinity of the modern village of Yassıhöyük, on the Northeast Ridge (1950-1). The highlighted features are: the zero contour (red), the conflated 1 m / 2 m contour line (blue), and Akok's survey stations and sight lines. Compare with Figures 2.4, 2.5, and 2.6. Source: G.H. Pizzorno and G. Darbyshire.

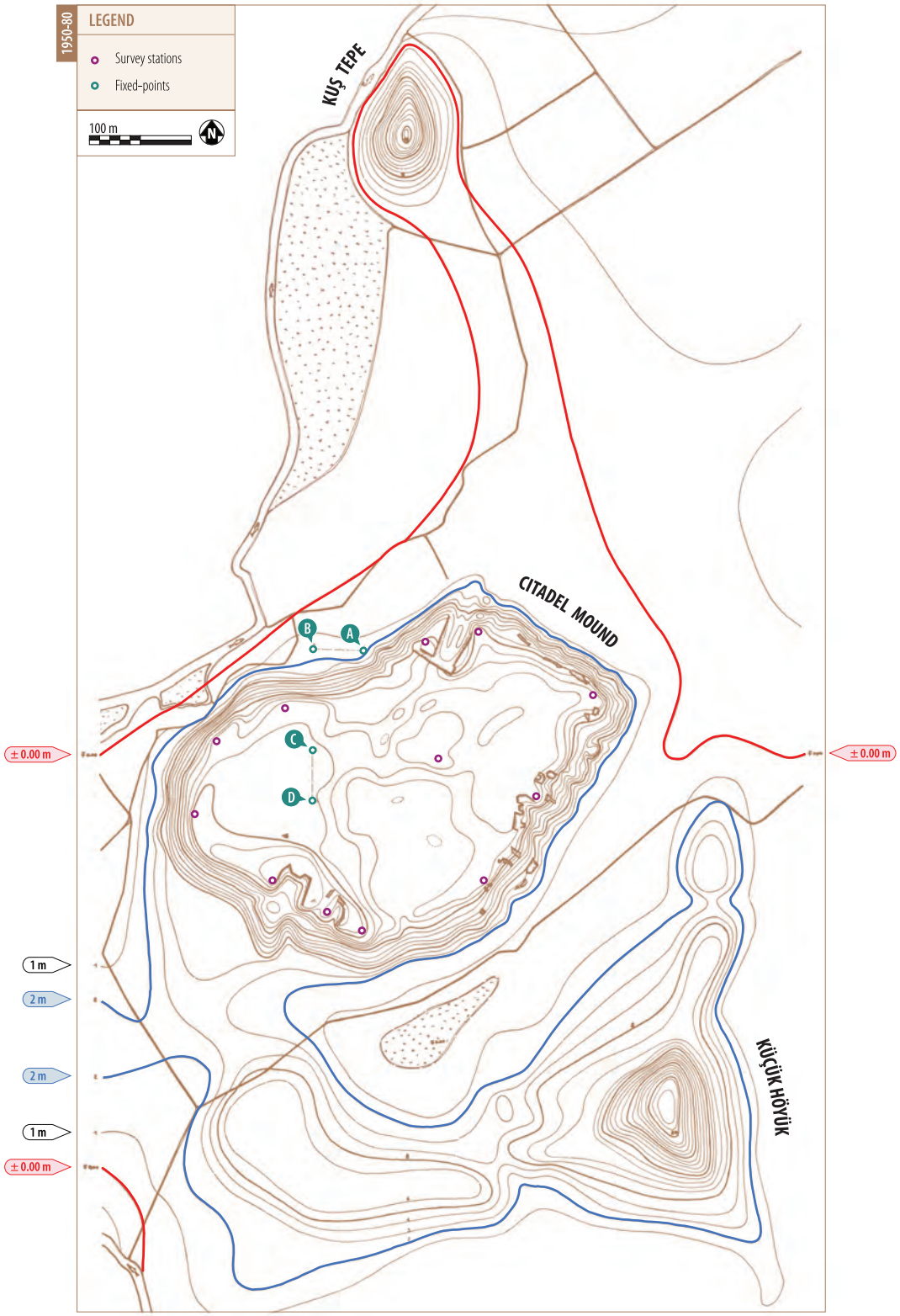

Fig. 2.4. Annotated version of Akok's map of the Citadel Mound, Kuş Tepe, and Küçük Höyük, prior to the 1950 excavations (1950-80). The highlighted features are: Akok's survey stations, his fixed points A–D, the zero contour (red), and the 2 m contour (blue). Compare with Figures 2.3, 2.5, and 2.6. Source: G.H. Pizzorno and G. Darbyshire.

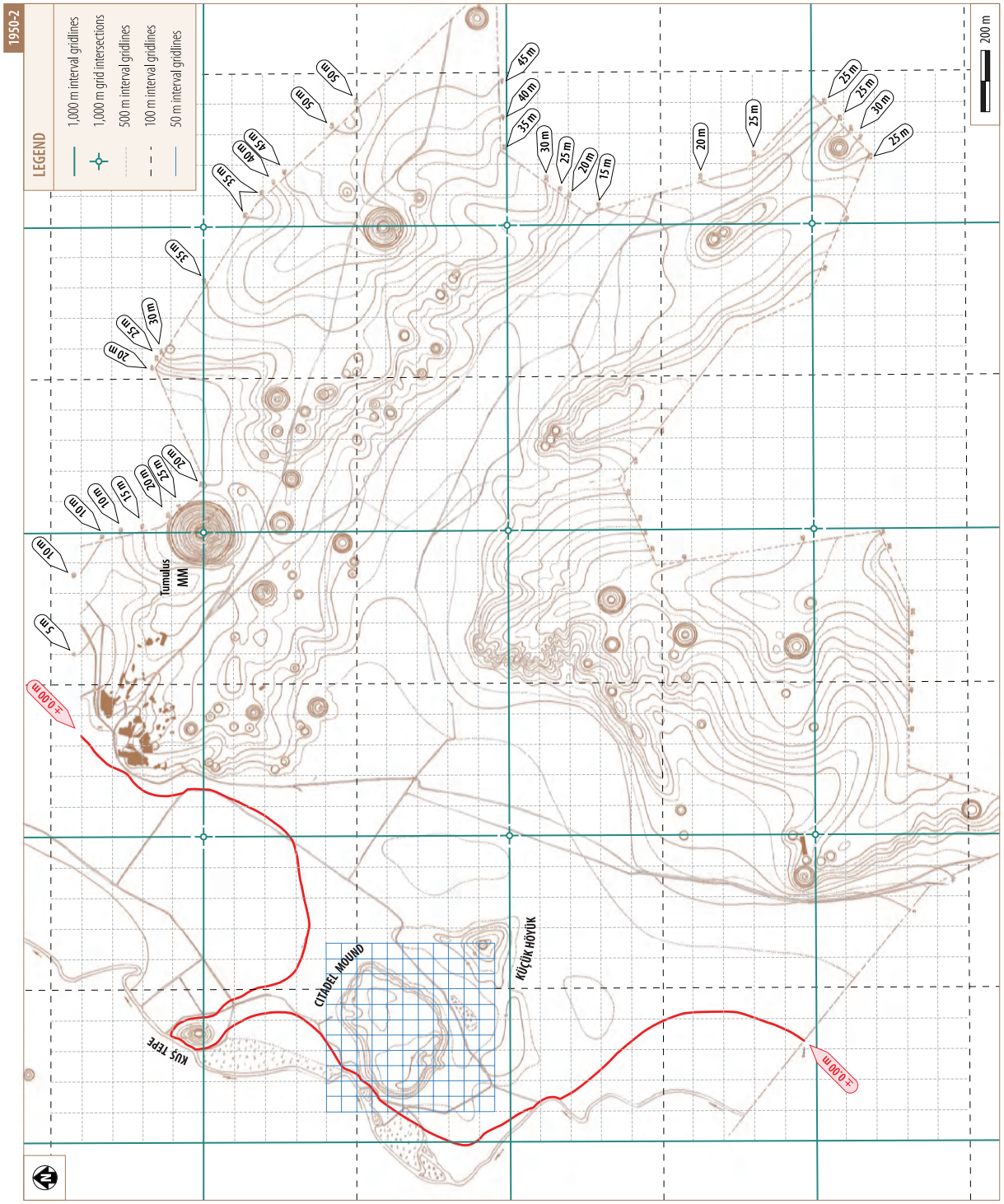

Fig. 2.5. Annotated version of Akok's site area map (1950-2). The highlighted features are his 1,000 m grid intersections, and the zero contour (red). Also included is a reconstruction of Akok's ideal site grid, with intervals of 1000, 500, 100, and, in the Citadel Mound area only, 50 m. Compare with Figures 2.3, 2.4, and 2.6. Source: G.H. Pizzorno and G. Darbyshire.

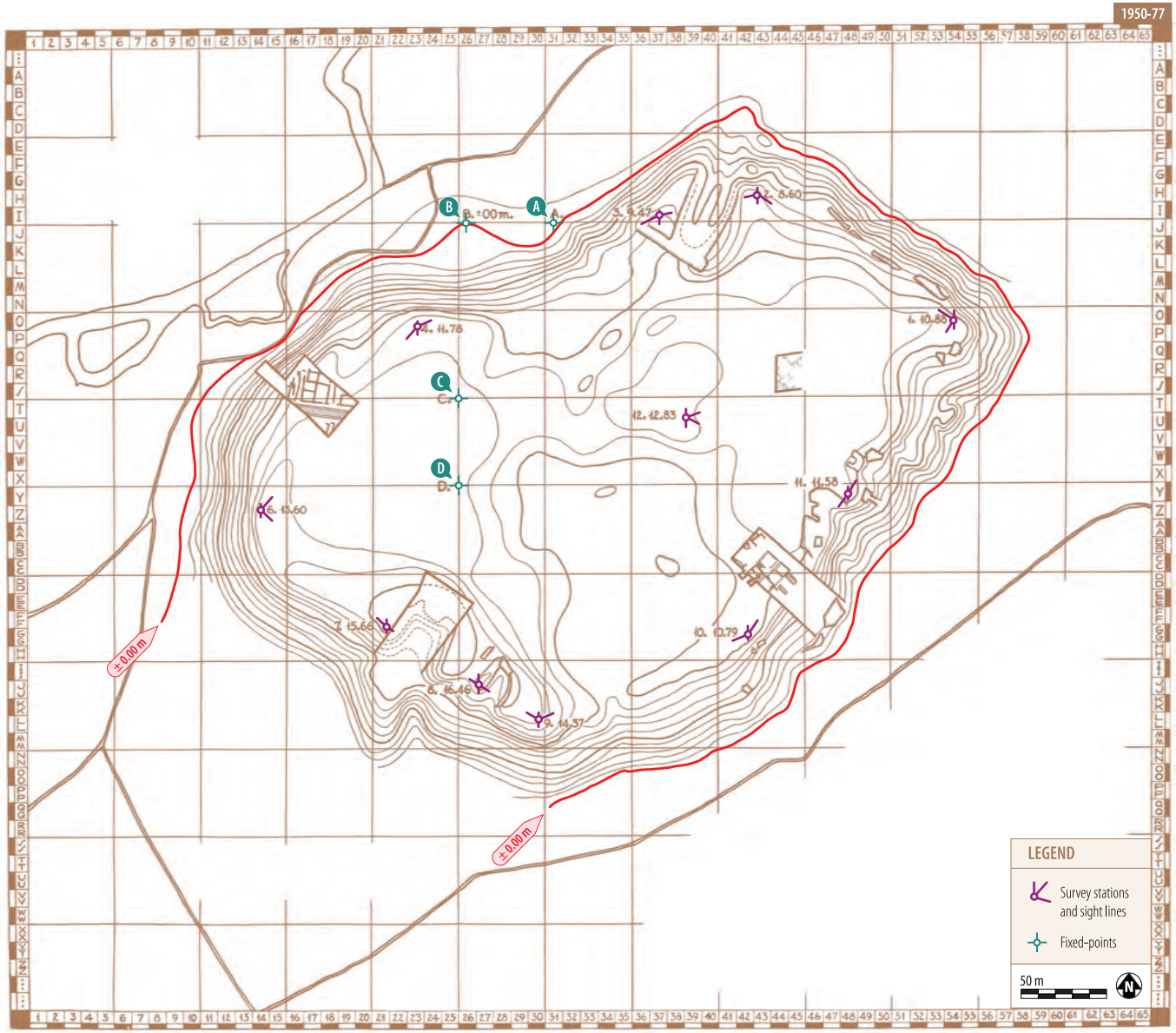

Fig. 2.6. Annotated version of Reed's inked map of the Citadel Mound (1950-77). The highlighted features are: Reed's new zero contour, formerly the 2 m contour (red); Akok's survey stations; and his fixed points A–D, as corrected by Reed. Compare with Figures 2.3, 2.4, and 2.5. Source: G.H. Pizzorno and G. Darbyshire.

Fig. 2.7. Annotated detail of map 1950-80 (cf. Fig. 2.4). The highlighted features are baselines AB and CD, and the 89-degree (i.e., not perpendicular) angle they form. Source: G.H. Pizzorno and G. Darbyshire.

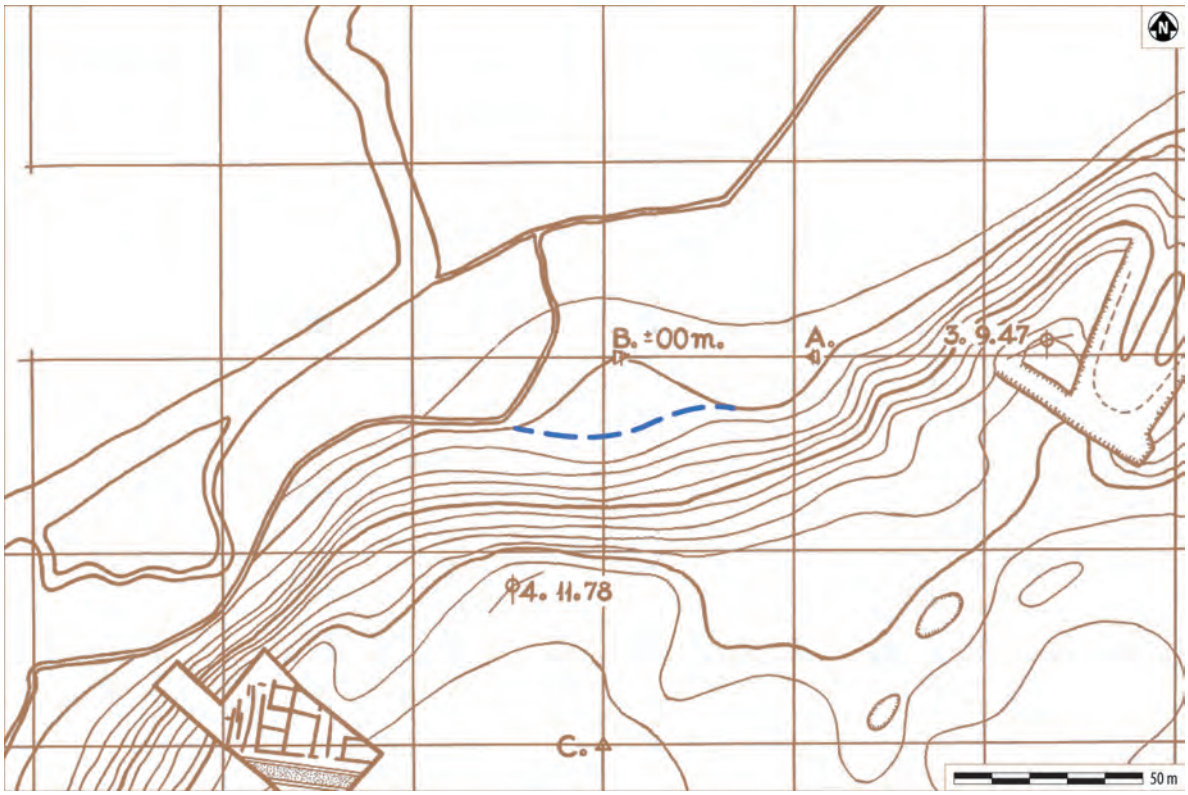

Fig. 2.8. Annotated detail of map 1950-77 (cf. Fig. 2.6), showing Reed's new zero line (formerly the 2 m contour) as redrawn to pass through fixed point B. The dashed blue line added to the original map indicates the tracing of the contour prior to Reed's alteration. Source: G.H. Pizzorno and G. Darbyshire.

Evaluating the Problems and Their Underlying Causes

Over the last 60 years the Gordion project has produced thousands of maps and plans, including state drawings, working versions and sketches, and hundreds of plans in the field notebooks. It is no easy feat to track mapping developments with so many drawings, created over such a long period of time by so many different people. However, the most serious issue is the quality of the plans, not their quantity. Individual drawings might appear to be of a standard commensurate with that of similar, coeval projects. The real problem only becomes apparent when one moves away from the single trench and tries to piece together larger areas of the site into a coherent whole. It is the absence of referencing information on most of the Young-era plans that is the most serious difficulty we have yet uncovered. Unreferenced plans lack any spatial information that would allow them to be connected to any other plan: they are "floaters" that cannot be easily or accurately pinned to an actual location on the ground.

The Nature of the Problems

During excavation and surveying, the main spatial referencing tool would have been the site grid (by itself an abstraction), and its reification on the ground: the fixed points. The purpose of a site grid is indeed to tie all loci to one spatial frame of reference. Unfortunately, the Gordion grid was rarely used, probably because it was never comprehensively articulated on the ground. It was only actually marked in one area—the Citadel Mound—and even there it was never established accurately or in any reliably durable manner. For areas beyond the Citadel Mound—the Lower Town and Outer Town zones, and the cemeteries—the excavation and survey data were referenced by eye to nothing better than Akok's flawed area maps. Indeed, Edwards (formerly Gordion's associate field director) subsequently revealed in a letter to Dyson (then director of the Penn Museum): "In the main the trenches were laid out…I think, by and large, without much of any reference to a grid which, as far as I know, was purely honorary" (1984). This statement is also supported by Remsen, who noted in his 1987 report that one of the most challenging aspects of mapping at Gordion "was the casual use and abandonment of the original grid." In fact, the only plans which show the site grid were either those made during the 1950 season, or later ones directly based on them. References to fixed points are notably absent on the more detailed plans of post-1950 vintage. While periodic attempts were made by the surveyors to re-establish the grid (e.g., Last in 1958, Cummer in 1973, and Remsen in 1993), the results were never satisfactory, and the grid fell again into disuse soon afterward.

In general, the surveying of archaeological features seems to have been referenced to temporary markers and the baulks of individual trenches. The grid only appears to have troubled the surveying team when it absolutely demanded consideration, especially when new trenches were to be opened in previously unexcavated areas of the Citadel Mound. Extensions to existing trenches seem to have been mostly "eyed-in", as noted by Cummer, "added from year to year to the original trench plan without their being surveyed from fixed points and with no consideration for scarp erosion" (1973). The site grid's representation on the ground, flawed from the moment of inception, was never rigorously re-examined. Even the most comprehensive attempt at fixing the errors, in 1993, was far too limited in scope, with Remsen comprehending neither the grid's abstract model nor the full range of problems that plagued its implementation on the ground.

The problems with the horizontal component of the mapping are reflected and compounded in its vertical aspect. There is no evidence to indicate that there was ever in place a functional, site-wide referencing system for elevations. As discussed above, each of the site maps created in 1950, and used exclusively thereafter, had a different vertical datum. Even within specific areas of the site, where the elevations could have been kept consistent, major problems exist with the altimetry. In the case of the Citadel Mound, the problems created by Reed's arbitrary redefinition of the contouring and elevations were never fully addressed. Remsen's report reveals that an undocumented attempt was made some time between 1963 and 1987, by "persons unknown," to re-base the elevations of the Citadel Mound on the original Akok datum (1987). But the result seems to have been the introduction of yet more confusion, as

the referencing was shifted from fixed points that had survived for years (e.g., point C')[19] to an assortment of ever-disappearing markers in the excavated areas (e.g., the TB series of fixed points).[20] The most comprehensive effort to unify the elevation system was again that of Remsen, who used the Turkish geodetic marker on top of Küçük Höyük (no. 1482) to tie the site's fixed points to a universal system of reference. Unfortunately, his assumption of internal consistency in the grid's implementation proved to be unfounded and, following the introduction of his new system in 1993, it was not long before problems began to be reported again (see discussion above). In addition, throughout the history of Penn's excavations at Gordion, there appears to have been persistent confusion among the surveyors with regard to the location and identity of the fixed points used for measuring elevations. Consequently, there is no unified, accurate altimetry for the Gordion Project's data. This state of affairs, when combined with the equally problematic planimetry, created a situation in which there was no reliable way to link features from different trenches, either vertically or horizontally.

A perfect illustration of how complicated matters became is the confusion surrounding fixed points C and S26, mentioned above. These two points are actually one and the same in the abstract site grid (the intersection of baselines S-T and 25-26), but they were somehow built twice on the ground in different locations, 1.5 m apart and with a vertical difference of 10 cm. This muddling had dire consequences, because the S26-S31 line was the one most frequently used as the basis for re-establishing the grid (such as when new fixed points were required). Thus, for example, in 1979, when Lightbody, Smith and Bell reinstituted the grid based on the S26-S31 line, they recorded that it was orientated 2° 42' west of magnetic north (Miller et al. 1974–2004:12–26). Yet in 1987, when Remsen re-established the grid using the same line, it was only 1° 45' west of magnetic north (Remsen 1987). This clearly indicates that they were each using a different point for their measurements, although both assumed that it was the true S26.[21] Consequently, the orientation of Lightbody, Smith and Bell's grid differs from Remsen's by almost a full degree. This might not seem much, but angular error increases with distance. Thus, for example, if we consider point N56 on the eastern edge of the Citadel Mound, its position in the two grids differs by almost 5 m. How many times this kind of situation arose in the course of Gordion's excavations is anybody's guess.

Lastly, even if the problems with the referencing could be ignored, there still remains the fact that the 1950 site area maps were never revised to keep pace with developments and they soon became outdated. Until our own research began, they remained the principal means of presenting Gordion's spatial layout, even though none of them accurately shows the archaeological and topographical details of the site as these came to be understood. In particular, the large tract west of the Sakarya River was never presented in detail, despite the fact that it includes a significant portion of the Outer Town as well as tumuli, ancient roads, and other remains (compare Fig. 2.5 with Fig. 2.1, and with our annotated satellite image in Darbyshire and Pizzorno 2009a:14).[22] In addition, many of the tumuli on the northern and northeastern perimeters of the settled area were never surveyed, and there was never a map showing all of the excavation trenches in the various settlement zones (Citadel Mound, Lower Town, Outer Town), tumuli, and other cemeteries.

Underlying Causes

Based on our review, several key factors emerge from the web of causality responsible for Gordion's mapping problems. One of the most glaring is that the surveying equipment was not well maintained. As we have seen, Miller in 1974, Remsen in 1987, and Gaukroger in 1996 all pointed out that the project's equipment was dirty or mechanically faulty. An illuminating example is revealed in a letter by Edwards: "DHC [Dorothy H. Cox, surveyor for the 1957 season] was unable to show this on her plan [of Building M], that is what was exposed last year, because of measurements from a faulty tape, I understand" (1958:3). More than once, surveyors strongly recommended that the project should establish a formal equipment-maintenance policy but, as far as we can tell, this was never done. Faulty equipment would naturally have led to surveying errors that are now extremely difficult to identify.

Despite Remsen's assessment that "much excellent work has been done over the years" (1987), the limited skill and carelessness of some of the surveyors

was a source of error, and from the very beginning of the project serious mistakes were made that were to have lasting consequences. These include a general lack of referencing on the maps and plans, and the occasional omission of scale and north arrow.

With regard to "north," it should be noted that inconsistency and imprecision in the designation of the cardinal points is widespread throughout the Gordion excavation corpus, and has continued to be a source of confusion. Besides the occasional use of magnetic north and, more rarely, true north, the excavators used two main orientation systems. In the Young excavations, the system for recording directions relied heavily on the use of "notebook north," sometimes called "notebook direction." Young arbitrarily selected true northeast to be used as north, so that, for example, the Phrygian megarons could be generally described as facing either north or south, whereas in fact they faced northeast or southwest. This system was used in Young's early publications, but starting with his 1968 report, magnetic north was employed. The Young excavation plans did not follow a consistent orientation, and there is usually no explicit indication of which "north" was being followed; in some cases north is not indicated on the drawings at all. In Voigt's excavations, the system employed was based on "dig east," which was marked as the point where the sun rises, and on "dig north," which was understood to be the general direction of the Sakarya River as seen from the Citadel Mound. Thus Voigt's "dig north" loosely corresponds to Young's west, or true northwest, so that the same megarons are described as facing east-west. The published plans from the Voigt excavations show magnetic north, which is also used in the accompanying written descriptions.

From the available documentation, it seems clear that it was the magnitude of the mapping tasks, in relation to the small number of personnel involved, that led to much of the confusion and many of the omissions and mistakes.[23] During the 1950 season, Akok was on-site for only two weeks, yet in that time he had to carry out two fundamental and substantial assignments: the creation of three site area maps, and the formulation and establishment of the site grid. Years later, Miller indicated in his 1974 report that time pressure was a major source of error in his own survey work. In addition to surveying, the mapping staff usually had to complete publication-ready plans in the field, and there was rarely enough time at the end of a season to review their work—neither on the ground nor on paper. To quote Cummer (1973:4):

> The worst aspect of our work was the "photo-finish," when we try to complete publication drawings within two days after digging stops. Inevitably mistakes are made and go unnoticed. There is no time for detail drawings and sections, no chance to study the structures for which we have spent three months and several thousand dollars to excavate. It would be more rewarding and more interesting for the staff to spend an extra two weeks together on the site, discussing the buildings and preparing careful drawings, rather than scattering and trying to piece work together later.

Some surveying staff also had other roles in the same season, such as trench supervisor or excavator, artifact illustrator, or architectural specialist, which in some cases may have distracted them from dealing with mapping issues as thoroughly as was required.

Young himself was also a factor. His determination to reach Iron Age levels meant that the remains of later periods were often not accorded the time and attention they deserved. The Hellenistic evidence suffered particularly as a consequence, with many buildings and associated artifacts being, at best, only rudimentarily mapped. As Edwards reported to Dyson: "(except in trenches I myself dug or supervised) so far as I know no [Hellenistic] levels were recorded and drawn by the architect. All others (still referring only to the upper levels) were, so far as I know, merely recorded in the notebooks" (1984). By contrast, the later excavations directed by Voigt placed equal weight on recording architectural, artifactual, and organic material of all periods.

Another problem was that continuity of mapping personnel does not seem to have been a high priority for the project. Less than half of them worked on-site consecutively for more than two seasons, and only Last worked as many as six.[24] As Remsen remarked in 1987, "much of the confusion seems to be due to the rapid turnover of architects at the site." He also highlighted another serious problem: the lack of documentation. The Gordion Project never established a policy for creating, main-

taining, and storing a comprehensive, and comprehensible, corpus of mapping records, and surveyors' reports were produced only intermittently. Remsen singled out the lack of documentation for the location and identification of fixed points as being the major reason why many of the markers had been lost or misidentified over the years (1987).

What is surprising, given the obvious complexity of the site, is that there were so few attempts to address the mapping challenges at Gordion, despite the warning signals highlighted in the extant surveyors' reports.

Articulating a Solution

During our initial evaluation of the status of Gordion's mapping corpus, carried out in 2007, we developed a strategy built around two key goals. The first was to salvage as much spatial information as we could from all past mapping activities, to allow us to produce maps and plans of the earlier work that were as accurate as possible. We came to realize that this could only be done with a holistic approach, wherein all types of available data are weighted and combined while carefully considering their levels of accuracy. The second goal was to institute a new best-practice mapping framework, to ensure that all present and future work at the site is properly referenced.

To accomplish these goals, it was essential that we first establish an absolute referential framework to which all spatial data (past, present, and future) could be anchored. Thus we decided to use as our absolute reference the Universal Transverse Mercator coordinate system (UTM), which provides a standard, worldwide framework for specifying locations on the surface of the Earth, and is therefore impervious to the problems of a custom site grid.

We then undertook the exhaustive archival research necessary to acquire a detailed understanding of the history of mapping at Gordion. As part of this process we realized that not all the extant surveying documentation had been accessioned into the Gordion Archive. A detailed search located many stray items (including surveyors' notebooks, other documents, and working drawings) in the dig-house at Gordion, which we subsequently transferred to the Penn Museum.

We then proceeded to identify the original errors and their causes, and to reconstruct the sequence of events outlined above. Armed with this knowledge, we devised a fieldwork strategy to obtain accurate UTM coordinates for key features on-site, in order to guide the referencing of the original plans and maps. These features included fixed points used in the past, as well as extant architecture and excavation trenches.

Regarding the fixed points, many of these had long been considered lost. However, our research enabled us to locate many of them through the use of a predictive model that we tested on-site in 2008. Some of the markers were in fact still extant on the surface (although hardly visible), while others we had to unearth because they had been buried at different times in the past for a variety of reasons. By measuring their coordinates, we were at last able to produce a map of the key fixed points referenced to a single coordinate system (see foldout).

With regard to the visible architectural features and excavation trenches, the Penn 2010 balloon and dGPS survey served the dual purpose of providing us with a fully referenced map of extant architecture in key areas of the site, and over 1,500 control points to further improve the referencing of our imagery.

Resurvey alone is insufficient, however, since most of the excavated remains, and many of the trench outlines, no longer survive (the most obvious exception being the Early Phrygian Destruction Level). To address this issue we designed a Geographic Information System (GIS), centered on a series of "snapshots" comprised of aerial photographs and satellite images taken at different times over the last 60 years. These snapshots, when properly geo-referenced into the GIS, provide spatial cues for aligning the plans of trenches and structures from the excavations. This work began in late 2008, the basis for the geo-referencing being a QuickBird satellite image, which had been rectified using SRTM-30 data (Shuttle Radar Topography Mission) in partnership with NASA/Goddard Space Flight Center. In 2010 we enhanced the accuracy of the image by using the control points surveyed on-site with a dGPS unit, as noted above.[25] The rest of the available imagery, including Turkish aerial photographs from 1959 and the balloon photographs from 1989 and 2010, were then rectified against the QuickBird image.[26]

In 2009–2010, we used a University of Pennsylvania Research Foundation grant (URF), awarded to the authors in collaboration with Brian Rose and Philip Sapirstein, to create the Digital Gordion Mapping Project (DGMP). Under our supervision, a team of five Penn students scanned the original maps and plans, and these scans together with the drawings' metadata were systematized and integrated into a custom-built database. The team then used the GIS to reference the scans against features visible either in the current or in the legacy imagery, or against other maps and plans that had already been aligned. Once this work has been completed, vector maps and plans of the site will be constructed from the rectified data.

Phase Plan of the Phrygian Citadel

During the rectification of the imagery in 2008, we conducted a series of trials to establish the best workflow for processing the maps and plans. As part of this exercise, we carried out a preliminary referencing of many of the Citadel Mound drawings. The accuracy of the results was inevitably limited, since at that time we lacked not only the more precise spatial data but also the in-depth knowledge of the history of surveying at Gordion that we later came to acquire. Nevertheless, the results allowed us to generate far more accurate plans of the architecture than were hitherto available. Over the course of the following two years we developed the capability to map the key architectural phases in accurate relation to each other. Some of the results of this work are presented here as a large color foldout phase plan of the Citadel Mound. This particular format was suggested by Brian Rose, who wanted something similar to the phase plan of Troy published by Hueber and Riorden (1994). To be consonant with the chronological span covered by the present volume, the plan is restricted to the Early (YHSS 6), Middle (YHSS 5), and Late (YHSS 4) Phrygian periods, omitting the architectural data for the Early Bronze Age, the Early Iron Age, and Hellenistic, Roman, and later times.

The production of an archaeological phase plan is far more than a cartographical exercise. It involves a substantial amount of archaeological research and interpretation because mapping introduces a broad range of questions and problems, especially in terms of spatial and chronological relationships between different elements. Improving the accuracy of Gordion's spatial representations has forced us to re-evaluate many old issues, and deal with new ones that have arisen. In addressing them, we have necessarily had to return to all the primary sources—maps and plans, field notebooks, reports, and photographs—to verify and refine our interpretations.

This research has given us a clearer understanding of architectural relationships, leading to a number of important new archaeological interpretations, some of which are annotated on the plan. A good example is the Late Phrygian "Mosaic Building," a complex inserted into the southwestern corner of the citadel, on top of the demolished remains of Middle Phrygian Building A, and so-called because of its ornate pebble mosaic floors. For the first time, the structural components found in the many excavation trenches in this area have been accurately correlated and aligned. This remapping has indicated that a major wall of the Mosaic Building is actually coaxial with a more distant wall fragment whose identity had long been in doubt, allowing us to posit that the complex could have been much larger than previously assumed.

Our research has also enabled us to include architectural reconstructions in those areas of the Citadel Mound not yet explored by excavation. These reconstructions are an aid to appreciating spatial relationships, and also serve as a predictive tool for planning future excavations and geophysical surveys. They are feasible because of the regularity of the spatial patterning apparent in some of Gordion's architectural layouts, especially in the Early and Middle Phrygian periods. Although the final phase of Early Phrygian is the best preserved and currently the best understood, the Middle Phrygian layout is more extensively attested and its general similarity to the preceding Early Phrygian setup has allowed us to plausibly extrapolate the plans of both periods. Furthermore, while only relatively short stretches of the citadel enclosure's outer walls have been excavated, these are enough to indicate the general extent of the enceintes, and we have offered new reconstructions.

Besides the cartographical and archaeological issues of the phase plan, there are many design considerations

that we have had to resolve. A great deal of thought has been given to appearance and presentation. We tested dozens of combinations of color schemes, line widths and typefaces, as well as other graphic elements. Throughout the design process, our primary goal was to maximize readability and usability. Given the great density of information on the plan, we wanted to ensure that the reader would not be overwhelmed by visual clutter. Quite often this meant having to emphasise one element of the plan over another. In some cases it was comparatively easy to decide which elements to prioritize. For example, placing the emphasis on excavated rather than extrapolated architecture was clearly preferable, and therefore actual excavated remains are represented on the plan with solid colors and lines while reconstructions are shown with semi-transparent colors and dashed lines.

A multi-phase plan presents particular design difficulties because of the great density of graphically overlapping information. A major issue was the selection of a color scheme to represent the architecture's diachronic dimension. Our intention was to make both phasing and periodization easy to comprehend. However, after exploring a variety of color schemes, we realized that the overall complexity made it impossible to emphasize both aspects equally. We therefore decided that architectural units spanning more than one phase would be best represented using color banding, which shows both the phase in which a structure was built (the broader bands) and its final phase (the narrower bands). Furthermore, to enhance the legibility of the banding, it made sense to maximize the contrast between the different phase colors. It also made sense to assign varieties of the same color to phases of the same period, to emphasize their relationship. Unfortunately, these individual color schemes did not work well together. On the one hand, the overly similar colors substantially reduced the contrast between the background and the banding, and thereby de-emphasized the phases. On the other hand, the widely differing colors dramatically increased the complexity of the presentation, and made the visual grouping of phases into periods an almost impossible task. Ultimately, we decided that it was preferable to emphasize the periods at the expense of the phases, since the former are the higher-level and more familiar analytical units at Gordion. Thus, all phases within a period share the same hue but vary slightly in lightness and saturation. The intended effect of this color scheme is that the reader readily discerns the periods at a glance, while the phases only become apparent upon closer scrutiny. To follow the phase changes within a particular period is therefore a much more involved exercise, but we assume that anyone interested in such detail would naturally expect to encounter a greater deal of complexity.

Conclusions

The process of resolving the mapping problems at Gordion outlined in this chapter should be considered a work in progress. Even though significant advances have been made, there is still much to be done. Nevertheless, analyses such as the phase plan that accompanies this volume highlight the potential of our approach for addressing Gordion's mapping quandaries. We hope that the publication of the phase plan will facilitate the work of Gordion researchers by providing them with an improved visualization of the spatial, functional, and chronological complexities of the Phrygian architecture on the Citadel Mound. Furthermore, the methodologies we are continuing to develop may be applicable to other archaeological sites with similar analytical difficulties, making Gordion a model for reconstructing and managing archaeological cartography.

NOTES

2.1. Surveyors' reports were prepared for the 1963, 1973, 1987, 1992, and 1993 field seasons (Williams 1963; Cummer 1973; Remsen 1987, 1992, 1993). Surveyors' logs survive for the seasons of 1955, 1956, 1958, 1959, 1974, 1979, 1980, 1987, 1989, 1996, 1997, and 2004 (Last 1955–56, 1958–59; Miller et al. 1974–2004; Gaukroger 1995, 1996, 1997). Note that at Gordion, the surveyors were often trained as architects, and the terms surveyor and architect were used interchangeably.

2.2. Reports on the excavations can be found in: DeVries 1990; Edwards 1959, 1963; Kohler 1980, 1995; Young 1950, 1951, 1953, 1955, 1956, 1957, 1958, 1960, 1962a, 1964, 1966, 1968, and 1981.

2.3. Reports on the fieldwork can be found in: Sams 1992, 1994c, 1996, 2002, 2005b; Sams and Burke 2008; Sams, Burke and Goldman 2007; Sams and Goldman

2006; Sams and Voigt 1990, 1991, 1995, 1997, 1998, 1999, 2003, 2004; Voigt 1994; Voigt et al. 1997.

2.4. The numbers in parentheses after a map indicate the Gordion Archive identification number for that map. The first four digits indicate the year in which the map was produced; the number after the dash is a sequential number assigned for archival purposes, and does not necessarily indicate the chronological sequence in which the maps were produced. The full references for the maps and plans mentioned in the present chapter are:

1950-1: Gordion, General Plan of Site and Central Tumulus Area (1:1,000), by Mahmut Akok

1950-2: Gordion, Topographical Survey (1:4,000), by Mahmut Akok

1950-77: General Plan of Citadel Mound Showing 1950 Trenches (1:500), by Edward B. Reed

1950-78: General Plan of Citadel Mound Showing 1950 Trenches [draft] (1:500), by Edward B. Reed

1950-80: Survey of Citadel Mound Area (1:1,000), by Mahmut Akok

1967-1: Outline of Trenches on Citadel Mound (1:200), by Joseph W. Shaw

1973-15: Point Plan (1:500), by Wilson W. Cummer and Fritz Hemans

1974-1: Survey of Entire Site and Preliminary Reconnaissance of Ancient Road and Sangarios Crossing (1:4,000), by John L. Miller

1974-2: Survey of Citadel Mound and Preliminary Reconnaissance of Ancient Construction in Sakarya Channel (1:1,000), by John L. Miller

1979-1: Survey Control: Archaic Level (1:500), by Bruce Lightbody, Richard Smith, and Robert Bell

1987-1: Limits of Excavation (1:500), by William C.S. Remsen.

2.5. In an apologetic note added to the draft, Reed informed Young that the reason for the omission was because he had "no sun print or record of [the] whole area." This indicates that Akok did not leave all of his work at Gordion after he left the site—and indeed, his three extant maps are labeled "Ankara, 1950," though they made their way to the Gordion Archive soon afterward (map 1950-2 was published in Young 1950). It might also suggest inadequate communication between Reed, Akok, and Young, although the extent to which the surveyors overlapped on-site is unclear.

2.6. A "sunprint" is a facsimile of a drawing, produced by chemical means. It was commonly used to create quick working copies of plans and maps.

2.7. The Körtes' vertical datum is indicated on their map at a point southwest of the Citadel Mound. See Fig. 2.2.

2.8. At its most basic, a contour is a line that connects points of the same elevation. In order to accurately represent terrain configurations to the naked eye, successive lines must show a fixed difference in elevation ("interval") between them. Thus, if the contour interval for a map is said to be 2 m and one is looking at the 6 m contour, the next lines up and down from it will be the 8 m and the 4 m contour respectively. If this basic principle does not apply, then the lines are not contours.

2.9. Dorothy Cox's work was very poorly documented, and in the absence of any surveying notes or reports it must be deduced from her drawings and from scattered references in later sources. The documentation for Last's work is rather better. His working drawings and two of his surveying notebooks are in the Gordion Archive (Last 1955–56, 1958–59). Unfortunately, the notebooks were mostly used as scratch paper, filled with calculations and lists of distances and elevations without a narrative, and so extracting information from them is a difficult task.

2.10. Points E and F were built along the same east-west line as point D (gridline X-Y), on the intersections with lines 30-31 and 35-36, respectively. Points G and H were built along the same east-west gridline as point C (gridline S-T), at the intersections with lines 30-31 and 35-36, respectively. Finally, point J was built at the intersection of gridline N-O with line 35-36 (see foldout).

2.11. His notes, while very incomplete, show that he set up fixed points G2, I, and K (see foldout).

2.12. The 1967 trench plan (and all trench plans based on it) is severely flawed, to the extent that the total area covered by the drawn trenches is almost 10% larger than the real area of excavation as measured on the ground.

2.13. Cummer's plan also renamed the fixed points: C became S26, and G, H, I, and K became S31, S36, S41, and N41, respectively. Cummer also plotted the points that he had added himself in previous seasons, including S31N30 and S26N30 (located not at grid intersections, but rather 30 m north of the S-T line on the 25-26 and 30-31 baselines, respectively), as well as fixed points N56 and WCW (see foldout).

2.14. The new fixed points were partly based on the Turkish geodetic marker on top of nearby Kuş Tepe, and were identified with a 2-digit year plus letter designation: 74A to L.

2.15. Of the 11, they could only identify 9: A, N41,

N56, G2, S26, S26N30, S31, S31N30, and WCW (see foldout). The points were plotted in schematic form on map 1979-1.

2.16. The discrepancies that Remsen found included the locations of the following fixed points: S26N30 (which was in fact 28.2 m due north of S26, rather than 30 m); N56 (3.2 m north of the east-west grid line, rather than on it); and N41 (15 m from the east-west grid line where it should have been). The discrepancy in the position of S26N30 (more than a meter south of its intended position, as also independently noted by Gaukroger in 1996) could account for Lightbody, Smith and Bell's suggestion in 1979 that the grid ought to be moved a meter northward.

2.17. The earlier drawings exhibited a slightly different north orientation compared with Gaukroger's, and their positions were shifted on the grid, both on the north-south and the east-west axes.

2.18. One of the points is marked by a round concrete installation featuring a bent iron rod aligned roughly east-west. Gaukroger believed this one to be S26 and true-to-grid. The other marker is a form-built concrete pylon, newer in appearance, with a nail in the top. Gaukroger erroneously believed that it had been built in 1979 (without explaining why) and he offered no indication as to its identity (1996).

2.19. It was probably at this time that a fixed point designated as C', located at the northwestern angle of the Middle Phrygian Gate Complex, began to be employed as vertical datum. It would continue to be used into the 1960s.

2.20. One of many examples of this state of affairs is a note written by Cummer in 1969, in which he states that his "elevations from M-3 [Megaron 3] point I (4.601) are regularly 0.14 m lower that those of A. Trik [in] 1965 and about 0.20 m higher than those of C. Williams [in] 1963."

2.21. The only other possible cause for the 57-minute arc discrepancy, barring surveyor's error, would be magnetic declination. This, however, is not the case, as the difference between the magnetic declination at Gordion in 1979 (3° 23' E of true north) and 1987 (3° 37' E of true north) is only 14 minutes.

2.22. The area west of the river was presumably omitted from the 1950 maps because it was, and still is, outside the Gordion Project's official zone of investigation (even though occasional rescue excavations have been permitted there by the authorities).

2.23. From information in the Gordion Archive we have reconstructed the list of mapping personnel who worked at the site, including at least 14 chief surveyors. The number of staff working at any one time was small: usually just a head surveyor, sometimes with one or two assistants.

2.24. The surveyors who spent three seasons or more at Gordion are Cox (1951–1953, 1957), Last (1955–1956, 1958–1962), Williams (1958, 1961, 1963), Cummer (1969, 1971, 1973, 1980), Remsen (1987, 1992–1994), and Gaukroger (1995–1997).

2.25. dGPS measurements are usually accurate to within 2 cm of the true global coordinate of a point.

2.26. This initial work could not have been accomplished without the help of Eileen Vote, to whom we are extremely grateful.

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The Archaeology of Phrygian Gordion, Royal City of Midas

C. Brian Rose, editor

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