

# Mapping a Maya Settlement



Image captions/credits on Page 2.

## Focus

Archaeological surveying

## Grade Level

9-12 (Mathematics/Earth Science)

## Focus Question

How do archaeologists map the ancient Maya seaport site at Vista Alegre?

## Learning Objectives

- Students will discuss the maritime cultural landscape approach, describe some of the interactions between human activities and ecological resources, and explain how artifacts may provide clues about these interactions.
- Students will plot Total Station data to construct a simplified version of the Vista Alegre site.
- Students will make inferences about how local hydrology might be related to anthropogenic features at the Vista Alegre site.
- Students will discuss how features of the Vista Alegre site may reflect the influence of maritime trading activities.

## Materials

- Copies of *Vista Alegre Base Map* and *Vista Alegre Survey Data*; one copy for each student group

## Audio-Visual Materials

- Interactive white board or other technology to display Figures 1 and 2

## Teaching Time

One or two 45-minute class periods

## Seating Arrangement

Groups of two to four students

## Maximum Number of Students

30

## Key Words

Maya  
Vista Alegre  
Archaeology  
Garbology  
Maritime trading  
Total Station

## Background Information

*NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.*

### Images from Page 1 top to bottom:

Canoe-based reconnaissance along the Yucatan's north coast. Dominique Rissolo and Jeffrey Glover (pictured) along with Zachary Hruby explored the north coast of the Peninsula in 2006 searching for Prehispanic and historical sites. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

[http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/canoexploration2006\\_hires.jpg](http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/canoexploration2006_hires.jpg)

A profile view of a partially preserved stucco floor that would have covered the entire plaza area north of the main pyramid at Vista Alegre. The profile allows one to study the construction technique of the stucco floor, including the subfloor ballast. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

[http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/u2\\_piso\\_profile\\_2619\\_hires.jpg](http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/u2_piso_profile_2619_hires.jpg)

Mold-made ceramic spindle whorl from Vista Alegre. These disks functioned as fly-wheels for handheld fiber spinning rigs. Spindle whorls are quite common at Vista Alegre and suggest that the site's ancient inhabitants were manufacturing cotton yarn or even bulk cloth, a major trade item at the time of Spanish Contact. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

[http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/spindlewhorl\\_kh\\_hires.jpg](http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/spindlewhorl_kh_hires.jpg)

The Castillo at Chichén Itzá is one of the most well-known buildings in Mesoamerica. It is a radial pyramid (with a set of stairs on each side) and is positioned in the middle of the massive plaza area that would have held large numbers of visitors at the height of Chichén's power much as it still does today during the Equinox and Solstice. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

[http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/castillo\\_chichen\\_hires.jpg](http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/castillo_chichen_hires.jpg)

Vista Alegre is the site of a Maya settlement on a small mangrove-shrouded island on the southern coast of the Yalahau Lagoon at the northeastern tip of the Yucatán Peninsula. The lagoon connects to the Gulf of Mexico, and most of Vista Alegre is surrounded by lagoons or estuaries. The lagoon connects to the Gulf of Mexico, and most of Vista Alegre is surrounded by lagoons or estuaries. This community was part of the great Mesoamerican civilization that developed true writing, sophisticated mathematics and astronomy, and trade networks that spanned thousands of miles. Archaeologists first visited the site in 1954, and subsequent research has recovered pottery remains that suggest Maya peoples have inhabited Vista Alegre for about 3,000 years. The site has not been continuously occupied, however; and archaeological evidence suggests that there have been four distinct periods of occupancy:

Vista Alegre I (800/700 BC to 450/400 BC)

Vista Alegre II (100/150 AD to 650 AD)

Vista Alegre III (850/900 AD to 1100 AD)

Vista Alegre IV (1100 AD to 1521 AD)

For more information about these periods and their relationship to the overall chronology of the Maya civilization, please see the Expedition Purpose for the Exploring the Hidden World of the Maritime Maya 2011 Expedition, <http://oceanexplorer.noaa.gov/explorations/11maya/background/edu/purpose.html>.

The Yucatán Peninsula rests on a foundation of limestone bedrock. Limestone is gradually dissolved by acidic water (normal rainwater is slightly acidic). This process creates underground caves, and makes the Yucatán limestone highly porous. In many places, underground limestone caves collapse and form sinkholes. Yucatán's sinkholes are called cenotes (pronounced "seh-NO-tehs"), and are very important in Maya history. Besides being a major source of fresh water, cenotes had religious significance and were sometimes sites of human sacrifice.



archaeologists often excavate trash pits (also called middens) to find objects that give clues about these interactions, ecological features, and events. Tell students that when this type of archaeological study is applied to modern cultures it is sometimes called “garbology.”

3. Provide each student group with a copy of *Vista Alegre Base Map* and *Vista Alegre Survey Data*. Each group should have access to a protractor, dividers, straightedge, and a sharp pencil. Tell students that these data were part of a survey of the Vista Alegre site, and that the data were collected with an instrument called a Total Station. This instrument makes very accurate measurements of horizontal and vertical angles, as well as distance. In use, the surveyor aims the Total Station at a reflector which is usually mounted on a long pole held by an assistant at the location the surveyor wants to mark. The Total Station measures the distance to the reflector and the angle relative to some reference direction (in this case north). Be sure students understand that the horizontal angles listed in the survey data are relative to north; so an angle of  $90^\circ$  is exactly east of the Total Station position, an angle of  $180^\circ$  is exactly south of the Total Station position, and so forth.

You may also want to point out that the measured distance between the Total Station and reflector is affected by any difference in height between these two instruments. If one is higher than the other, the measured distance will be greater than the horizontal distance that would be measured if they were at the same height. In actual surveys, these effects are eliminated by Total Station data processing software based on vertical angle measurements and information about the height of the Total Station and reflector. For this exercise, students may assume that the Total Station and reflector were exactly horizontal relative to each other.

Have students plot the location of the sacbe, andador, and the three structures, and calculate the height of the pyramid as directed on the Survey Data sheet. You may want to plot the data for one structure as a class exercise if students are unsure about the plotting procedure.

4. Have each student group present their results, then show Figure 1 (see page 5). Discuss any discrepancies between students’ plots and this figure. Students should have used the Pythagorean Theorem to calculate the height of the Pyramid:

$$(250 \text{ m})^2 = (249.758 \text{ m})^2 + (\text{height})^2$$

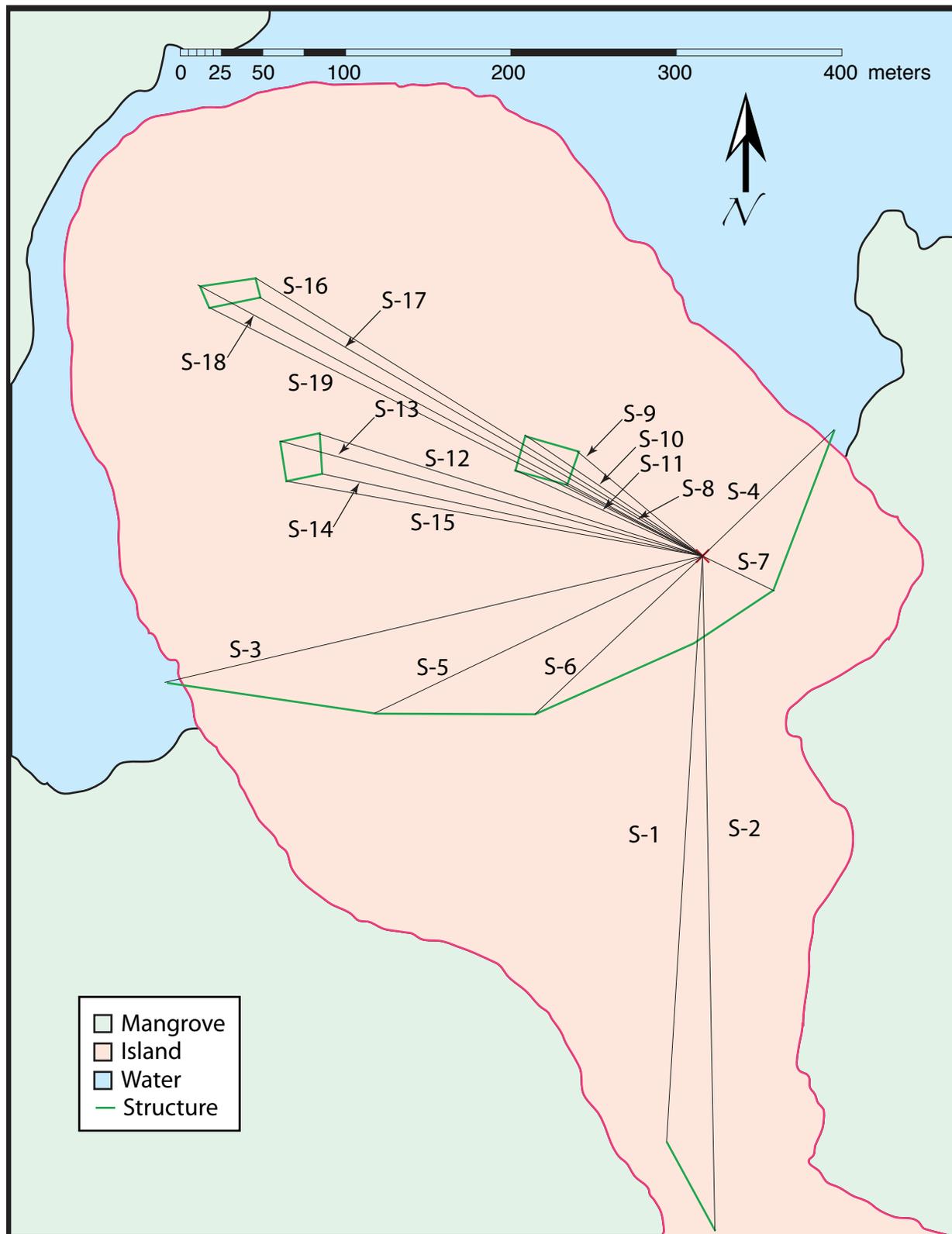
$$62,500 \text{ m}^2 = 62,379 \text{ m}^2 + (\text{height})^2$$

$$62,500 \text{ m}^2 - 62,379 \text{ m}^2 = (\text{height})^2$$

$$121 \text{ m}^2 = (\text{height})^2$$

$$\text{height} = 11 \text{ m}$$

Figure 1. Structures and Features from Table 1 Plotted on Base Map



After this discussion, tell students that modern Total Stations contain microprocessors that make these calculations, and with appropriate software can generate display plots of the survey data. It is normal, however, for beginning surveyors to make these plots themselves from angle and distance data so they understand how the Total Station achieves its results.

5. Tell students that limestone landscapes frequently are fractured in various directions, and the junctions of two or more fractures are often the sources of freshwater discharge. In the Yucatán Peninsula as a whole, fracture intersections are known to be the site of many of the largest freshwater springs, particularly along the Caribbean coast, and these locations also were the sites of major Maya trading ports.

Show students Figure 2, which diagrams the location of limestone fractures in the vicinity of Vista Alegre, and ask what features on their data plots correspond to potential locations of freshwater discharge. Students should recognize that both ends of the sacbe coincide with fracture junctions. The presence of freshwater springs at these locations may have been an important consideration for the location of the sacbe. It is very likely that an important use of the sacbe was for exchanging cargo with trading canoes. With freshwater springs at each end, the sacbe also could have been used to bring fresh water to the Vista Alegre settlement. Having freshwater springs at these locations would also have made it convenient bring freshwater aboard the canoes.

Tell students that a similar junction has been located farther inland at the end of the andador where another structure known as the Templo Perdido is located. Ask students why these fracture junctions might not be sources of fresh water today. Students should infer that rising sea level could have caused saltwater and sediments to intrude into these junctions. In addition, diminished rainfall could reduce the availability of fresh water at these locations.

### The BRIDGE Connection

[www.vims.edu/bridge/archeology.html](http://www.vims.edu/bridge/archeology.html)

### The “Me” Connection

Have students write a brief essay about how knowledge of ancient Maya settlements might be of personal importance or benefit.

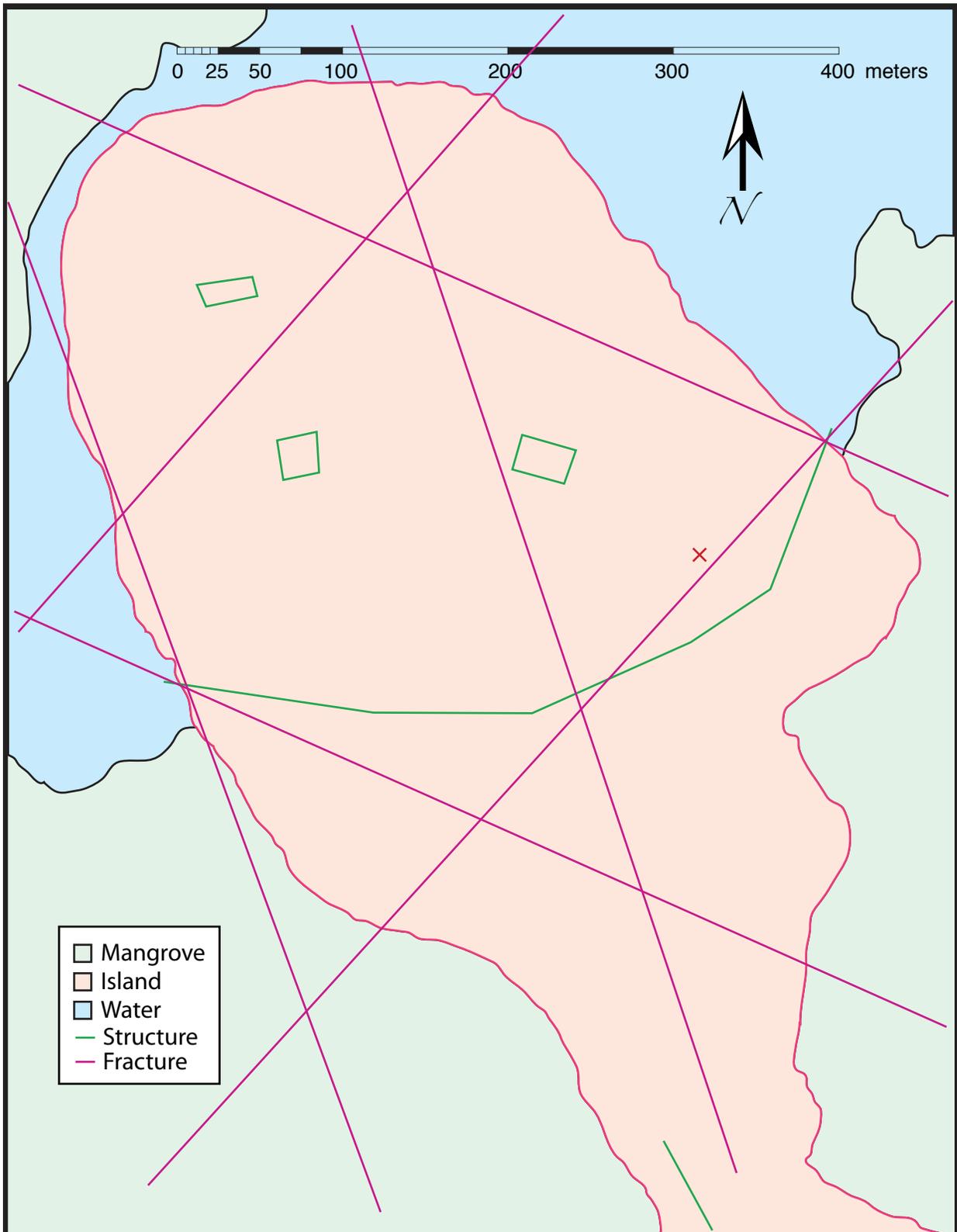
### Connections to Other Subjects

English/Language Arts, Geography

### Assessment

Students’ data plots and class discussions provide opportunities for assessment.

Figure 2. Location of Limestone Fractures in the Vicinity of Vista Alegre



### Extensions

1. Visit <http://oceanexplorer.noaa.gov/explorations/11maya/welcome.html> for more about the Exploring the Hidden World of the Maritime Maya 2011 Expedition.
2. For more activities about the Maya civilization, see Other Resources, below.

### Other Relevant Lesson Plans from NOAA's Ocean Exploration Program

#### **The Puzzle of the Ice Age Americans**

(from the Exploring the Submerged New World 2009 Expedition)  
<http://oceanexplorer.noaa.gov/explorations/09newworld/background/edu/media/puzzle.pdf>

Focus: Origin of the first humans in the Americas (Anthropology, Earth Science)

Students will describe alternative theories for how the first humans came to the Americas and explain the evidence that supports or contradicts these theories, explain how exploration of a submerged portion of the North American west coast may provide additional insights about the origin of the first Americans, and describe the role of skepticism in scientific inquiry.

#### **By Land or By Sea or Both?**

(from the Exploring the Submerged New World 2009 Expedition)  
<http://oceanexplorer.noaa.gov/explorations/09newworld/background/edu/media/landsea.pdf>

Focus: Watercraft in Paleoamerican Migrations

Students will describe evidence that supports the idea that the initial settlement of North and South America involved watercraft, discuss types of watercraft that might have been involved in new world settlement, and explain at least three advantages and three disadvantages of coastal settlements compared to inland settlements.

### Other Resources

*The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.*

<http://oceanexplorer.noaa.gov/explorations/11maya/welcome.html>  
– Web site for the Exploring the Hidden World of the Maritime Maya 2011 Expedition

<http://celebrating200years.noaa.gov/edufun/book/welcome.html#book>

- A free printable book for home and school use introduced in 2004 to celebrate the 200th anniversary of NOAA; nearly 200 pages of lessons focusing on the exploration, understanding, and protection of Earth as a whole system

Glover, J. B., D. Rissolo, and J. P. Mathews, 2011. The Hidden World of the Maritime Maya: Lost Landscapes Along the North Coast of Quintana Roo, Mexico. -in- B. Ford, ed. When the Land Meets the Sea. Volume 2, pp 195-216, The Archaeology of Maritime Landscapes. Springer Science+Business Media. New York.

<http://www.smm.org/sln/ma/> – Maya Adventure, from the Science Museum of Minnesota; includes science activities and information related to ancient and modern Maya culture

<http://teacher.scholastic.com/lessonrepro/lessonplans/profbooks/ss970818d.htm> – Peoples of Mexico - The Maya from Scholastic.com

[http://www.pbs.org/wgbh/nova/teachers/programs/2804\\_maya.html](http://www.pbs.org/wgbh/nova/teachers/programs/2804_maya.html) – Teacher’s Guide to accompany the NOVA production, Lost King of the Maya; includes an activity using the Maya calendar

<http://www.civilization.ca/cmcc/exhibitions/civil/maya/mminteng.shtml> – “Mystery of the Maya” Web site from the Canadian Museum of Civilization

<http://school.discoveryeducation.com/lessonplans/programs/mayanewsreport/> – Lesson plan (grades 9-12), “A Classical Maya News Report” from Discovery Education

Martin, Simon and Nikolai Grube. 1995. Maya Superstates. *Archaeology* 48(6):41-46.

Webster, David L. 2002. The Fall of the Ancient Maya. Thames & Hudson, London.

## Correlations

### Framework for K-12 Science Education

#### B. Crosscutting Concepts

2. Cause and effect: Mechanism and explanation
7. Stability and change

#### C. Disciplinary Core Ideas

##### Life Sciences

Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystems Dynamics, Functioning, and Resilience

LS2.D: Social Interactions and Group Behavior

Core Idea LS4: Biological Evolution: Unity and Diversity

LS4.D: Biodiversity and Humans

Earth and Space Sciences

Core Idea ESS3: Earth and Human Activity

ESS3.C: Human Impacts on Earth Systems

Core Idea ETS2: Links Among Engineering, Technology, Science, and Society

ETS2.B: Influence of Engineering, Technology and Science on Society and the Natural World

**Ocean Literacy Essential Principles and Fundamental Concepts**

Essential Principle 2.

The ocean and life in the ocean shape the features of the Earth.

*Fundamental Concept c.* Erosion—the wearing away of rock, soil and other biotic and abiotic earth materials—occurs in coastal areas as wind, waves, and currents in rivers and the ocean move sediments.

Essential Principle 5.

The ocean supports a great diversity of life and ecosystems.

*Fundamental Concept i.* Estuaries provide important and productive nursery areas for many marine and aquatic species.

Essential Principle 6.

The ocean and humans are inextricably interconnected.

*Fundamental Concept b.* From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation’s economy, serves as a highway for transportation of goods and people, and plays a role in national security.

*Fundamental Concept c.* The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

*Fundamental Concept f.* Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).

### Send Us Your Feedback

In addition to consultation with expedition scientists, the development of lesson plans and other education products is guided by comments and suggestions from educators and others who use these materials. Please send questions and comments about these materials to:

[oceaneducation@noaa.gov](mailto:oceaneducation@noaa.gov).

### For More Information

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### Acknowledgements

This lesson was developed and written for NOAA's Office of Ocean Exploration and Research (OER) by Dr. Mel Goodwin, Science and Technology Consultant to OER's Education Team.

Design/layout: Coastal Images Graphic Design, Mt. Pleasant, SC.

### Credit

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## Mapping a Maya Settlement

### Vista Alegre Survey Data

Archaeologists, surveyors and others who need to make precise measurements of the location of various objects often use an instrument called a Total Station. This instrument combines a digital version of a theodolite (an instrument for measuring horizontal and vertical angles) with an electronic distance measuring device (EDM). To survey the Vista Alegre site diagrammed on the Base Map, archaeologists located their Total Station at the spot indicated by the red X. Table 1 shows the distance from this point to the locations of various structures on the site, as well as the angle of these locations relative to north. All of these structures are approximately rectangular, and the data in Table 1 locate the four corners of each structure. Structure 12 is a pyramid that may have been used as a lookout or signalling station when Vista Alegre was occupied. Note that a sacbe is a road, and an andador is a raised walkway.

To plot a location from Table 1 onto the Base Map:

1. To plot angles between  $0^\circ$  and  $180^\circ$ , position your protractor so that the vertex is directly over the red X, and  $0^\circ$  on the protractor corresponds to the direction of the north arrow (this means that the base of your protractor will be vertical with  $0^\circ$  at the top). To plot angles between  $180^\circ$  and  $359^\circ$ , position your protractor so that the vertex is directly over the red X, and  $180^\circ$  on the protractor corresponds to the direction of the north arrow (now the base of your protractor will be vertical with  $0^\circ$  at the bottom).
2. With a sharp pencil, make a small dot at the point on the outer ring of the protractor that corresponds to the angle for a selected location listed in Table 1. If the angle is greater than  $180^\circ$ , subtract  $180^\circ$  from the angle measurement and plot the result. So, if the angle you want to plot is  $225^\circ$ , plot  $45^\circ$  (remember, if the angle to plot is greater than  $180^\circ$ , your protractor must be positioned with zero degrees at the bottom).
3. Now draw a light line from the red X to the point plotted in Step 2.
4. Use the scale at the top of Figure 1 to set your dividers so that the space between the divider points corresponds to the distance for the selected location shown in Table 1.
5. Place one of the divider points at the center of the red X, and the other point on the line that you drew in Step 3. This is the location of the selected point listed in Table 1.

Total Stations usually measure elevation angles relative to vertical, so an elevation angle of  $90^\circ$  means that the Total Station was pointed exactly horizontally.

The distance to the apex of the Pyramid at Vista Alegre was 250.000 m from the Total Station, and the distance to a point directly beneath the apex at the base of the Pyramid was 249.758 m. Assuming the elevation angle was  $90.0^\circ$ , how high was the Pyramid?

**Table 1. Distance and Angle from Total Station Location to Locations of Various Structures at Vista Alegre**

Survey Line Number	Point Description	Distance (meters)	Angle (degrees from north)
S-1	West end of Andador	355	183
S-2	East end of Andador	409	181
S-3	West end of Sacbe	334	257
S-4	East end of Sacbe	110	46
S-5	Intermediate point #1 on Sacbe	220	244
S-6	Intermediate point #2 on Sacbe	139	227
S-7	Intermediate point #3 on Sacbe	48	115
S-8	South corner Structure 21	94	298
S-9	East corner Structure 21	99	309
S-10	North corner Structure 21	130	305
S-11	West corner Structure 21	125	295
S-12	Northeast corner Pyramid base	243	288
S-13	Northwest corner Pyramid base	265	285
S-14	Southeast corner Pyramid base	235	282
S-15	Southwest corner Pyramid base	256	280
S-16	Northeast corner Structure 14	319	302
S-17	Southeast corner Structure 14	310	300
S-18	Northwest corner Structure 14	347	298
S-19	Southwest corner Structure 14	334	297

## Mapping a Maya Settlement Vista Alegre Base Map

