



# The Geographer's Tools

## Main Ideas

- Geographers use two- and three-dimensional tools to learn about the earth.
- Geographers use computer-assisted technology to study the use of the earth's surface.

## Places & Terms

**globe**

**map**

**cartographer**

**map projection**

**topographic map**

**Landsat**

**Geographic Information Systems (GIS)**

**A HUMAN PERSPECTIVE** At noon on a sunny midsummer day, sometime around 255 B.C., Eratosthenes drove a stake into the ground at the mouth of the Nile River in Alexandria, Egypt. He then noted the angle of the shadow cast by the stake. Meanwhile at Syene (modern-day Aswan, Egypt), another person drove a stake into the ground—but it cast no shadow. Using the angle of the first shadow and the distance between Syene and Alexandria, Eratosthenes calculated the circumference of the earth. By today's measurements, he was off by about 15 percent, but he was remarkably accurate considering the simple tools he used. Eratosthenes was one of the earliest geographers to use tools and critical thinking to measure and describe the earth.

## Maps and Globes

A geographer's tools include maps, globes, and data that can be displayed in a variety of ways. The oldest known map is a Babylonian clay tablet created about 2,500 years ago. The tablet is about four inches high and shows the Babylonian world surrounded by water. Over the centuries, mapmaking evolved into a very complex task. However, a map's function has remained the same—to show locations of places, landforms, and bodies of water, and where they are in relation to other parts of the earth.

**TWO OR THREE DIMENSIONS** A **globe** is a three-dimensional representation of the earth. It provides a way to view the earth as it travels through space. But since the earth is a sphere, we can see only one half of it at any time. For certain tasks, globes are not very practical because they are not easily portable.

People often prefer to use **maps**, which are two-dimensional graphic representations of selected parts of the earth's surface. Maps are easily portable and can be drawn to any scale needed.

The disadvantage of a map is that distortion occurs as the earth's surface is flattened to create the map. A **cartographer**, or mapmaker, reduces some types of distortion by using different types of map projections. A **map projection** is a way of drawing the earth's surface that reduces distortion caused by presenting a round earth on flat paper. To learn more about map projections, see the Geography Skills Handbook, pages 18–19.

This globe, created circa 1492, is turned to show Africa and Europe.





### BACKGROUND

Navigational maps, often referred to as charts, help their users to plot a course through air or water.

**TYPES OF MAPS** The three types of maps are general reference maps, thematic maps, and navigational maps. A general reference map is sometimes called a **topographic map**, which is a representation of natural and man-made features on the earth. Thematic maps emphasize specific kinds of information, such as climate or population density. Sailors and pilots use the third type of map—navigation maps. You can learn more about using different maps in the Geography Skills Handbook, pages 20–23.

## The Science of Mapmaking

A cartographer decides what type of map to create by considering how the map will be used. Keeping that purpose in mind, he or she then determines how much detail to show and what size the map should be.

**SURVEYING** The first step in making a map is to complete a field survey. Surveyors observe, measure, and record what they see in a specific area. Today, most mapping is done by remote sensing, the gathering of geographic information from a distance by an instrument that is not physically in contact with the mapping site. These data are gathered primarily by aerial photography or by satellites.

The data gathered includes information such as elevation, differences in land cover, and variations in temperature. This information is recorded and converted to a gray image. Cartographers then use these data and computer software to construct maps. See the illustration below to learn more about satellite surveying.

### How Satellites Gather Map Data

**1** As the satellite orbits the earth, a scanner constantly records data from the earth's surface.

**2** Instruments measure invisible electromagnetic waves emitted by each object on earth. Because these waves are unique for every object, computers can analyze and identify them.

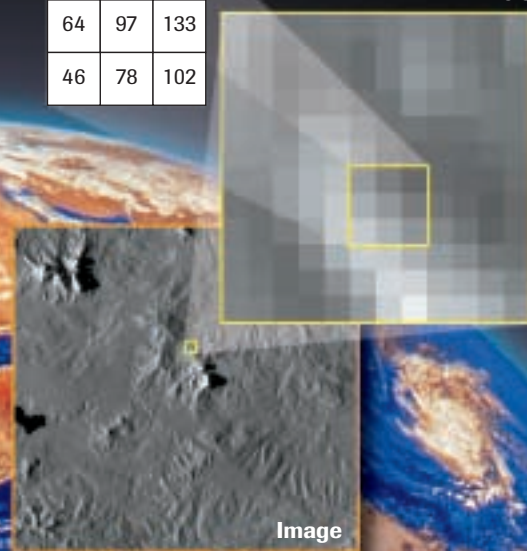
**3** The data collected is converted first to code and then to pixels—electronic dots. Computer software then converts the pixels into usable images.

The first step in mapmaking is collecting data. Remote sensors gather information for constructing maps.



	Code		
<b>3</b>	97	128	151
	64	97	133
	46	78	102

Pixels



Image





**SATELLITES** Today, geographers rely heavily on satellites to provide geographic data. Two of the best-known satellites are Landsat and GOES. **Landsat** is actually a series of satellites that orbit more than 100 miles above the earth. Each time a satellite makes an orbit, it picks up data in an area 115 miles wide. Landsat can scan the entire earth in 16 days.

Geostationary Operational Environment Satellite (GOES) is a weather satellite. This satellite flies in orbit at the same speed as the earth's rotation. By doing so, it always views the same area. It gathers images of atmospheric conditions that are useful in forecasting the weather.

## Geographic Information Systems



**Geographic Information Systems (GIS) allow geographers to solve problems by combining geographic information about a location from several sources.**



10	20	30	40	50	60	70	80	90
20	30	40	50	60	70	80	90	100
30	40	50	60	70	80	90	100	110
40	50	60	70	80	90	100	110	120
50	60	70	80	90	100	110	120	130
60	70	80	90	100	110	120	130	140
70	80	90	100	110	120	130	140	150
80	90	100	110	120	130	140	150	160
90	100	110	120	130	140	150	160	170
100	110	120	130	140	150	160	170	180
110	120	130	140	150	160	170	180	190
120	130	140	150	160	170	180	190	200
130	140	150	160	170	180	190	200	210
140	150	160	170	180	190	200	210	220
150	160	170	180	190	200	210	220	230
160	170	180	190	200	210	220	230	240
170	180	190	200	210	220	230	240	250
180	190	200	210	220	230	240	250	260
190	200	210	220	230	240	250	260	270
200	210	220	230	240	250	260	270	280
210	220	230	240	250	260	270	280	290
220	230	240	250	260	270	280	290	300
230	240	250	260	270	280	290	300	310
240	250	260	270	280	290	300	310	320
250	260	270	280	290	300	310	320	330
260	270	280	290	300	310	320	330	340
270	280	290	300	310	320	330	340	350
280	290	300	310	320	330	340	350	360
290	300	310	320	330	340	350	360	370
300	310	320	330	340	350	360	370	380
310	320	330	340	350	360	370	380	390
320	330	340	350	360	370	380	390	400
330	340	350	360	370	380	390	400	410
340	350	360	370	380	390	400	410	420
350	360	370	380	390	400	410	420	430
360	370	380	390	400	410	420	430	440
370	380	390	400	410	420	430	440	450
380	390	400	410	420	430	440	450	460
390	400	410	420	430	440	450	460	470
400	410	420	430	440	450	460	470	480
410	420	430	440	450	460	470	480	490
420	430	440	450	460	470	480	490	500
430	440	450	460	470	480	490	500	510
440	450	460	470	480	490	500	510	520
450	460	470	480	490	500	510	520	530
460	470	480	490	500	510	520	530	540
470	480	490	500	510	520	530	540	550
480	490	500	510	520	530	540	550	560
490	500	510	520	530	540	550	560	570
500	510	520	530	540	550	560	570	580
510	520	530	540	550	560	570	580	590
520	530	540	550	560	570	580	590	600
530	540	550	560	570	580	590	600	610
540	550	560	570	580	590	600	610	620
550	560	570	580	590	600	610	620	630
560	570	580	590	600	610	620	630	640
570	580	590	600	610	620	630	640	650
580	590	600	610	620	630	640	650	660
590	600	610	620	630	640	650	660	670
600	610	620	630	640	650	660	670	680
610	620	630	640	650	660	670	680	690
620	630	640	650	660	670	680	690	700
630	640	650	660	670	680	690	700	710
640	650	660	670	680	690	700	710	720
650	660	670	680	690	700	710	720	730
660	670	680	690	700	710	720	730	740
670	680	690	700	710	720	730	740	750
680	690	700	710	720	730	740	750	760
690	700	710	720	730	740	750	760	770
700	710	720	730	740	750	760	770	780
710	720	730	740	750	760	770	780	790
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790	800	810	820	830	840	850	860	870
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820	830	840	850	860	870	880	890	900
830	840	850	860	870	880	890	900	910
840	850	860	870	880	890	900	910	920
850	860	870	880	890	900	910	920	930
860	870	880	890	900	910	920	930	940
870	880	890	900	910	920	930	940	950
880	890	900	910	920	930	940	950	960
890	900	910	920	930	940	950	960	970
900	910	920	930	940	950	960	970	980
910	920	930	940	950	960	970	980	990
920	930	940	950	960	970	980	990	1000
930	940	950	960	970	980	990	1000	1010
940	950	960	970	980	990	1000	1010	1020
950	960	970	980	990	1000	1010	1020	1030
960	970	980	990	1000	1010	1020	1030	1040
970	980	990	1000	1010	1020	1030	1040	1050
980	990	1000	1010	1020	1030	1040	1050	1060
990	1000	1010	1020	1030	1040	1050	1060	1070
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1010	1020	1030	1040	1050	1060	1070	1080	1090
1020	1030	1040	1050	1060	1070	1080	1090	1100
1030	1040	1050	1060	1070	1080	1090	1100	1110
1040	1050	1060	1070	1080	1090	1100	1110	1120
1050	1060	1070	1080	1090	1100	1110	1120	1130
1060	1070	1080	1090	1100	1110	1120	1130	1140
1070	1080	1090	1100	1110	1120	1130	1140	1150
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1090	1100	1110	1120	1130	1140	1150	1160	1170
1100	1110	1120	1130	1140	1150	1160	1170	1180
1110	1120	1130	1140	1150	1160	1170	1180	1190
1120	1130	1140	1150	1160	1170	1180	1190	1200
1130	1140	1150	1160	1170	1180	1190	1200	1210
1140	1150	1160	1170	1180	1190	1200	1210	1220
1150	1160	1170	1180	1190	1200	1210	1220	1230
1160	1170	1180	1190	1200	1210	1220	1230	1240
1170	1180	1190	1200	1210	1220	1230	1240	1250
1180	1190	1200	1210	1220	1230	1240	1250	1260
1190	1200	1210	1220	1230	1240	1250	1260	1270
1200	1210	1220	1230	1240	1250	1260	1270	1280
1210	1220	1230	1240	1250	1260	1270	1280	1290
1220	1230	1240	1250	1260	1270	1280	1290	1300
1230	1240	1250	1260	1270	1280	1290	1300	1310
1240	1250	1260	1270	1280	1290	1300	1310	1320
1250	1260	1270	1280	1290	1300	1310	1320	1330
1260	1270	1280	1290	1300	1310	1320	1330	1340
1270	1280	1290	1300	1310	1320	1330	1340	1350
1280	1290	1300	1310	1320	1330	1340	1350	1360
1290	1300	1310	1320	1330	1340	1350	1360	1370
1300	1310	1320	1330	1340	1350	1360	1370	1380
1310	1320	1330	1340	1350	1360	1370	1380	1390
1320	1330	1340	1350	1360	1370	1380	1390	1400
1330	1340	1350	1360	1370	1380	1390	1400	1410
1340	1350	1360	1370	1380	1390	1400	1410	1420
1350	1360	1370	1380	1390	1400	1410	1420	1430
1360	1370	1380	1390	1400	1410	1420	1430	1440
1370	1380	1390	1400	1410	1420	1430	1440	1450
1380	1390	1400	1410	1420	1430	1440	1450	1460
1390	1400	1410	1420	1430	1440	1450	1460	1470
1400	1410	1420	1430	1440	1450	1460	1470	1480
1410	1420	1430	1440	1450	1460	1470	1480	1490
1420	1430	1440	1450	1460	1470	1480	1490	1500
1430	1440	1450	1460	1470	1480	1490	1500	1510
1440	1450	1460	1470	1480	1490	1500	1510	1520
1450	1460	1470	1480	1490	1500	1510	1520	1530
1460	1470	1480	1490	1500	1510	1520	1530	1540
1470	1480	1490	1500	1510	1520	1530	1540	1550
1480	1490	1500	1510	1520	1530	1540		



**GEOGRAPHIC INFORMATION SYSTEMS** The newest tool in the geographer's toolbox is **Geographic Information Systems (GIS)**. GIS stores information about the world in a digital database. GIS has the ability to combine information from a variety of sources and display it in ways that allow the user to visualize the use of space in different ways.


When using the system, geographers must look at a problem and decide what types of geographic information would help them solve the problem. The information could include maps, aerial photographs, satellite images, or other data. Next, they select the appropriate layers of information. Then, GIS creates a composite map combining the information. Study the diagram on page 12 to learn more about the way GIS works.

**A. Answer** GPS allows the military to know their precise position. GOES alerts the military to weather problems.



#### Making Comparisons

**A** How might the military use both GOES and GPS?

**GLOBAL POSITIONING SYSTEM (GPS)** A familiar tool of geographers is GPS or Global Positioning System. It was originally developed to help military forces know exactly where they were on the earth's surface. The system uses a series of 24 satellites called Navstars, which beam information to the earth. The exact position—latitude, longitude, altitude, and time—is displayed on a hand-held receiver. Hikers, explorers, sailors, and drivers use GPS devices to determine location. They are also used to track animals. 

Geographers use a variety of other tools including photographs, cross sections, models, cartograms, and population pyramids. These tools help geographers to visualize and display information for analysis. They are looking for patterns and connections in the data they find. You will learn how to use these tools in the Geography Skills Handbook, which follows, and in the Map and Graph Skills pages in this book.



**MOVEMENT** Scientists use a GPS device to track this brown bear in Minnesota.

**What other uses could be found for a GPS device?**



## Assessment

### 1 Places & Terms

Explain the meaning of each of the following terms.

- globe
- map
- cartographer
- map projection
- topographic map
- GIS

### 2 Taking Notes

**REGION** Review the notes you took for this section.

*Tools:*

- How would a globe show a region differently than a map?
- How does GIS aid in understanding a region?

### 3 Main Ideas

- a. What are the three basic types of maps?
- b. What are some geographers' tools in addition to maps and globes?
- c. How does a cartographer decide which type of map is needed?

### 4 Geographic Thinking

#### Making Generalizations

How does modern technology help geographers? **Think about:**

- digital information
- satellite images



**See Skillbuilder Handbook, page R6.**



**MAKING COMPARISONS** Choose a place on the earth and in an atlas, and find three maps that show the place in three different ways. Create a **chart** that lists the similarities and differences in the way the place is shown on the three maps.