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978-1-009-07324-0 — Archaeological Mapping and Planning
Hans Barnard
Excerpt
More Information

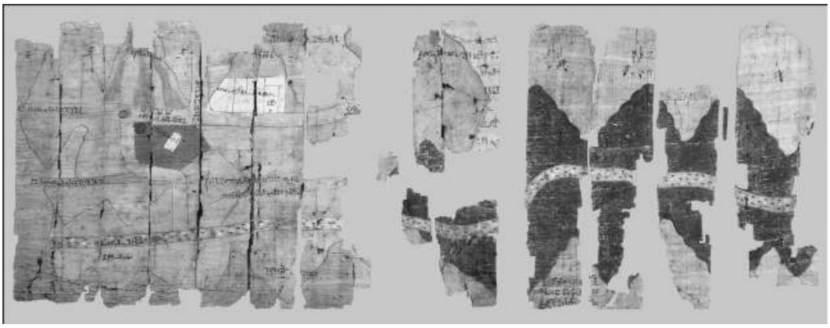


Figure 1 The eastern part of a map on papyrus showing gold mines, stone quarries, and other features in Wadi Hammamat, Egypt (*Museo Egizio*, Turin, Cat. 1879 + 1969 + 1899), drawn by Amennakhte, son of Ipuy, for Pharaoh Ramesses IV (1156–1150 BCE). This is generally considered the oldest surviving map. South is at the top, allowing the waters of the River Nile to flow down. Photograph courtesy of James Harrell.

He had bought a large map representing the sea,
Without the least vestige of land:
And the crew were much pleased when they found it to be
A map they could all understand.

The second stanza of *Fit the Second: The Bellman's Speech,* in: *The Hunting of the Snark: An Agony in Eight Fits* (1876).

Lewis Carroll (Charles L. Dodgson)

1 Theoretical Background: Points, Lines, Angles, and Polygons

Archaeology is special within the sciences because it is the only discipline that irretrievably destroys its evidence while it is being recovered. As the layers within an excavation unit are one by one removed and objects unearthed and retrieved, their all-important relative contexts can only be observed as this process progresses. It is impossible to reconstruct their intricate relationship and repeat the process. This places great responsibilities upon the excavators, who need to record the information that they infer as it becomes available. Ideally, their records should serve as a proxy for the excavation unit and allow future scholars to study it in ways similar to those used by the original excavators. Records comprise notes, photographs, drawings, and plans with abundant overlap, cross-references, and redundancies.These recording techniques, and more, do not render one another dispensable, rather, they are complementary.

Primary data on all archaeological features include their spatial and temporal properties. These are expressed in four dimensions: three in space – usually referred to as X or easting(s), Y or northing(s), and Z or elevation – and one in time, the age of the objects or their date of production or deposition. Temporal properties are usually established and recorded once the objects have been unearthed and moved into a laboratory to be cleaned, stabilized, analyzed, and studied. The spatial properties have to be recorded in situ, which potentially allows objects to remain where they were found, rather than be retrieved. This approach keeps the archaeological record intact and prevents issues related to storage, preservation, and ownership. This Element aims to introduce the basic principles of archaeological mapping and planning, which entails establishing, recording, and visualizing spatial data associated with archaeological features, ranging from ancient buildings to individual artifacts. It will not present detailed instructions on how to operate specific instruments or software packages, but rather the mathematical and practical backgrounds of mapping and planning in the field.

With this knowledge, archaeologists should be able to learn swiftly how to operate the instruments and software available to them, as well as assess the validity of the results that they obtain. This is especially relevant as access to state-of-the-art resources can be limited. Many of these are relatively expensive to purchase and maintain and they often have a rather short life span. This may not be an issue for well-established archaeological institutions, which are mostly based in Europe, but can form a significant obstacle for archaeologists elsewhere. Even when potentially available, many countries impose restrictions on the import or the use of electronic and imaging equipment, including electronic survey instruments and especially drones. Moreover, many archaeological sites are in places where access to the Internet or cell phone service, or even electricity, is intermittent or absent. Furthermore, most readily available technologies are designed to execute the reverse of archaeological mapping or planning, as they are primarily geared toward laying out designs in the field, rather than reducing reality into a map (Figure 1). Finally, during an initial visit to establish the archaeological potential of a larger area, it can be necessary to record observations of interest swiftly and with minimal means. The methods and techniques discussed in this Element, some of which date back centuries or even millennia, will enable archaeologists to create acceptable maps with simple means in adverse circumstances.

Like all practical skills, such as driving a car or playing the piano, mapping and planning cannot entirely be learned from an illustrated text, but rather by apprenticeship and practice. During this process, each archaeologist will develop a personal style and work flow, which nevertheless should always aim to reach a final result that can readily be understood and used by other archaeologists. The most important skill that an archaeological surveyor should develop, or have, is the ability to visualize a mental image of the area to be planned and imagine what the final map should look like. Making a sketch map before starting the actual survey work will not prove just helpful in this, but near indispensable. Additional useful skills include a constant awareness of the cardinal directions and the length of one's stride. All these will improve with experience and enable a proficient surveyor to create a relatively accurate sketch map in a short amount of time. All digital methods and technologies are complementary to these basic skills and cannot fully replace them as an effective avenue to gain insights in exposed ancient remains. The importance of knowing the basics and the value of drawings can hardly be overstated. They allow for interpretations to be reflected – by highlighting or instead disregarding specific details – and, more importantly, they provide an opportunity to study the ancient remains and their intricate relationships to the extent necessary to produce an accurate drawing.

Examples of different types of maps and plans are provided throughout the text – starting with Figure 2, but mostly concentrated in Section 6 – to serve as examples and provide inspiration. In other places specific values are listed in the text or tables. These are provided to complement the illustrations and the text, as they can readily be obtained in much more detail from a calculator or cell phone. Where necessary these numbers and the equations associated with them will be embedded in electronic survey equipment and software. A list of the most often used abbreviations is provided in Table 16.

All measured survey activities are based upon points, lines, and polygons, almost exclusively triangles. To provide a handle on these and allow their properties to be expressed, established, or calculated, these are located within

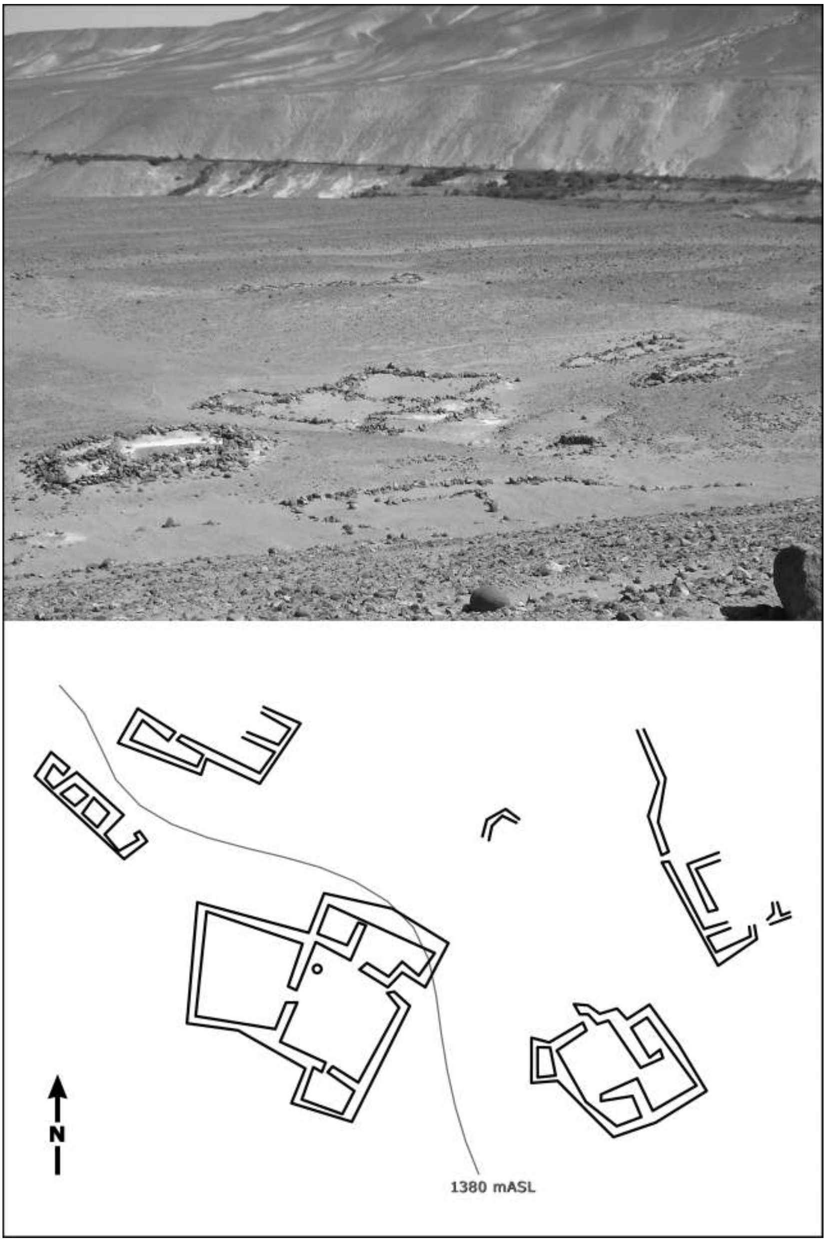


Figure 2 Photograph of the remains of ancient structures, looking south (top), and the corresponding measured plan of the same structures (bottom)

a grid or coordinate system. A line is the shortest connection between two points and can be imagined to continue infinitely in either or both directions (Figure 3, top). Lines are one dimensional, meaning that they have no width or height, but

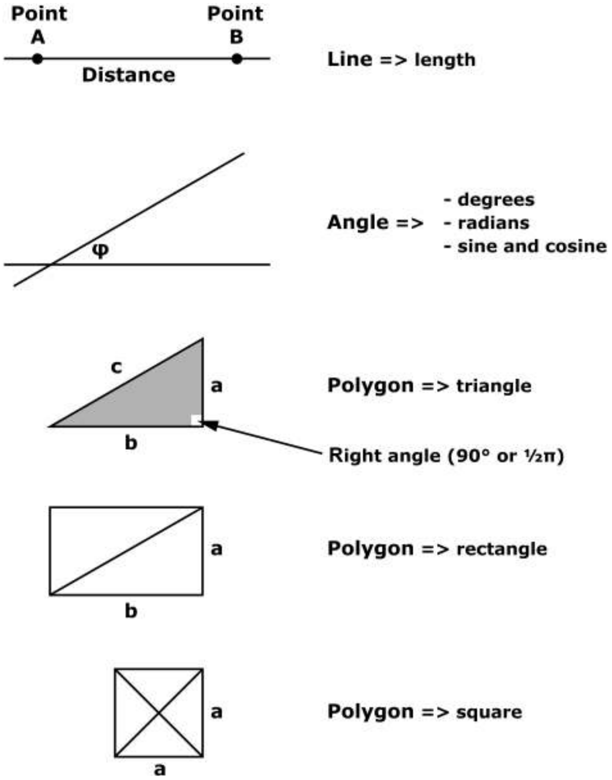


Figure 3 The basic elements of mapping and planning: points, lines, angles and polygons (triangles)

only length. A distance between two points is the length of the line between these points. In archaeology distances are expressed in millimeters, centimeters, meters, and kilometers (Table 1), as they are in other sciences. One meter is 39.37008 inches or 3.28084 feet (Table 2). Note how metric units can be converted into each other by simply moving the decimal point three places, either to the left or the right.

When drawing a measured plan or map of an archaeological site, or any other feature in the terrain, this involves uniformly scaling down the measured distances to fit the selected medium and purpose of the final result. For this distances are divided by a convenient number, most often 10, 20, or 100 (written as 1:10, 1:20, and 1:100, respectively), or multiples thereof (Table 3). For practical purposes it is better to avoid scales that will result in awkward numbers, such as 3 and 30, but also 4 and 25. The topographic maps that exist of most regions in the world and are often the base for more detailed archaeological maps are most commonly drawn to a scale of 1:25,000 (1 cm on the map is 250 m in the terrain and 1 km in the terrain is 4 cm on the map) or 1:50,000

Table 1 Terminology of the metric system

Decimals	10^n	Prefix	Symbol
1 000 000 000 000 000 000	10^{18}	exa-	E
1 000 000 000 000 000	10^{15}	peta-	P
1 000 000 000 000	10^{12}	tera-	T
1 000 000 000	10^{9}	giga-	G
1 000 000	10^{6}	mega-	M
1 000	10^{3}	kilo-	k
1	10°		
0.001	10^{-3}	milli-	m
0.000 001	10^{-6}	micro-	µ
0.000 000 001	10^{-9}	nano-	n
0.000 000 000 001	10^{-12}	pico-	p
0.000 000 000 000 001	10^{-15}	femto-	f
0.000 000 000 000 000 001	10^{-18}	atto-	a

Table 2 Conversions of selected units of distance

Unit	Equivalent		
1 millimeter	0.03937 inch		
1 meter	39.37008 inches	3.28084 feet	
1 kilometer	0.62137 mile	3280.83990 feet	39 370.07874 inches
1 inch	25.4 millimeter		
1 foot	304.8 millimeters	0.3048 meter	
1 yard	914.4 millimeters	0.9144 meter	
1 mile	1 609 344 millimeters	1609.344 meters	1.60934 kilometers

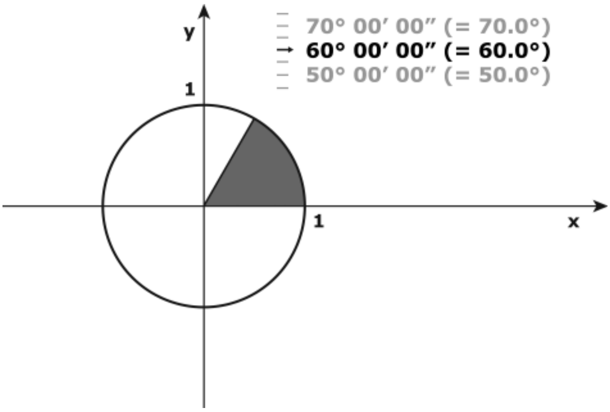
Table 3 Length in centimeter on a map of selected distances in the terrain at the most commonly used scales. Note that specific scales are more appropriate for certain ranges of features than others

	Scale				
Actual distance	1:10	1:20	1:100	1:200	1:1,000
1 cm	0.1	–	–	–	–
10 cm	1	0.5	0.1	–	–
1 m	10	5	1	0.5	0.1
10 m	100	50	10	5	1
100 m	–	–	100	50	10
1 km	–	–	–	–	100

(1 cm on the map is 500 m in the terrain and 1 km in the terrain is 2 cm on the map). Maps showing larger areas usually have too little detail to be of much use for archaeological research.

Lines that are not exactly parallel will eventually intersect. This can create either four angles that are exactly the same, identified as right angles, or a pair of obtuse and a pair of acute angles (Figure 3). Angles can be expressed in three different, but related ways. All involve imagining the meeting point of the two lines to be the center of a circle with a radius of one measuring unit (which can be 1 millimeter, inch, foot, yard, meter, kilometer, mile, or something else entirely), a so-called unit circle. The actual size of the unit circle is irrelevant as during the scaling of distances angles will remain unchanged.

The first method to express the size of an angle is to match it with the segment of the circle created by the two lines (Figure 4). Conventionally, a circle is divided into 360° (degrees), each of which is subdivided into 60′ (minutes), each of which is again divided into 60″ (seconds), or 60 × 60 = 3600″ for each degree (Animation 1). Alternatively, degrees can be divided into minutes and decimal minutes (D° M.mmmmm′, Table 4) or into decimal degrees (D.ddddd°). In this system, a right angle is 90° (or 270°) and a straight line 180°. Other methods to divide circles have been developed, but are much less common. Most often used is the division of the full circle into 400 gons (400^g), making a right angle 100^g (or 300^g) and a straight line 200^g.



Animation 1 The unit circle (with a radius of one unit of length), divided into 360°. The animated version of the image is available at www.cambridge.org/barnard

Table 4 Conversion of selected minutes and decimal minutes. These figures are provided here to complement the text and illustrations

Minutes	Decimal minutes	Decimal minutes	Minutes
0′	0	0	0′
10′	D.16666 . . .	D.10	6′
15′	D.25	D.20	12′
20′	D.33333 . . .	D.30	18′
30′	D.5	D.40	24′
40′	D.66666 . . .	D.50	30′
45′	D.75	D.60	36′
50′	D.83333 . . .	D.70	42′
60′ (1°)	D+1	D.80	48′
		D.90	54′
		D+1	60′ (1°)

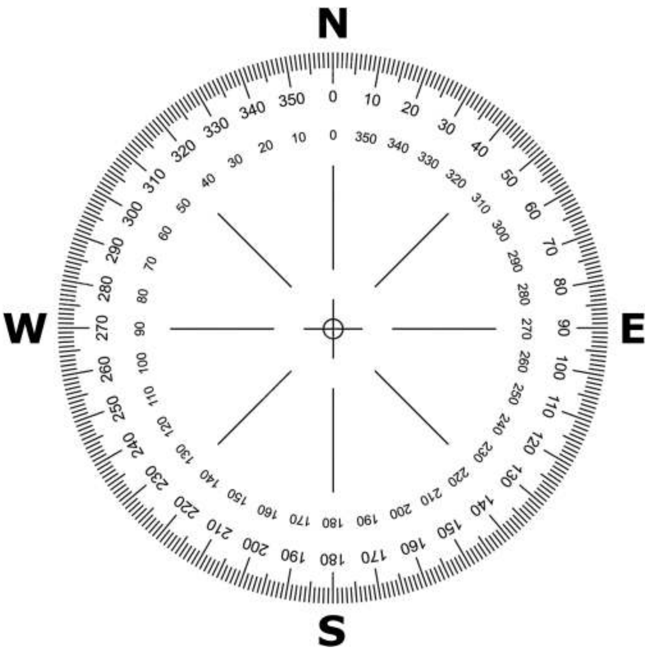


Figure 4 A full circle divided into 360° (degrees), see Figure 28