

13 · Roman Large-Scale Mapping in the Early Empire

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We have already emphasized that in the period of the early empire¹ the Greek contribution to the theory and practice of small-scale mapping, culminating in the work of Ptolemy, largely overshadowed that of Rome. A different view must be taken of the history of large-scale mapping. Here we can trace an analogous culmination of the Roman bent for practical cartography. The foundations for a land surveying profession, as already noted, had been laid in the reign of Augustus. Its expansion had been occasioned by the vast program of colonization carried out by the triumvirs and then by Augustus himself after the civil wars. Hyginus Gromaticus, author of a surveying treatise in the *Corpus Agrimensorum*, tells us that Augustus ordered that the coordinates of surveys be inscribed on the corners of “centuries” and that he fixed the width of main, intermediate, and subsidiary roads within centuriated areas (fig. 13.1).

The early empire was marked by a further expansion, codification, and upgrading of the role of the land surveyors (*agrimensores*) working for the Roman state as well as of that of surveyors on other applications of large-scale mapping in the towns and in engineering projects. As Roman influence spread, more public domains were to be divided up and more colonies founded. Centuriation, the division of land into centuries by surveying, was, as earlier, being applied particularly to colonies consisting of settlements of smallholders with allocations of land. That the demands on the land surveyor were truly immense can be appreciated from the size of some of the new schemes for centuriation. The most important to be initiated under Tiberius—which, we may presume, led to mapping—was the centuriation of a vast area of Roman North Africa corresponding to the mid-south of Tunisia. Some idea of the dimensions may be obtained from surviving centuriation stones,² which extend as far as the Chott el Fedjedj, the Bled Segui, and Graïba. There were at least 140 centuries to the right of the *decumanus maximus* and at least 280 beyond the *kardo maximus*, which places the farthest centuriation stone, in all probability, nearly 200 kilometers beyond the *kardo*. No remains of survey maps have been found from this scheme.

A further stimulus to large-scale surveying and mapping practice in the early empire was given by the land reforms undertaken by the Flavians. In particular, a new outlook both on administration and on cartography came with the accession of Vespasian (T. Flavius Vespasianus, emperor A.D. 69–79). Born in the hilly country north of Reate (Rieti), a man of varied and successful military experience, including the conquest of southern Britain, he overcame his rivals in the fierce civil wars of A.D. 69. The treasury had been depleted under Nero, and Vespasian was anxious to build up its assets. Frontinus, who was a prominent senator throughout the Flavian period (A.D. 69–96), stresses the enrichment of the treasury by selling to colonies lands known as *subseciva*. These were of two types, either areas remaining between square or rectangular centuries of allocated land and the outer boundary of the land in question, or unallocated portions of centuries.

A similar tightening of the land regulations by Vespasian resulted in the only official Roman survey maps that have come down to us, the cadasters of Arausio (Orange). It is also thought that there was in the Flavian period a predecessor of the official plan of Rome, the *Forma Urbis Romae*,³ and the collection of surveyors’ manuals known as the *Corpus Agrimensorum*, although it contains manuals and extracts from quite different periods, may owe its real origin to treatises composed in the first century A.D. If we bring these strands together, it can be shown that the early empire is the key period in our understanding of the history of classical large-scale cartography.

1. Defined broadly to include the period from the emperor Tiberius (A.D. 14–37) to the emperor Caracalla (A.D. 211–17).

2. *Corpus Inscriptionum Latinarum* (Berlin: Georg Reimer, 1862–), vol. 8 suppl., pt. 4 (1916): nos. 22786 a–m, 22789.

3. Gianfilippo Carettoni et al., *La pianta marmorea di Roma antica: Forma Urbis Romae*, 2 vols. (Rome: Comune di Roma, 1960).

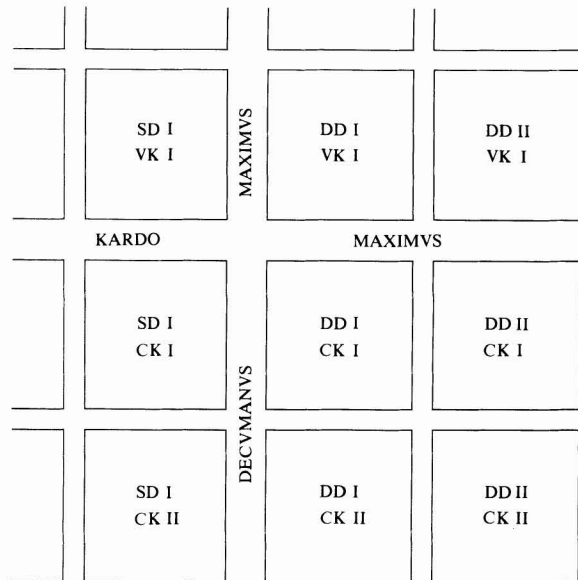


FIG. 13.1. THE METHOD OF NUMBERING CENTURIES. SD = *sinistra decumani* (to left of *decumanus maximus*), DD = *dextra decumani* (to right of *decumanus maximus*), VK = *ultra kardinem* (beyond *kardo maximus*), CK or KK = *citra kardinem* (near side of *kardo maximus*). These abbreviations were carved on the boundary stones identifying the areas. After O. A. W. Dilke, *The Roman Land Surveyors: An Introduction to the Agrimensores* (Newton Abbot: David and Charles, 1971), 92.

SURVEY METHODS OF THE AGRIMENSORES⁴

The principal Roman surveying instrument was called the *groma*.⁵ It was used in military as well as civilian surveying, and its origin has been traced back to Egyptian practice.⁶ Since the *Corpus Agrimensorum* does not give a picture of the *groma*, we have to rely on other sources such as the tombstone of a Roman surveyor, Lucius Aebutius Faustus, dating to the first century B.C., with a relief depicting his profession (fig. 13.2). Below the inscription is a dismantled *groma* or *stella*, with a staff 73 centimeters long and crossarms 35 centimeters. The representation is only schematic, however, and is difficult to interpret. The only example of what is believed to be an actual *groma* was found in 1912 during the excavations at Pompeii. Its metal parts were discovered in the workshop of a surveyor called Verus (fig. 13.3).⁷

The *groma*, a forerunner of the later surveyor's cross,⁸ fulfilled the vital need in centuriation for an instrument to lay out long lines at right angles to each other. The cross was placed on a bracket, rather than directly on the staff, to avoid obstruction when sighting from one plumb line to another. The method of operation was for



FIG. 13.2. INSCRIPTION ON A ROMAN SURVEYOR'S TOMBSTONE. Dating from the first century B.C., this tombstone indicates the profession of Lucius Aebutius Faustus by the schematic diagram, below the inscription, of a dismantled *groma*. Ivrea, Museo Civico. From Hermann Schöne, "Das Visirinstrument der Römischen Feldmesser," *Jahrbuch des Kaiserlich Deutschen Archäologischen Instituts* 16 (1901): 127–32, pl. 2.

4. Carl Olof Thulin, ed., *Corpus Agrimensorum Romanorum* (Leipzig, 1913; reprinted Stuttgart: Teubner, 1971), only one volume published; Friedrich Blume et al., eds., *Die Schriften der römischen Feldmesser*, 2 vols. (Berlin: Georg Reimer, 1848–52; reprinted Hildesheim: G. Olms, 1967); O. A. W. Dilke, *The Roman Land Surveyors: An Introduction to the Agrimensores* (Newton Abbot: David and Charles, 1971).

5. Dilke, *Roman Land Surveyors*, 66–70 (note 4), gives a full description of this instrument and also refers to the Grecian star (*stella*), which was hand-held.

6. Edmond R. Kiely, *Surveying Instruments: Their History* (New York: Teachers College, Columbia University, 1947; reprinted Columbus: Carben Surveying Reprints, 1979), 13–14.

7. For a fuller description see Dilke, *Roman Land Surveyors*, 69–70 (note 4).

8. See P. D. A. Harvey, "Local and Regional Cartography in Medieval Europe," chapter 20 of this volume, pp. 464–501.

the surveyor to plant the *groma* in the ground, keeping the center of the cross one bracket length away from the required center of survey. He then turned it until it faced the required direction, which he had ascertained be-

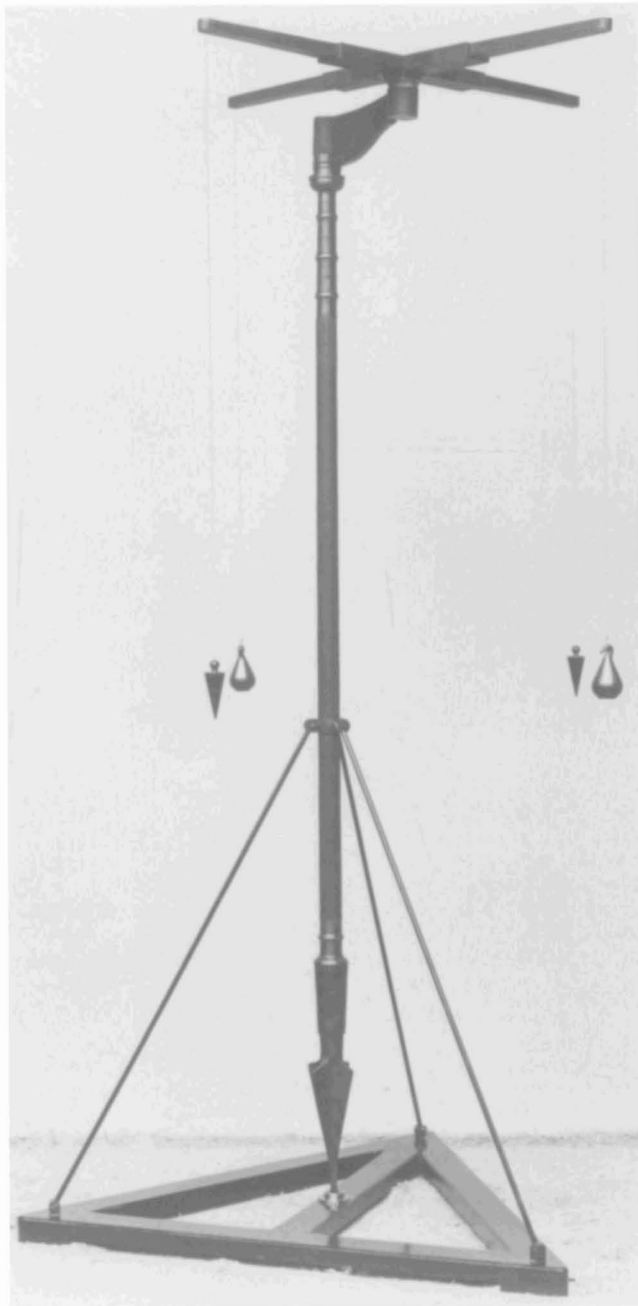


FIG. 13.3. RECONSTRUCTION OF A GROMA. This is a replica of the only original *groma* in existence (the original is in the Archaeology Museum, Naples). This Roman surveying instrument for laying out right angles was preserved in the Pompeii workshop of a surveyor named Verus. The triangular support and base are of modern design. Conjectured height of the original: 2.06 m. By permission of the Trustees of the Science Museum, London.

forehand, finding south either by means of a portable sundial (figs. 13.4 and 13.5) or by observing shadows.⁹ Sighting was done by looking from one plumb line to its opposite number, the plumb bobs being grouped into pairs to avoid confusion. Sights could be set onto a second *groma*, positioned first perhaps one *actus* (35.48 m) away, then a similar distance from the first and second *gromae* at right angles. The square would then be completed and cross-checks taken. The *groma* thus had only a limited use: it enabled straight lines, squares, and rectangles to be surveyed. But these were exactly what the *agrimensor* normally required, and more complicated equipment was unnecessary on a straightforward survey.¹⁰

Assuming these basic instruments were used, we can also reconstruct how the survey proceeded in the field. The usual method of recording allocations was for the land surveyor to divide up the apportioned land, draw lots for the landholdings, and take the settlers to their lands. He also had to make a map (*forma*) of any land he had so divided and compile a register of it. A field notebook must have been used, and one can only surmise that draft maps and notes were executed on wax tablets or on papyrus (later on parchment or vellum): probably size was the determining factor. The longer-term record in bronze would be prepared by the appropriate craftsmen.

The unit of measurement was the *actus* of 120 Roman feet, in origin the distance that oxen plowed before the plowman turned them. The standard Roman foot was 29.57 centimeters, so the standard *actus* was 35.48 meters, but variations are encountered. The measurements of area were:

One square *actus* (*actus quadratus*) = 14,400 square feet (Roman) = 0.126 hectare.

Two square *actus* = one *iugerum* = 28,800 square feet (Roman) = 0.252 hectare.

9. The portable sundial may have been invented or perfected during Hadrian's principate (A.D. 117–38) and was designed to operate at any latitude. Although discovered specimens date only from later periods, the instrument is depicted on medallions from Claudiopolis (Bithynium) and from Milan, each having on its obverse a representation of Antinous, a Bithynian youth who was a favorite of the emperor Hadrian: the first-mentioned is in a private collection; copy in the Landesmuseum, Trier. See Edmund Buchner, "Römische Medallions als Sonnenuhren," *Chiron* 6 (1976): 329–48. For the Milan medallion see Giorgio Nicodemi, *Catalogo delle raccolte numismatiche*, 2 vols. (Milan: Bestetti, 1938–40), vol. 2, *Le monete dell'Impero romano da Adriano ad Elio Cesare*, pl. XVI, 3849.

10. That the Roman land surveyor also had other surveying instruments available to him as well as instruments for drawing maps is, however, made clear by the contents of Verus's workshop in Pompeii. Besides the portable sundial, these include the endpieces of a measuring rod, a folding ruler, and bronze compasses: see Dilke, *Roman Land Surveyors*, 73–81 (note 4).

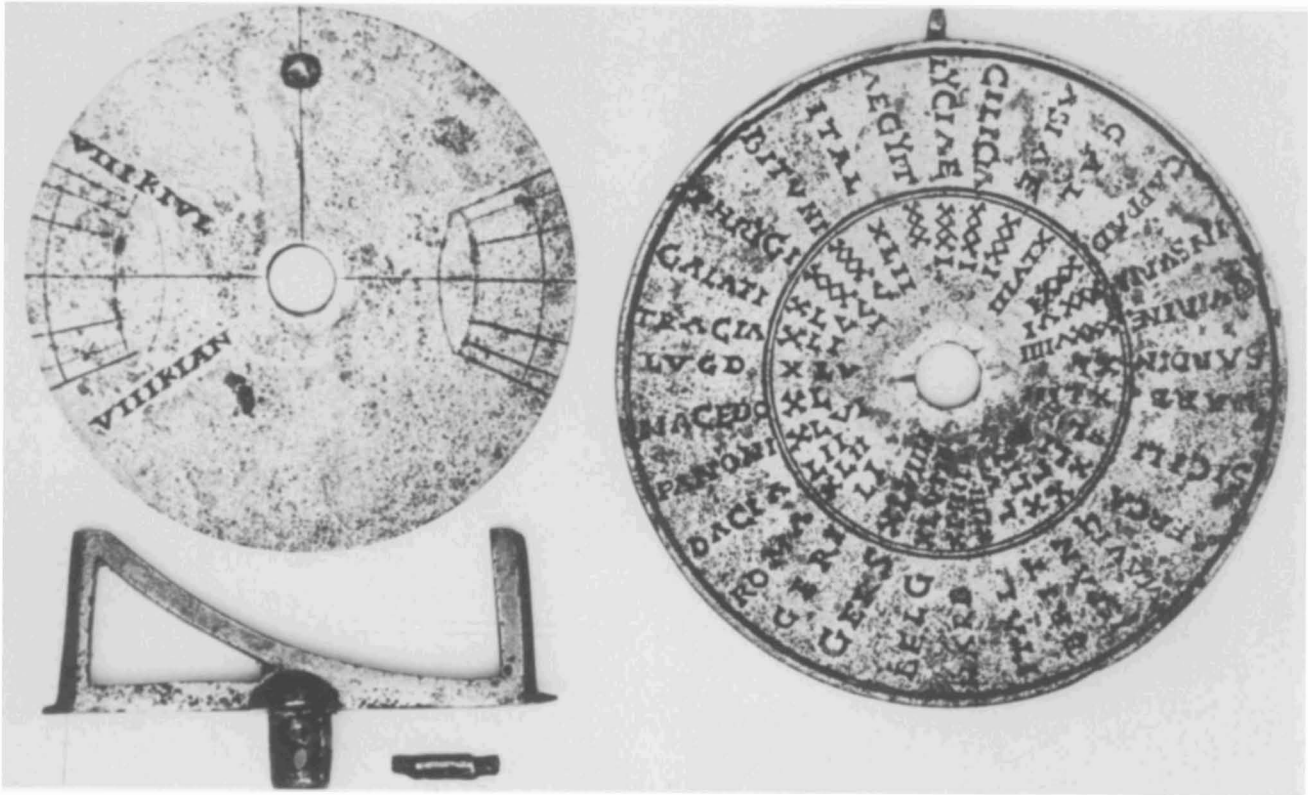


FIG. 13.4. A PORTABLE SUNDIAL, DISASSEMBLED. This shows the individual parts of a bronze instrument said to have been found near Bratislava. It dates from after A.D. 120.

By permission of the Museum of the History of Science, Oxford (R. 40).

Two *iugera* = one *heredium* = 0.504 hectare (little used in practice).

One hundred *heredia* = one *centuria* = about 50.4 hectares (fig. 13.6).

This refers to the regular century of 200 *iugera*, but various other sizes, both larger and smaller, are found. These regular squares had sides of 20 *actus*, properly speaking 709.68 meters, though variants from 703 meters to 714 meters are found. Between each pair of centuries was a *limes*, literally “balk,” for which appropriate width was provided; in one direction each of these constituted a *kardo*, and at right angles to it was a *decumanus*.

The system of coordinates used for naming centuries started from the two main roads of a centuriated area, the *kardo maximus* and the *decumanus maximus*. It was assumed that the surveyor counted the centuries from the center, distinguishing (a) *citra kardinem*, CK or KK, “this side of the *kardo*,” from *ultra kardinem*, VK, “beyond the *kardo*,” (b) *sinistra decumani*, SD, “to the left of the *decumanus*,” from *dextra decumani*, DD, “to the right of the *decumanus*.” These were followed by the figure denoting the number of the particular century from the intersecting main roads.

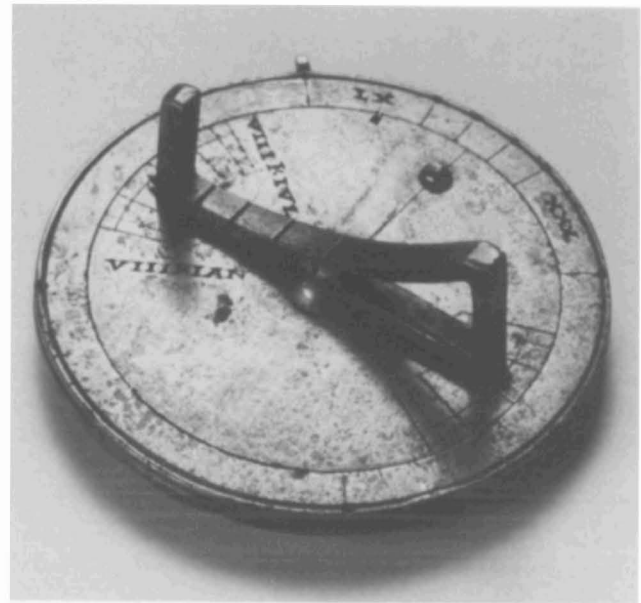


FIG. 13.5. A PORTABLE SUNDIAL, ASSEMBLED. The instrument is seen here in its actual form. It could have been used to lay out a centuriation scheme toward the south. Diameter of the original: 6 cm. By permission of the Museum of the History of Science, Oxford (R. 40).

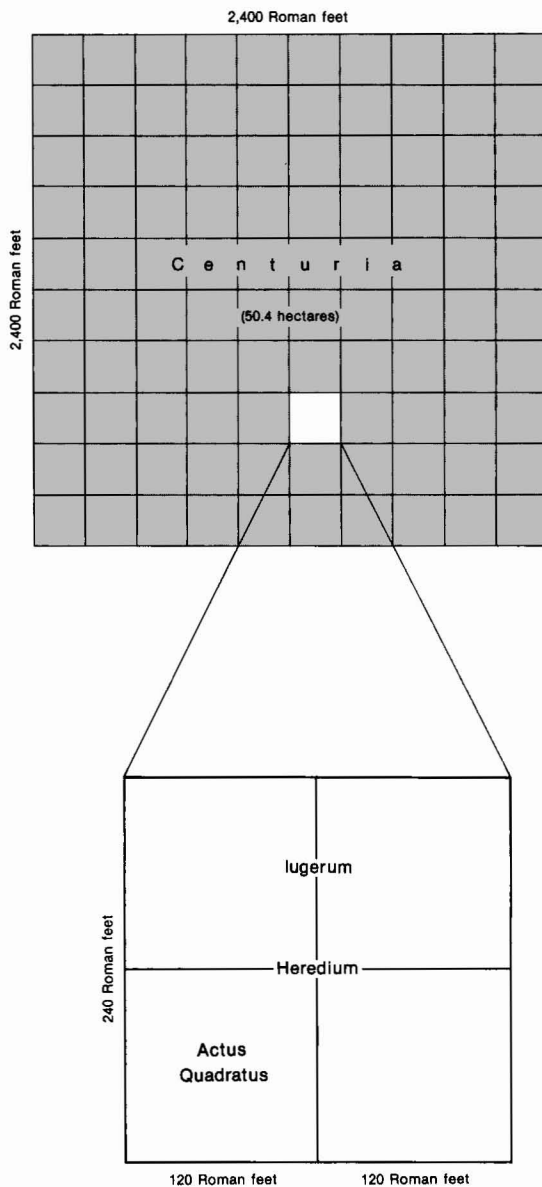


FIG. 13.6. ROMAN AREAL UNITS. The upper diagram shows a regular century of 200 *iugera*, here subdivided into 100 *heredia* (though the *heredium* was not used in calculations). The lower diagram shows that 4 square *actus* = 2 *iugera* = 1 *heredium*.

Three passages of Hyginus Gromaticus give details about the procedure for survey mapping. In one he comments:

When we have ended all centuries with inscribed stones, we shall surround parts assigned to the state, even if they are centuriated, with a private boundary and shall enter them on the map appropriately, as “public woods” or “common pasture” or both. We shall fill the whole extent with the inscription, so that on the map of the area a more scattered arrangement

of lettering may show greater width. We shall likewise bound excepted or granted farms, giving them inscriptions as with public places. We shall similarly show granted farms, for example, “farm of Seius granted to Lucius Manilius son of Seius.” In Augustus’s allocation of land, excepted farms have a different status from granted farms.¹¹

Besides indicating the central importance of the maps in the process of land allocation and registration, Hyginus Gromaticus shows a cartographic awareness that is almost modern when he implies that the spacing of lettering can also reflect the extent of the land represented. Later he goes on to elaborate how the maps were to be used to record various legal categories of land:

We shall write both on the maps and on the bronze tablets [*tabulae aeris*, i.e., tablets attached to bronze maps] all mapping indications, “given and assigned,” “granted,” “excepted,” “restored, exchanged for own property,” “restored to previous owner,” and any other abbreviations in common use, to remain on the map. We shall take to the emperor’s record office the mapping registers [*libri aeris*] and the plan of the whole surveyed area drawn in lines according to its particular boundary system, adding the names of the immediate neighbors. If any property, either in the immediate neighborhood or elsewhere, has been given to the colony, we shall enter it in the register of assets. Anything else of surveying interest will have to be held not only by the colony but by the emperor’s record office, signed by the founder. This is how we shall allocate undeveloped land in the provinces. But if a borough has its status changed to that of colony, we shall examine local conditions.¹²

It is clear that both the maps, when they were transferred to bronze, and the registers that were to accompany them were prepared in duplicate. One copy of each document was kept locally within the colony; the other was preserved in a central record office in Rome. Roman practice thus anticipated modern cadastral surveys. In the great age of European and American cadastral surveys in the eighteenth and nineteenth centuries,¹³ for example, maps provided local and central governments with a similar record of the allocation of land and served to register private and public property. Such surveys, moreover, as in the Roman model, often contained a written and a graphic part and indeed sometimes expressed their indebtedness to their classical lineage.

11. Hyginus Gromaticus *Constitutio limitum* (On setting up centuriation), in *Corpus Agrimensorum*, 131–71 (note 4), quotation on 159–60, author’s translation.

12. Hyginus Gromaticus *Constitutio limitum*, 165–67 (note 11), author’s translation.

13. Such surveys will be dealt with in volumes 4 and 5 of the present *History*.

THE *CORPUS AGRIMENSORUM*

The main textual channel through which Roman ideas about land surveying and mapping were to be transmitted to later societies—as well as a principal source for reconstructing the techniques described above—is known as the *Corpus Agrimensorum*.¹⁴ These documents consist of an extant collection of short works in Latin of quite varied dates that have been recognized as the primary written records of Roman land surveying. One or two items are dated from the republic, three or four from the early empire, and quite a number from the late empire, with even later additions in some manuscripts. The *Corpus* may have been compiled in the middle or late fourth century A.D.¹⁵ and revised from time to time.

Of the writers contained in the *Corpus*, only the first is well known. Sextus Julius Frontinus was governor of Britain from A.D. 74 to 77,¹⁶ during which time he played a prominent part in gaining control for the Romans of southern and central Wales. His works that have fully survived are the *Stratagems* and the *Water Supply of Rome*. The works under his name in the *Corpus Agrimensorum*—*On the Status of Land*, *On Land Disputes*, and *On Centuriation*—are clearly only parts of the originals.¹⁷ Balbus, whose short treatise on measurements is preserved, seems to have served in an expedition of Domitian's against northern tribes and to have been writing in the early second century A.D. The two pseudo-Hygini seem to be different writers in the latter part of this period, each presumably claiming the author of his treatise was C. Julius Hyginus, the librarian of Augustus. In addition to these two, there is a work on camp measurement by another pseudo-Hyginus.¹⁸

The collection is only very roughly based on chronological order: Agennius Urbicus, a late commentator on Frontinus, very reasonably appears immediately after Frontinus, but some items are quite displaced in order. Of the treatises attributable to the early empire, those of Frontinus and the pseudo-Hygini are illustrated; that of Balbus contains geometric drawings. Whether the drawings preserved reflect the authors' illustrations is difficult to say. Frontinus, Balbus, and the earliest pseudo-Hyginus do not refer to drawings, whereas Hyginus Gromaticus uses the adverb *sic* to draw attention to them. The collection was obviously meant to help with the teaching of land survey, and for this purpose the illustrations interspersed with the text represent a great advance in educational method.¹⁹ This was probably helped by the gradual changeover from the use of papyrus to parchment or vellum as the regular writing material.

The chief manuscripts containing illustrations are the Arcerianus A (hereafter abbreviated as A) in the Herzog

August Bibliothek, Wolfenbüttel, now dated to about A.D. 500,²⁰ and the ninth-century Pal. Lat. 1564 (hereafter abbreviated as P) in the Biblioteca Apostolica Vaticana, Rome. The miniatures in each of these are mostly very well preserved, and those of the Wolfenbüttel manuscript have recently been studied from the point of view of art history.²¹ In some cases A and P substantially agree in their diagrams, in others they show appreciable differences. On the whole, where they differ, A presents a more accurate interpretation.

The subjects of the illustrations include surveying techniques, material relating to centuriation and boundary stones, and maps of towns and surrounding lands, together with diagrams of legal definitions and other theoretical matters.²² In terms of convention, too, illustrations suggest that a distinctive style of large-scale mapping was developing during the early empire. The simplest diagrams are monochrome, light brown. In the more elaborate illustrations, however, colors were employed with some measure of consistency. Roads are usually depicted red or brown, sometimes green. Water is blue or bluish green. Buildings are mostly pale brown, yellow, or gray; the predominant color for roofs is red. Mountains are usually mauve or, if wooded, green; sometimes they are brown.

The maps of colonies with centuriated land that appear in the *Corpus* are teaching maps, different from the large-scale survey maps the land surveyors had to produce (figs. 13.7–13.9). Many of the colonies, including five from Hyginus Gromaticus, can be certainly or with some probability identified from either text or map or both; others are called *Colonia Iulia*, which without

14. In addition to references in note 4, see James Nelson Carder, *Art Historical Problems of a Roman Survey Manuscript: The Codex Arcerianus A, Wolfenbüttel* (New York: Garland, 1978); Hans Butzmann, ed., *Corpus Agrimensorum: Codex Arcerianus A der Herzog-August-Bibliothek zu Wolfenbüttel*, *Codices Graeci et Latini* 22 (Leiden: A. W. Sijthoff, 1970).

15. This date would suit the *Libri Colonialium*, lists of colonies with names of founders and other data, which are incorporated into the *Corpus Agrimensorum*; see Blume et al., *Schriften der römischen Feldmesser*, 1:209–62 (note 4).

16. See Anthony R. Birley, *The Fasti of Roman Britain* (Oxford: Clarendon Press, 1981), 71, 77–78.

17. For the probable scope and titles, see Carl Olof Thulin, "Kritisches zu Iulius Frontinus," *Eranos* 11 (1911): 131–44.

18. The best edition is Antonino Grillone, ed., *De metatione castrorum liber* (Leipzig: Teubner, 1977).

19. A parallel can be drawn with the illustration of architectural manuals: Vitruvius *De architectura* 1.1.4; see *On Architecture*, 2 vols., trans. Frank Granger, Loeb Classical Library (Cambridge: Harvard University Press; London: William Heinemann, 1931–34).

20. Carder, *Art Historical Problems*, 205 ff. (note 14). Others give the date as early sixth century, such as Carl Nordenfalk, *Die spätantiken Zierbuchstaben* (Stockholm: published by the author, 1970).

21. Carder, *Art Historical Problems* (note 14).

22. For a fuller classification see O. A. W. Dilke, "Illustrations from Roman Surveyors' Manuals," *Imago Mundi* 21 (1967): 9–29.

further definition could refer to any early imperial foundations; others again contain geographical features such as mountains or sea but are not identifiable. The most clearly recognizable (fig. 13.7) is Colonia Anxurnas, the Volscian Anxur, later Tarracina, where the text says: "In some colonies they set up the *decumanus maximus* in such a way that it contained the trunk road crossing the colony, as at Anxur in Campania. The *decumanus maximus* can be seen along the Via Appia; the cultivable land has been centuriated; the remainder consists of rugged rocks, bounded as unsurveyed land by natural landmarks."²³ The Roman colony at Tarracina was founded on the coast in 329 B.C.; each of the three hundred settlers received a very small allotment of land: two *iugera*. As the text shows, the centuriation was here centered on the Via Appia, at least after that road was built in 312 B.C.²⁴ *Paludes* in the illustration refers to the Pomptine (Pontine) Marshes, which the Via Appia crossed but which were only partially drained in antiquity. The mountains are the Monti Lepini; between them and the sea, which is also shown on the miniature, the road crossed the plain known as La Valle, where proof of centuriation is in fact available only on the opposite side from that shown in the miniature. A second map of a colony in Hyginus Gromaticus (fig. 13.8) is Minturnae (Minturno Scavi), founded in 295 B.C. This shows the colony on both sides of the river Liris (Garigliano), though in fact the walls lay only on the right bank of the river, to the left of the miniature map. Also featured are the Vescini Mountains, the Augustan new assignation, a bronze statue, and the sea. As with the illustration for Tarracina, this map assumes a viewpoint above the sea looking toward the mountains. A third map shows Hispellum (Spello), founded as a colony probably about 30 B.C. (fig. 13.9). The words *flumen finitimum* refer to a river on the Umbrian plain that separated the territory of Hispellum, the walls of which encircle a hill overlooking it, from that of a neighboring settlement. The river is not easily identifiable;²⁵ such maps are not always precise depictions of particular locations. They were not derived directly from surveys but were designed for teaching, so their planimetric accuracy may vary considerably.

To illustrate legal definitions, both picture maps and ground plans were used to represent smaller areas. Some of these are of centuriation, and others of features such as farms and common pasture. An example of a picture map depicting a farm is the miniature accompanying a definition in Frontinus (fig. 13.10). The text says: "*Ager arcifinius*, which is unsurveyed, is bounded in accordance with ancient practice by rivers, ditches, mountains, roads, rows of trees, watersheds, and any areas able to be claimed from previous occupation."²⁶ As many of these features as could easily be shown are

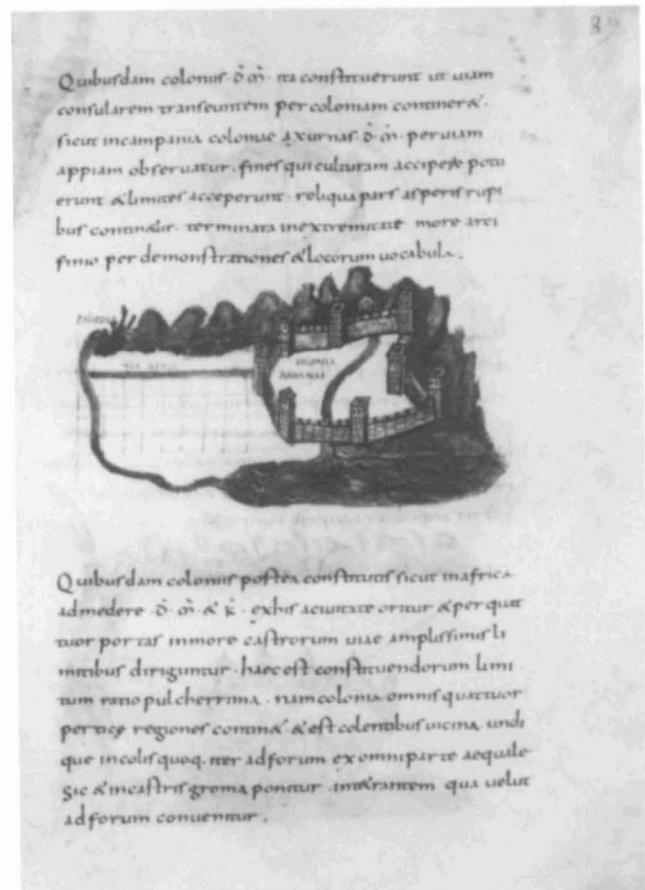


FIG. 13.7. MINIATURE OF THE CENTURIATION AROUND TARRACINA, ITALY. This, like figures 13.8 and 13.9, is a picture map illustrating the geographical relation between the positions of Roman colonies and the centuriation schemes that were associated with them. The colony of Tarracina, known to the Romans as Anxur-Tarracina, was established in Campania in 329 B.C. Only the cultivable land was surveyed, with a centuriation based upon the Via Appia. Size of the original: 28 × 19.6 cm. Photograph from the Biblioteca Apostolica Vaticana, Rome (Pal. Lat. 1564, fol. 89r).

23. Hyginus Gromaticus, *Constitutio limitum*, 144 (note 11), author's translation.

24. Focke Tannen Hinrichs, *Die Geschichte der gromaticchen Institutionen* (Wiesbaden: Franz Steiner, 1974), doubts whether the still-discernible centuriation goes back as early as the fourth century B.C. See O. A. W. Dilke and Margaret S. Dilke, "Tarracina and the Pomptine Marshes," *Greece and Rome*, n.s., 8 (1961): 172–78; Gérard Chouquer et al., "Cadastres, occupation du sol et paysages agraires antiques," *Annales: Economies, Sociétés, Civilisations*, 37, nos. 5–6 (1982): 847–82, esp. fig. 7c.

25. According to Adolf Schulten, "Römische Flurkarten," *Hermes* 33 (1898): 534–65, this could have been the river Ose; see O. A. W. Dilke, "Maps in the Treatises of Roman Land Surveyors," *Geographical Journal* 127 (1961): 417–26.

26. Frontinus *De agrorum qualitate*, in *Corpus Agrimensorum*, 1–3 (note 4), quotation on 2, author's translation; Carder, *Art Historical Problems*, 44–46 (note 14).

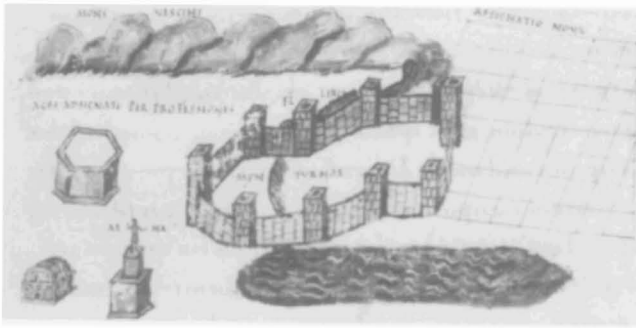


FIG. 13.8. MINIATURE OF THE CENTURIATION AROUND MINTURNAE, ITALY. Founded on the borders of Latium and Campania in 295 B.C., this colony, the modern Minturno Scavi, is depicted here as seen from above the sea, looking toward the Vescini mountains.

Size of the original detail: 8 × 14 cm. Photograph from the Biblioteca Apostolica Vaticana, Rome (Pal. Lat. 1564, fol. 88r).

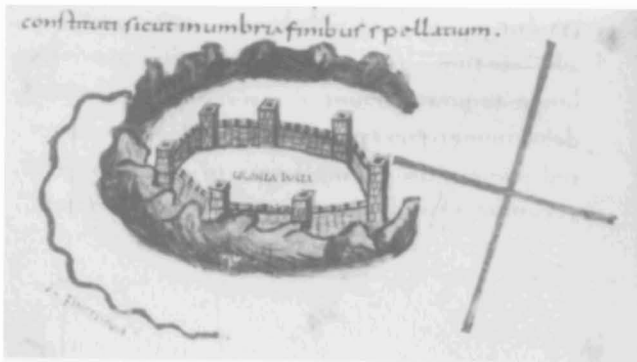


FIG. 13.9. MINIATURE OF THE CENTURIATION AROUND HISPELLUM, ITALY. A schematic representation of the boundary of the territory of the colony of Spello, in Umbria, founded ca. 30 B.C., with that of the neighboring settlement. The boundary follows the river on the left.

Size of the original detail: 10.5 × 14.4 cm. Photograph from the Biblioteca Apostolica Vaticana, Rome (Pal. Lat. 1564, fol. 88v).

incorporated into the map, together with some extra features such as two temples presumably serving as boundaries. The squares on the right of the map were probably intended to illustrate the areas of previous occupation. An example of the ground plan used to define the status of land, a simple painted miniature (fig. 13.11), also illustrates Frontinus's text: "There is also property vested in pastureland, relating to farms, but held in common; so these common pastures are called *communia* in many places in Italy, while in some provinces they are called *pro indiviso*."²⁷

Finally, among the treatises attributable to the early empire, a large percentage of the illustrations are devoted to centuriation diagrams, some of which are of carto-

graphic interest, others less so. Thus rectangles of 40 by 20 *actus*, such as are found in Orange Cadaster A, are depicted as in figure 13.12,²⁸ where both *kardo maximus* and *decumanus maximus* are labeled KM: one should be DM. In another line drawing (fig. 13.13),²⁹ two adjacent centuriation systems are shown, one perhaps oriented according to the cardinal points, one not.³⁰ It is, however, in a late and corrupt manuscript that the nearest approach to the Orange cadasters is found, albeit only with specimen names and holdings (fig. 13.14); thus, "The farm of Seius Agerius has ten *iugera* freehold," "Sextilius's farm has thirty *iugera*," "Vennius's farm has fifty *iugera*, noted in register," and so on.³¹

There can be little doubt that these texts and diagrams, particularly those dealing with centuriation, had an effect both on the adoption of similar schemes in more recent times and on the discovery of centuriation systems. In 1833 the Danish sea captain C. T. Falbe, who had read about Roman land surveying, noticed that squares around Carthage had sides of 2,400 Roman feet; and similar work was done in the Po valley in 1846 by E. N. Legnazzi and in the Trieste area in 1848 by P. Kandler.³² Ever since then the discoveries of centuriation have been so extensive that we can appreciate what an important part the *agrimensores* played in the planning and mapping of the countryside.

Teaching maps for surveyors were not always designed as early as the treatises they were supposed to illuminate. The illustrations accompanying the treatise

27. Frontinus *De controversiis*, in *Corpus Agrimensorum*, 4–10 (note 4), quotation on 6, author's translation; see also fig. 18 (manuscript A).

28. Thulin, *Corpus Agrimensorum*, fig. 78 (manuscript A) (note 4).

29. Thulin, *Corpus Agrimensorum*, fig. 74 (manuscript A) (note 4).

30. Such conflicts of orientation are frequently discovered from aerial photography, a good example being Enfidá, Tunisia. But in such cases, unless there is archaeological or other evidence, it is usually impossible to tell whether adjacent systems are contemporary: John Bradford, *Ancient Landscapes* (London: Bell, 1957); Gérard Chouquer and Françoise Favory, *Contribution à la recherche des cadastres antiques*, *Annales Littéraires de l'Université de Besançon* 236 (Paris, 1980); Institut Géographique National, *Atlas des centuriations romaines de Tunisie* (Paris: Institut Géographique National, 1954). See also Monique Clavel-Lévêque, ed., *Cadastres et espace rural: Approches et réalités antiques* (Paris: Centre National de la Recherche Scientifique, 1983). For a bibliography on centuriation, see O. A. W. Dilke, "Archaeological and Epigraphic Evidence of Roman Land Surveys," in *Aufstieg und Niedergang der römischen Welt*, ed. Hildegard Temporini (Berlin: Walter de Gruyter, 1972–), 2.1 (1974): 564–92, esp. 585–92.

31. Author's translation from illustration in the sixteenth-century Jena manuscript of Frontinus; see Thulin, *Corpus Agrimensorum*, fig. 17 (note 4).

32. C. T. Falbe, *Recherches sur l'emplacement de Carthage* (Paris: Imprimerie Royale, 1833); Pietro Kandler, *Indicazioni per riconoscere le cose storiche del Litorale* (Trieste, 1855); cf. G. Ramilli, *Gli agri centuriati di Padova e di Pola nell'interpretazione di Pietro Kandler* (Trieste: Società Istriana di Archeologia e Storia Patria, 1973).

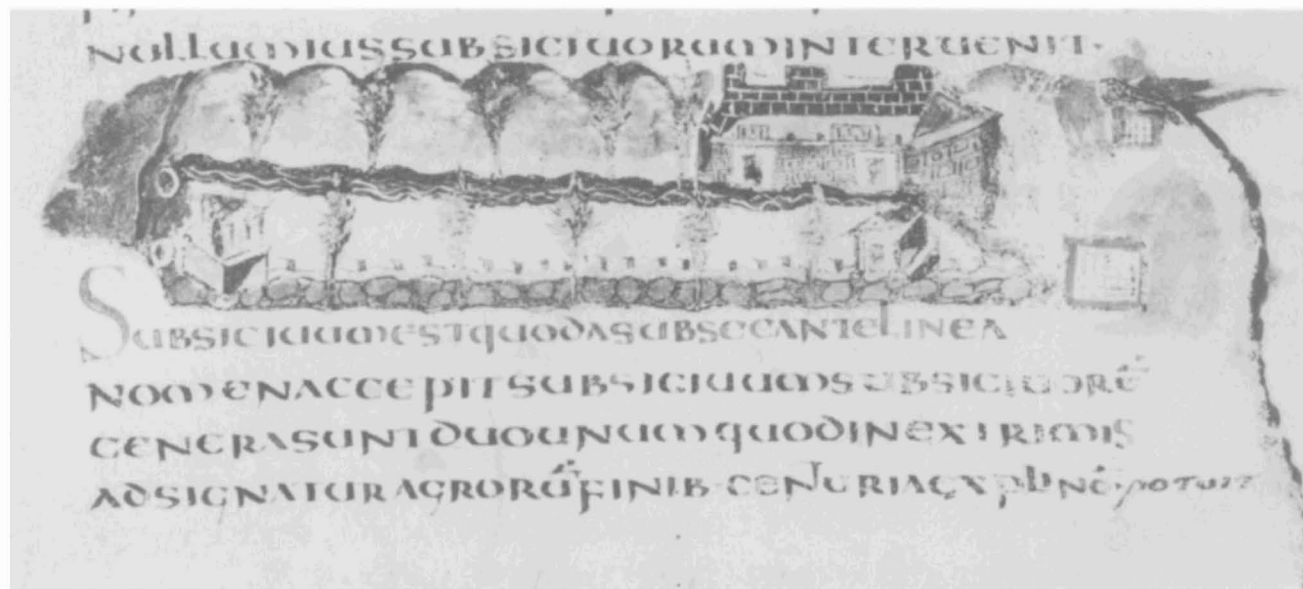


FIG. 13.10. *AGER ARCIFINIUS*. A miniature picture map of a farm, this is designed to illustrate the accompanying text's definition of unsurveyed farmland in the *Corpus Agrimensorum Romanorum*.

Size of the original map detail: 4.5 × 21 cm. By permission of the Herzog August Bibliothek, Wolfenbüttel (Codex Guelf. 36.23 Aug. 2°, fol. 18r).

of Hyginus Gromaticus, *Constitutio limitum* (On setting up centuriation), include two regional maps³³ that appear in two different forms: one in the Arcerianus A (A), one in Pal. Lat. 1564 (P). Whereas the A map is in each case simple, with little wording and with straight lines, the P map is very complex, with much wording and with winding as well as straight lines. The winding lines designate both roads and rivers, though Roman roads in the areas indicated did not wind in this way. In one case what looks like a single region turns out to portray places widely separated, in Campania, Latium, and the Po valley.³⁴ The other map³⁵ does not depict scattered areas, but it is poorly oriented and it uses the word *ut*, meaning “for example,” one farm being said to have been made over by P. Scipio, the famous general of perhaps six hundred years earlier. These, then, are likely to have been theoretical maps used for teaching. As such they are probably to be dated to the fourth or fifth century A.D.

THE CADASTERS OF ARAUSIO

Whereas no survey maps in bronze have survived, we do possess substantial fragments of the cadastral maps carved in stone found at Orange (the Roman Arausio) in the Rhône valley. They originally consisted of several rows of tablets that must have been fixed to a wall for permanent display. The term “cadaster” in this sense means a large-scale land survey carried out for taxation purposes.³⁶ Unfortunately, since the collapse of a floor

at the Orange museum in 1962 caused much damage, not all the fragments survive. But the important surviving fragments, found mostly in 1949–51, are now well displayed on walls, and the lost pieces were carefully documented by Piganiol.³⁷

The inscribed stones fall into three categories. First, there is an inscription of A.D. 77 explaining the purpose of the emperor Vespasian's edict; second, there are fragments of three cadasters, now known as A, B, and C; and third, there are several inscribed stones from the Orange public record office (*tabularium*).

The inscription in the first category may be rendered thus when letters have been restored and abbreviations completed:

The emperor Vespasian, in the eighth year of his tribunician power [i.e., A.D. 77], so as to restore the state lands the emperor Augustus had given to soldiers of the second legion Gallica, but which for some

33. Dilke, “Treatises,” 417–26 (note 25).

34. Thulin, *Corpus Agrimensorum*, fig. 136a (note 4); Blume et al., *Schriften der römischen Feldmesser*, vol. 1, fig. 197a (manuscript P) (note 4).

35. Thulin, *Corpus Agrimensorum*, fig. 135a (note 4); Blume et al., *Schriften der römischen Feldmesser*, vol. 1, fig. 196b (manuscript P) (note 4).

36. Its derivation is probably not from medieval Latin *capitastrum* but from Byzantine Greek κατὰ στίχον, “line by line” (of a ledger).

37. André Piganiol, *Les documents cadastraux de la colonie romaine d'Orange, Gallia*, suppl. 16 (Paris: Centre National de la Recherche Scientifique, 1962); cf. Dilke, *Roman Land Surveyors*, 159–77 (note 4).

years had been occupied by private individuals, ordered a survey map to be set up, with a record on each century of the annual rental. This was carried out by . . . Ummidius Bassus, proconsul of the province of Gallia Narbonensis.³⁸

The territory involved is that of the colony founded at Arausio in or immediately before 35 B.C. The colony was planned for veterans of the second legion Gallica, replaced in 35 B.C. by the second legion Augusta, under the title *colonia Iulia firma Secundanorum*. The amount of land received by each veteran (other than centurions) may have been $33\frac{1}{3}$ *iugera*—8.4 hectares or 20.8 acres.

38. Author's translation. The inscription is recorded in Piganiol, *Documents cadastraux d'Orange*, fig. 11 and pl. 3 (note 37).

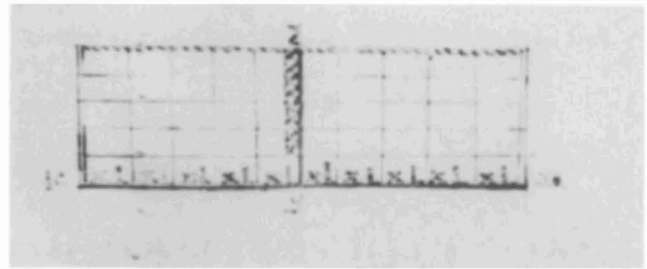


FIG. 13.12. MINIATURE FROM THE *CORPUS AGRIMENSORUM*. A depiction of a centuriation scheme, 40×20 *actus*. The *Corpus* records that cadasters of such dimensions were executed at two unidentified places in Spain near Mérida. Size of the original: 2.4×7 cm. By permission of the Herzog August Bibliothek, Wolfenbüttel (Codex Guelf. 36.23 Aug. 2°, fol. 45r).

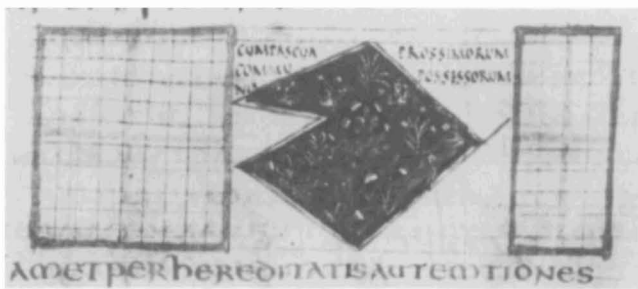


FIG. 13.11. A GROUND PLAN FROM THE *CORPUS AGRIMENSORUM*. This miniature was designed to illustrate the status of land, in this case the pasture shared by two centuriated areas.

Size of the original: 5.2×14.1 cm. By permission of the Herzog August Bibliothek, Wolfenbüttel (Codex Guelf. 36.23 Aug. 2°, fol. 21r).

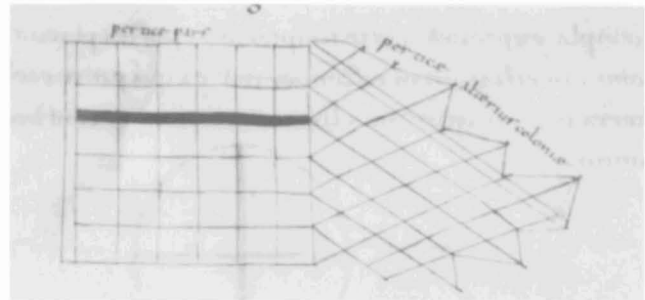


FIG. 13.13. ADJACENT CENTURIATION SCHEMES. This vignette from the *Corpus Agrimensorum* shows two neighboring centuriation schemes with different orientations. Size of the original: 6×11 cm. Photograph from the Biblioteca Apostolica Vaticana, Rome (Pal. Lat. 1564, fol. 84v).

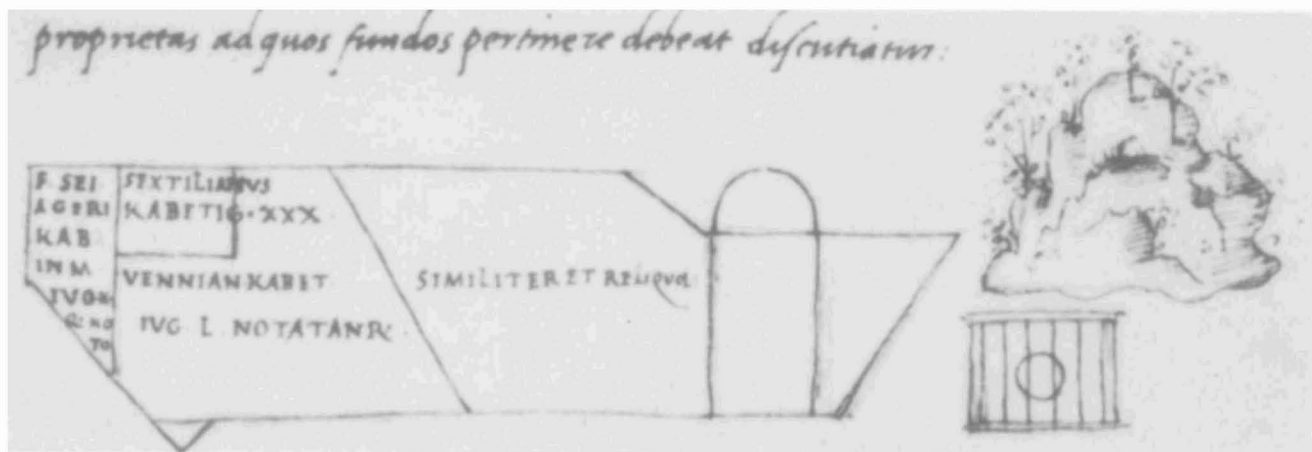


FIG. 13.14. THE MAPPING OF SMALLHOLDINGS. This paradigmatic miniature is the only one from any of the manuscripts of the *Corpus Agrimensorum* that resembles the results of an actual centuriation map.

From James Nelson Carder, *Art Historical Problems of a Roman Land Surveying Manuscript: The Codex Arcerianus A, Wolfenbüttel* (New York: Garland, 1978), ill. 22. By permission of the Universitätsbibliothek, Friedrich-Schiller-Universität, Jena (MS. Prov. f. 156 [Apographon Jenense], fol. 77r).

Occupation of state land (*ager publicus*) was an offense, since it could, among other things, deprive the state of revenue. After the devastation of the civil war of A.D. 69, Vespasian was keen to build up Rome's financial resources, and this was an easy way.

Although the cadasters are in some respects similar to diagrams in the *Corpus Agrimensorum*, they are strictly confined to centuriated land. It has been shown that the illustrations of the *Corpus* represented topographical features other than the lines of centuriation and, moreover, that they often extended beyond the areas that had been centuriated, to show other landscapes in pictorial form. Such a style is not found in these cadasters, nor was it used on the bronze maps of surveyors, as far as we know. At Arausio, the cadasters list financial requirements and legal status; in the *Corpus*, the main concerns are surveying and legal status.

The Roman colony of Arausio was founded in the territory of the Tricastini,³⁹ and in Cadaster B, originally the most extensive of the three cadasters, the phrase TRIC RED, *Tricastinis reddita* (restored to the Tricastini), occurs. Although it may well be true that some of the poorest land was among that restored to the local tribe, the move may have been connected with a change in the status of its capital (St-Paul-Trois-Châteaux) which, at some time before A.D. 97, was elevated to colonia Flavia Tricastinorum.

The considerable detail required could be recorded only on a large-scale plan of this type, in this case about 1:6,000 overall, with the main intersecting roads of the centuriated area, the *kardo maximus* and *decumanus maximus*, given double width. A number of roads not in alignment with the centuriation are duly noted, as are also rivers and islands, though without names. The proportions of squares and rectangles are not always correct; some centuries appear as rectangles rather than squares.

The orientation of Cadasters B and C can be established, but that of Cadaster A, which is very fragmentary, has given rise to discussion. Piganiol held that north was at the top, but both Oliver and Salviat maintain that in this case south is at the top and that the cadasters were erected on three walls of the record office in such a way that Surveys A, B, and C would have south, west, and north at the top of the diagram, for easy consultation, though each would have been constructed by a surveyor initially facing west.⁴⁰ Whether we can go further with Salviat and claim that all three cadasters were virtually contemporary is very doubtful. If we look at the evidence from aerial photography, we find that there is only one centuriation scheme consisting of rectangles rather than squares.⁴¹ Since Cadaster A is of rectangles (whereas B and C represent squares), it is only logical to equate it with this area roughly between Orange and Carpentras

and not, as Salviat claims, with an area farther south. The rectangles between Orange and Carpentras are not quite on the same orientation as the squares farther north, which again suggests that the three cadasters were not simultaneous. As with so much else in Roman mapping, one has the problem that much material survives only in its final, revised form; if accepted as it stands, it may telescope what happened over a considerable period of history.⁴²

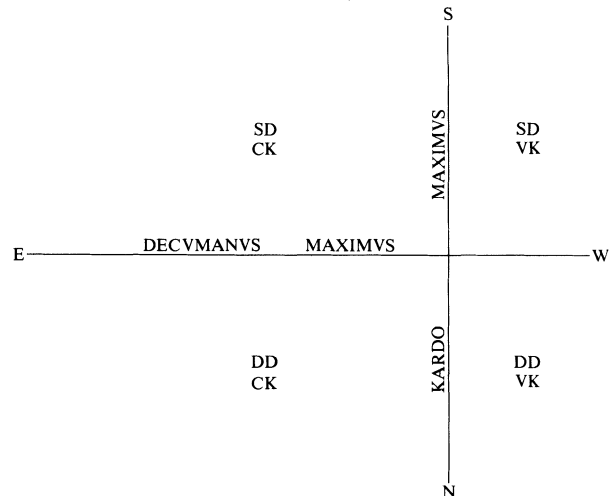


FIG. 13.15. THE PROBABLE LAYOUT OF ORANGE CADASTER A. Unlike the other two cadasters at Orange, this seems to have consisted of rectangles of sides 40×20 *actus*, as depicted in figure 13.12.

After F. Salviat, "Orientation, extension et chronologie des plans cadastraux d'Orange," *Revue Archéologique de Narbonnaise* 10 (1977): 107–18, esp. 111.

39. Claude Boisse, *Le Tricastin des origines à la chute de l'Empire romain* (Valence: Sorepi, 1968).

40. J. H. Oliver, "North, South, East, West at Arausio and Elsewhere," in *Mélanges d'archéologie et d'histoire offerts à André Piganiol*, 3 vols., ed. Raymond Chevallier (Paris: SEVPEN, 1966), 2:1075–79; F. Salviat, "Orientation, extension et chronologie des plans cadastraux d'Orange," *Revue Archéologique de Narbonnaise* 10 (1977): 107–18.

41. M. Guy in Raymond Chevallier, "Sur les traces des arpenteurs romains," *Caesariodunum*, suppl. 2 (Orléans-Tours, 1967), 16.

42. Thus, on Cadaster A, annual rents payable by landholders are cited in *denarii* and *asses*. The number of *asses* to the *denarius* was changed in the 140s B.C. from ten to sixteen. At Orange the old decimal terms were used in addition to the *as*; ten *libellae* or twenty *singulae* or forty *teruncii* went to a *denarius*. Abbreviations were as follows:

⌘	1 <i>denarius</i>
Ⓢ	$\frac{1}{2}$ <i>denarius</i> (<i>semis</i>)
—	1 <i>libella</i>
≡	2 <i>libellae</i>
≡≡	3 <i>libellae</i>
ℒ	1 <i>singula</i>
Ⓣ	1 <i>teruncius</i>
Ⓐ	1 <i>as</i>

Thus eleven *asses* are expressed as S-TAI, that is, $\frac{1}{2} + \frac{1}{10} + \frac{1}{40} + \frac{1}{16} = \frac{11}{16}$ *denarius*.



FIG. 13.16. FRAGMENT 7 OF ORANGE CADASTER A. This fragment shows not only landownership, but also a river with an island between two roads that run across the grain of the centuriation. Among other abbreviations used on this and other fragments are: EXTR, *ex tributario*—withdrawn from tribute-paying status (tribute was paid there only by the Gauls); REL COL, *reliqua coloniae*—remaining to the colony, that is, lands not allocated to veterans but rented by the community;

Cadaster A has been reconstructed by Salviat as in figure 13.15, the lines indicating the approximate extension in each direction from the center of the survey. The centuries are rectangular, and since the largest preserved total area of allocations is 330 *iugera*, we may confidently surmise that each rectangle measured 400 *iugera*, unlike those in Cadasters B and C. Those of A clearly consisted of 40 *actus* east-west by 20 *actus* north-south, dimensions known from the *Corpus Agrimensorum* to have existed in Spain. Fragment 7 Piganiol (fig. 13.16) is of interest from the topographic point of view. It shows, near the intersection of the *kardo maximus* (given an exaggerated width) and the *decumanus maximus*, a braided river with a road on each side, these roads being at a totally different orientation from the centuriation scheme. This must have been a tributary of

RP, *rei publicae*—state lands (occurs only in Cadaster A); SVBS, *subseciva*—either areas remaining between surveyed centuries and the outer boundary of the colony's territory or land within a century that was unsuitable for allocation or for which landholders could not be found.

Size of the original: 29.5 × 36 cm. By permission of the Musée Municipal d'Orange, Vaucluse (fragment 7 of Cadaster A).

the Rhône not very far from its junction with the main river.

Cadaster B, when discovered, was by far the best represented of the three cadasters, and when complete it must have been over 5.5 meters high and 7 meters long. It is in squares of the standard measurement of 200 *iugera*, representing 20 by 20 *actus*. On figure 13.17, which shows the layout, the numbers indicate the minimum number of centuries in each of the four directions. Thus the north-south extension of the surveyed area occupied at least 63 centuries, that is, over 44 kilometers. It must have reached somewhere near Montélimar to the north; but centuriation does not seem to have extended to the west of the Rhône, and in the northeast not all the land was suitable for allocation. Although such an area is smaller than some in Tunisia, it is much

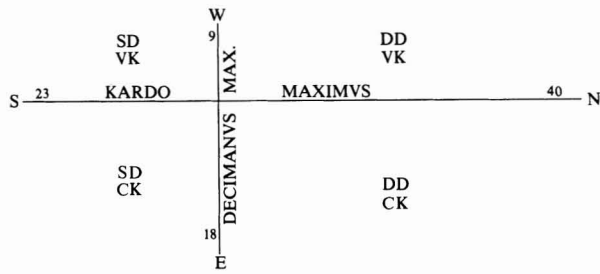


FIG. 13.17. THE PROBABLE LAYOUT OF ORANGE CADASTER B. The figures indicate the minimum number of centuries in each direction, each century being a square of 20×20 actus.

After O. A. W. Dilke, *The Roman Land Surveyors: An Introduction to the Agrimensores* (Newton Abbot: David and Charles, 1971), 166.

larger than the norm in Europe except for parts of the Po valley. What we cannot do is determine directly the minimum area of the whole of this cadastral survey from these measurements, since some centuries may never have been incorporated. Piganiol's attempt to pinpoint the survey was inexact,⁴³ since in the Gorge de Donzère area north of Orange it would assume an ancient course of the Rhône too far east in view of the rock formation. This difficulty can be eliminated by a slight shift of orientation and a slight diminution of the space allocated to each century. The widest river in Cadaster B occupies only about 20 percent of the side of a century, that is, about 140 meters, whereas the present width of the Rhône is considerably greater; nevertheless, there is reason to believe that the Rhône, as well as some of its tributaries, is shown.⁴⁴ Lands restored to the Tricastini are in the largest quarter of the survey, that to the northeast (DD CK), which was not a particularly fertile area (fig. 13.18).

Cadaster C, on a scale of about 1:6,000, is not well preserved, but it seems to have covered an area south of Orange. Its western portion included islands in the Rhône called insulae Furianae, extending at least 5 kilometers north-south and 2 kilometers east-west (fig. 13.19). Changes since Roman times in the course of the Rhône south of Orange have made it impossible to identify the areas shown with any certainty. The interest of this western section is that it is the most extensive large-scale Roman map of a river with islands. It is surprising that such an area, only partially cultivable and obviously liable to change of river course, should have been centuriated with the same system of coordinates as the rest; but this reflects the thoroughness and completeness of these surveys.

The chronology of the three cadasters is disputed. Piganiol held that Cadaster A was of the date of Ves-

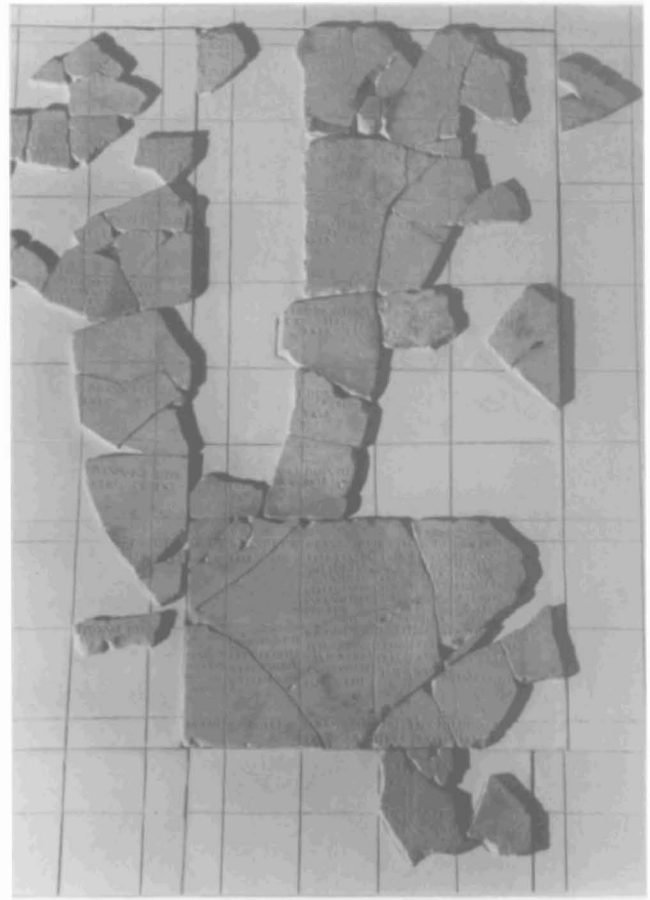


FIG. 13.18. REASSEMBLED PLAQUE III J FROM ORANGE CADASTER B. The area is in the northeastern quarter of the survey (DD CK on fig. 13.17) and shows lands restored to the native Tricastini.

Size of the original: 121×58 cm. By permission of the Musée Municipal d'Orange, Vaucluse.

pasian's edict and that the other two were later, B preceding C. This seems more likely than the view already mentioned that the three are contemporary. Cadaster A is the only one in which state lands are listed; if these, as happened in certain other colonies, were presented by Domitian to the local authority, that would account for their nonappearance in the other cadasters. Domitian may also have been responsible for the elevation to "colonia" of the capital of the Tricastini, and this suggests a connection with the comparatively high percentage of lands restored to the Tricastini in Cadaster B.

43. O. A. W. Dilke, "The Arausio Cadasters," in *Akten des VI. internationalen Kongresses für griechische und lateinische Epigraphik, München, 1972, Vestigia 17* (Munich: C. H. Beck'sche Verlagsbuchhandlung, 1973), 455-57.

44. See diagrams, reprinted from the article cited in the previous note, in O. A. W. Dilke, *Gli agrimensores di Roma antica* (Bologna: Edagricole, 1979), 82, fig. 46 bis.

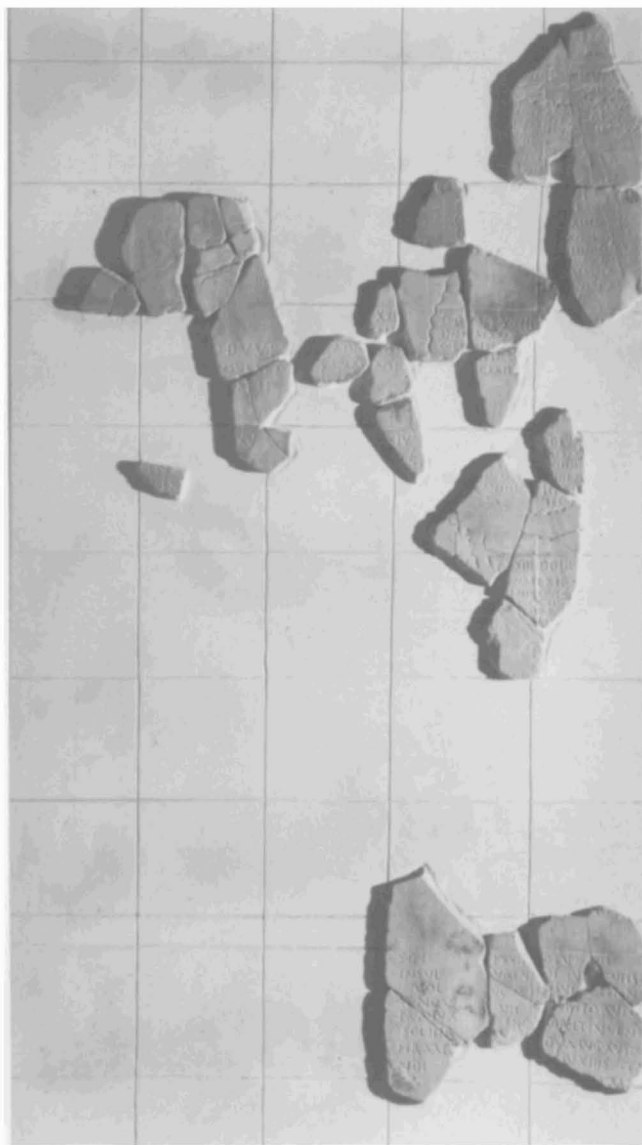


FIG. 13.19. ORANGE CADASTER C. Assembly of the insulae Furianae. These islands in the Rhône, now washed away, were in the western portion of the cadaster. Size of the original: 109 × 54 cm. By permission of the Musée Municipal d'Orange, Vaucluse.

LARGE-SCALE TOWN MAPS: THE *FORMA URBIS ROMAE*

In view of the importance of cities in Roman life—as well as the skills possessed by the *agrimensores* in large-scale surveying—it is not surprising that by the date of the early empire large-scale plans of towns are also encountered. It has been suggested that such plans, which were constructed upon larger scales than those of the centuriated areas, may have been drawn by architects rather than by land surveyors;⁴⁵ the word *forma*, it may



FIG. 13.20. FRAGMENT OF A ROMAN PLAN. This urban property plan, one of the few that have survived, shows private dwellings with the names of the owners, which include women. Antiquarium Comunale, Rome. Size of the original: 12 × 13 cm. Photograph courtesy of Thames and Hudson.

be noted, could be applied both to a surveyor's map and to an architect's plan of a house.

For both urban and rural properties a few detailed plans have survived that may have originated in (or have been based upon) architectural drawings of some kind. Some plans may have served as a record of town holdings in the same manner as the Orange Cadasters. A fragment of a plan in the Antiquarium Comunale, Rome,⁴⁶ has the names of owners of private property inscribed, and as at Orange, these include women's names (fig. 13.20). A plan of baths, however, of uncertain date and now in the Palazzo dei Conservatori, Rome, confines itself to the details of buildings. When it was discovered in 1872 on the Via di Porta San Lorenzo, the figures were thought to refer to military units; in fact they are measurements in Roman feet, and the scale is fairly consistent (fig. 13.21).⁴⁷

The chief specimen of a country estate plan is the "Urbino plan," found on the Via Labicana, Rome, and now in the ducal palace at Urbino (fig. 13.22).⁴⁸ It has been thought to be an estate with a funeral monument

45. Dilke, *Roman Land Surveyors*, 112 (note 4).

46. Carettoni et al., *Pianta marmorea*, 207, no. 2 and pl. Q, fig. 47 (note 3); *Corpus Inscriptionum Latinarum*, 6.4.1 (1894): 2897, no. 29846 (note 2); P. D. A. Harvey, *The History of Topographical Maps: Symbols, Pictures and Surveys* (London: Thames and Hudson, 1980), 130, fig. 75.

47. Carettoni et al., *Pianta marmorea*, 209, no. 7 (note 3); *Corpus Inscriptionum Latinarum*, 6.4.1 (1894): 2897, no. 29845 (note 2).

48. For more information on the "Urbino plan" see Carettoni et al., *Pianta marmorea*, 207–8, no. 3, and pl. Q, fig. 51 (note 3); *Corpus Inscriptionum Latinarum*, 6.4.1 (1894): 2897, no. 29847 (note 2).

and adjoining gardens. The sides of the property along the private road are given the measurements of 546 and 524½ Roman feet. It features a public road, with a measurement of 1,683 Roman feet, that led to the property. There is also a series of miniature large-scale maps of farms or villa estates in the *Casae litterarum* (fig. 13.23),⁴⁹ a Late Latin treatise included in manuscripts of the *Corpus Agrimensorum*. The word *casa* does not here mean cottage, as in classical Latin, but denotes a farm or villa estate.⁵⁰ The exact purpose of these miniature maps is disputed, but there is an interesting possible indication of scale. The title of one set contains the words *in pede V fac pede uno (pedem unum)*. If the V really stands for V̄, that is, 5,000, we have a scale of 1:5,000.⁵¹

From such detailed plans of individual sites, it was a logical step to large-scale representations of entire towns. While it is not clear how and to what extent such maps were used in town planning, they had become an established part of Roman large-scale mapping by the early empire. Besides the most famous example—the *Forma Urbis Romae*, to be described below—it is likely that other ancient settlements had their own plans of this type. One detailed town plan clearly recognizable as such from the Roman world is a fragment from Isola Sacra (near Ostia) preserved in the museum of ancient Ostia (fig. 13.24).⁵² This has no inscription except numerals, which may denote measurements in Roman feet. Walls are represented by double lines, whereas in the *Forma Urbis Romae* they are single lines.

The *Forma Urbis Romae* can be studied as an exceptional artifact not only because of its size and large scale, but also because the many surviving fragments have allowed a detailed reconstruction to be made.⁵³ Engraved on marble, it may be regarded as an official plan of Rome, covering the exact area of the city's limits at the date when it was constructed. Its original size was 13.03 meters high by up to 18.3 meters wide, and a reproduction at this size, reflecting knowledge of it in 1959 and purposely not updated, is to be seen in a courtyard of the Musei Capitolini. The extant fragments are in the Palazzo Braschi, on Corso Vittorio Emanuele, where they have recently been studied afresh.⁵⁴ The date of completion of the plan is between A.D. 203 and 208: the two latest buildings to be included are the Septizodium (an ornamental gateway built in A.D. 203) and a building inscribed SEVERI ET ANTONINI AVGG NN, which presumably means “the unnamed building of the emperors Severus and Antoninus [Caracalla].” Whether it was an original composition or a revision is uncertain; if the latter, it could have been a revision of a city plan of Vespasian (A.D. 69–79) and Titus (A.D. 79–81), who had Rome surveyed in A.D. 74. We do not know whether the work of their surveyors (*mensores*) was displayed in

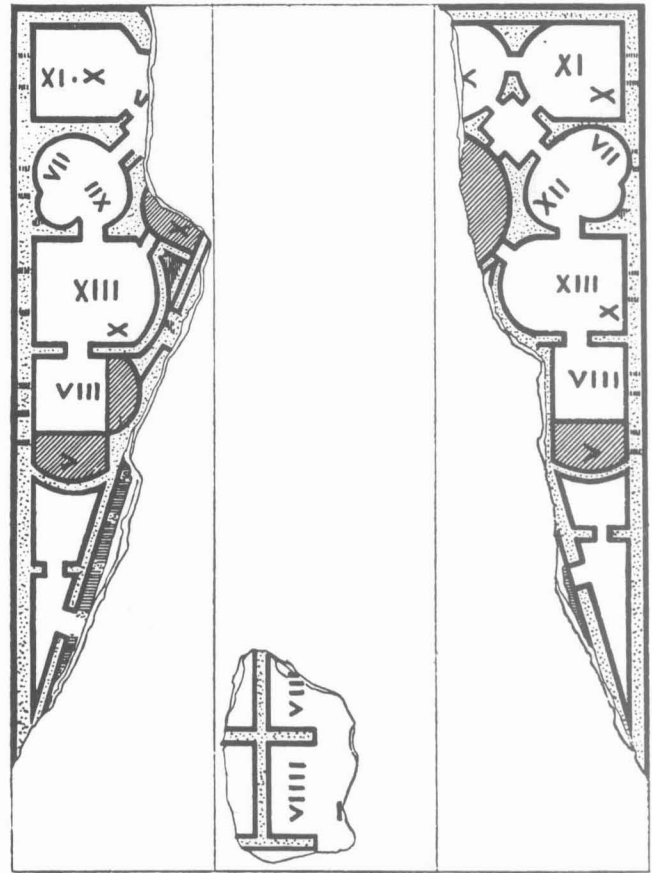


FIG. 13.21. PLAN OF ROMAN BATHS. Fragments of a multicolored mosaic of a thermal bath in the Via di Porta San Lorenzo, Rome. Size of the original: 1.62 × 1.15 m. From Gianfilippo Carettoni et al., *La pianta marmorea di Roma antica: Forma Urbis Romae*, 2 vols. (Rome: Comune di Roma, 1960), 209. By permission of the Musei Comunali di Roma.

49. Åke Josephson, *Casae litterarum: Studien zum Corpus Agrimensorum Romanorum* (Uppsala: Almqvist och Wiksell, 1950); Blume et al., *Schriften der römischen Feldmesser*, vol. 1, figs. 254 ff. (note 4). Of the two principal manuscripts, Wolfenbüttel Arcerianus A has only the Latin alphabet; both Latin and Greek are included in a Berlin fragment.

50. Adolf Schulten, “Fundus,” in *Dizionario epigrafico di antichità romane*, ed. E. de Ruggiero (Rome, 1895–), 3:347.

51. It is a frequent misconception, recently repeated in the popular media, that the Romans could express thousands numerically only by repetition of M: on the contrary, they regularly placed a bar over a numeral or numerals to multiply by one thousand. In mileages this convention is sometimes misunderstood by later writers, who multiply the thousands by the remainder of the figures, obtaining an entirely wrong answer.

52. Carettoni et al., *Pianta marmorea*, 208, no. 5 (note 3); Harvey, *Topographical Maps*, 130, fig. 76 (note 46).

53. Carettoni et al., *Pianta marmorea* (note 3).

54. Emilio Rodríguez Almeida, *Forma Urbis Marmorea: Aggiornamento generale 1980* (Rome: Edizioni Quasar, 1981).

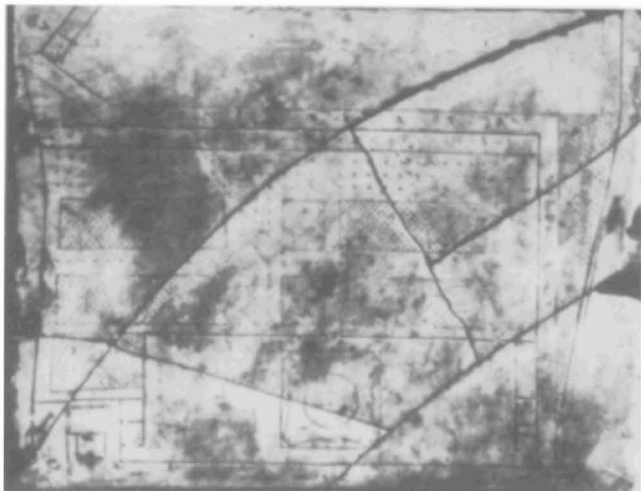


FIG. 13.22. THE "URBINO PLAN." An example of a plan of a Roman country estate. Of uncertain date, it features a *harundinetum* for the cultivation of reeds, a *fossa* (ditch), and measurements along both the public and private (*via privata*) roads.

Size of the original: 74 × 83.2 cm. From Gianfilippo Carettoni et al., *La pianta marmorea di Roma antica: Forma Urbis Romae*, 2 vols. (Rome: Comune di Roma, 1960), pl. Q, fig. 51. By permission of the Musei Comunali di Roma.

public in the form of a plan. In A.D. 191, however, there was a fire in Vespasian's Temple of Peace, and when Septimius Severus restored it, the *Forma Urbis Romae* was affixed to the outer wall of a library attached to that temple (fig. 13.25). This wall still exists outside the Church of Saints Cosmas and Damian, and holes that served to fix the plan can be seen on it. These dowel holes have enabled archaeologists to deduce the original positions of many fragments.

The first fragments were found in 1562, and one published in 1590 was recognizable as a fairly complete plan of the Ludus Magnus, a gladiatorial school founded by Domitian near the Colosseum (fig. 13.26). Other fragments found in the Renaissance but since lost are recorded in Vat. Lat. 3439 (Rome, Biblioteca Apostolica Vaticana). Since 1874, when the *Forma Urbis Romae* was published by H. Jordan, the number of fragments discovered has more than doubled.

Clearly the map first had to be drawn and inscribed on less permanent material by surveyors (*mensores*), presumably under the direction of a senior architect. Unlike land surveyors and camp measurers, urban surveyors have left no manuals. But we have some of their instruments (an inscribed set square, for example, was found recently on the Watling Street site in Canterbury),⁵⁵ and we can guess that they started with the most prominent

buildings, since an examination of scales, as mentioned below, has shown special treatment of many of these. For the final version the assistance of *lapicidae*, stone cutters, was required, both to engrave the map and wording on the marble and to affix the marble to the wall.

One of the main advantages of a detailed map of Rome was to improve the efficiency of the city's administration. Augustus had divided Rome into fourteen districts, each subdivided into *vici*. These districts were administered by annually elected magistrates, with officials and public slaves under them. The officials included *vigiles*, municipal police who also acted as a fire service. Another important part of the administration, though not one subordinated to the districts, was the water supply. As an example of possible map use, if the *vigiles* could see from the map the location of the nearest aqueducts and *castella* (local reservoirs), they would be able to fight a fire more easily. For this purpose copies of relevant portions of the *Forma Urbis Romae* may have been made on papyrus or on wax tablets. The long persistence of the Augustan system of district administration may be seen from two late extant topographical manuals, the *Curiosum Urbis regionum XIV* and the *Notitia regionum XIV*, datable to A.D. 354 and 375 respectively.

The orientation of the *Forma Urbis Romae* is approximately to the southeast (about 43° east of south, with variations between 36° and 50°). Such a layout may have been inherited from a previous map, since the first Augustan district of Rome was in the southern part of the city, while the mention in Tacitus of the gardens of Sallust as being in the left part of the city would, if it refers to a plan, suit either east or south at the top.⁵⁶ The average scale is approximately 1:240 or 1:250, but there is a tendency to make important buildings bigger than they should be, so that the scale variation in the extant parts is from 1:189 to 1:413. Yet this plan, when allowance is made for some mistakes in outline of build-

55. Hugh Chapman, "A Roman Mitre and Try Square from Canterbury," *Antiquaries Journal* 59 (1979): 403–7; O. A. W. Dilke, "Ground Survey and Measurement in Roman Towns," in *Roman Urban Topography in Britain and the Western Empire*, ed. Francis Grew and Brian Hobley, Council for British Archaeology Research Report no. 59 (London: Council for British Archaeology, 1985), 6–13, esp. 9 and fig. 13.

56. Tacitus *Histories* 3.82; see *The Histories*, trans. Clifford H. Moore, Loeb Classical Library (London: William Heinemann; Cambridge: Harvard University Press, 1925–37 and later editions). Ferdinando Castagnoli, "L'orientamento nella cartografia greca e romana," *Rendiconti della Pontificia Accademia Romana di Archeologia* 48 (1975–76): 59–69, shows that south was a more frequent orientation in the Roman world than is generally supposed. Left and right probably do not refer to the riverbanks. True, the Horti Sallustiani were on what we should call the left bank; but so was 90 percent of the ancient city.

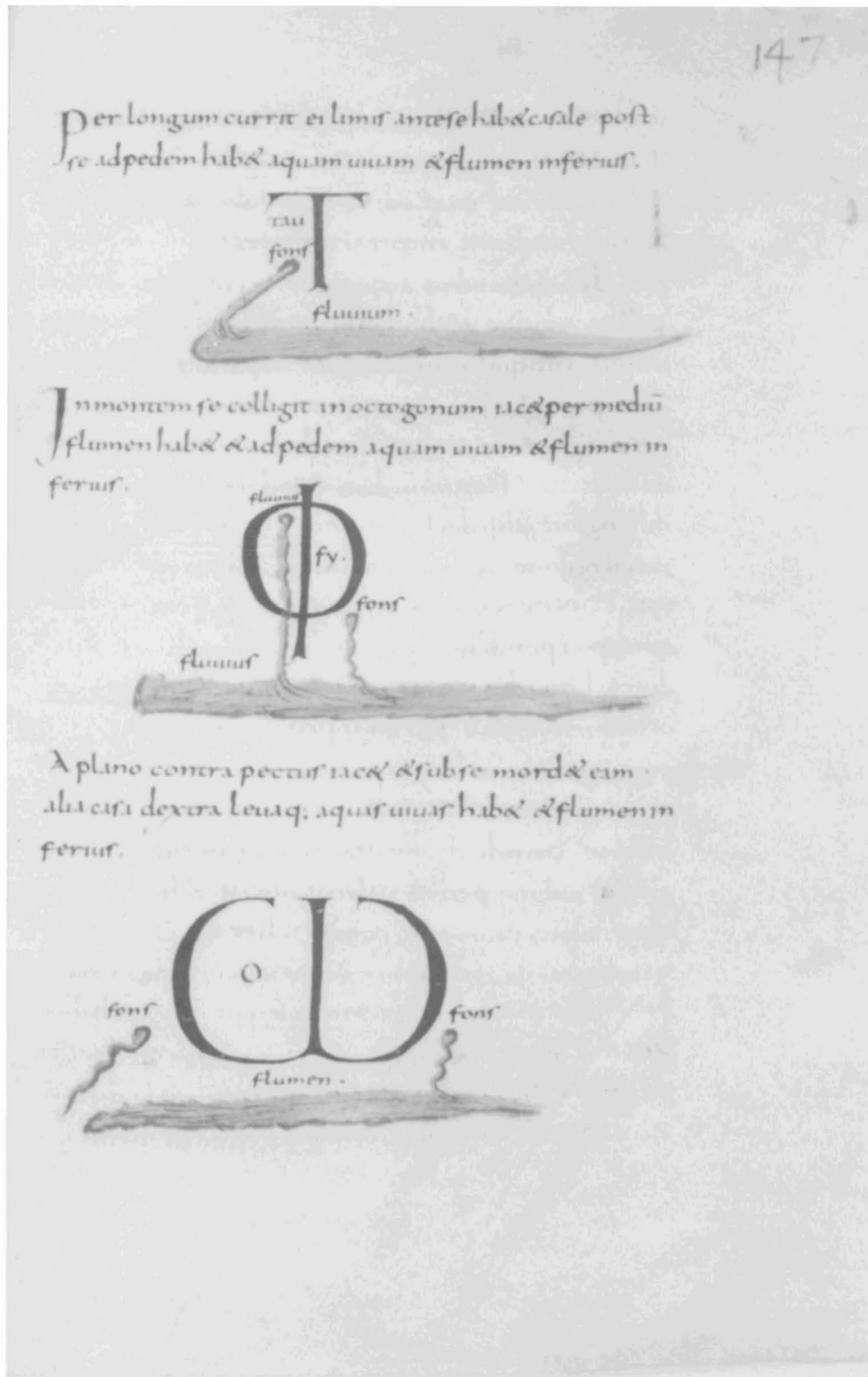


FIG. 13.23. VIGNETTES FROM THE *CASAE LITTERARUM*. An example of a genre in a Late Latin treatise, consisting of maps of farms (as letters) in different topographical situations. The descriptive text above the lowest miniature can be translated: “w is situated away from level ground against the

breast of the hill, with another villa set into the hill beneath. It has fresh springs to the left and right, and a river below.” Size of the original: 28 × 19.6 cm. Photograph from the Bibliotheca Apostolica Vaticana, Rome (Pal. Lat. 1564, fol. 147r).

ings, represents a degree of accuracy not surpassed in plans of Rome for over fifteen hundred years.⁵⁷

Distortion of scale is caused not only by the enlargement of important buildings, but also by representation of certain features in elevation or sign rather than in plan.⁵⁸ Chief among these are the arches carrying aqueducts, which had they not been shown in elevation would have been much more difficult to recognize (fig.



FIG. 13.24. THE ISOLA SACRA FRAGMENT. This is clearly part of a Roman town plan, with double lines for walls. The only inscriptions are numerals that may denote measurements. Museo Ostiense, near Rome. Size of the original: 14 × 17 cm. Photograph courtesy of Thames and Hudson.

13.27). These may perhaps be reckoned among the cartographic signs used; others include stairs, noticeable in that they are sometimes fully represented, sometimes shown as a triangle with steps inside, and sometimes depicted simply by two lines forming an acute angle and resembling such a triangle. Indeed, as Harvey has pointed out, the conventionalization of much of the detail, while at the same time preserving the accuracy of its position, is one of the most remarkable features of the map. He writes:

Walls are mostly shown by single lines, though on some important buildings the lines are drawn double and the intervening space hollowed out. . . . Single lines also mark certain boundaries. Dots mark columns or probably sometimes trees, and both dots within rectangles and small rectangles alone, either in outline or hollowed out, presumably mark columns standing on square bases. Larger rectangles and circles are used for bases of statues, altars in front of temples, public fountains and so on, and a wide circle sometimes marks the precincts of a building. . . . All the principal buildings are named, and it is likely that the lettering was coloured—perhaps other parts of the plan as well.⁵⁹

57. Amato Pietro Frutaz, *Le piante di Roma*, 3 vols. (Rome: Istituto di Studi Romani, 1962); O. A. W. Dilke and Margaret S. Dilke, "The Eternal City Surveyed," *Geographical Magazine* 47 (1975): 744–50. Recent research suggests that the shape of a building in the Campus Martius area is more incorrect than most on the *Forma Urbis Romae*.

58. Thomas Ashby, *The Aqueducts of Ancient Rome* (Oxford: Clarendon Press, 1935).

59. Harvey, *Topographical Maps*, 128 (note 46).

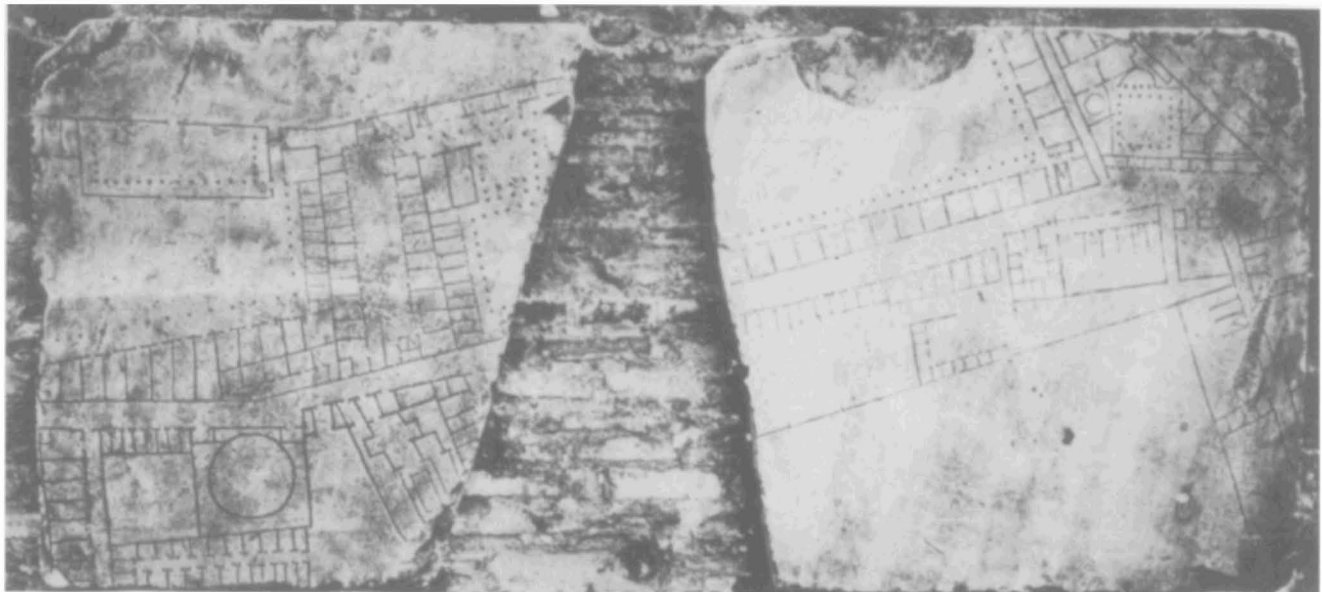


FIG. 13.25. *FORMA URBS ROMAE*. Reconstructed position of two fragments of the plan on the original wall. The fragments cover an area of the Via Portuense with the south bank of the Tiber at top left.

Height of original fragments: 74 cm. From Gianfilippo Carrettoni et al., *La pianta marmorea di Roma antica: Forma Urbis Romae*, 2 vols. (Rome: Comune di Roma, 1960), pl. N, fig. 37. By permission of the Musei Comunali di Roma.

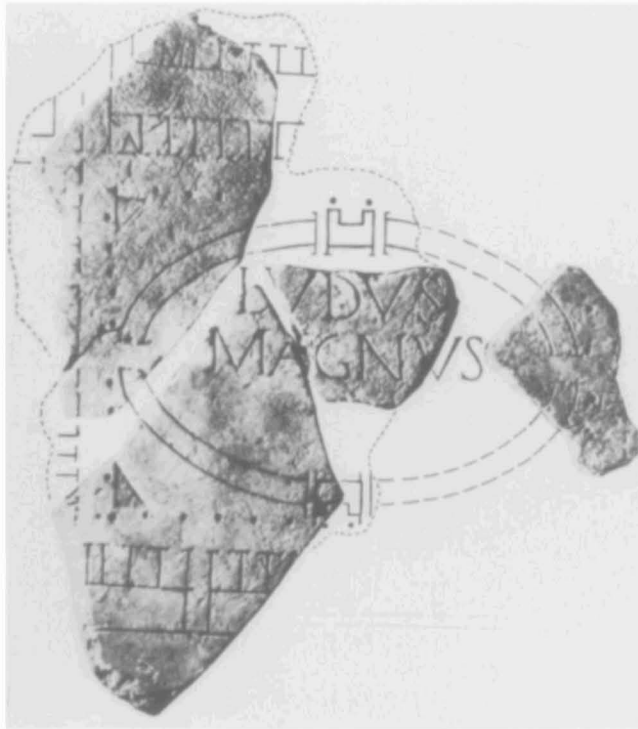


FIG. 13.26. THE LUDUS MAGNUS ON THE *FORMA URBIS ROMAE*. This reconstitution of fragments, first published in 1590, shows a gladiatorial school near the Colosseum. From A. M. Colini and L. Cozza, *Ludus Magnus* (Rome: Comune di Roma, 1962), 8, fig. 8. By permission of the Musei Comunali di Roma.

The whole map thus represents a sophisticated cartographic achievement that in both concept and execution differs little from the town plans of today. It remains the most impressive surviving monument to the work of Roman surveying and mapping.

If the *Forma Urbis Romae* was exceptional in the early empire, it is clear that not all town plans either were drawn to such a large scale or served practical purposes in connection with property or civic administration. Some were decorative or symbolic in purpose. In this category is a maplike mosaic found in Rome's port of Ostia. This was the principal center for overseas trade, particularly imports to Rome such as grain, oil, and animals for the amphitheater.⁶⁰ Among a number of mosaics, one of the most striking representations, though a simple one, is a mosaic of a Roman site virtually in plan, to be seen at ancient Ostia, near the road from the entrance to the museum (fig. 13.28).⁶¹ This is in the meeting place of the *cisiarii*, whose light vehicles were usually drawn by mules, and has been tentatively dated to about A.D. 120.⁶² Here the mosaic has as its centerpiece a small, square, walled town (unrealistic, if it is intended to be Ostia), with a tower at each corner. These

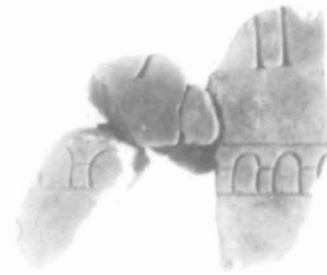


FIG. 13.27. AQUEDUCT ARCHES ON THE *FORMA URBIS ROMAE*. The stylized depiction of aqueducts in elevation is typical of cartographic signs used on the *Forma Urbis Romae*. By permission of the Musei Comunali di Roma.

towers are shown not in plan but in elevation, each lying directly opposite the center of the town and supported by giants known as Telamones. The carts, whose mules have satirical names like Podagrosus ("gouty"), are shown with their drivers outside the town.

ENGINEERING PLANS FOR TUNNELS AND AQUEDUCTS

The final category of large-scale surveys and mapping from the early empire is associated with engineering works of various kinds. The construction of tunnels and aqueducts may, in particular, have involved the use of large-scale plans. Tunnels in antiquity could be dug either for roads or for aqueducts. If they were dug from both sides simultaneously, the result might be a near miss, as happened with the Siloam tunnel⁶³ or that mentioned by Nonius Datus. To avoid this, the Greek mathematician Heron (Hero) of Alexandria, who was evidently writing at some time around A.D. 62,⁶⁴ shows by

60. J. H. D'Arms and E. C. Kopff, eds., *The Seaborne Commerce of Ancient Rome: Studies in Archaeology and History*, Memoirs of the American Academy in Rome, 36 (Rome: American Academy in Rome, 1980).

61. For later mosaics see pp. 263–66 below.

62. Giovanni Becatti, ed., *Mosaici e pavimenti marmorei*, 2 pts. (1961); both are vol. 4 of *Scavi di Ostia* (Rome: Istituto Poligrafico dello Stato, 1953–), pt. 1, 42–44 and pt. 2, pl. CVIII.

63. Siloam inscription from Jerusalem of the reign of King Hezekiah, Istanbul Archaeological Museum.

64. Heron is associated with a recollection of the eclipse of A.D. 62; see note 66 below and Otto Neugebauer, "Über eine Methode zur Distanzbestimmung Alexandria-Rom bei Heron," *Historisk-Filologiske Meddelelser udgivne af det Kongelige Danske Videnskabernes Selskab* 26 (1938–39), nos. 2 and 7, esp. no. 2, pp. 21–24. Other dates have been suggested; see, for example, Dimitrios Sakalis, "Die Datierung Herons von Alexandrien," inaugural dissertation (University of Cologne, 1972), who gives A.D. 90–150, pointing out that Proclus (fifth century A.D.) lists him after Menelaus, who was writing about A.D. 98.

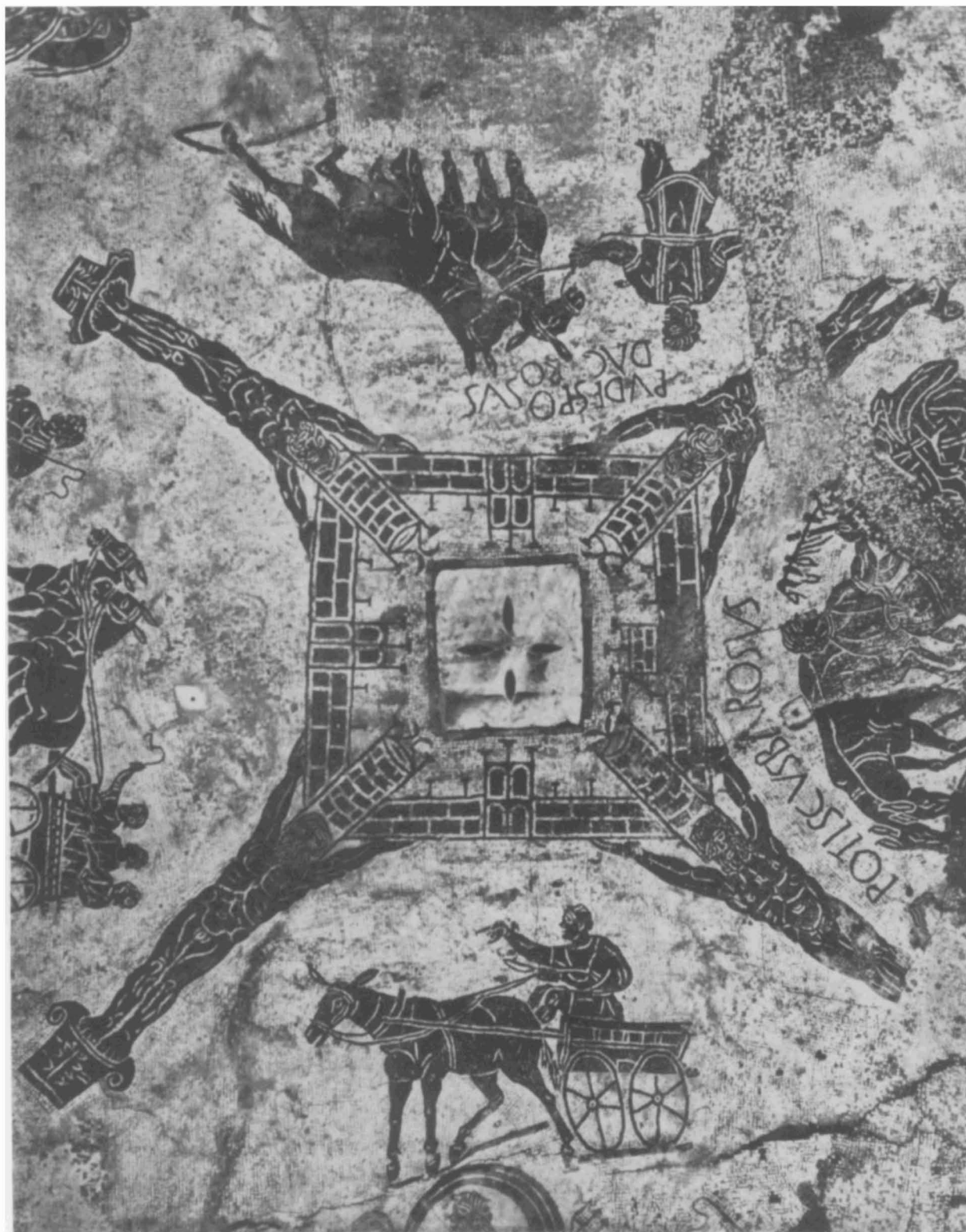


FIG. 13.28. THE CISIARII MOSAIC, OSTIA. Dated to about A.D. 120, this mosaic shows a decorative plan of a small walled town with towers at each corner supported by giants. Museo Ostiense, near Rome.

Size of the original: 8.7 × 8.7 m. From Giovanni Becatti, ed., *Mosaici e pavimenti marmorei*, 2 pts. (1961); both are vol. 4 of *Scavi di Ostia* (Rome: Istituto Poligrafico dello Stato, 1953–), pt. 2, pl. CVIII (no. 64).

a plan the method he advocates (fig. 13.29).⁶⁵ Keeping the gradient uniform, he draws lines along one side of the hill, then at right angles as many times as is necessary, to the appropriate point on the other side of the hill. In theory at least, the gradient could be worked out by means of his dioptra, which was used for angle observation either in surveying or in astronomical work. Yet although this instrument was most ingenious and elaborately constructed, it was obviously rather heavy and complicated for extensive field survey and is never mentioned in the *Corpus Agrimensorum*.⁶⁶

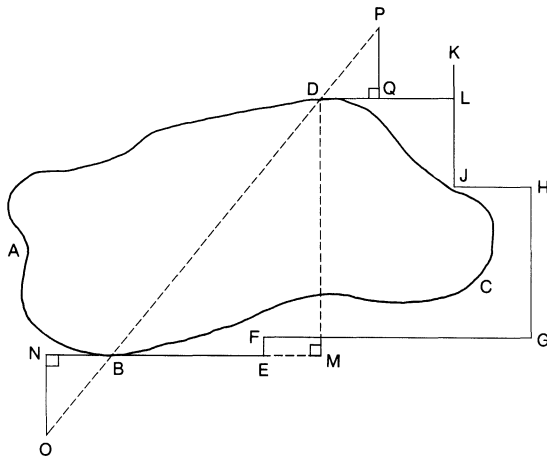


FIG. 13.29. HERON'S TECHNIQUE FOR TUNNELING THROUGH A HILLSIDE. The instructions specify that a tunnel is to be dug from both sides through a hill (in plan) ABCD. From B draw a random line BE, a perpendicular EF, and so on around the hill to K. Construct a line from D to be perpendicular to JK at L. Measure lengths around the hill. Calculate the lengths of BM and DM, being sides of the right-angled triangle BDM. Produce EB to a random point N and construct O such that $BN:NO = BM:MD$. Likewise, Q and P are located such that $DQ:QP = BM:MD$. The direction of the tunnel follows sightings along OB and PD.

After Heron of Alexandria, *Opera quae supersunt omnia* (Leipzig: Teubner, 1899–1914), vol. 3, *Rationes dimetiendi et commentatio dioptrica*, ed. Hermann Schöne (1903), 238.

The surveying treatise on the aqueducts of Rome is by Frontinus, who was appointed curator of waterways by the emperor Nerva in A.D. 97. His work, as it has come down to us, is not illustrated, but in one passage he says: "My enthusiasm did not stop at inspecting individual details. I also took care to make maps of the aqueducts. From these it is clear where the valleys are and how big, where rivers are crossed, where channels made on mountain sides demand more care in constantly inspecting and repairing the conduit. This has given me the advantage that I am able to put the situation immediately under review and discuss it as if I were on the spot."⁶⁷ Such a description seems to imply something approaching a relief map, far more detailed than the aqueducts on the *Forma Urbis Romae*. Whereas the latter are shown pictorially, Frontinus had a working map, possibly with something like transverse profiles.

65. Heron *On the Dioptra*, in his *Opera quae supersunt omnia*, 5 vols. (Leipzig: Teubner, 1899–1914), vol. 3, *Rationes dimetiendi et commentatio dioptrica*, ed. and trans. Hermann Schöne (1903), 238, fig. 95. Schöne also provides a reconstruction of the *dioptra*.

66. For a description and reconstruction of Heron's *dioptra* and his other leveling instruments, see Kiely, *Surveying Instruments*, 20–27 (note 6). Heron also devised a method of distance measurement with his *dioptra*, but again this does not seem to have been taken up in practice. As described in his *On the Dioptra* 35 (note 65), the method involved the use of the *dioptra* together with lunar eclipse observations (a theory already known to Hipparchus), so that the distance between two places could be established. Those he chose were Alexandria and Rome, and his method is known as *analemma*, literally "high rise." The construction of the *dioptra* is explained by Otto Neugebauer, *A History of Ancient Mathematical Astronomy* (New York: Springer-Verlag, 1975), 845 ff., 1379, fig. 23, summarizing his article cited in note 64. Unfortunately, Heron did not have data in hand for the two locations; he seems to have had Alexandrian data for the eclipse of A.D. 62. His estimate of the time difference, two hours, is wide of the mark; the correct time difference between Alexandria and Rome is one hour, ten minutes.

67. Frontinus *De aquis urbis Romae* (Water supply of Rome) 1.17, author's translation, see Frontinus, *The Stratagems [and] The Aqueducts of Rome*, rev. Charles E. Bennett, based on trans. by Clemens Herschel, ed. Mary B. McElwain, Loeb Classical Library (Cambridge: Harvard University Press; London: William Heinemann, 1925).

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