1. The Very Earliest Maps

Imagine what it would be like to live in a world without maps. How would you know what was beyond the horizon? Do you think you would be able to travel a hundred miles and find your way home again? Would you trust a neighbor's directions to get to a marketplace twenty miles away?

In ancient times, most people lived out their lives without ever seeing a map. The maps that did exist were extremely basic and showed only major land features such as rivers and mountains. It is likely that some maps were destroyed on purpose because they were intended to reveal secret routes to resources or treasures. Other maps would have been drawn in the dirt or on stones and were erased soon after they were made. The very earliest maps that are still in existence today were drawn on clay by the people of Mesopotamia (the area we now call Iraq). The one shown here, on the left, is from a place called Ga-Sur (modern day Kirkuk) and was made somewhere around 2500 BC. The lines and squiggles represent mountains and rivers. The one on the right was made in about 600 BC, when the people of that area were called Babylonians. Inside the circle is the whole world as they knew it, including Assyria and Armenia. The circle is labeled as "Bitter River" and the area outside it seems to be a sea or ocean, with the stars pointing to certain islands. The words on the side of the stars tell how far away these islands are. The Babylonian form of writing is called cuneiform (*cue-nee-i-form*) and looks like little wedge shapes pressed into the clay. All writing or drawing was done while the clay was wet. They also drew on stones, etching the lines into the stone with a sharp tool.

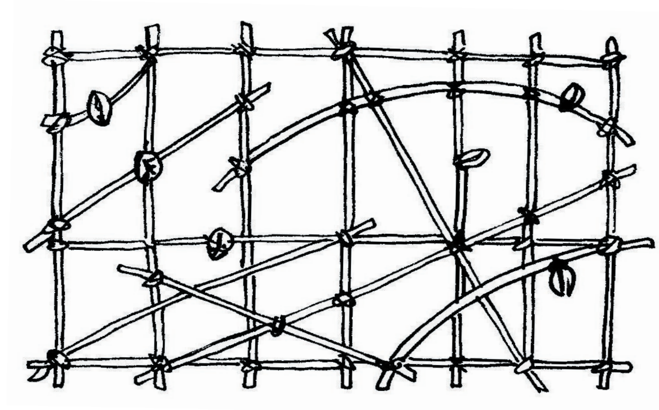
2500 BC

600 BC

The oldest paper map still in existence is from Egypt and was drawn on papyrus somewhere around 1300 BC. It is a local map showing roads, buildings, and what look like mountains. The pharaohs were very organized about collecting taxes from their citizens and we know the tax collectors did use maps, so this map might well have been used by Egyptian tax collectors to find their way to certain neighborhoods. This map is now in a museum in Turin, Italy (the city made famous by the "Shroud of Turin"-- the supposed burial shroud of Christ).

The "Turin" Papyrus is from Egypt, about 1300 BC

The ancient Polynesians made maps of the ocean from the materials they had available to them: reeds and shells. The shells marked where islands were located and the reeds often corresponded to certain latitudes or to strong currents or prevailing winds. The Polynesians were expert navigators, and with little more than these maps and the ability to sight the North Star, they could sail from island to island in their part of the world. The tool they used to sight the North Star was nothing more than a loop on top of a stick.



None of these ancient peoples even tried to make a map of the world because they knew that their information about the world was very limited. They understood that there was a lot more to the world than the part they lived in, but they couldn't begin to guess the true shape and size of the world. The best they could do was to make up stories. Some believed that the Earth was a great disk surrounded by water called Oceanus, and the sky was resting on four invisible pillars. The sun rose from the waters of Oceanus each morning and plunged back into them at night. Other ancient peoples guessed that the Earth was a giant cylinder or rectangle. A few guessed it might be a sphere, but only because they liked that shape. Some believed it to be supported underneath by a god, or even by a giant turtle!

Ancient peoples did get a few things right, however. They all believed that there was a huge body of water out there, much bigger than any piece of land. Many cultures believed that to north lay a land so cold that no one could live there. They also discovered many things about the sun, moon and stars that would give future mapmakers valuable information. They observed shadows made by the sun, the phases of the moon, lunar and solar eclipses, planetary motion and passing comets. They kept charts of the position of the stars at various times of the year. The Bablyonian clay tablet shown here contains a list of dates when eclipses occurred. Little did they know that their observations would lead to great discoveries about the shape of the world.

Bablyonian record of eclipses

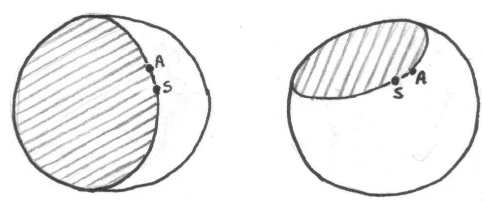
The first ancient people that took on the task of trying to find out the shape and size of the entire world were some of the greatest thinkers of all-time: the Greeks. Aristotle was quite sure the Earth was a sphere. He gave several reasons for thinking so. First, during a partial eclipse of the moon, he said that you could see the shadow of the Earth--and it was round. Second, he pointed out that certain stars that were above the horizon in Egypt were below the horizon in Greece. If the Earth was a sphere, that's exactly what you would expect to see. Third, when you looked out to sea, you could see ships "appearing" on the horizon and anyone who had ever sailed knew that ships didn't come out of the water. Only a spherical shape could explain this phenomenon. Most people were convinced by his argument and thus, since the time of Aristotle, people have believed the Earth to be a sphere. The old story that people believed the Earth was flat until the time of Columbus isn't true at all.

The Greeks also discovered the principles of geometry. They could use basic facts about triangles to help them solve all kinds of problems. Using triangles, the Greeks figured out how large the world is. After they had figured out both the shape and size of the world, they were then ready to move on to the greatest mapping question of all time: how can you draw something round on a flat surface?

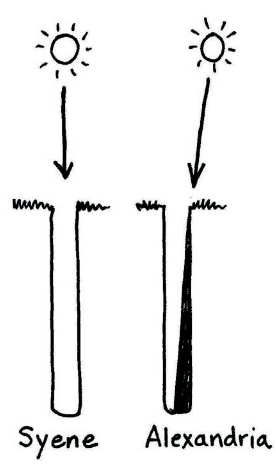
2. Strabo and Eratosthenes

In the year 25 BC, a Greek man named Strabo went to visit Alexandria, Egypt. The highlight of his trip was visiting the famous library there. Alexandria was a center for education in the ancient world. The royal library contained over half a million manuscripts collected over hundreds of years. You could read the works of Roman poets and historians, the writings of Greek philosophers and mathematicians, or the ancient charts kept by the Babylonians. Strabo was most interested in books on astronomy and geography. He read enough about both to realize that they were connected. He said, "It is impossible for anyone to attain knowledge of geography without knowledge of the heavenly bodies and the eclipses that have been observed." Tragically, the books that Strabo was able to read are no longer in existence. The great library of Alexandria has been plundered and destroyed several times since Strabo was there. The only way we know about these books is through the book Strabo himself wrote, simply called Geography.

Strabo was right about geography and astronomy being connected. One of the books he read there at the library was about a Greek man, named Eratosthenes, who had lived 200 years before him. Geography took a huge leap forward in about 250 BC when Eratosthenes used observations of the sun's behavior to figure out the size of the Earth. Eratosthenes was Greek, but he lived in Egypt, since Egypt had been conquered by the Greeks under Alexander the Great (hence the name of the city, Alexandria). Eratosthenes was very scholarly and he eventually became the librarian in Alexandria. Being a Greek, he was a thinker, and was particularly fond of thinking about geometry. He reasoned that if the Earth was a sphere, then the whole question of the size of the Earth just boiled down to a simple geometry problem no harder than any others he had solved in his math books. He only needed to add some astronomical observations about the sun to the rules of geometry.



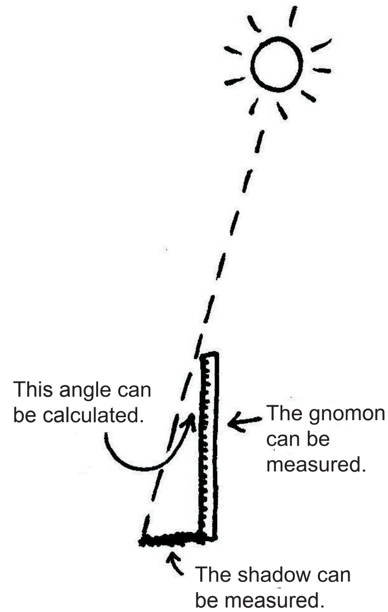
The first astronomical observation he made was in a city below Alexandria, called Syene (near modern day Aswan). He found that the sun reached its highest point (the meridian) at exactly the same time of day as it did in Alexandria. This meant that Syene must be directly south of Alexandria. (The compass as we know it today had not been invented yet so all measurements north and south had to be done using astronomy.) This also meant that if you drew a line between these two cities and kept on going, the line would trace out a perfect circle all the way around the globe. If Syene had been east or west of Alexandria, the circle they traced out would be smaller than the full distance around the Earth. Eratosthenes needed two cities that were lined up north and south of each other so that the distance between them was part of the total measurement around the globe.

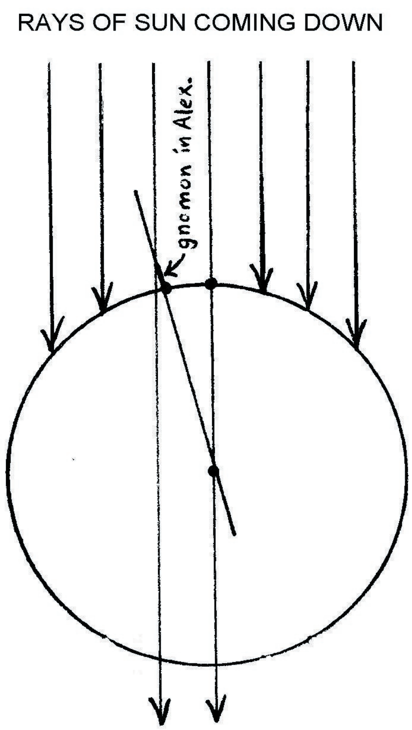


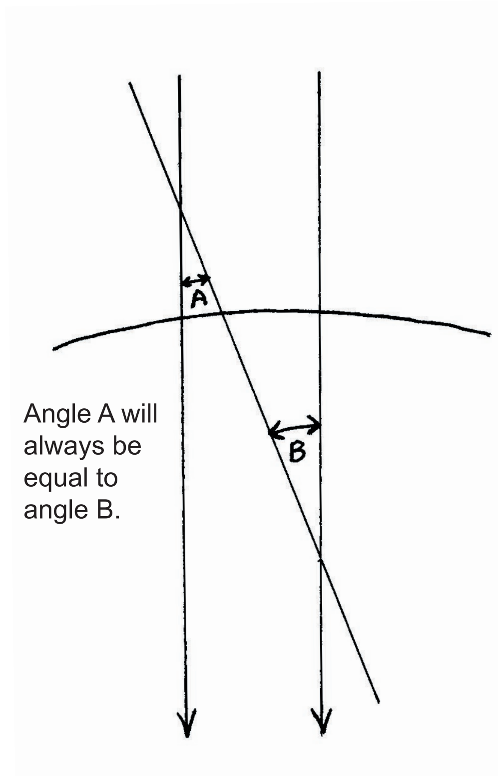
Eratosthenes' next astronomical observation was that on the longest day of the year (called the summer solstice) the sundials down in Syene cast no shadow. On this day of the year you could see to the bottom of the deepest well in Syene and there would be no shadow at the bottom. This meant that the sun's rays must be coming directly down--perfectly straight down, not even at the slightest angle. He also knew that in Alexandria the sundials did cast a shadow on the longest day of the year, and there were shadows at the bottom of deep wells. This meant that the sun's rays were coming down at an angle.

Eratosthenes, like all educated Greeks, was also very good at geometry. He knew that if you have a triangle with a perfectly "square" corner of 90 degrees (called a "right" triangle) you can figure out the measurement of the angles if you know the measurement of two sides. Eratosthenes simply measured how tall the gnomon was (that's the thing that sticks up and casts the shadow) and measured how long the shadow was. He then calculated the angle of the sun's rays; the angle was about 1/50 of a circle. (In other words, if you put 50 of those little angles together, you would have a complete circle.) Now all he had to do was apply one more rule of geometry and he would know how big the Earth was.

Eratosthenes drew a diagram showing a circle representing the Earth, two dots representing the cities of Alexandria and Syene, a dot at the center of the Earth, lines showing the rays of the sun coming straight down (he assumed the rays were parallel, and he was right) and a little tiny line representing the gnomon of a sundial in Alexandria.







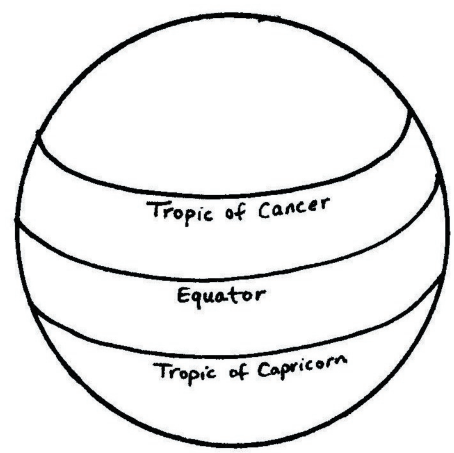
The rules of geometry said that because the lines he had drawn for the rays of the sun were parallel, the angle of the shadow on the sundial (marked as angle A) had to be exactly the same as the angle marked as B. Therefore, the distance between Alexandria and Syene was 1/50 of the total distance around the Earth. He already knew that these two cities were exactly 500 miles apart. All he had to do was multiply 500 miles times 50 to get 25,000 miles. We know today that the circumference of the Earth at the Equator is 24,901.55 miles. Eratosthenes was almost exactly right! His "error" was due to the facts that Syene and Alexandria are not precisely north and south of each other (they're off by just a tiny bit) and that the Earth is not perfectly round. Neither of these facts could possilby have been known to anyone in Eratosthenes' time.

3. Lines on the globe

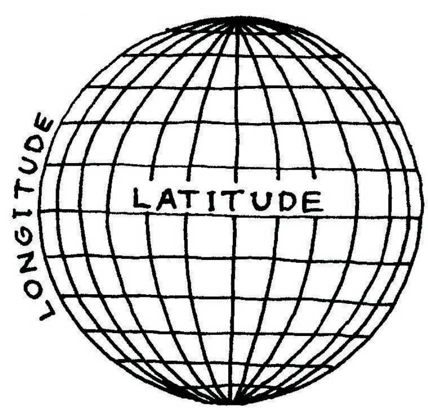
People living after 250 BC knew that the Earth was a sphere with a circumference of about 25,000 miles. The next question was how to map it. Once again, astronomy provided the basic answers.

You will remember that on the longest day of the year, the sundials in Syene cast no shadow at noon, and you could see to the bottom of the deepest wells. In Alexandria, this never happened. The sun never got to a point where it shone directly down. Apparently, the sun stopped its travels north somewhere around Syene, then headed south again. They decided that this was an important line (although it was imaginary, of course, and you couldn't really see it on the ground). You could find this line anywhere around the globe, just by observing the sun, so it would be a good starting point for making a map of the world. They also decided that they should go ahead and mark the equivalent line to the south, where the sun stopped traveling south and headed north again. Then there should be a line in the middle, too.

Now the lines needed names. The one in the middle was equally distant from the other two, and it divided the Earth into two equal parts, so it was named the equator. Since the people doing the naming were astronomers, names for the other lines were taken from star constellations. On the day when the sun reached its highest point in the north, the constellation Cancer, the crab, became visible on the horizon. This line was called the Tropic of Cancer. On the day when the sun reached its lowest point in the south, the constellation Capricorn, the goat, was visible on the horizon. This line became known as the Tropic of Capricorn. Now there were three fixed lines on the globe. These lines would never change, because the sun never changed. They circled the globe, staying perfectly parallel to each other.



Using geometry, other lines could be drawn, perpendicular to these lines, creating a grid that divided up the globe into equal sections that could be measured and put onto maps. The lines going around the Earth like belts were later given the name "latitude" and the lines going from north to south were eventually called "longitude." Longitude lines don't have any natural starting point like the equator. Astronomy could not provide an easy and obvious answer to measurment of longitude. Measuring longitude was a puzzle that would not be solved until the 1700s.

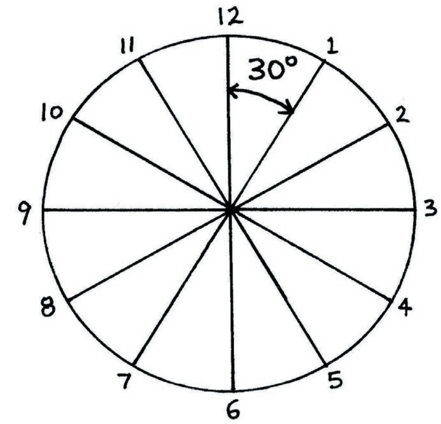


Greek geographers realized that these lines of longitude would not act like lines on a flat surface. Because they were on a spherical surface, these lines would come closer and closer together at the poles, yet without bending. How can two lines stay perfectly straight and yet bend towards each other? It would be impossible on anything but a curved surface.

It is common to get these names mixed up and forget which is which. A simple way to remember them is to think of the lines of latitude as looking like a ladder. "Lat" and "lad" sound almost the same. You could imagine climbing up to the North Pole on a ladder of latitude lines.

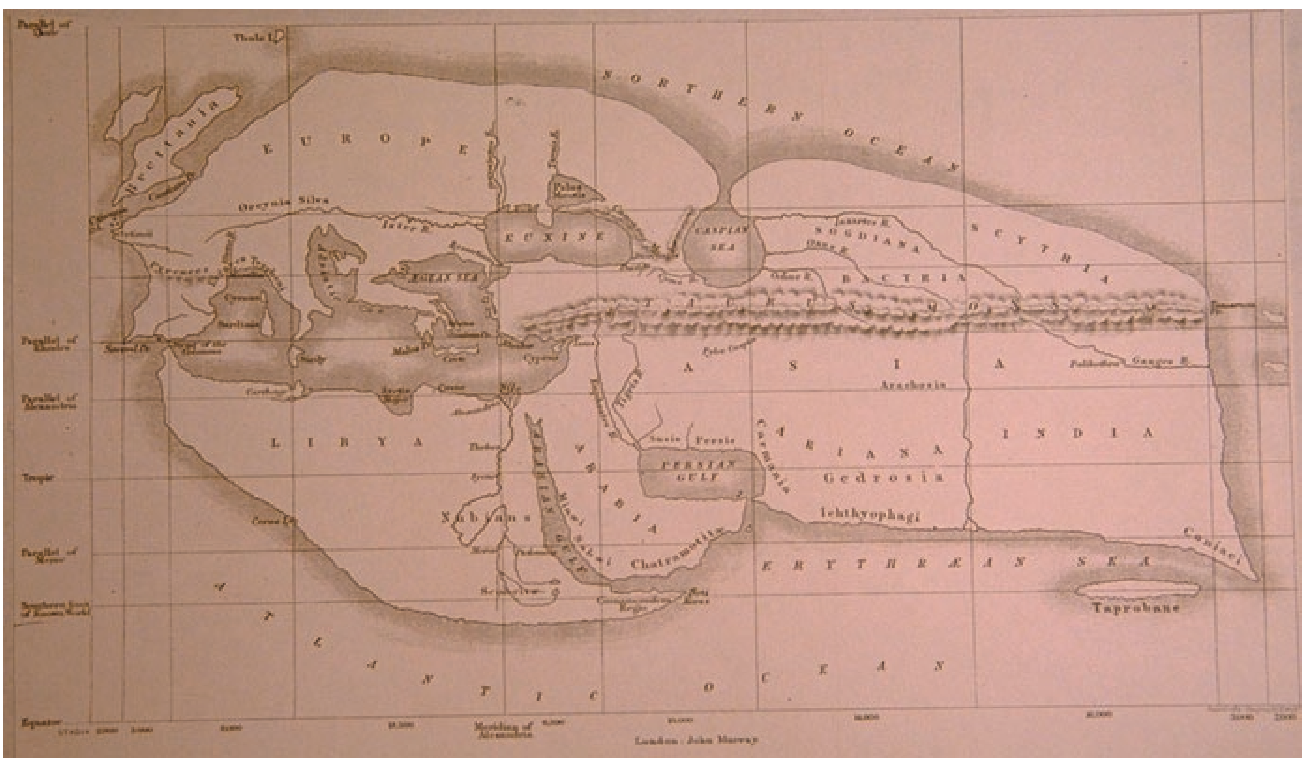
You will hear a lot about latitude at first, and not very much about longitude. In fact, you may begin to think we've forgotten about longitude. This is because the problem of measuring longitude (accurately) is so difficult that it was not solved until the

The number of lines that were drawn and the distances between them were based on the ideas of the Babylonians. The astronomers and mathematicians of Babylon used a system of counting that was based not on the number 10, but on the number 60. The number 6 was used a lot, too, so they decided that a circle should be divided into (60x6) 360 parts. (They also decided that the day should be divided into (6x4) 24 hours, with each hour consisting of 60 minutes, and each minute divided into 60 seconds.) There isn't any reason that you couldn't divide a circle, into 100 parts or 63 parts or 382 parts. We use the number 360 just because everyone has since the time of the Babylonians. It's a 2500-year-old tradition. Each of the 360 parts of the circle is called a degree (not to be confused with temperature degrees) and those degrees can be broken down into smaller parts called minutes (not to be confused with minutes of time). It would have been nice if less confusing names had been chosen, rather than degrees and minutes, but it's an ancient tradition and we're stuck with it!



The numbers on our clocks are 30 degrees apart. (12 x 30 = 360)

According to Strabo, Eratosthenes was the first person to draw lines on a map of the world. None of Eratosthenes' maps exist any more; all we have are descriptions of them. Someone in the 1880s read those descriptions and tried to guess what Eratosthenes' map might have looked like.



This is the entire world as Eratosthenes knew it. The line at the bottom is the equator. The lines of longitude seem to be spaced out according to sites they knew such as Alexandria, the tip of the Italian peninsula, the Straits of Gibraltar, and the tip of Portugal. There wasn't any obvious starting point for longitude, like the equator is for latitude. It didn't really matter where you started measuring. Eratosthenes was the person drawing the map and he lived in Alexandria, so Alexandria became his starting point, his "prime meridian" of longitude. (It wasn't until the 1800s that Greenwich, England, was recognized world-wide as the official Prime Meridian.)

Can you find the Persian Gulf, the Tigris and Euphrates Rivers, and the Nile River?

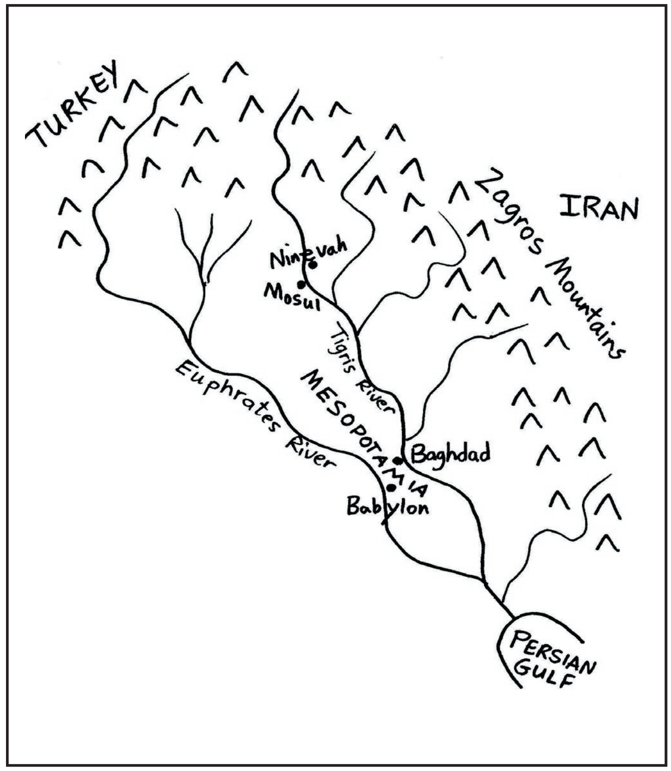
MAP DRAWING 1: Mesopotamia

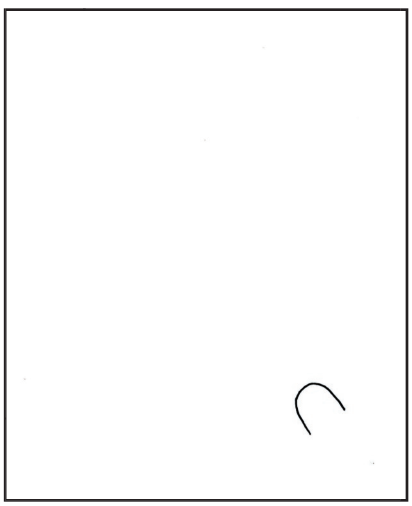
Mesopotamia means “between the rivers.” (“Meso” means “middle” and “potam” means “river.”) Mesopotamia is located in the modern country of Iraq.

At the very northern reaches of Mesopotamia was the territory of Assyria, with its capital at Nineveh. (This is the city that Jonah was sent to in the famous Bible story.) Assyria rose to power first, then the Babylonians conquered them, then both of them were overtaken by the Persians, coming from the area we now call Iran.

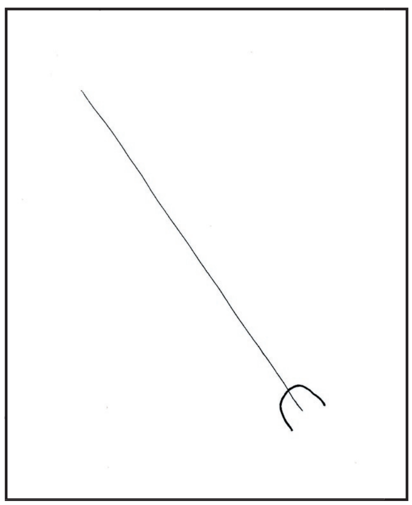
The ancient cities of Nineveh and Babylon are completely gone. The modern cities of Mosul and Baghdad are now the largest cities in those regions.

Here is a way you can remember which river is which: the Tigris is on Top. Both words start with the letter “T.” (Perhaps you can think of another way to keep them straight. Whatever works for you is fine.)

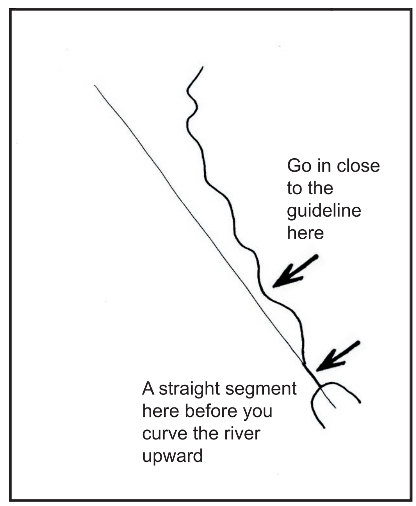




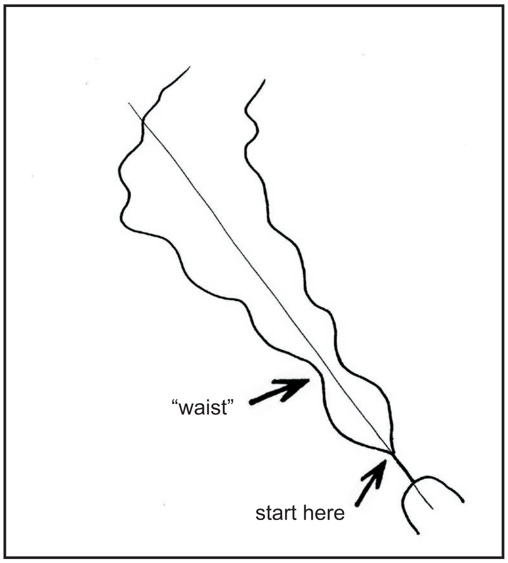
STEP 1: Draw a tilted arch. This will be the top of the Persian Gulf. In this drawing you will see only the top of the gulf. You can label the gulf now, or you can wait until the end, in step 7.



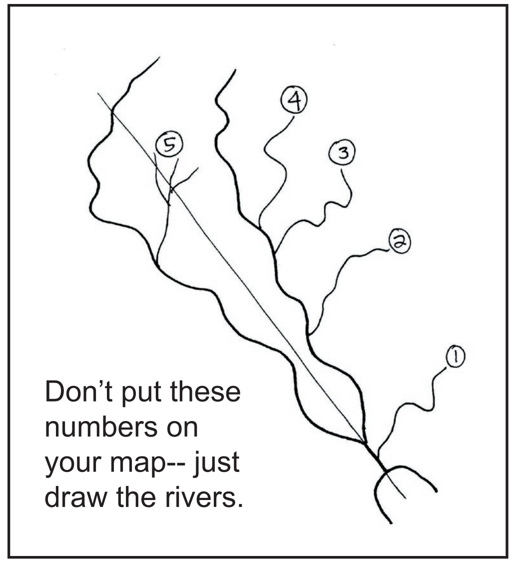
STEP 2: Draw a very light guideline up from the tilted arch. You will be erasing this line soon, so make it light. The guideline is just to help you gauge where to draw the lines for the two rivers.



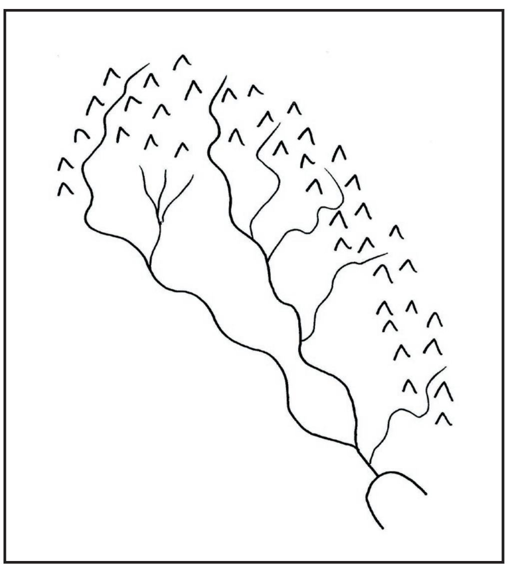
STEP 3: Start right at the top of the Persian Gulf and begin to draw the Tigris River. Draw along the straight guideline to make a short, straight segment, then make the river curve away from the guideline. Bring the river back in again, almost to the guideline, then curve it out and away again, making a few ripples before it fades off.



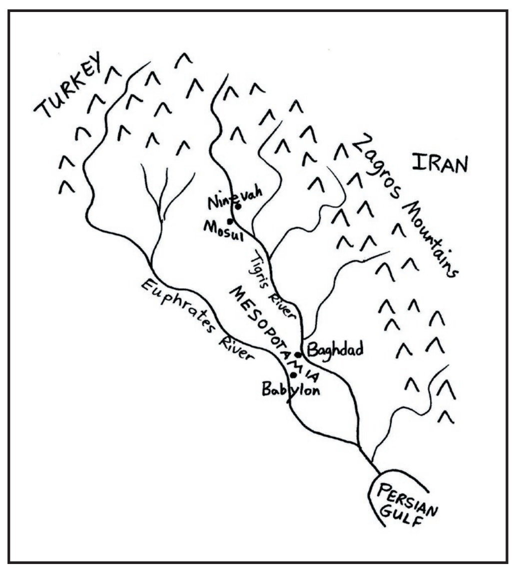
STEP 4: Draw in the lower river (the Euphrates), starting at the top of the first little straight part. You can see that this river also comes in toward the guideline right at the place the top one did, making sort of a "waist" (shown by the arrow). Continue the river on up and fade it off in the same direction as the first one.



STEP 5: Now add five smaller rivers. These smaller ones are called tributaries. Don't worry about making them the exact shape you see here. The important thing is to know that they are there and to understand that it's the water from these tributaries that creates the larger rivers. (Don't write the numbers on your map.)



STEP 6: Erase your guideline now and draw in some mountains. (You may want to draw over your good lines with pen before you erase your guideline.) Tributaries almost always flow out of a mountain range. Snow and rain from the mountains drain down into the valleys and create streams. These streams feed into larger streams which then feed into rivers. We will see this pattern again and again as we map the world. Tributaries flow out of mountains.

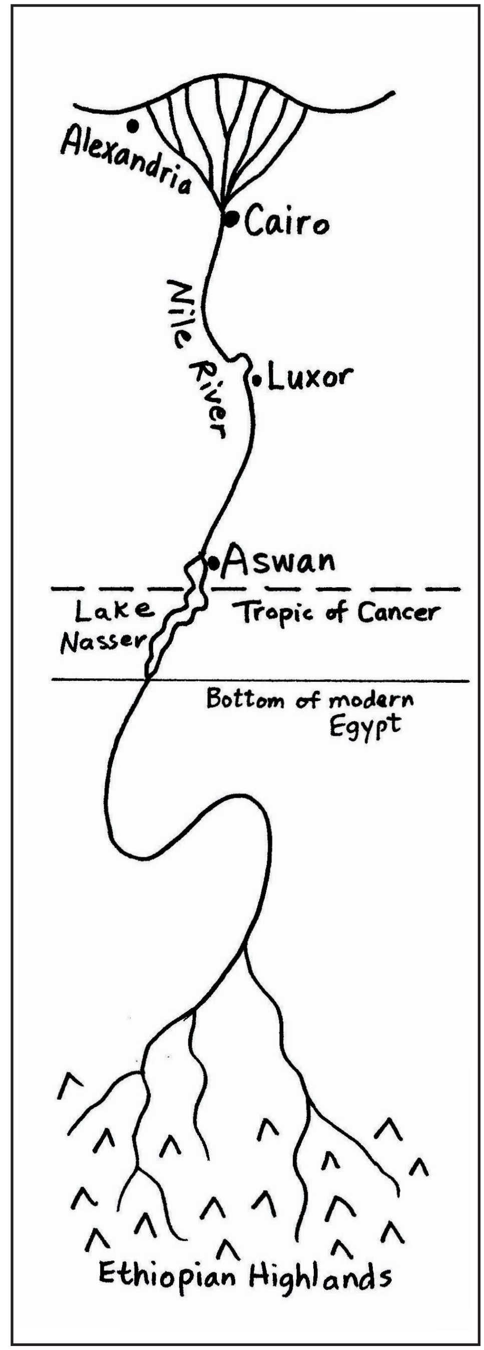


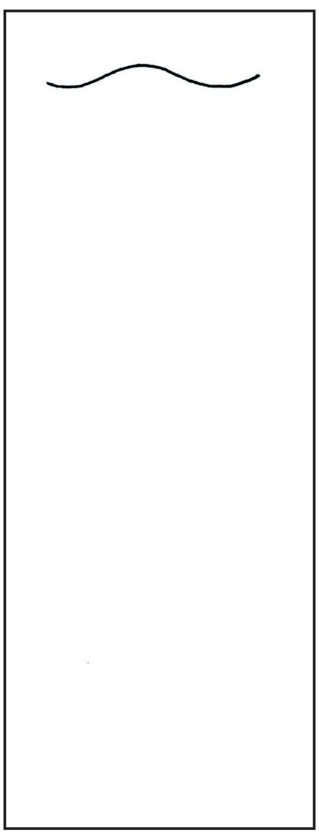
STEP 7: Now it's time to label. The **T**igris River is on the **T**op, and the Euphrates is the lower one. The cities of Baghdad and Babylon are right at the "waist." The cities of Nineveh and Mosul are above the highest tributary. Label the Persian Gulf if it isn't already labeled. You may want to label the mountains on the right as the Zagros Mountains. The area between the rivers is Mesopotamia. Optional: Label modern countries of Turkey and Iran, which border Iraq.

MAP DRAWING 2: The Nile river

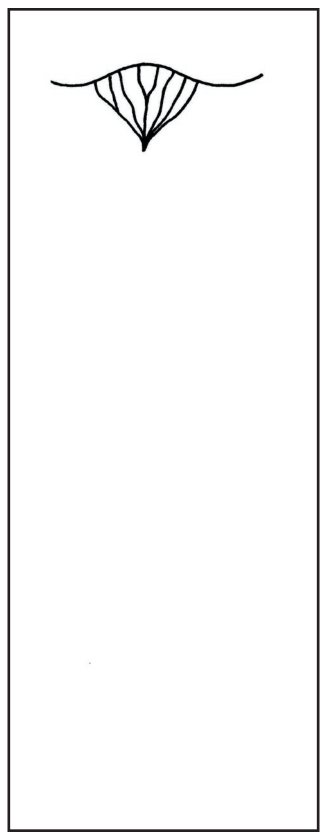
The Nile River flows from south to north, a fact which surprised European explorers and mapmakers. The reason that the river flows north is obvious when you look at the overall geography of the river. We see tributaries flowing out of the mountains in the south. The tributaries join together to make the Nile, and it flows towards the nearest sea: the Mediterranean.

On this map we will draw and label the Tropic of Cancer. Knowing where certain geographical features cross the Tropic line will help you later, when you try to draw a large portion of the world from memory.

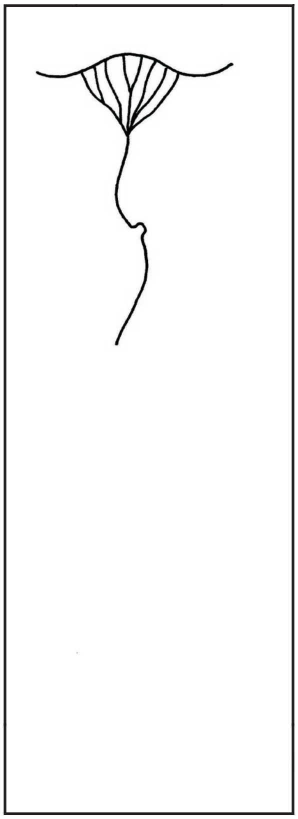




STEP 1: Draw a curvy line at the top. Make sure the curve goes up in the middle and down on each side.



STEP 2: Draw lines converging to form an upside-down triangle. This is the “delta” region of the river. A delta is where a river splits into smaller branches as it flows towards the sea.



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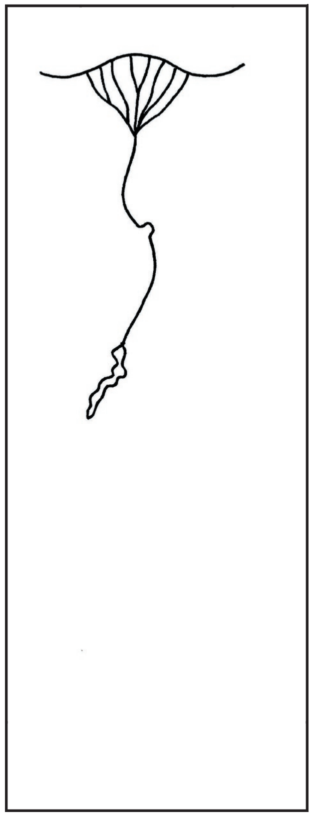

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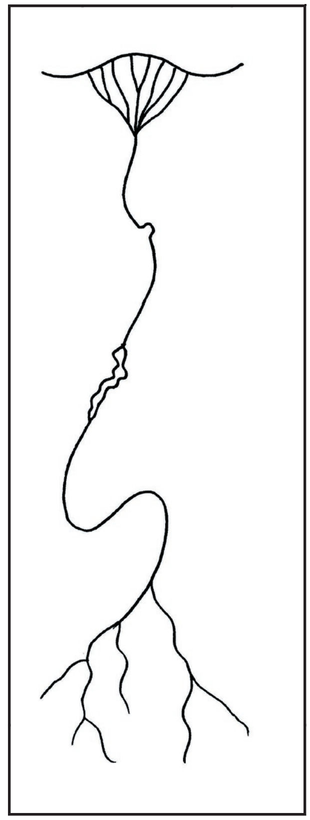

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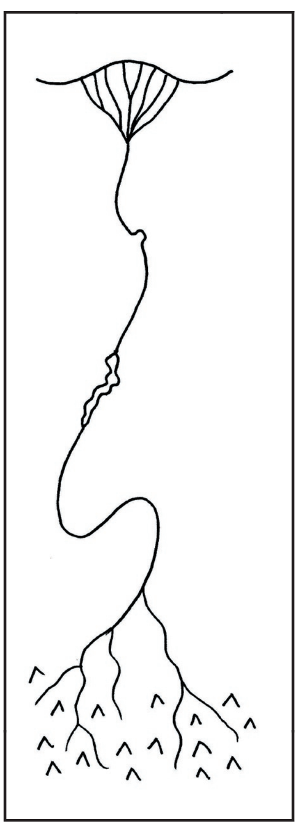
STEP 3: Draw a shallow "S" shape (one that doesn't curve too much). If you want to be more accurate, add a little bump right in the middle. (This bump is the location of the Valley of the Kings, at Luxor. This is where you go if you want to see King Tut's tomb.)

STEP 4: Add a narrow "squiggle" lake just below the shallow "S."

STEP 5: Now make a very curvy "S" shape. At the bottom of this "S," add tributaries going off to the south.



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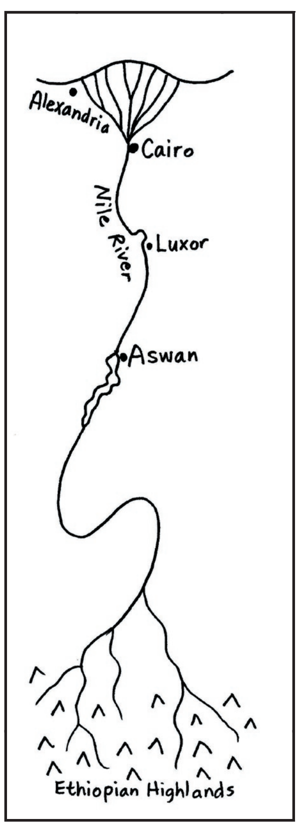

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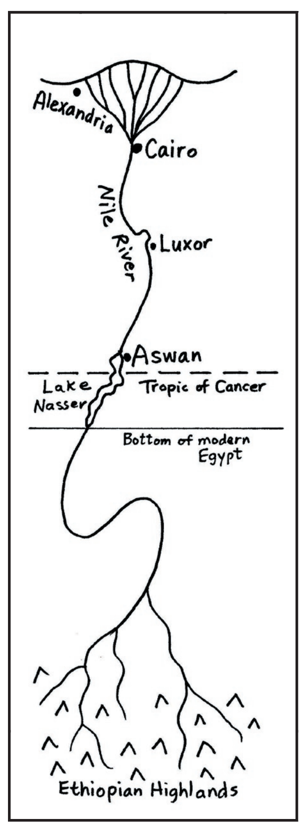

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STEP 6: Add mountains in and around the tributaries. These mountains provide all the water for the Nile River.

STEP 7: Label the mountains "Ethiopian Highlands." Label Lake Nasser and four cities: Aswan, Luxor, Cairo and Alexandria. At Aswan, there is a huge dam that controls the flow of the Nile River. Cairo is where you go to see the famous pyramids of Giza.

STEP 8: Draw a line right below Aswan, cutting across the top of Lake Nasser. Label it as the Tropic of Cancer. You may also want to draw a line showing the bottom of modern Egypt, at the bottom of Lake Nasser.

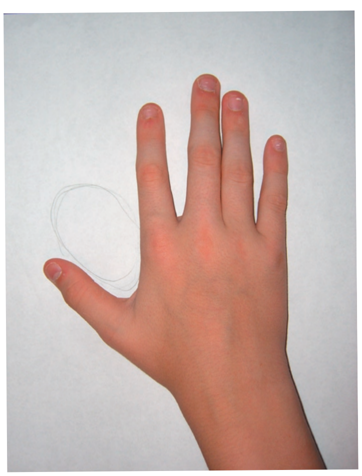
MAP DRAWING 3: Greece

Ready for a challenge? Great! This map of Greece will certainly be a challenge, but if you follow the directions step by step, you will be surprised how easily you can learn to draw it. (Don't worry-- map drawing 4 will be a lot easier than this one!)

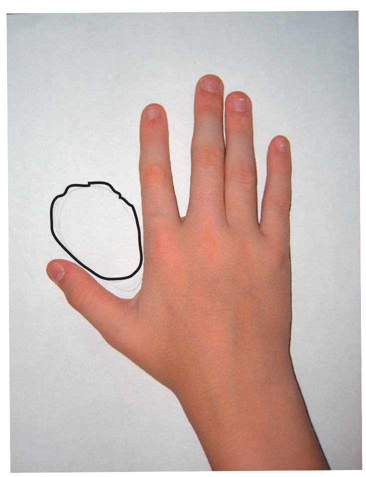
To begin, you will need to do some preparation steps that you didn't have to do with the first two maps. For this map, you will create the basic shape using your hand. When you draw around your hand, make your lines as light as you possible can, because they are only guidelines, not actual lines on your map.

<u>NOTE</u>: The sketched-in lines below look much darker than your lines will. Your lines should be so light you can hardly see them!

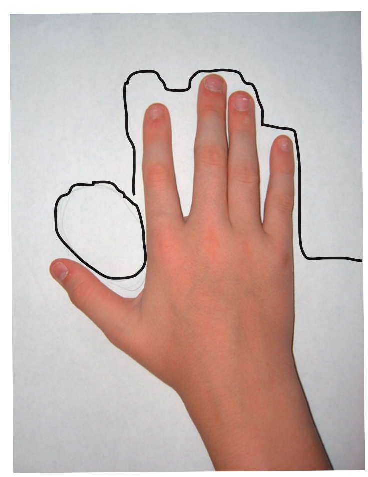
<u>Preparing your paper</u>:



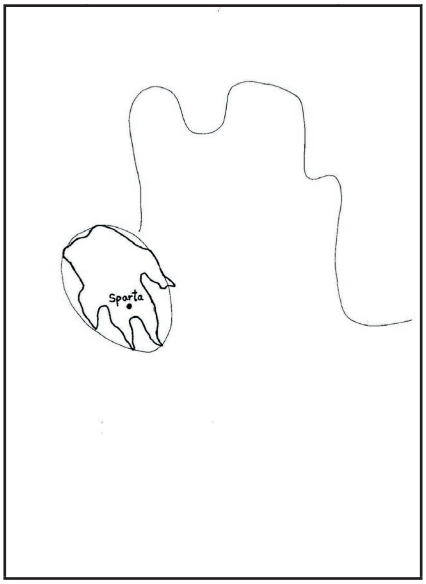
STEP 1: Lay your right hand on your paper, right in the center, so that it looks just like the one shown here. You need to have a space between your index finger and the other fingers.



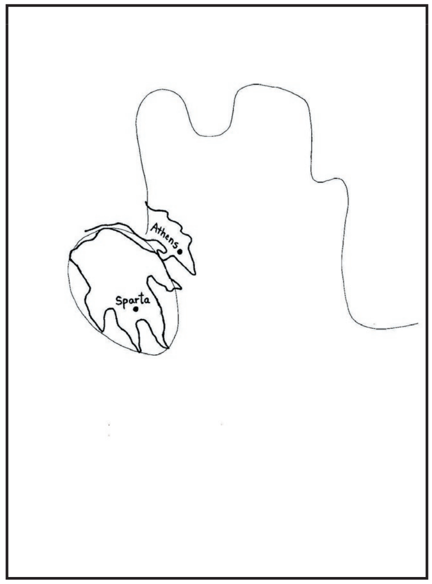
STEP 2: With your left hand, use a pencil to sketch in an egg shape between your thumb and your hand. Draw VERY LIGHTLY as you will eventually erase this line.



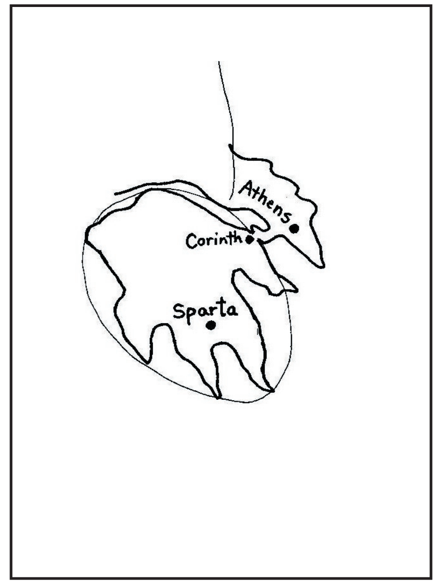
STEP 3: Use a pencil to sketch a "mitten" around your hand, going well up over your index finger and going down into the dip between the fingers. Go off the paper at the bottom knuckle of the pinky, as shown here.



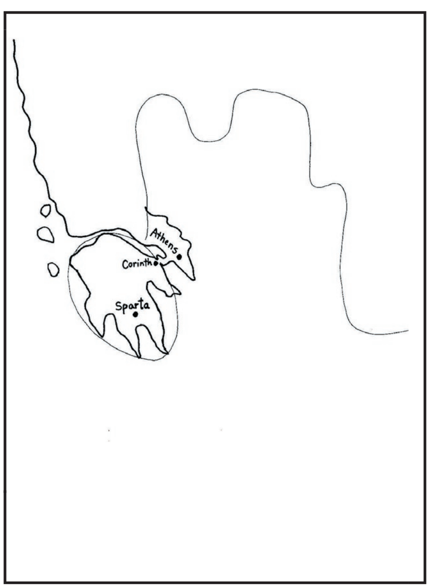
STEP 4: Draw a weird 3-fingered hand inside the egg shape. The pinky is bent and the fingers have long skinny nails. Try to copy the shape you see here as accurately as you can, or use an atlas to look at the real shape. (Maybe it's a dragon's foot, belonging to the dragon in the next step?) Label "Sparta."



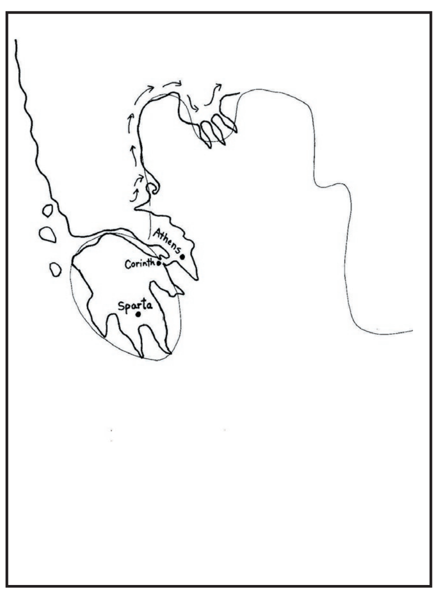
STEP 5: Does this next shape remind you of the backside of an animal? Maybe it has its head buried in the sand? (With its lumpy back, does it look a bit like a dragon?) Draw a foot shape that touches the thumb of the hand, then draw a stubby tail and a lumpy back. Extend the line up over the back of the hand, too. Label "Athens."



STEP 6: Now you need to connect these first two shapes. Erase the lines where they touch (which will be a very small area) and adjust the lines so that there is a tiny land bridge connecting the two land masses. The correct name for this feature is an "isthmus." (That's a very strange word, isn't it?) Label the city on the isthmus "Corinth."

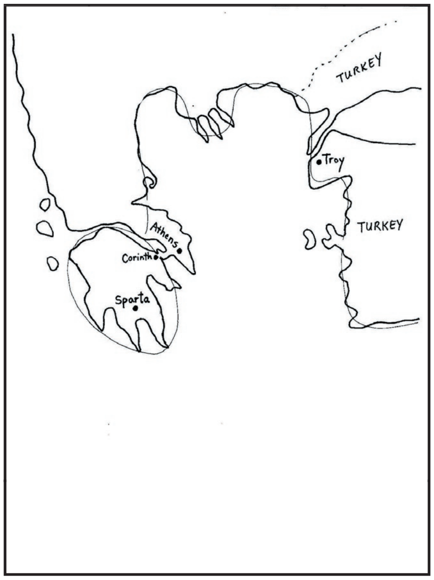


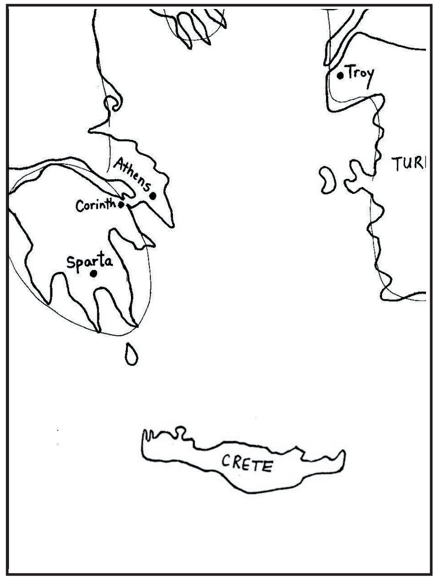
STEP 7: Pick up where you left off on the back of the dragon/animal and draw up the coastline, forming the sleeve that the weird hand came out of. Draw three islands off the coast. You can make up what these might be, according to your own imagination.

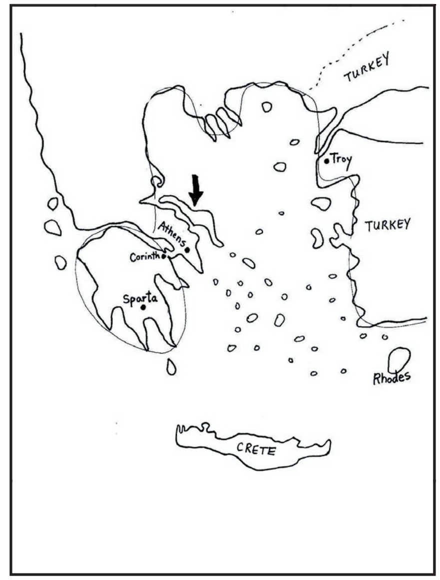


STEP 8: Continue the coastline on the other side. Draw up along your guide line. When you come to the dip between your fingers, draw a cow's udder with three very skinny teats leaning off to the right.

STEP 9: Continue along your guide line, then draw another peninsula in the shape you see here. Notice how there is still some of your guideline left below this peninsula.



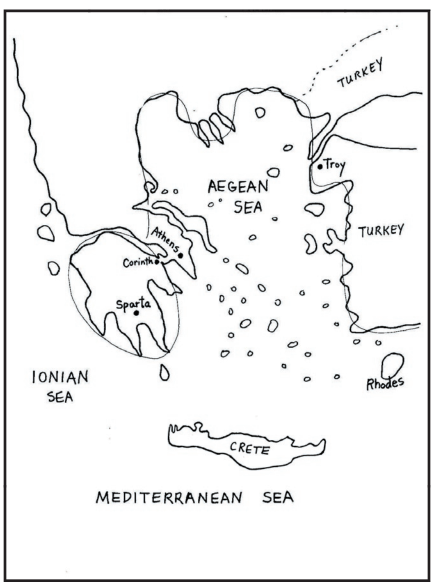


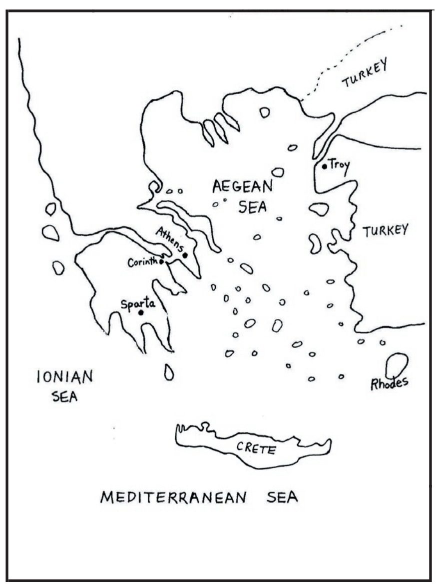


STEP 10: Draw in the land mass below the peninsula and label it "Turkey." Notice the hand reaching out from Turkey to snatch the island? (Or maybe you think it looks like something else.) Put in the dotted line where the top of Turkey is, and label the location of the ancient city of Troy.

STEP 11: Make a "drip" just below the index finger of the hand. Then imagine a line going straight down from the thumb-- this is where the head of Crete will be. Draw in Crete and label it. We think Crete looks like a Martian with two short antenae and a bulbous nose, lying on his back, with one leg chopped off. (Maybe the dragon got him?) What do you think?

STEP 12: Greece has hundreds of small islands. The islands behind the dragon look like they are strung out in long lines. Make sure you get the long skinny island right above the back end of the dragon (marked with the arrow). The big island on the far right is Rhodes. It had a huge statue on it (called The Colossus), which was one of the Seven Wonders of the Ancient World.





STEP 13: Label these bodies of water: the Aegean Sea (remember it's "ae" then "ea," and it's pronounced *Uh-GEE-an*), the Ionian Sea, and the Mediterranean. ("Medi" means "middle" and "terra" means "earth." The Greeks believed this sea to be in the middle of the world.)

STEP 14: Erase your light pencil guidelines. (You may want to trace over your good lines with pen before you erase your guidelines.) If you want to make the coastlines more accurate, you can consult an atlas for the exact shape. Now trace over your "good" lines with a black pen, then erase all pencil lines.

STEP 15: Optional: Label the Sea of Marmara and the Dardanelles Strait. If this step is one too many, just skip it. We'll learn these later on, too.

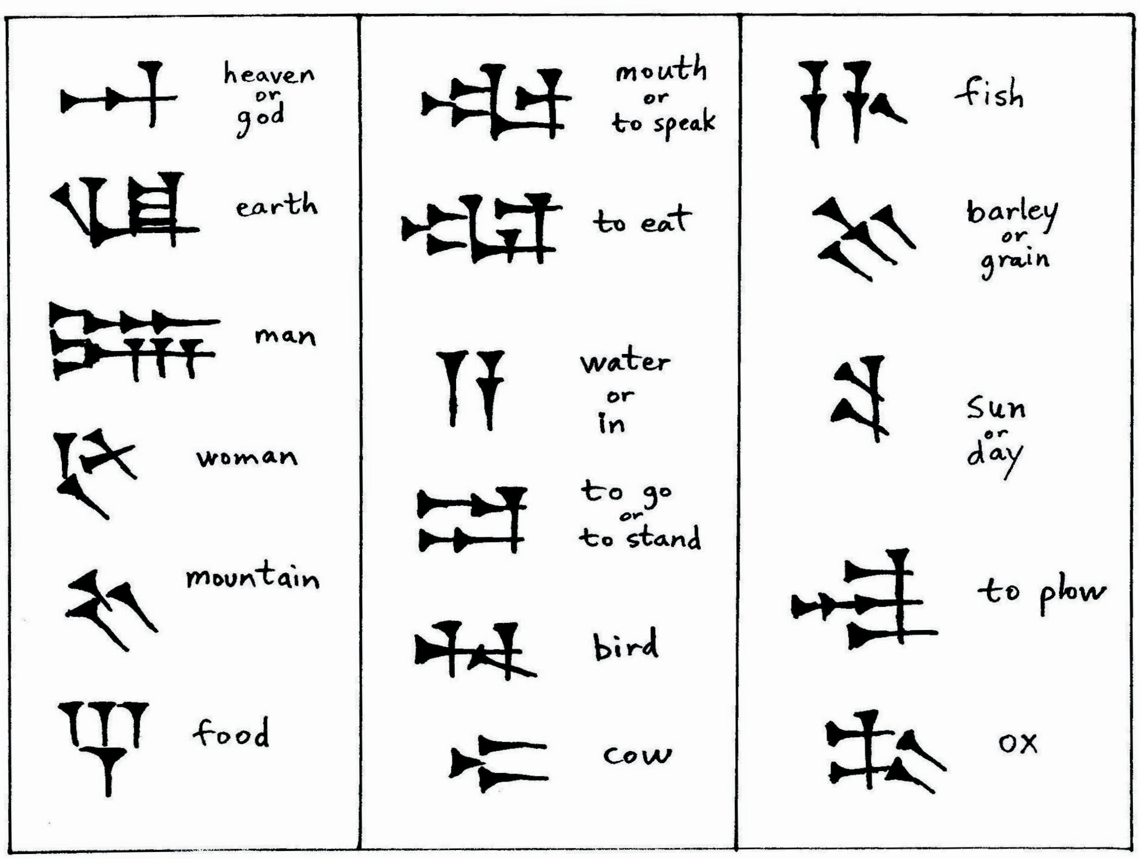
ACTIVITY IDEA 1A: An edible Babylonian clay map

The “clay” in this project is a modified cookie dough recipe. (You could also use any of your favorite sugar cookie or gingerbread cookie recipes, but leave out the baking powder or baking soda.) The result will be a little crunchy when you eat it, but it will be edible. Have your students work on a piece of aluminum foil so that their tablets can be easily transferred to a baking sheet.

You will need to provide little wedge-shaped stamps for making cuneiform letters as well as pointed sticks for scratching designs. For the wedge-shaped stamps, you might want to use Sculpey (a clay that you harden by baking in the oven) or if you prefer working with wood, you could use any wood scrap, even the end of a popsicle stick. A piece of dowel rod sharpened in a pencil sharpener makes a good tool for scratching lines in the clay. You may also want to experiment with tools you have around the house, such as plastic silverware.

<u>Edible clay:</u>
3/4 cup sugar
2/3 cup shortening
1/2 cup cocoa powder
2 eggs
2 cups flour　　　　*Bake at 375 F for 10-12 minutes or until done.*

Mix ingredients in order. If the dough is sticky, add more flour. Take a ball of dough and flatten it into a tablet. This recipe makes enough clay for 8 tablets that are about 4” x 5”. Here are a few real cuneiform words that your students might like to use on their tablets:

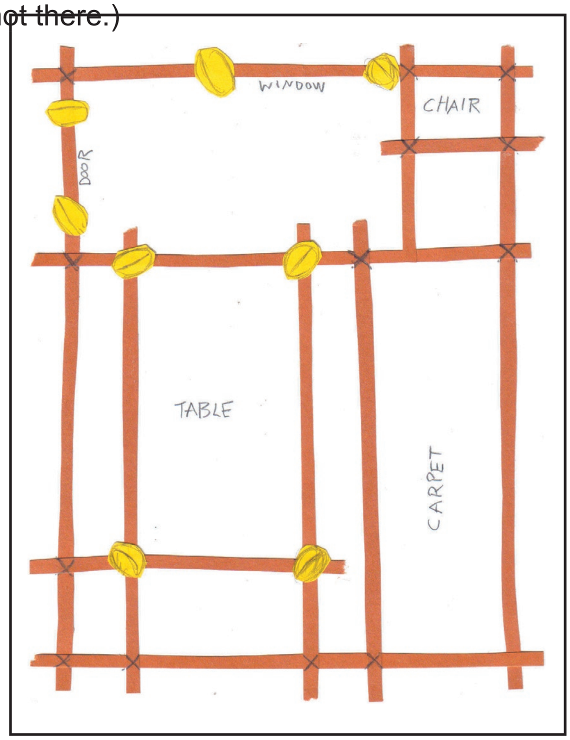


ACTIVITY IDEA 1B: A local map (of your room) on modern papyrus (paper)

Most ancient maps were local maps, like the one on the papyrus. They were made by simply imagining what the area looks like from above, with very little measuring. Have the students make a map of the room they are in, by just imagining it from above and without taking any measurements. Provide paper and pencils and possibly rulers (although the ancients didn't worry overly much about perfectly straight lines).

ACTIVITY IDEA 1C: A Polynesian-style map of your room

Make a map of the room you are in using long, thin pieces of brown paper to represent the reeds used by the Polynesians. If you have a paper cutter, this can make quick work of making strips. Provide a piece of white paper to work on and use a glue stick to tack the thin paper strips at each corner where they cross. Have students cut light brown or yellow "shells" to mark out where important objects are in the room. The "shells" must be on the paper strips (simulating being tied to the reeds), not on the white paper. (The white paper sheet is there just to make your reed map less flimsy. You have to sort of pretend it's not there.)



ACTIVITY IDEA 2: Practice using a ruler, a compass and a protractor

This activity prepares the students for future activities. It is important that they feel comfortable using these tools and understand these terms: ***parallel, perpendicular, radius, diameter, and degree.***

Each student will need a ruler, a compass and a protractor, as well as a pencil, an eraser, and at least four sheets of paper. Follow the instructions below, in order. Students who have never used a compass or a protractor before may need to have the techniques demonstrated to them.

1) Practice making parallel lines.

Make two parallel lines of any length. Draw the first line using the ruler, then measure off two dots on the same side of the line, the same distance from the line. Then use the ruler to connect the dots. Make two parallel lines that are 2 inches long and 2 inches apart.

2) Practice making perpendicular lines.

Make two perpendicular lines that are each 2 inches long. Draw the base line, then use the protractor to measure the 90 degree angle for the second line.

3) Make these perpendicular lines into a design.

Connect the ends of these perpendicular lines to form a square with an X through it.
Divide each of these triangles in half using the protractor to bisect the angles.
Add a few more lines, either perpendicular or parallel, to make a design you like.

3) Practice making circles.

Use the compass to make circles of various sizes. You will need to work on a surface that allows the point of the compass to stick into the paper a bit.

4) Divide a circle into 32 equal parts.

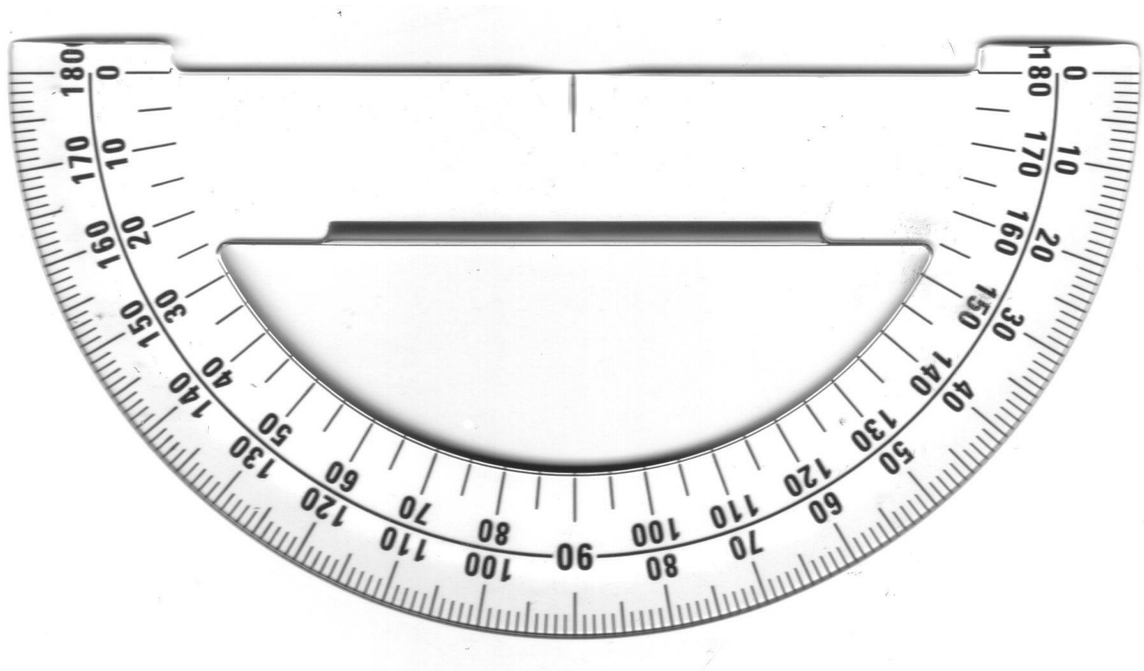
Use the measuring device on the compass to set the compass radius at 3 inches. Use the compass to draw a circle that will have a diameter of 6 inches across. Draw perpendicular lines that cross in the center, sort of like "cross hairs." (Draw one line first, either straight up and down or straight across. Then use the protractor to measure the 90 degrees for the second line.) Now use the protractor to bisect each wedge into two 45 degree sections. (Put the center of the straight edge of the protractor [the 2 1/2 inch line] right on the center dot of your circle. Make a mark at the 45 degree point, then remove your protractor and connect the dots with your ruler.) Divide these sections in half, then in half again so that the circle is divided into a total of 32 wedges, each a little over 11 degrees (11.25) wide.

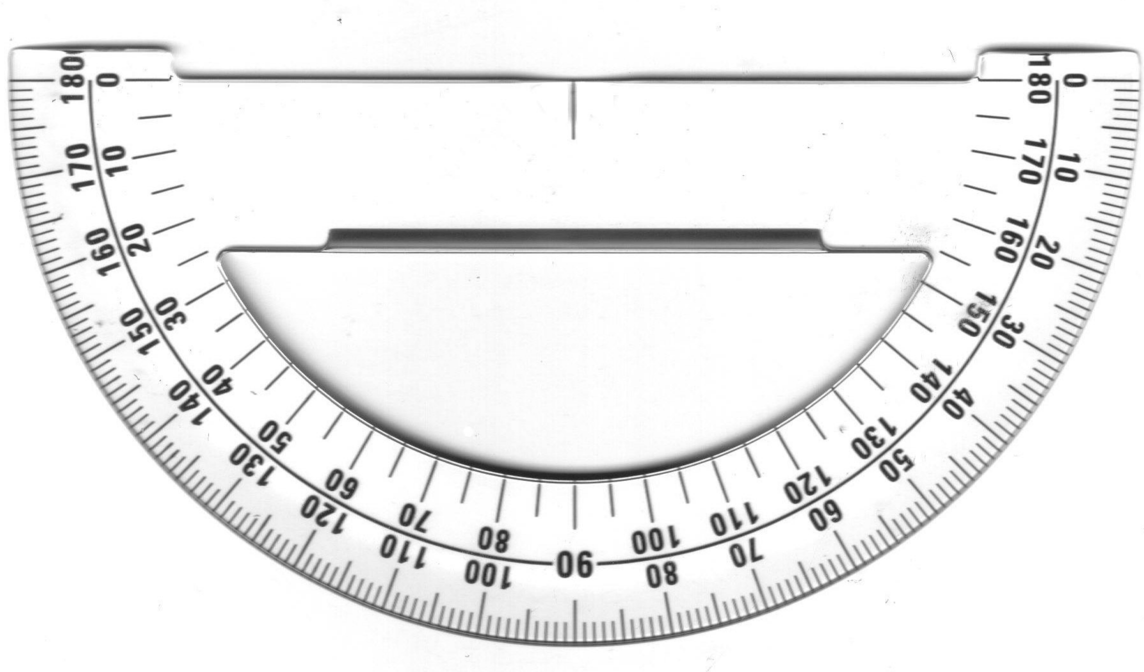
Ponder this question: Would your job have been easier if a circle was divided into 400 degrees instead of 360?

5) Follow these directions to make an artistic design:

Make two perpendicular lines that are 6 inches long. Connect the ends of these lines to form a square with an X through it. Find the midpoint of each side, using the ruler. Connect the midpoints to each other to form a square. Then connect the midpoints to the center point. Take your compass and set its metal point on one of those midpoints. Then pull the compass pencil until it touches the center point. Now draw an arc from the center point out to the corner. Draw the same arc with the compass set on the other midpoints.

If you don’t have access to protractors for some reason (or can’t justify the expense for your class, which is exactly what happened to me and I ended up using paper protractors) you can print this page onto heavy card stock paper and then cut out these protractors. (Don’t forget to cut out the inside, too.) They won’t have the advantages of clear plastic protractors, but they will get you through the activities for which you need them.





ACTIVITY IDEA 3A: Quick quiz: “Above or below the equator?”

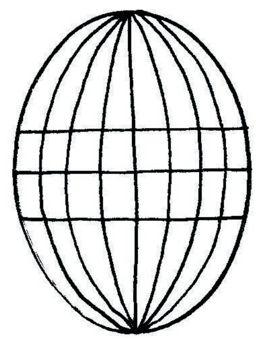
This activity does not require studying an atlas. This is just a quick (and fun) way to do a sort of “pre-test” to find out how much everyone knows about basic geography. (Even we adults will find out we know less about geography than we thought!) Read the list below, one at a time, and have the students guess whether each one is above, below, or on the equator. If you are working with a group, you might want to use the “silent quiz” format. Pause for about 5 to 10 seconds and tell the student to think their answer in their head. Then you say the answer out loud and they see if they were right. You could also have the student write their answers down if you are looking for writing practice. Or you can use a different format that suits you better.

Florida (above)
Spain (above)
Hawaii (above)
Morocco (above)
Japan (above)
China (above)
Zaire (on)

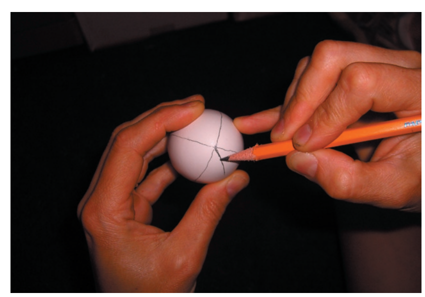
Australia (below)
the Panama Canal (above)
Venezuela (above)
Ethiopia (above)
Peru (below)
Philippines (above)
New Guinea (below)

Egypt (above)
India (above)
Kenya (on)
Madagascar (below)
Ecuador (on)
Galapagos Islands (on)
Sudan (above)

ACTIVITY IDEA 3B: Longitude on an egg



This project demonstrates that lines of longitude can look either straight or curved, depending on the angle of view. Each student will need a hard-boiled egg and a pencil. Have the students put a dot on the top and bottom of the egg, where the north and south poles would be. Then draw lines connecting the poles, as straight as they can, all around the egg. Make a total of about sixteen lines around the egg. Start by dividing it into quarters, then eighths, then sixteenths. Have the students hold the egg straight in front of them. Notice that the line of longitude that appears to be in the middle of the eggs looks straight. The lines at the edges will look most curved. Turn the egg and notice that this perspective doesn’t change as the lines move. The line that used to be in the center and looked straight will now be on the edge and look curved.



Add an equator line and two lines for the tropics. Now turn the egg slowly and observe how the longitude and latitude lines always look perpendicular at the places they cross if you are looking at them from a “straight on” view. This is the strange truth about longitude lines: they appear to curve while also appearing to remain perpendicular!

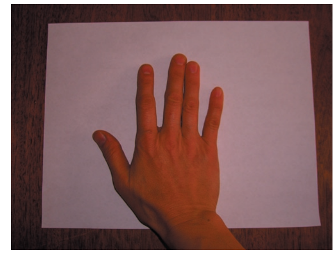
Drawing tip: Use your pinky finger to steady your hand on the egg while your draw.

ACTIVITY IDEA 3C: Draw your egg on paper

Use a compass to draw a circle that is 4 inches in diameter (set your compass at 2 inches). Put the ruler on the center point and draw the equator. Draw parallel lines 1/2 an inch from the equator to make the tropics of Cancer and Capricorn. Draw a line perpendicular to the equator and passing through the center point. Make three marks along the equator, 1/2 an inch apart, dividing the space on each side of the equator evenly. Make curved lines that go through these points. It should look like the drawing of the egg shown in project 3B, only circular, not oval.

ACTIVITY IDEA 3D: Draw or paint a more accurate map of Greece

<u>To draw a map</u>:



For this drawing, orient your paper horizontally. (This will result in having more of Turkey appear on your map.) Place your hand on your paper as shown. Sketch in the egg and the Aegean Sea outline. Then use the outline map on the next page as you draw in the land forms. You should compare the actual shapes to the basic memory shapes you learned. (You will be surprised how much the real shapes look like what we imagined them to be!) Do the steps, in order, but use the outline map to copy the correct shapes as best you can.

After you are done sketching in pencil, go over your "good" lines with a black fine-point permanent marker, or a black felt-tip pen. Then erase your pencil lines.

OPTIONAL: Use an atlas to add a few more place names. (This option is for students who process information very quickly. If the students have barely managed to get the basic labels, don't add more.)

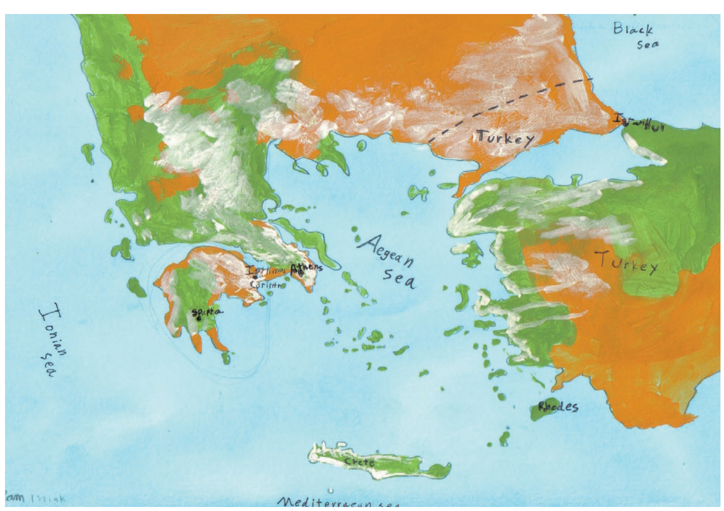
<u>To paint a map</u>:

You will need: light blue card stock paper, small paint brushes, pencil, eraser, thin-line black permanent marker, acrylic paints (green, tan, cream, maybe dark green) and a physical map of Greece (a satellite image would be the best). I used a NASA satellite image from the Internet http://www.in2greece.com/blog/uploaded_images/nasa-greece-map-742017.jpg) If you can't access this one, just use Google image search with key words "Greece map satellite image."

NOTE ABOUT ACRYLIC PAINTS: These are very inexpensive and can be purchased at any craft store or department store that has a craft section, such as WalMart. Acrylics are permanent and won't smear when dry, unlike poster paints. They can be watered down and used like watercolors or they can be applied thickly like oil paints. They are absolutely the most versatile and easy-to-use paints around. The only drawback is that they won't come out of clothes if you don't catch the spill right away. (If they dry on hands or tables they can be scrubbed out fairly easily.) Wearing good clothes while painting with acrylics is not a good idea, to say the least. However, the advantages of acrylic paint far outweigh this disadvantage.

Sketch in the "egg" and the hand outline. Follow the same steps you did before, but while you do so use the outline map on the next page as a guide for your shapes. Try to make your shapes look like the shapes you see on this map.

After you have completed your map in pencil, use acrylic paints to add color, imitating the colors you see on the satellite map. After the paint is dry, erase pencil lines, then label the map using the black marker.



Example of student work