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EARTHCACHE
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EarthCaching
An Educator's Guide

EarthCaching™
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NATIONAL GEOGRAPHIC

Education Foundation

EarthCaching™ – An Educator's Guide

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Introduction

The Geological Society of America has taken one of the fastest growing outdoor activities of our day, Geocaching [pronounced "geo-cashing"], and developed an exciting educational activity that engages students in learning about Earth and its processes. It is called EarthCaching. By combining GPS technology with outdoor field experiences, students experience the wonders of Earth in an entirely new way.

Kids these days are wired. From cell phones and iPods to PDAs and personal video games, there always seems to be a portable electronic device within easy reach. Some may find this unsettling, but it seems clear that the next generation will continue to use, depend upon, and be amazingly adept at managing these tiny wonders. Will our kids be lost in a virtual world of technology and lose touch with the "real" world? Can these kids become engaged with the natural, physical world beyond the range of their tiny screens?

Indeed, they can. Welcome to EarthCaching.

EarthCaching is an educational activity that bridges the lure of a hand-held electronic device—specifically, a GPS receiver—with the wonders of the outside world and the adventure of a treasure hunt as well!

GPS, Geocaching and EarthCaching

EarthCaching (pronounced "Earth–cashing") is a new concept in education, but one that encompasses many elements that are proven to engage students and promote learning. Field experiences, hands-on interactive tasks, cutting edge technology, and the thrill of discovery all contribute to making learning meaningful, not to mention fun, for learners of all ages. EarthCaching is based upon the widespread use of GPS technology, the exponential growth of the adventure game of geocaching worldwide, and the ongoing need to improve geography and Earth science understanding for all.

What is GPS? (Adapted from: www.nps.gov/gis/gps/feature.html)

GPS, the Global Positioning System, consists of 25 satellites that orbit Earth and enable people with GPS receivers to determine their geographic location on the ground. Depending on the type of GPS receiver used, the accuracy of one's location can be determined anywhere from within centimeters to within a few meters. GPS is used in countless applications—including navigation, transportation, commerce, industry, research, surveying, and education—with the purpose of pinpointing an object or location to a specific point on Earth's surface. Increasingly as a result of its low cost, ease of use, and general fun, GPS is being used recreationally for both locating and navigating. It has sparked a completely new realm of entertainment and adventure—geocaching.

What is Geocaching? (Adapted from www.geocaching.com)

Geocaching is an entertaining game of exploration and discovery that allows GPS receiver users to search for "caches," or hidden objects, that have been placed somewhere on Earth. Caches have been set up all over the world by thousands of people in thousands of places. Locations of the caches are cataloged online at www.geocaching.com. To search for a cache, a user would first find a listing of locations online, input the latitude and longitude coordinates as a "waypoint" into his or her GPS receiver, and then use the receiver to find the cache. The cache is generally a container in which small items are hidden. Once found, a cache may provide the visitor with a wide array of rewards, including trinkets, messages, or other surprises. The geocacher can then physically log his or her visit and, if desired, take a trinket from the cache and leave one in its place. Geocachers may also report and log their visit to the cache online.

What is EarthCaching?

EarthCaching is an Earth science/geography-based educational activity that draws from the ever-increasing use of GPS receivers and the growing popularity of geocaching. Educators and others realize that Earth itself offers its own treasures to uncover and endless opportunities for exploration, discovery, and learning. EarthCache™ sites, then, are "virtual" caches that provide the visitor who finds them with new knowledge or insights about the location itself - an "educational treasure" which is arguably more valuable than a trinket anyway! Instead of leaving or taking anything from the site, visitors are asked to follow the EarthCache™ notes,

make and record observations while at the site, and then log their visit on the EarthCache™ Web site by reporting what they learned. Like geocaches, EarthCaches™ are developed by people all over the world. However, because they are meant to be educational, all EarthCache™ sites that are posted on the EarthCache™ Web site must provide some scientific information about the site. All EarthCache™ locations that are submitted for posting are subject to approval and oversight by the Geological Society of America (GSA).

The EarthCaching Web site at 🕐www.earthcache.org is the hub of all things related to EarthCaching. This is where all EarthCache™ locations are posted and logged, and where guidelines and additional resources can be found. From this Web site, educators can link to a special area that specifically addresses the needs of students and teachers in a classroom setting as well as suggestions for utilizing EarthCache™ sites in a variety of other ways. On either the 🕐www.earthcache.org Web page or the 🕐www.geocaching.com Web page, EarthCache™ sites are distinguished by this symbol 🕐.

EarthCaching and Learning About Earth

Why do things happen where they do? How has the landscape changed, and what is causing these changes? How do landscape features tell about the geologic history of an area? What role do humans play in affecting each landscape? These are but a few questions posed in Earth science and geography classes. Though answers could be sought from a variety of sources, EarthCaching engages and stimulates curiosity in new ways. EarthCaching is an innovative approach to learning about the "whys and hows of where"—why and how things happen where they do. By integrating technology with hands-on field studies, EarthCaching contributes to Earth "literacy" for learners of all ages.

Individuals or groups can visit EarthCache™ locations around the world, either in the field or online, to learn something new about Earth and its systems. EarthCache™ sites are generally located where there is an interesting geologic or geographic phenomenon or feature. Because many different people create EarthCache™ sites, the topics or themes of the caches vary greatly. Consequently, the sites can provide information on a wide range of landforms, vegetation, and rock strata to climate, soil types, population distribution, or human impacts on the landscape. The possibilities are limitless, provided they offer some nugget of information about a particular place and the land that lies beneath it. Anyone who wishes to teach others about a place of interest can create and submit an EarthCache™ provided the guidelines be followed.

Lesson plans that incorporate EarthCaching can be linked to a variety of disciplines including Earth science, biological science, geography, history, math, language arts, foreign language, civics, and the visual

"... Earth itself offers its own treasures to uncover and endless opportunities for exploration, discovery, and learning."

EarthCache™ sites are distinguished by this symbol: 🕐

GPS unit on sandstone ripple marks at Dinosaur Ridge Earth-Cache™ site in Morrison, CO.

arts. Participants gain skills and experience related to location (e.g. longitude and latitude), navigation, and the use of geospatial technology. The diagram below illustrates the role that EarthCaching can play in education. As a part of the teacher's toolbox, EarthCaching can be incorporated into a lesson plan to support learning objectives by giving students the opportunity to see geologic and geographic features of Earth firsthand or online.

EarthCaching in Education

Desired Outcome	**Learning Objectives & Essential Questions**	
Lesson Plan		**Other Learning Experiences**
New Learning	**Geospatial Skills** · **Earth Literacy** · **Related Learning & Skills**	
Evaluation & Assessment	**Demonstration of Learning & Understanding** (Evaluations and Assessments based on Bloom's Taxonomy)	
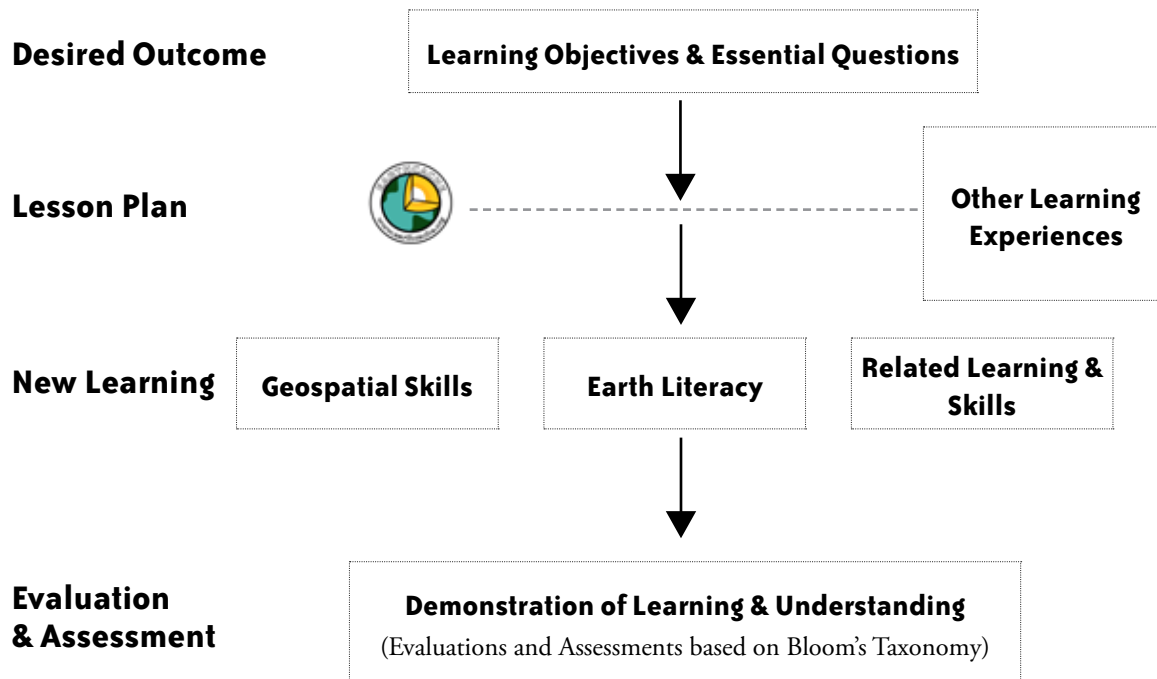
Knowledge

Observation, recall of information and major ideas

Comprehension

Interpret facts, compare and contrast, predict outcomes

Application

Apply concepts & theories to new situations, solve problems using new skills/knowledge

Analysis

Recognize patterns, identify components, recognize hidden meanings

Synthesis

Relate knowledge from several disciplines, generalize from facts, draw conclusions

Evaluation

Discriminate between ideas, value evidence and recognize subjectivity, develop reasoned arguments

Connections To Curriculum

EarthCaching can support standards and enhance learning in a variety of disciplines. Its applications are most obvious in the fields of Earth science and geography. The development and/or study of an EarthCache™ site will help students study the composition of Earth, its history, and the natural and physical processes that shape it. By studying similar EarthCache™ sites around the world or comparing various sites in close proximity to each other, students can develop and test hypotheses, make observations, and draw conclusions about Earth. EarthCaching also provides the opportunity for students to experience how science and technology interact and to gain proficiency in the use of technology in science (e.g., GPS unit, computer, and the Internet).

However, EarthCaching is not limited to Earth science and geography. The table below illustrates how EarthCaching can be used to enhance learning in a variety of disciplines.

Discipline	Sample Standard/ Learning Objective[1]
Scientific Inquiry/ Earth Science/ Biological Science	• Know and understand the methods of scientific inquiry (e.g., formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment; demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations) • Know and understand the composition of Earth (e.g., each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles) • Know and understand the history of Earth and the natural, physical processes that shape it (e.g., interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the Earth system)
Science & Technology	• Understand the intersection of science and technology (e.g., science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research) • Gain proficiency in the use of technology for the purposes of supporting scientific inquiry
Physical and Human Geography	• Know and understand the major processes that shape patterns in the physical environment (e.g., earthquake zones and volcanic activity) • Understand how physical systems are dynamic and interactive (e.g., the relationships between changes in land forms and the effects of climate such as the erosion of hill slopes by precipitation, deposition of sediments by floods, and shaping of land surfaces by wind)
Human Geography	• Understand the impact of human migration on physical and human systems (e.g., the impact of European settlers on the High Plains of North America in the nineteenth century) • Understand contemporary issues in terms of Earth's physical and human systems (e.g., the processes of land degradation and decertification, the consequences of population growth or decline in a developed economy, the consequences of a world temperature increase)
History	• Know how physical and human geographic factors have influenced major historic events and movements (e.g., the course and outcome of battles and wars; geographic challenges of exploration) • Demonstrate understanding of the characteristics of western European societies in the age of exploration (e.g., identify geographic factors that influenced U.S. expansionism in the late 19th century)

[1]National standards and learning objectives are drawn from the published national standards for each discipline.

Discipline	Sample Standard/ Learning Objective[1]
English/Language Arts	• Demonstrate reading comprehension (e.g., use reading skills and strategies to understand a variety of informational texts such as textbooks, primary source documents, and maps) • Use descriptive and technical writing (effectively communicates in writing factual and technical information)
Mathematics	• Compute fluently and make reasonable estimates; develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios (e.g., use UTM (Universal Transverse Mercator) coordinates to determine the distance in miles north (or south) and east (or west) a location is from the EarthCache™ site. Calculate in meters as well) • Compute fluently and make reasonable estimates; judge the reasonableness of numerical computations and their results (e.g., determine the straight-line distance of above using Pythagorean's Theorem)
Foreign Language	• Demonstrate understanding of the nature of language through comparisons of the language studied and their own (e.g., use EarthCache™ sites in foreign languages to test comprehension, comparing with English version) • Understand and interpret written and spoken language on a variety of topics through the use of foreign EarthCache™ sites

[1]National standards and learning objectives are drawn from the published national standards for each discipline.

Coordinate Systems and GPS Technology

Before embarking on an EarthCaching adventure, it is helpful to have a basic understanding of coordinate systems (specifically longitude and latitude) and an introductory understanding of GPS technology.

Coordinate Systems

"The Earth is effectively a sphere, so how do we describe where a point is on its surface?" - National Atlas of the United States of America

Location, location, location. In order to make use of an EarthCache™ site, you must know where it is. The location of an EarthCache™ site is given in terms of longitude and latitude. It is important for students to understand the coordinate system that describes the position of any point on Earth's surface. There are a number of resources on the Internet that can be used to introduce or enhance understanding of longitude and latitude. A few have been provided below.

1. **National Geographic Society**
   www.nationalgeographic.com/expeditions/lessons/01/g68/mapmaking.html
   The National Geographic Society provides numerous lesson plans for teachers related to all aspects of geographic study. This link is for a lesson that has secondary level students review the concepts of longitude and latitude, explore the importance of having a system of measuring Earth's surface, and identify situations in which it would be helpful to use longitude and latitude.

2. **National Atlas of the United States of America**
   www.nationalatlas.gov/articles/mapping/a_latlong.html
   Operated by the U.S. Department of the Interior, this site is rich in information and resources related to physical and cultural geography, Earth science, and history and government. This link connects directly to information related to longitude and latitude. The site also provides links to additional resources related to the topic.

3. **NASA – National Aeronautical and Space Administration**
   www-istp.gsfc.nasa.gov/stargaze/Slatlong.htm
   Under the auspices of NASA, Dr. David Stern of the University of Maryland developed an online guide entitled "Stargazers and Starships." Chapter 5 of the guide gives an extensive explanation of longitude and latitude, including illustrations, and provides a link to related teacher lesson plans.

4. **United States Geological Survey (USGS)**
   www.education.usgs.gov/common/lessons/gps.html
   GPS, Map, and Compass - The USGS site contains information on GPS and its uses and includes links to geocaching and EarthCaching. It also includes sections on using a compass with a topographic map and information on GIS (geographical information system).

5. **World Atlas – Absolute and Relative Location**
   www.world atlas.com/aatlas/imageg.htm
   This site is helpful for introducing absolute and relative location (has definitions).

The Global Positioning System (GPS)

GPS technology is used to locate an EarthCache™ site. The technology allows the use of a small receiver to determine a position, or location, anywhere on Earth. The technology is based on a system of 24 satellites that continually orbit Earth on fixed paths. These satellites communicate their positions to a GPS receiver and the receiver uses the signals to calculate its position on Earth. It can then report that position in terms of longitude and latitude. The GPS receiver, which in this document will also be referred to as a GPS unit or a GPSr (a term just starting to be used in the media), can also be used, in a compass-like fashion, to navigate toward a specific location (such as an EarthCache™ site) using longitude and latitude.

While only a few are shown below, there are a number of teaching resources on the Internet that can be used to introduce students to the concepts involved in the Global Positioning System (GPS) and how it can be used to study Earth.

1. **How Stuff Works**
   www.howstuffworks.com/gps1.htm
   Global Positioning System
   This site provides an excellent explanation of how GPS works, including illustrations and videos by the authors.

2. **Garmin: What is GPS?**
   www.garmin.com/aboutGPS/
   What is GPS?
   Garmin, a manufacturer of GPS units, provides an explanation of GPS technology and how it works. There is a link to a downloadable PDF guide entitled "GPS Guide for Beginners."

3. **PBS NOVA: Longitude**
   www.pbs.org/wgbh/nova/longitude/gps.html
   GPS: The New Navigation
   NOVA Online, operated by PBS, hosts a site that provides access to a game that demonstrates how the GPS works. Where was the first accurate timepiece for finding longitude tested? What piece of information is required from both the satellite and the GPS receiver to determine the longitude and latitude (location) of a place on Earth? Contains a fun presentation of GPS concepts.

4. **The Geographer's Craft**
   www.colorado.edu/geography/gcraft/notes/gps/gps_f.html
   Global Positioning System Overview
   Hosted by the Geography Department at the University of Colorado—Boulder, this site contains materials that were developed by and are copyrighted by Peter H. Dana of the University of Texas in Austin. There are a number of illustrations and explanations of the GPS, its development and operation.

Using a GPS Receiver (GPSr)

After students understand GPS technology, they will need to experience

"When people talk about a 'GPS,' they usually mean a GPS receiver. The Global Positioning System (GPS) is actually a constellation of 27 Earth-orbiting satellites (24 in operation and 3 extras in case one fails). The U.S. military developed and implemented this satellite network as a military navigation system, but soon opened it up to everybody else."

- How Stuff Works

Source: 1998 National Air & Space Museum

the technology first-hand by using a GPSr to (1) determine their own location on Earth and (2) navigate to a specific location. There are numerous GPS receivers on the market and some are more sophisticated than others are. While each manufacturer of GPS units may design a unit that looks and feels slightly different from other units, they all work on the same concepts, and knowing how one model works will give the user enough of an understanding to figure out other models. Manufacturers often provide informative and user-friendly online manuals for their units. These online manuals can be used to create effective lesson plans, exercises, and skill evaluations for students learning to use the receivers. An example of a lesson plan helping students use their GPSr can be found in Appendix B. Please edit the lesson plan for use with your students' units.

Getting Started With EarthCaching

Getting started with EarthCaching is straightforward, although there are a few necessary minimum requirements. At the very least, one needs:

A GPS receiver, and access to the ⏱www.earthcache.org web site via an internet connection.

GPS Receivers

Before setting out to find an EarthCache™ site, you should become familiar with the basic functions of your GPS receiver. At the very least, EarthCaching requires that you are able to follow a waypoint. To learn more about using GPS, visit the Web sites and activities on the previous pages. Also, use Chapter 4, EarthCaching When You Can't Leave Campus, for exploring the EarthCache™ Web site itself before using the GPS unit.

No GPS receiver? No problem.

If you do not have access to a GPSr or require additional units, there are a number of options for obtaining them. Please see the "Resources" section below for some ideas. In addition, in Chapter 4, EarthCaching When You Can't Leave Campus, you will find creative ideas for using the EarthCache™ Web site itself without using a GPS receiver at all.

Using ⏱www.earthcache.org

The EarthCache™ Web site (⏱www.earthcache.org) is the virtual starting point for your EarthCaching adventures. Here you will find the most updated information about EarthCaching including:

- a listing of all GSA-approved EarthCache™ sites;
- tips on how to find your first EarthCache™ site in the field;
- guidelines for how to create and post a new EarthCache™;
- strategies and ideas for using EarthCaches™ in education, with or without leaving campus;
- special EarthCache™ site-related programs (grants, incentives, news, etc.)

The information below highlights certain parts of the EarthCache™ Web site that might be helpful in getting started.

User Registration

In order to see a list of EarthCache™ sites online and to find their latitude and longitude coordinates, you must register as a user. This is a quick and free process and is required of www.geocaching.com users (the site that hosts the actual EarthCache™ site listings). Simply follow the directions online when you are prompted to create a new account. Know that your username will be viewed by others when you log your visits online, so you might want to give it some thought and come up with a clever name!

Selecting an EarthCache™ Site to Find

On the 🕐www.earthcache.org web site, there is a listing of all EarthCache™ sites that have been approved by GSA. To see a list of all available EarthCache™ sites, click on the **View EarthCache™ Listings** button. A spreadsheet listing of all EarthCache™ sites will appear. As you will see, the listing includes the following information about each cache:

Type	Country	State/Prov	Waypoint	Classification	Developer
🕐	Canada	British Columbia	20 million year old cache	Fossil Site	Landsharkz
🕐	USA	Idaho	A Gneiss Stop EarthCache	Structural feature	Bridger & RollyR
🕐	USA	Maryland	A Look Into The Past EarthCache	Syncline	Simulatmore

You may sort the caches by any of these columns simply by clicking once on the column heading. This will make it simpler to find an EarthCache™ site in your area or to locate EarthCaches™ related to a specific classification (e.g., fossil site, volcanic feature, etc.)

A click on the name of the EarthCache™ (in the "waypoint" column) will link you to the detailed information about the cache hosted by www.geocaching.com. (Note: EarthCache™ site information is available online to anyone, even without registering as a user. However, the specific location of the EarthCache™ site and its location relative to the user are available only to registered users of the two host sites. Therefore, students may explore EarthCache™ sites online without going through the user registration procedure, but will be unable to access longitude and latitude information.)

Components of an EarthCache™ Site Listing

Once you have registered, logged in, selected an EarthCache™ site you would like to visit, and found its page online, you will see that there is a great deal of information available. At the very least, each EarthCache™ listing will include:

- the coordinates (latitude and longitude) of the site to visit;
- a generalized map of the area;
- guidelines and/or information for learning about this location.

You will need to print out the information about the cache in order to proceed, as the educational content on the location should be taken with you on your adventure. Some EarthCache™ sites have additional clues that need to be "decrypted" in order to make sense! You should read all the information included so you know exactly how to fully experience the EarthCache™ site. At some sites, you will need to take digital photographs.

Visiting an EarthCache™ Site

Field visit: You have found an online listing of an EarthCache™ site that you would like to visit. You have its location in latitude and longitude and have printed out the informational pages about the cache. You know the basics of operating your GPS receiver. Now what? Time for a field trip!

Enter the latitude and longitude for the EarthCache™ site into your GPSr by creating a new waypoint and editing the coordinates. Then set your GPSr to select the new waypoint to find (or GOTO) that location. Reading the manual that comes with your GPSr may clarify this process. Your GPSr display will indicate how far and in what direction you must travel to find the EarthCache™ site. Depending on how far you are from the cache, you may need to drive to get near it; obviously, that will vary by situation.

Your GPSr should be able to place you within 15 feet of the EarthCache™ site. In almost all cases, this is close enough for you to learn about some amazing geologic or geographic aspect of that place. Be sure to take notes and answer the questions that are posed to you by the EarthCache™ listing (refer to your printout). You will need to demonstrate that you have learned something in order to log your visit successfully!

As an educator, you may also require your students to obtain additional information about the site. To learn more about teacher and student use of EarthCache™ sites, please see the subsequent sections in this document.

Online visit: If a field trip to an EarthCache™ site is not possible, educators and students can still learn a great deal from the EarthCaches™ Web site. Although "being there" is the ideal way to visit an EarthCache™ site, valuable learning opportunities can be found in the listings, the logs, the photos, and the comments of other EarthCachers. The section entitled "EarthCaching with No GPS Receiver" includes some creative ideas for "online" EarthCaching.

Logging Your Visit

When you return to your computer, go back to the listing for the EarthCache™ site you visited and click on the button to **Log Your Visit.** Here you can write comments, rate your experience, and even upload a photo that you have taken. You also must answer the question(s) posed by the EarthCache™ site developer to get credit. This is now a fundamental requirement of EarthCaching.

The records of EarthCache™ sites that you have visited, as well as any visits you make to other cache types, can be found on your own account pages at www.geocaching.com.

Note: Online EarthCache™ site visits (i.e. when you do not actually visit the cache in the field, but still learn about the place) may not be logged. Only field visits can be logged online.

Creating and Submitting a New EarthCache™ Site

Anyone can create and submit an EarthCache™ site, provided the guidelines are followed carefully. The most up-to-date guidelines can be found online at www.earthcache.org and must be adhered to in order to receive GSA approval. Creating an EarthCache™ site is perhaps the most effective way to learn about Earth processes and the geography of the cache, as one must provide the information to others in a clear, concise and interesting manner. Teachers, students, and others are welcome to create new EarthCache™ sites thereby sharing their knowledge with

the entire EarthCaching community. Note that in cases where the location of caches are on private or restricted property, they should not be posted on the Web site but rather just used "internally" with the aid of the EarthCache™ site form (Appendix A) or given only to individuals who have access to the property (e.g., school grounds). A teacher may also not want to post an EarthCache™ site online so that s/he can have new students create the same EarthCache™ location each year.

Educational Uses of EarthCaching

EarthCaching is a simple and effective tool for use in a variety of disciplines and can be incorporated into a variety of activities. The materials included here address three different approaches to the educational uses of EarthCache™ sites:

- Teacher EarthCache™ Site Development,
- Student EarthCache™ Site Development, and
- EarthCaching When You Can't Leave Campus
- On Campus EarthCaching
- EarthCaching Without a GPSr

As of December 2006, there are more than 600 EarthCache™ sites worldwide and that number is growing rapidly. Using existing EarthCache™ sites, through either actual site or online visits, can aid teachers in guiding students to valuable learning about Earth and its processes. As the number and variety of EarthCache™ sites grow, the opportunities for their use in education expand. Browsing the list of existing EarthCache™ sites can spawn even more ideas for their use.

Teacher EarthCache™ Site Development

Teachers may find that there are useful and relevant educational sites located in their own geographic region that can be developed into EarthCache™ sites for use by their students and others. Teachers may develop an EarthCache™ using the criteria found at www.earthcache.org and submit it for posting on the Web site or develop one for use only by their students.

Student EarthCache™ Site Development

Teachers may want their students to have the educational experience of developing EarthCache™ sites as part of a larger lesson plan/unit. Student-developed EarthCache™ sites are generally not developed for posting on the EarthCache™ Web site (but can be); rather, they are used to enhance the students' learning experience related to content, scientific inquiry, observation, evaluation, and analysis.

EarthCaching When You Can't Leave Campus

If you are unable to leave campus to visit an EarthCache™ site, there are at least two other options for incorporating EarthCaching into your lesson.

- On Campus EarthCache™ sites: Use teacher- or student-developed EarthCache™ sites located on or near the school campus to accomplish learning objectives.

- EarthCaching without a GPSr (online visits): Visit an EarthCache™ site by looking at the online entry at www.earthcache.org. Students can use the EarthCache™ site information, along with other sources, to accomplish learning objectives. Teachers should consider previewing online EarthCache™ sites since each varies in the type, amount, and quality of information provided. (Note: Online visits to an EarthCache™ site may not be logged on the Web site as a visit.)

Lesson Plans

Lesson plans that use one or more EarthCache™ sites can be found at www.earthcache.org. Teachers may also develop lesson plans to be shared with others. Lesson plans are attached to specific EarthCache™ sites, but can be applied to others as well.

Helpful Hints and Issues to Consider

EarthCaching has great potential as a learning tool, but there are also a number of potential challenges to using it in schools, including resources, safety issues, expertise, accountability, accessibility, and time.

Resources

By definition, EarthCaching utilizes specific technology so consequently access to GPS receivers and computers with Internet connections is ideal. The spectrum of access to these technologies still varies widely in schools, but continues to improve.

Internet Access

At the very least, a teacher needs to have access to www.earthcache.org online. This is the gateway to the EarthCaching community, including locations of caches, logs, activities, and teaching ideas. Powerful computers or a high-speed connection are not required as there are no large downloads or images to access. Student access to the Web site is beneficial only if online activities will be used or students wish to explore and find EarthCache™ site listings on their own. Always follow your school district guidelines for Internet safety.

GPS Receivers & Batteries

GPS receivers are becoming increasingly popular and consequently have become easier to find. Optimally, a teacher would have access to a class set of receivers (one GPSr per two or three students is sufficient) that can be taken along on field trips to EarthCache™ sites. Below are ideas for acquiring GPSrs.

Borrow:
- Borrow units from public or private organizations in town.
- Forest services, city or university departments, GIS/GPS professionals in the community, and educational museums may lend kits.
- GITA and state Geographic Alliances may lend kits.
- Students may have and bring in their personal GPSr if appropriate.
- Borrow from other school district departments and employees (many may own their own GPS unit or another school or district department may have acquired one or more).

Acquire:
- Write a grant for the needed units (some large retailers such as Best Buy and Wal-Mart as well

as local educational foundations may offer grant opportunities), and don't forget funds for batteries.

- Request a donation from GPS unit suppliers (outdoor stores, camping/fishing stores).
- Work with neighboring schools or with district to acquire a school/district set, or with state or federal agencies (like United States Geological Survey) that may have lending programs. Consider local county agricultural extension.

Field Trip Availability

The most powerful way to engage students in EarthCaching is to have them get out into the field and use GPSrs to find the caches. In some cases this can be done on campus (if such a cache exists), but more likely it will require a field trip. Budget constraints and time limitations are certainly considerations, but it is very possible to combine EarthCaching with other field trip objectives. If a cache is on the way to another field trip destination, it may not be difficult to incorporate a stop along the way.

Scaleable Uses of EarthCache™ Sites with Accessibility to Technology

GPSr	Computer	Lesson Ideas
1	1	• Have one student collect data; have rest of class take notes, collect samples, draw pictures, make rubbings, describe settings, record information from interpretive signs, write the class story of how it reached the position, measure objects, estimate sizes or densities, and answer questions about site. Ask class to switch persons using the unit often so that as many as possible get to experience the device.
1	1	• Change GPSr units to UTM (Universal Transverse Mercator, see www.erg.usgs.gov/isb/pubs/factsheets/fs07701.html), work on student's ability to use distance formula between points. Have student with GPSr call out two different coordinates and calculate the distance between them. Distance formula = square root of the difference of the northings squared added to the difference of the eastings squared. Common formula representation: $d = \sqrt{(\Delta x)2 + (\Delta y)2}$ • Check out the GPSr to students for finding local EarthCache™ sites (or geocaches) or creating their own. Try to allow each student access to the GPSr once per semester.
1 each	1 or More	• Each student makes a log of the trip to EarthCache™ site. • Encourage groups of students or families to visit more remote EarthCache™ sites. • Set up several EarthCache™ sites for technique building that are close to the school. Use a few locations that are farther away for class field trips or for creating new EarthCache™ sites.
0	1 teacher, all students have access in library or at home	• Encourage students to use the EarthCache™ Web site as a source of info and pictures in homework reports. • Assign students different landforms to research on the Web site and report to the class. • Have students give a report about a favorite EarthCache™ site. • Find an EarthCache™ site that has similar features to what is found in the local region.

GPSr	Computer	Lesson Ideas
0	1 with internet access in classroom	• Print out EarthCache™ site descriptions and make copies for students to study and use during specific units. • Use EarthCache™ sites for picture illustrations on worksheets (provide address of the EarthCache™ site). • Show groups of students cool places around the world during down times in your class.
0	A few in class	• Have students find sites of interest and plan how to get there. • Rotate small groups of students to look up EarthCache™ sites that have to do with topics covered. • Have students plot locations of EarthCache™ sites while rotating through stations.
	1 for each student	• Students create an EarthCache™ site within the semester on their own time. (Perhaps bring class to a local site before assigning them to create their own.) • Students create an EarthCache™ site by filling out a form printed from the site. • Students research background information about the natural history of their (or any) area to create a set of resources on a centralized folder that other student groups can use in the future for creating EarthCache™ sites. Encourage students to add to this file as they see articles in the newspaper or other sources throughout the year. Have students read through other opportunities listed in the Student Projects section of this folder.
2-3	1 or More	• Obtain or print out topographic maps from USGS, Terra Server, NASA World Wind, TopoFusion, or a commercial vendor like TOPO Maps USA from National Geographic. Have students without GPS units work together with the GPSr operators to find their current locations and to find EarthCache™ sites on the maps. • Split students into teams and assign roles so that they can produce a report by the time they return. Each student can focus on different aspects of the area: terrain, soil type, texture, rock description, major landforms, etc. • Have students break into as many groups as you have GPS units to practice finding waypoints using a deck of cards. The first GPSr holder walks away from the group and drops a card at least 10 feet away from any of the other teams' cards. The GPSr holder marks the position and returns back to their team that sets the GPSr to GoTo the card. Each of the teams must determine their card from the other teams' cards as a relay. The next person completes their turn by whispering the correct card into the lead person's ear. If they found the wrong card, they must look again for the correct card before handing the GPSr to the next person. • Make as many teams as GPS units and have each team create a very hastily written 'pseudo' EarthCache™ site with a waypoint. Hand the description and activity to one of the other teams and everyone can race to find and finish the activity.

Safety Issues

As with any activity that takes groups out in the field, safety must always be a top priority. Of particular concern is that often times GPS users will be so intent on following directions on their little screen that they forget to watch where they are going in reality! A frequent mantra should be "Look Up!" This is valid for all age groups!

Students working in small groups (3-4) can identify individual responsibilities within the group. One member can be the navigator (using the GPS unit), another may be the recorder (writing down what the group finds, observes, and learns) and another may be specifically responsible for the safety of the group (keeps them off the roadway or prevents them from stepping off a cliff!).

When creating a new EarthCache™ site, be sure to give safety considerations utmost priority. Especially considering that groups may be visiting the site, the area selected should be clearly marked, have ample space, and visitors should be conscious of sensitive ecosystems. Indeed, many fascinating geologic features can be seen in road cuts, but it is not recommended that an EarthCache™ site be created on the shoulder of the Interstate. Use common sense.

Again, always follow your district guidelines for Internet safety. It is strongly suggested that the teacher be the author for any EarthCache™ sites posted online, since the outside community can contact the author of the site. Do not allow student information to be accessed on any public site, including www.earthcache.org.

Expertise

Because GPS and other spatial technologies are becoming more and more commonplace in our society, there are ample resources available to support the novice. The best place for introductory information is the www.earthcache.org Web site, but advice and/or more specific support can be found either online or within your community. The GIS Education listserv (EDGIS) is a community of educators who use GIS in an educational context. Many will also be familiar with classroom applications of GPS. (For more information or to subscribe, visit list.terc.edu/mailman/listinfo/edgis). Alternatively, you may wish to find GIS and GPS users in your community. These technologies are in use by most local (state, county, and city) governments for planning purposes and by emergency services such as police and fire departments. Many private businesses also use these technologies (e.g., transportation and shipping, natural resource exploration, etc.). Local community colleges and vocational schools may offer certification programs and are excellent resources for discovering GIS and GPS resources in your community.

Accountability

In today's educational climate, it seems that teachers must constantly be accountable for any new activity they introduce into the classroom. What will students learn? Does it address the standards? Can it be justified? (See Standards in Appendix E.) EarthCaching can provide students with solid content in diverse disciplines (depending on the nature and use of the cache) as well as technology skills. Simple assessments are incorporated into the discovery of the cache itself (as "something" must be learned in order to log the cache) and additional assessments can be created depending on the desired learning outcome. In addition, one of the best authentic assessments would be for students to create and submit their own EarthCache™

sites. This requires that they use GPS technology, follow pre-determined criteria, provide substantive Earth science content, write clearly and thoughtfully and submit their work to an outside source for approval.

Accessibility

Language

At the present time, all EarthCache™ sites must be posted in English. However, if the cache is located in a non-English speaking country, the host language may also be included. In this case, the English translation may contain some grammatical errors, but will be easily understandable.

Maps

Despite the claims of GPSr aficionados, you really can still get lost even if you are carrying one! It is still a good idea to have a map of the area in which you will be traveling, preferably a large-scale topographic map. This will not only help you get to the general location of where you need to be, but also inform you of features on the land that the GPSr might not (i.e., cliffs, rivers, roads, other hazardous obstacles). Additionally, most EarthCache™ site listings offer basic maps and information online as to the ease or difficulty of access to the EarthCache™ location.

Disabilities

When an EarthCache™ site is posted, the author can indicate whether the area is handicap accessible. If this is a concern, be sure to look at the "Difficulty" and "Terrain" ratings and other comments related to physical accessibility provided by the EarthCache™ site creator when planning your visit to the site.

(Ratings out of 5 stars. 1 is easiest, 5 is hardest)

X **Difficulty ★★★☆☆ Terrain ★★☆☆☆**

Time

The time required to incorporate EarthCaching into instruction can range from an hour-long overview to a whole semester of related activities. Clearly, it depends on the course, the teacher, the subject and the resources. The activities suggested in the subsequent sections provide examples of simple to more involved possibilities.

Whether you have an hour or a semester to spend, and a single computer and GPSr or a lab set of each, EarthCaching can be used in a variety of ways. The chart below provides some examples ranging from the most fundamental to the most involved activities—in both time and resources. Choose what might work and of course, be creative!

Time		Activity
On Campus	**Off Campus**	
1-2 hours		• Visit www.earthcache.org and look at listings and logs.
2-4 hours		• Have students map EarthCache™ locations and their significant features.
6-8 hours		• Teacher creates offline EarthCache™ site within walking distance so students can experience the activity.
	Day Trip	• Encourage students to EarthCache™ site on their own. Extra credit?
	A Few Days	• Take a field trip to multiple EarthCache™ sites if possible.
Many Days Over a Semester		• Have students create their own EarthCache™ sites. Authentic assessment is whether it is approved by GSA!

X

X

Teacher EarthCache™
Site Development

As indicated in the Introduction, EarthCaching has many interdisciplinary applications and is an excellent way to get students hooked into Earth science, geography, mathematics and language arts. Assuming you have now decided to try using EarthCaching with your students, developing an EarthCache™ site to meet your classroom needs can be an exciting endeavor. The goal of this section is to simplify the process of turning an idea into an EarthCache™ site. This is accomplished by outlining steps to create an EarthCache™ for the classroom and providing the steps that were taken in creating an EarthCache™ site for Dinosaur Ridge in Morrison, Colorado.

How to Develop an EarthCache™ Site
for Use in Your Classroom

Identify an Objective

The first step in creating an EarthCache™ site, as in any lesson or unit, is to identify the objectives. What do you want the student to learn from this EarthCaching experience? In the physical geography class, an objective that relates to the interaction of humans with the environment might be appropriate.

Examples:
1. To develop in students an understanding of Earth/geographic systems and concepts.

2. To develop in students a deeper understanding of technology and how it can be applied to geography (GPS, GIS, databases, etc.)

If the EarthCache™ site were being developed for the science classroom, objectives that relate to scientific inquiry and Earth science concepts would be needed.

Examples:
1. To develop in students an understanding that Earth as we know it today has developed over long periods of time, through the continual process of change.

2. To develop in students an understanding of how scientists derive hypotheses, collect and analyze data, and draw conclusions about a given location or condition.

If the EarthCache™ site is being developed for the mathematics classroom, objectives that relate to research and measurement can be developed.

Examples:
1. Students will be able to interpret and develop scale drawings such as those based on maps of EarthCache™ locations to solve real-world problems.

2. Students will be able to select appropriate units of measurement and determine/apply them in a real-world context when researching an actual EarthCache™ location.

If the EarthCache™ site is being developed for the language arts classroom, objectives that relate to effectively communicating ideas and non-fiction information might be suitable.

Examples:
1. Students will be able to select and use an appropriate format for writing according to the intended audience and purpose.

2. Students will be able to write notes, comments, and observations that demonstrate a working knowledge and comprehension of the EarthCache™ location.

Develop Goals Based on Education Standards/Learning Expectations

Once the objectives for the unit have been determined, specific goals must be developed in order to choose the type of EarthCache™ site to be created. Within each class, state and/or national standards should be consulted in determining specific goals for the EarthCache™ site unit.

Because EarthCaching is interdisciplinary, standards in a number of disciplines can be addressed. Included in Appendix E are the relevant national and state standards. A link to state standards is also located at www.geosociety.org/educate/standards.htm. Reviewing your state standards can help you determine how best to develop your EarthCache™ site to ensure that it is appropriate for your teaching curriculum.

Depending on your purpose or disciplinary focus, you can develop goals that emphasize certain aspects of the cache location.

- If you are planning the EarthCaching unit within an Earth science class, knowledge of the local geology will be needed to set the goals for the EarthCache™ site you will develop.

Examples:
1. Students will be able to observe the differences between sedimentary and metamorphic rock outcrops.

2. Students will observe and describe an unconformity.

3. Students will describe the effects of glaciers on the land surface.

Within a physical geography class, a goal that ties in local geology with changes due to human interaction might be appropriate.

Examples:
1. Students will be able to identify the interaction between people and the physical environment (e.g. at a man-made reservoir).

2. Students will be able to develop an original question regarding the interconnectedness of the geology of the site and the human use of the site.

If the EarthCache™ site is being developed for the mathematics classroom, goals that relate to research and measurement might be appropriate.

Examples:
1. Students will be able to produce scale drawings of artifacts or items of interest found at the EarthCaching location.

2. Students will be able to correctly use the metric system on-site when collecting empirical data at the EarthCache™ location.

Within a language arts class, a goal for describing the local geology might be appropriate.

Examples:
1. Students will be able to properly complete a data collection field form.

2. Students will be able to accurately describe rock formations and topography found at the EarthCache™ location.

Identify an Actual Location

Once your learning goals and objectives have been developed, the next step to creating an EarthCache™ site is selecting a location that will enable the goals to be met. Though there are numerous educationally significant locations, finding a site that guides the students to

accomplish desired educational goals is key. Checking the EarthCaching Web page for possible EarthCache™ sites in your area that already address your objectives and goals is a logical place to start. Sources that will assist in identifying an appropriate location are all around you.

Here is a list of sources that you can access:

1. poll colleagues,
2. contact state or university geological departments,
3. personal experience/knowledge,
4. local library,
5. historical/preservation societies,
6. state/local visitor centers,
7. points of interest around campus (in compliance with state/local law), and
8. survey markers and Benchmarks.

From this point on, using the EarthCache™ site template available in Appendix A will help you gather all of the information you need to develop the EarthCache™ location.

Thinking About Geography

Geographers look at the world from a spatial perspective. Everything and every place can be looked at geographically. The following guidelines suggest a way for teachers and students to think about the world around them (used with permission from the Florida Geographic Alliance and Dr. Ed Fernald).

Model for Studying Place

When selecting a place or learning about a place for the first time, it is good to think about what you already know and what you would like your students to learn about the EarthCache™ location. Some potential questions are listed below.

1. Location and Physical Characteristics:
   a. Where is the EarthCache™ site you want your class to study?

   b. What is it a part of?

   c. What are the physical characteristics of the place (rocky, sandy, hot, cold, humid, dry)?

   d. What is the quality of the water, soil, and air (good or bad)?

2. Population and Culture:
   a. Is there evidence of human activity at this location?

   b. Do people live close to or far from the EarthCache™ location?

   c. How have people used the EarthCache™ site in the past?

   d. How have humans changed the landscape around the EarthCache™ location?

3. Economic and Land Use:
   a. What types of resources are located near the EarthCache™ site (reservoir, power plant, dams, highways, airports, landfills)?

   b. Is it near or in a recreational area?

4. History:

a. What past human activity took place at your EarthCache™ location? (Sometimes the character of a place is so heavily influenced by people that one must look at what has happened in the past to make decisions for the future.)

b. What natural events have occurred (hurricanes, floods, earthquakes, droughts, tornadoes)?

5. Problems and Prospects:
    a. What are some positive qualities regarding people and nature at the EarthCache™ location?

    b. What are some negative qualities regarding people and nature at the EarthCache™ location?

Ways to Sharpen Senses and Observation Powers

1. What is the reason you chose this place for an EarthCache™ location?

2. What do you see (vegetation, neighborhoods, bodies of water, footprints, animal tracks/scat, garbage, feathers, anthills, or prairie dog towns)?

3. What do you hear (machines, cars, kids, birds, water, wind in trees, planes)?

4. What do you smell (mowed grass, garbage, food, stagnant water, flowers, salt water)?

5. What do items found at the EarthCache™ site feel like (soft, slippery, coarse, wet, dry)?

Generally, observations are described in words. Sometimes, however, it is good to sketch what you see. It is your impression of what you are observing and it may provide a deeper appreciation for the site you have selected. Even if you are taking digital photos, try sketching your EarthCache™ location and relate it to what you saw, heard, smelled, and felt.

Ensure Access and/or Get Permission

EarthCache™ sites will always be on land owned by someone. For this reason, EarthCache™ sites developed on private and public land **must** have prior approval of the landowners before submission. EarthCaches™ developed in National Parks, National Forests, or other public lands are encouraged. These must have verbal or written approval from the appropriate land-managing agency. The name and contact details of the person from whom you received approval **MUST** be provided on your EarthCache™ Site Submittal Form.

Develop a Content Explanation of EarthCache™ Site

Once your site has been chosen, you will need to develop the educational content for the EarthCache™ site based on the directions in the Submittal Guidelines section at www.earthcache.org (see Appendix A, guidelines). The first guideline indicates:

> **EarthCache™ sites must provide Earth science lessons.** They take people to sites that can help explain the formation of landscapes or to sites of interesting phenomena such as folds, faults, intrusions, or reveal how scientists understand our Earth (such as fossil sites, etc.).

As the developer of the site, you must create the educational notes for the EarthCache™, keeping in mind your site will be used by the general public as well as educators and students. Your sources for finding the site, listed above, may also be useful in gathering information

for writing these notes. Online searches might also yield information as well as visits to local libraries or visitor centers. **EarthCache™ sites must be educational**, providing accurate, but simple explanations of what visitors will experience at the site. The educational notes must be written to a reading age of an upper middle school (14-year-old) student. Please read Appendix A for additional guidelines and instructions for the creation of an EarthCache™ site.

Develop Logging Requirements

Every EarthCache™ site needs a way to test that the visitors have learned something by going to the site. The visitors' experiences are what they record in their log. Just saying they have been to the EarthCache™ site, or even posting a photograph, is not enough. We suggest the following ways to have people log their visit:

1. Have them provide an answer to a question about the site, such as the estimated size of some object (like the size of a boulder, crystal, waterfall, etc.).

2. Have them provide the answer to a question that they can find on some preexisting signage.

3. Have them provide a hypothesis for why a feature exists at that location (e.g. Why do you think the waterfall has two drops rather than one drop at this location?).

4. Have them compare and contrast this site with another EarthCache™ site that you have developed. If you do this, visitors must be informed in your text that they must have visited both sites in order to log their visit(s).

Geocaching members log any cache they have visited online. They must open the cache they have visited, where there is a link in the top right corner that reads, "Log your visit". Simply click on the link, type in the information required for the log as indicated in the cache text, and submit. An email will be sent directly to the cache owner. If a visitor does not correctly submit the log requirements, the owner will contact the visitor via email.

Submit Your EarthCache™ Site for Approval

Now that you have developed your EarthCache™ site in accordance with the EarthCache™ Site Guidelines, the process is easily completed by following the steps for submittal set forth on the EarthCache™ Web site.

Develop Student Activities

Once your EarthCache™ site is online, you may wish to develop specific activities for your students to complete during their visit. The activities should guide your students toward completion of the educational goals you have identified.

Possible Student Activities Utilizing Teacher-Developed EarthCache™ Sites

1. **Latitude/Longitude Refresher Exercise**
   a. In the classroom:

      i. give students latitude and longitude coordinates of the EarthCache™ site you plan to visit,

      ii. provide students a paper topographic map of the area containing the EarthCache™ location and have them physically plot the coordinates on the map,

iii. compare student work to the actual coordinates you (the teacher) have determined, and

iv. after the coordinates exercise, have students study the topographic map and brainstorm reasons why they will be visiting this particular EarthCache™ site.

2. **Predicting Change Over Time**
   a. At an EarthCache™ site:

   i. after students have achieved the goal of your EarthCache™ site lesson, have students discuss what kinds of factors might cause change in the area (climate, seismic activity, human/environment interaction, movement of human or animal populations, etc.).

   ii. using what they have learned or already knew about the area, have students predict how this area might change over various ranges of time.

      1. 50 years
      2. 100 years
      3. 1,000 years
      4. 10,000 years
      5. 1,000,000 + years

3. **Geography and Local History**
   a. After students have studied the events of a famous battle, for example, create an EarthCache™ of the site (e.g. Gettysburg) addressing what Earth-based phenomena were contributing factors to the outcome of the battle.

   i. In groups, have students write about different areas of the battlefield and explain how the lay of the land (rivers, valleys, hills, outcrops), weather, climate, and timing (day or night time) influenced the progress of the battle in that particular area.

4. **Extractable Resources**
   a. Create an EarthCache™ site where resources are being mined, grown and harvested, or caught.

   i. Have students survey the site and predict the sustainability of the site and/or resource.

   ii. Have students explain how the extraction of this resource influences the quality of local human life.

   iii. If the site is not being sustained, but has the potential for sustainability, direct students to construct a written sustainability plan.

5. **Natural Disaster**
   a. Create an EarthCache™ site where a natural disaster has taken place.

   b. Students will analyze the nature of the disaster.

   i. What Earth related conditions needed to be present for this disaster to occur?

   ii. Why did it occur when it did?

   iii. What immediate effect did it have on who or what?

   iv. If the event occurred a long time ago, what have been the lasting effects?

   v. Were there any beneficial effects of this event?

   vi. What is the potential for this kind of event to occur again at this site? What are the

implications of a similar disaster?

6. **Physical Observations of the Site**
   In Florida school districts, students complete the following activity when visiting an EarthCache™ location (from the Florida Geographic Alliance):

Observation Data Collection Sheet

a. Date of Visit: _____

b. Observer's/Group Name: _____

c. Weather Conditions: Sunny_____   Cloudy_____   Rainy_____
                          Hot_____   Cold_____   Humid_____

d. Location and Comments: Absolute Location_____
                               Relative Location_____

e. General Topography: _____

f. Land Use:

    1. Human Alterations: _____

    2. Nearby Uses: _____

    3. Disturbances: _____

g. Vegetation/Comments: _____

h. Water/Comments: _____

i. Birds/Comments: _____

j. Insects/Comments:_____

k. On the page below, please sketch what you see, hear, smell, and feel at the EarthCache™ location you are visiting (if appropriate).

Evaluation Tools

The process of creating your EarthCache™ site for the classroom is nearly complete. It is now time to assess your students' mastery of the educational goals upon which your EarthCache™ site is based.

There are numerous ways to assess students and evaluate whether or not they have mastered educational goals using EarthCaching. The assessments that you develop will vary depending upon the lesson's objectives, educational goals, and student activities. In each case, expectations should be clear and a rubric or other scoring guide provided (see Appendix C).

> ### *Examples:*
>
> a. Journal Entry
>
> b. Reflection Questions
>
> c. Traditional Written Test
>
> d. Laboratory
>
> e. Field Manuals and Assignments
>
> f. Mathematical Computation and Measurements
>
> g. Assessment in which the students are required to use the skills they have learned during their EarthCaching experience to navigate a scenario-based exercise

Pre-existing EarthCache™ sites may already have attached lesson plans that educators have developed for the site. Check the EarthCache™ Web page for educators for additional ideas and evaluations.

Submit Your EarthCache™ Site Lesson Plan

Once your lesson plan and evaluations for students are complete, you can submit them to the EarthCaching site for use by other teachers. At the www.earthcache.org

Web site, open the "EarthCache™ for Teachers" page. There you will find directions for submitting your lesson plans for your specific EarthCache™ site. You may also do this when you submit your EarthCache™ site for approval.

Sample Procedure for Teacher-Developed EarthCache™ Site

Developing the Dinosaur Ridge EarthCache™ Site

The following is an example of an actual EarthCache™ site in Colorado and the development process that led a teacher to develop it for her Earth science class.
(Site: www.geocaching.com/seek/cache_details.aspx?wp=gcmqgg)

> 1. **Identify Objectives**
>   a. The objectives for the Earth science class for which EarthCaching will be used are:
>
>   i. Students know and understand longitude and latitude, maps, GPS technology, and computer/Web site use.

b. To develop in students an understanding that Earth as we know it today has developed over long periods of time, through the continual process of change.

c. An understanding of how life has evolved over time in a record preserved in sedimentary rocks.

2. **Identify Educational Standards/Learning Expectations**
   a. Colorado State Science Standards:

      i. Standard 4.1: Students know and understand the composition of Earth, its history, and the natural processes that shape it. Benchmarks (5–8): explaining how fossils are formed and used as evidence to indicate that life has changed through time; modeling natural processes that shape Earth's surface (for example, weathering, erosion, mountain building, volcanic activity);

      ii. Standard 5: Students know and understand interrelationships among science, technology, and human activity and how they can affect the world. Benchmark (5–8): describing how people use science and technology in their professions (scientists can use GPS to pinpoint locations of phenomenon).

   b. Colorado State Geography Standards:

      i. Standard 1.1: Students know how to use maps, globes, and other geographic tools to acquire, process, and report information from a spatial perspective. Benchmark (5–8): explaining the characteristics and purposes of and explaining differences among maps, globes…; interpreting and constructing maps…

      ii. Standard 1.2 Students develop knowledge of Earth to locate people, places, and environments. Benchmark (5–8): locating places using latitude and longitude.

      iii. Standard 3.1: Students know the physical processes that shape Earth's surface patterns. Benchmark (5–8): describing the consequences of physical processes on Earth's surface.

3. **Identify Goals**
   a. The goals for this visit will be:

      i. to understand maps and use latitude and longitude to locate significant outcrops displaying Earth processes.

      ii. to understand how sedimentary rocks form in horizontal layers with youngest on top, oldest on bottom (Law of Superposition) and how tectonics or erosion may cause these layers to be exposed. Students have already studied this and will use the opportunity to observe this law in the field.

      iii. to observe how fossils are preserved in sedimentary layers and how the ages of these fossils can be estimated relative to one another.

4. **Select a Location:**
   a. Site was chosen based on previous knowledge from a field trip to the Dinosaur Ridge Visitor's Center and a GSA field trip to the area. Materials from the Friends of Dinosaur Ridge (A Field Guide to Dinosaur Ridge by Martin Lockley) and from a 2002 GSA Annual Meeting Field Trip "Geological Reconnaissance of Dinosaur Ridge and Vicinity" field book were used to make the EarthCache™ site and student activity.

   b. Ensure access and/or get permission

      i. Site has public access, but traffic can be dangerous. Enlist additional adults to

supervise students during the trip, warn them about the narrowness of the road.

5. **Develop a Content Explanation of EarthCache™ site**
   a. Visit actual field site and record the latitude and longitude waypoints at each of the important locations. Based on text and previous knowledge, it was determined that the EarthCache™ site would include waypoints for the following geologic phenomena: Dinosaur bone fossils at type section; Brontosaurus bulges in sandstone; white ash layer; spherical concretion (although this is not significant to the objectives); ripple marks; and dinosaur tracks. These points were all logged, and the EarthCache™ site was submitted with text explaining the geology based on the information found concerning the site.

6. **Develop Logging Requirements**
   a. Logging requirements should involve making sure the visitor is receiving some education at the site. The logging requirements at this site involve submitting a picture and answering three questions related to the site: "To LOG this site, please submit a picture in front of one of the features and submit answers to the following questions:

      i. About how far apart are the Brontosaurs' (Apatosaurus) footprints (on average)?

      ii. How old is the white ash layer, according to the explanatory text in front of it?

      iii. Are the dinosaur bones at stop 2 older or younger than answer 2? (Think about the layers and their position relative to each other)."

7. **Submit EarthCache™ site for Approval**
   a. The Dinosaur Ridge EarthCache™ site was submitted in accordance with the EarthCache™ site guidelines (www.earthcache.org). The process was easily completed by following the steps set forth in the introduction section of this text and at www.earthcache.org. Approval of the EarthCache™ site was received and the site immediately went 'live' and was used in the classroom.

8. **Assessment/Evaluation**

   Students completed activities on mapping using latitude and longitude. They visited the www.earthcache.org site to see the Dinosaur Ridge EarthCache™ site they would be visiting.

   a. Mapping the Trek (Thinking Spatially)

      i. In class, conduct a few classes on freehand mapping.

      ii. Review and require map elements:

         1. Title
         2. Orientation
         3. Date
         4. Author
         5. Legend
         6. Scale
         7. Index

      iii. As practice, students will create a detailed map of a (small) area familiar to them using all the elements listed above.

      iv. Before navigating to Dinosaur Ridge, give each student a piece of blank grid-paper (2x2 cm squares).

      v. As students begin navigating their way to the site, instruct them to draw a detailed map of the route using GPS waypoints and personal observation. They must use all map elements listed above. Also, using the elevation feature on their GPSr to create

contour lines, if possible.

vi. To assess, compare students' maps to a published 1:24,000 scale map of the area to see how accurate their rendering is. If map is not available, reference ⊕www.terraserver-usa.com and enter coordinates provided in decimal minutes. TerraServer will provide aerial and topographic maps at this site. Also, check for detail with students' use of map symbols.

b. Create a Side-Profile Map of Dinosaur Ridge

i. Locate a 1:24,000 scale topographic map of the Dinosaur Ride area.

ii. Create a line graph only with the "Y" values filled in. The values for "Y" coincide with the elevation values on the topographic map from lowest to highest.

iii. Place the line graph below the map, trace light vertical lines from the elevation contour to its corresponding value line on the map and then draw a dot at that point on your graph.

iv. After you have "connected" the contours to the values, you will have a series of dots that you can then connect, which will in turn give you a side-profile drawing of Dinosaur Ridge.

v. For detailed instructions on creating side profile maps, go to the excellent site ⊕www.interactive2.usgs.gov/learningweb/teachers/volcanoes_download.htm, and see lesson 2 on volcanoes. This is a great visual instruction for drawing side-profile map. Another good site is: ⊕www.geology.isu.edu/geostac/Field_Exercise/topomaps/topo_profiles.htm.

vi. After the map is drawn, direct students to place markers on their maps, indicating where (1) the major rock layers are located and (2) where the major features are located; for example, where the dinosaur bones, Brontosaurus Bulges, the ash layer, the large concretion, the ripple marks, and the large collection of dinosaur footprints tracks are located. Have them label or key the symbols on their maps. An excellent resource for this activity is a stratigraphic column of the area showing the relationship between the various rock layers.

c. Compare Ages of Features – Wrap Up and Understanding

i. After the first two activities are completed, have students compare the relative ages of the features seen at the site.

ii. Have them write a short history of the area concerning only the features mentioned (i.e. dinosaurs died and bones quickly covered to form fossils; then much later an Apatosaurus walked on wet sand, leaving large depressions in the sediment that were preserved, etc…).

Student EarthCache™ Site Development

Now that you have practiced EarthCaching yourself, you might want to design lessons that engage students in creating their own EarthCache™ sites. In this type of project, learners or teams of learners develop EarthCache™ sites either as stand-alone caches or as part of a larger class-themed project. The primary audience for these caches would be the students themselves or members of the local community. However, projects that meet the criteria for an official EarthCache™ site could still be submitted for publication at www.earthcache.org. The template provided in Appendix A may be used by students to guide development of their own EarthCache™ sites for the classroom, or to prepare them for possible submission to the EarthCache™ Web site. Students will need access to research materials about the location in order to write up their educational notes. This may involve visits to local libraries or Internet access. Local geology field trip guides from a nearby university, college, or geology museum may also be useful.

How to Use Student EarthCaching in Your Classroom

Creating EarthCache™ Site Themes

Student-developed EarthCache™ sites could take many forms and meet many instructional objectives. Listed below are three major types of student-developed EarthCache™ sites that you might be interested in having your students try.

Content EarthCache™ Sites

This type of EarthCache™ site relates directly to topics that learners may be exploring in formal class instruction. Students demonstrate understanding of the content by developing local EarthCache™ sites related to this material. This is the most immediate way that students can connect their classroom to their world. Concepts introduced in an Earth science or physical geography class can be explored in the students' immediate surroundings.

For example:

1. Learners investigating geologic time or stratigraphy may develop a project similar to Red Rocks EarthCache™ Site (www.geocaching.com/seek/cache_details.aspx?wp=gcmqgg).

2. Students studying coastal features might develop EarthCache™ sites related local bays, estuaries, and Earth processes occurring there.

3. In many northern regions, students can easily find and cache evidence of glaciers.

4. In urban settings, students can search for geologic aspects of building stone.

Connected EarthCache™ Sites

In this type of EarthCache™ site, learners or teams of learners develop caches that are linked spatially and/or thematically. For example, learners might develop EarthCaches™ at various locations along a river course to observe seasonal changes of a shoreline.

Connected EarthCache™ sites consist of a series of locations that illustrate a particular Earth system concept or changes in a concept throughout a specified spatial area. If your community has nature trails, a stream, or even just a road running through it, a series of connected caches are a possibility.

To begin creating connected EarthCache™ sites you must identify what concept occurs in more than one location in your area. An example could be soils. If your area contains several different types of soil exposed in accessible areas, you could link them together into a series of caches, giving a broader understanding of soils in your area.

Your next step would be to write up the EarthCache™ sites so that each is significant on its own, but also becomes an integral part of the broader concept you are investigating. As in the soils example, learners could describe the chemical components of the soil at a particular site. By exploring other students' caches, learners could discover how soils differ and compare how they were created. This would provide a better understanding of the soils of your area. Similar strategies can be applied to investigations of water and water systems, historic areas, or economic conditions.

Community EarthCache™ Sites

In developing Community EarthCache™ sites, learners investigate an issue of concern to the local community, publicize some element of the issue through the EarthCache™ site, and propose a potential solution to the problem. These types of caches could be either stand-alone or connected caches.

For example:

1. Students might investigate the issue of combined vs. separated storm water/sewer systems. Teams of learners might create an EarthCache™ site at the location of a combined sewer overflow, those places where raw sewage occasionally enters the local water system, and describe the Earth system affected at the location.

2. Alternatively, students might create an EarthCache™ site at the location of a local or regional landfill. Such a cache might describe the geologic formations or soils at these locations and describe the processes that created or deposited them.

Publishing

Whether or not a student-developed EarthCache™ site meets all the publishing requirements of an "official" EarthCaches™, it remains critical that students present and publish their work in some way. The work the student completes constitutes a potentially valuable teaching tool for you as the instructor as well as a learning tool for other teachers and students. Individual instructors will define how the local EarthCache™ sites will be published. These may include strategies as simple as student posters and handouts or as interactive as PowerPoint presentations or local Web sites. Listed below is a broad range of alternative publication strategies.

Intranet

Many schools have a school- or district-wide intranet for use by teachers and students. An area can be set up on the intranet to display the student-generated EarthCache™ sites. Such a site could be as simple or elaborate as time, skill, and interest allows. If the school or district has a technician with interest or students with an aptitude in managing online sites, additional functionality can be offered such as keyword searches on the content of the local EarthCache™ sites developed by students. Teachers should consider, however, whether there are an abundant number of possible EarthCache™ sites within reach of the school. This may affect publishing if the teacher wants to use the sites for subsequent yearly classes.

Teacher Web Site

The same technique used in intranet posting can be used to post local EarthCache™ sites to your own teacher Web site that students and/or community members might access. Set up a page where students can scroll through the various local EarthCaches™ and learn about their community through the eyes of their peers.

PowerPoint

An interactive PowerPoint presentation is a powerful tool to present local EarthCache™ sites developed by students. Students can design a series of PowerPoint slides that include the different sections of the local EarthCaches™. There can be links on the slides that include video, jpg images, and even sound clips that enhance the description of the area of the EarthCache™ location. If other students will be able to view the PowerPoint independently, text can be added

to inform readers about it. If the PowerPoint is going to be presented, the text portions will need to be very short bullet points, and the local EarthCache™ student developer will need to "teach" their peers the parts that are not graphic or auditory. If students choose this method, do remind them that audiences do not like to read PowerPoint slides; they prefer the presenter tell them about the materials.

EarthCache.org Database

Students who meet the official EarthCache™ logging requirements can be encouraged to submit their projects for review and posting as part of the international EarthCache™ database. Such posting would unquestionably meet the criteria for authentic assessment. Be certain that students have read and understand the official submission requirements. Approximately 60% of first submissions are rejected due to failure to comply with one or more of the official requirements.

It should also be noted that only one EarthCache™ site is allowed at each particular location. Learners interested in posting on the international Web site should confirm before beginning work that no EarthCache™ currently exists for the proposed cache site. Likewise, if multiple teams of investigators intend to create EarthCaches™ for the same location, you might encourage them to work cooperatively to develop a single EarthCache™ site.

Finally, you should also be aware of the need to supervise the listings that are accepted for publication on the EarthCache™ site. Supervision consists of approving logging requests from individuals who have visited the cache and responding to inquiries from visitors. Students may be expected to supervise their own EarthCache™ listings or you may consider taking on this responsibility yourself. If a site is not properly supervised, the Web site management reserves the right to archive the listing until such supervision is in place. Please note that there is a "firewall" between the EarthCache™ supervisor and other individuals accessing the Web site. In other words, other users are not able to contact the EarthCache™ supervisor directly through personal email. Make it clear, however, that no personal information should ever be included in an EarthCache™ site since it is accessible by the outside world.

Authentic Assessment Strategies

Student involvement with EarthCaching projects may be evaluated in a number of ways. These may include traditional, knowledge-based assessments based on the content material addressed in the assignment. Projects are also candidates for constructed response and essay-based assessments. As collaborative, project-based learning experiences, EarthCache™ sites also lend themselves to rubric-based evaluation and authentic assessment.

The latter consists, in its essence, of asking learners to demonstrate the knowledge or skill defined as the expected learning outcome. Most often, this learning is assessed using a rubric that specifies what the learner is to be able to do or know by the end of the activity. Authentic assessment also frequently demands the development or creation of a product of some sort. Many elements within a student-developed EarthCache™ site project lend themselves to authentic assessment strategies.

General Assessment

The most elemental form of authentic assessment involves evaluating whether or not the project meets the standards of a publishable EarthCache™ site. After completing a project, learners

may simply analyze the project using the provided checklist to confirm that all the elements of a publishable project are present, and then submit the project for consideration. If the project is accepted, it is successful. If the project is rejected, it will need to be revised and improved until it meets all requirements for publication.

Content Specific Assessment

Student-developed EarthCache™ sites may also be evaluated based on attainment of local standards and content objectives. Such evaluations would require locally developed rubrics defining the desired outcomes and the tasks that would be considered evidence of their attainment.

Peer Assessment

Learners might also be encouraged to assess and evaluate each other's performance. This evaluation could take place both within and between groups.

Intra- and Intergroup Assessment

Intragroup assessment might consist of providing team members an opportunity to constructively evaluate the performance of other members of the team. This could be done formatively, during the project, as a means of improving cooperation and collaboration skills while producing a superior product. It might also be done summatively, at the conclusion of the project as a means of evaluating the effectiveness of each team member's level of contribution. An example of a peer assessment rubric is provided in Appendix C of this document.

Intergroup assessment might also consist of teams of learners attempting to carry out other teams' EarthCache™ sites. Evaluation could address both mechanical and content questions. Are the directions adequate? Is it possible to complete the investigation successfully? Is the learning outcome appropriate to the content under consideration? Is the learning meaningful and engaging? Again, this type of evaluation would benefit from the use of locally developed rubrics.

The following link will take the user to an online 'toolbox', The Authentic Assessment Toolbox, that offers assistance and support to teachers wishing to explore strategies and develop rubrics and other tools designed to assist with the evaluation of EarthCaching projects: www.jonathan.mueller.faculty.noctrl.edu/toolbox/.

EarthCache™ Masters Program

Students who really enjoy EarthCaching and continue to pursue the activity on their own can also be made aware of the EarthCache™ Masters Program. This GSA program gives them an opportunity to earn a physical reward for visiting EarthCache™ sites — an EarthCache™ pin. There are four EarthCache™ Master Levels and four pins to earn. Details of the program can be found in Appendix F.

Checklists for Student-Developed EarthCache™ Site Projects

Field Checklist

❐ GPS receiver (at least one)

❐ Extra batteries

❐ Topographic map

❐ Notepad or clipboard with paper

❐ Pencils

❐ What you need to be comfortable in the field

    o Appropriate clothing

    o Hat

    o Water

    o Sturdy shoes

    o Sunscreen

    o Bug repellent

    o Watch (coordinate time to meet if necessary)

    o Plastic bags to cache in, trash out

Assignment Checklist

❐ Copy of assignment criteria

❐ EarthCache™ site form

❐ Background information needed for understanding the site

EarthCaching
When You Can't Leave Campus

Even if you cannot leave your campus, elements of EarthCaching will:

- transform the way you teach maps and map reading. Students will have a reason to learn about coordinate systems, latitude and longitude, and navigating to locations on the surface of Earth,
- provide an efficient way for your students to visit sites of interest on your campus,
- allow you to make online visits to locations of interest beyond your campus, and
- allow you and your students to collect geospatial data to drive class discussions and lessons.

Aspects of EarthCaching in the classroom can be used with varying levels of access to technology, from a single computer and printer to complete computer labs and anywhere from none to a full class set of GPS receivers. Lessons can be as brief as part of a class period, or extend across an entire unit of study.

EarthCaching with a GPS Receiver on Campus

Develop a Campus EarthCache™ Site

A campus EarthCache™ site that you develop can be used as a way for your students (and perhaps their families!) to experience an EarthCache™ without needing a field trip. Follow the directions for developing an EarthCache™ site in Teacher EarthCache™ Site Development (Chapter 2), but do not submit it. Use the EarthCache™ site only for your classes. Simply use the template in Appendix A or the lesson plan EarthCaching the Campus in Appendix D.

Use the Introduction of this document to familiarize yourself with geocaching and EarthCaching. Browse several EarthCache™ sites, searching by location or classification. As you read, think about how you might incorporate actual EarthCaches™ or aspects of EarthCaching into your lessons.

1. Familiarize yourself with the operation of your particular GPS receiver. In particular, learn how to input waypoints, and how to navigate from a place to a waypoint.

2. Search your local area for existing EarthCache™ sites (go to www.earthcache.org) and visit them if you can. It will give you practice in using your GPS unit, give you an idea of the time required to find a cache, and you'll see how the creator of the EarthCache™ used the site to develop a logging question or activity related to the site. You can also see if there is a lesson plan for students already developed for the site.
   a. If there is no EarthCache™ site nearby, widen your search to include all geocaches in your area, and if you find one, visit it!

   b. If there is no EarthCache™ site or geocache near you, that's OK. If you have an idea for one that you could submit (see Teacher EarthCache™ site Development, Chapter 2), do it! Your students will be interested in seeing a local site featured online, and it will pique their interest in the technology and process of finding and learning from EarthCache™ sites. Remember, GSA cannot accept an EarthCache™ site on your school campus if it is a closed campus.

3. Look at the lesson developed by a teacher in New York State (EarthCaching the Campus) in Appendix D and at the list of other ideas for local EarthCaching in Chapter 2. Then begin to create your own lessons or activities scaled to your needs and constraints.

Creating a Cache Tour on Campus

Provide students with classroom instruction in GPSr use. The tour can simply be an exercise in GPSr use:

1. Provide students with blank EarthCache™ submission forms (Appendix A).

2. Send students into the "field" (your campus), having groups or individuals collect one or more caches each. These practice caches may be something as simple as lampposts, positions on playing fields, particular parking spaces, fence lines, signage, etc. Make students aware that a practice cache is not an EarthCache™ since there will not be educational information about something related to the Earth.

The tour can be a genuine EarthCaching exercise:

1. Provide students with the blank EarthCache™ site submission form template (Appendix A).

2. Send students into the "field" (your campus), having groups or individuals collect one or

more EarthCache™ sites each. Caches should be an actual location involving Earth science education, whether a stream, soil, erosional feature, rock outcrop, etc. Some suggestions for features in an EarthCache™ site that will not be submitted to GSA:

    a. Geologic features (stream and stream features, rock outcrops, evidence of glaciation, mass wasting, etc.).

    b. Geographic/landscape features (hills and valleys, faults, streams, soils, roads and buildings, swamps, meadows, fields, forest, land use, etc.).

3. Using the lesson plan EarthCaching the Campus as a template, create a campus EarthCaching lesson. Simply overwrite the existing text with your information where appropriate. Better yet, have your students create lessons for each other!

Develop an EarthCaching Orienteering Tour

The geocaching exercise in Appendix B ("Geocaching") was featured in the regional Science Olympiad competition in SE New York in February of 2005, and is provided solely as an example. While that competition included physical geocaches, the concept can be modified to include virtual EarthCache™ sites, rather than physical geocaches.

This type of lesson serves the dual purpose of preparing your team for the Science Olympiad if your school participates.

Develop a Real EarthCache™ Site

If your campus has actual features that could be used to create acceptable EarthCache™ sites, provide students with the EarthCache™ template and follow the instructions in Chapter 3 (Student EarthCache™ site Development). If your campus is closed, however, it cannot be accepted for publication on the EarthCache™ Web site. You also may not want to submit the EarthCache™ so that you can have classes in subsequent semesters develop it themselves.

Using EarthCaching Without a GPS Receiver

Using Existing EarthCache™ Sites

If only the teacher has access to a computer, EarthCache™ sites can be used as printouts. After the teacher selects the objectives for the lesson, EarthCaches™ that fit the objectives can be selected and printed out. Students can work individually or in groups to map and study the sites. See the following lesson, Sample Lesson 1 – Erosion.

If the teacher has access to a computer projector, the class can visit the sites online. If only a traditional overhead projector is available, the sites can be printed on a transparency and viewed using the overhead.

If the students have computer access, sites can be assigned based on the lesson objectives. Students can visit the site online and do further research.

Mapping Activities to Meet State and National Standards

Students can research online at www.earthcache.org or from printouts provided by the

teacher to find the latitude and longitude of various formations and locate these on maps provided by the teacher. This can lead to discussions about why the features are in particular locations. It could also prompt discussions about the reliability of data – are these locations accurate (yes), are these all the locations where this feature would be found (no), and the reason why (not all places like this have an EarthCache).

Have students mark the location of EarthCache™ sites on a world map mounted on the wall to help them learn to use latitude and longitude. They could locate the latitude and longitude of the caches online or from teacher-provided handouts.

Use EarthCache™ Sites to Study Features of Earth

EarthCache™ sites contain a wealth of information about geographical and physical features of the landscape. Existing EarthCaches™ can be sorted by classification, to find locations that contain specific features, such as glacial formations or caves. See Sample Lesson 2 - Glaciers.

Students Create EarthCache™ Sites of Places around the World

This type of lesson would be for classroom use only, enabling students to research various places and physical phenomena around the world.

1. To study change over time, students could research glacial coverage of North America, and create connected EarthCache™ sites for the leading edge of a glacier at various time periods.

2. Students could research and create caches documenting the changes in the course of a river.

3. EarthCaches™ could be created to study historical events, such as the Industrial Revolution. See Sample Lesson 3 – Industrial Revolution

4. Students could create EarthCaches™ to learn about physical features such as wetlands, fossil beds, or mountains.
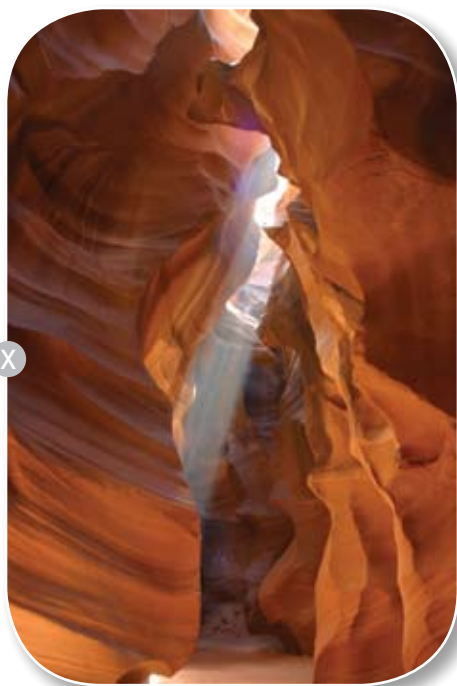
EarthCaching without Leaving the Classroom Sample Lesson 1 - Erosion

Objective: The student is able to describe the ways in which Earth's processes are dynamic and interactive. (National Geography Standard 7.D)

Essential Questions: What causes erosion? How does erosion change the face of Earth?

Time: 1-2 class periods

Materials:

1. Printouts of EarthCache™ Web pages from www.earthcache.org, including several that represent physical weathering (Pompey's Pillar, Garden of the Gods, Castles in the Air, Tyssoy #4, Doane Rock, Hickory Run Boulder Field, and Marsden Rock), and several that depict chemical weathering (Ensor Sink, That Old Sinking Feeling, Lost River, and Desert Varnish). Be sure to print pictures of each EarthCache™ site along with the text. EarthCache™ sites can be found by searching through the titles alphabetically.

2. World maps with global grid, one for each student

3. Colored pencils, paper, textbooks, dictionaries

Procedure: Students will work as partners, then in small groups to complete the lesson. Evaluations will be done individually.

1. Think/Pair/Share: Have students individually write down what they know about erosion, and then discuss this with a partner. Each pair should create a list of 3-5 things they believe cause erosion. Have the pairs share their list with the class, writing the causes on the board.

2. Help the students divide the types of erosion mentioned into groups based on chemical or physical weathering. Tell them they will be using EarthCache™ sites to explore how erosion changes the surface of Earth and its causes.

3. Divide the class into groups and pass out a map to each student and four EarthCache™ site handouts to each group, being sure to include at least two of each type (physical and chemical). Instruct the students to mark the location of each of their EarthCaches™ on their map, using the latitude and longitude of the cache. Then they are to complete the questions below for each EarthCache™ site.

Evaluation: Each student will pick one example of physical weathering and one of chemical weathering. For each type, the student will create a picture timeline of before, during and after the weathering to show how the process has changed the Earth. Have the students continue to the timeline into the future to predict what might happen. Students share their timelines with the class.

Questions: Answer these questions for **each** EarthCache™ site.

1. What is the name of the EarthCache™ site?
2. Where is the EarthCache™ located? (continent, country, name of nearest city)
3. Is this cache in a national park or other state-protected area?
4. What words used in this EarthCache™ listing did you have to look up in the dictionary? What do they mean (in your own words)?
5. Briefly explain the erosion process at this cache and how it has changed the landscape.
6. Is the process physical or chemical? Explain.

EarthCaching without Leaving the Classroom Sample Lesson 2 - Glaciers

Objective: To increase student awareness of where glacial activity has occurred in the past and where glaciers are located today.

Essential Questions: Where were glaciers located during the last Ice Age? Where are glaciers located now? How are these locations different?

Time: 1 period

Materials:

1. Computers for students
2. Access to Internet
3. Printed (paper) map of North America for each student with global grid

Procedure:

The students must log on to the Internet and go to www.earthcache.org. They should click on the 'view EarthCache™ listings' button. Next, the EarthCaches™ must be sorted based on classification by clicking on that heading. Have students go through the pages until they come to the glacial features EarthCache™ sites. They should select several from the U.S. and Canada to investigate, and should mark and annotate all these locations on their maps.

The annotations should indicate what sort of features are at the site, and the time period when the features were created.

Have students observe where glaciers exist today using a program like GoogleEarth (to download visit www.earth.google.com/) or National Geographic MapMachine (www.plasma. nationalgeographic.com/mapmachine/index.html and click on satellite). Visit mountain areas and Polar Regions where glaciers or ice caps are clearly delineated.

Evaluation: Annotated maps should be marked correctly, with glacial features in the proper places.

Additional:

Have students come up with a hypothesis regarding glaciers and use EarthCache™ sites around the world to test their hypotheses. Some guiding questions:

1. Do glaciers affect the culture of people living near them?

2. Compare several highly glaciated areas (like the Midwest or northern Europe) to see if there are any similarities in commerce, agriculture, etc.

EarthCaching without Leaving the Classroom
Sample Lesson 3 - Industrial Revolution

Objective: The student should understand the causes and consequences of the agricultural and industrial revolutions, 1700-1850.

Essential Questions: How did the local deposits of coal affect the development of industry in England?

Time: 2 to 3 periods

Materials:

1. Computers for students
2. Access to the Internet
3. GoogleEarth to locate coordinates (to download visit www.earth.google.com/)

Procedure:

Students will research the coalfields around Manchester to learn about the beginnings of the Industrial Revolution. They will use GoogleEarth to locate the coordinates for a mine in Lancashire, England. The links and essay below might also be useful in research.

Evaluation: Students will create a virtual EarthCache™ site for a coalmine.

GoogleEarth: 53˚ 38' 39.05"N, 1˚ 37' 08.36" W

The following excerpt is from The National Coal Mining Museum at: www.msim.org.uk/uploadedDocs/Document_Depository_01/The%20Manchester%20Coalfields.doc

The Manchester Coalfields

The Museum holds the Lancashire Coal Mining Collection, which was previously held at the Lancashire Museum of Mining, Buile Hill Park, Salford. Much of the collection relates to the Manchester Coalfields.

In 1761, the Duke of Bridgewater opened the Bridgewater Canal to move coal from his mines at Worsley to the centre of Manchester. The Bridgewater Canal not only sparked the development of Manchester as the word's first industrial city, it also encouraged the exploitation of coalfields to the west of Manchester. Coal was crucial to the growth of the cotton industry in Manchester as it fuelled the steam engines that drove textile machinery. Many shafts were sunk and the coal was transferred to the canal by tramway. Very large amounts of coal were extracted and deeper pits soon became necessary. The coalfields were extensively modernized between the 1890s and 1914. Many of the existing pits were deepened and new pits were constructed to very great depths. Some of the deepest pits remained in use until the 1960s.

The economic depression of the 1920s hit the Manchester coalfields very hard. Many pits had already worked out their best coal and others were approaching the end of their reserves. The result was mass pit closures. By 1930, output from the Manchester coalfields was 15 million tonnes while parts of the West Manchester coalfields had stopped production completely.

Manchester Coalfields Ltd was formed in 1929 to stem the decline of the coalfields. The new company was an amalgamation of the best of the existing mines and only a few mines survived outside of Manchester Coalfields Ltd. The enterprise was run by a young and enthusiastic general manager, Humphrey Browne. He worked hard not only to stop the decline in the Manchester coalfields but also to instigate improvements. At first, some collieries were closed but planned closures always took account of social effects. The company pursued a policy of mechanisation. In the first 16 years of the company's existence the percentage of mechanically cut coal had increased from 17% to 98% with an annual output of 4 million tonnes. Mechanisation also affected the handling of coal and the use of ponies underground ceased in 1932. Workers at Manchester Coalfields Ltd pits were on average 1s 6d (7.5p) per shift better off than their colleagues at other pits.

Mining was a dangerous business. However, Manchester Coalfields was very generous in its provision of welfare facilities, such as pithead baths and canteens. It also had a very robust safety culture and saw training as a major priority. Mining was not just a brute force job; a great deal of intelligence was needed to do the job efficiently and safely. Some boy entrants had the opportunity to attend part-time education for up to four years at a local technical college and gain Mine Manager's certificates. After 1942, provision was made to send boys to university.

Production from the Lancashire coalfields as a whole had decreased to 12,500,000 tonnes by 1950 as the coal ran out. In the Manchester Coalfield Ltd pits production was down to 3,500,000 tonnes and it was recognised that the future of some of the collieries was in doubt. After nationalisation the National Coal Board progressively closed many of the older pits from 1958 onwards. The following decade saw the almost complete abandonment of the Manchester coalfields.

For more information, read:

Challinor, R. The Lancashire and Cheshire Miners. Newcastle-upon-Tyne, UK: Frank Graham, 1972.

Hayes, Geoffrey. Coal Mining. Princes Risborough, UK: Shire Publications Ltd, 2000.

Hayes, Geoffrey. Collieries in the Manchester Coalfields. Eindhoven, NL; De Archeologische Pers, 1993.

Malet, Hugh. Bridgewater: the Canal Duke, 1736-1803. Manchester, UK: Manchester University Press

Other sites:

www.ashton-under-lyne.com/coal.htm

www.ncm.org.uk/index.asp

Template – EarthCache™ Site Submittal Form

The following template is based on the form used on the EarthCache™ Web site www.earthcache.org while adding additional content-related fields. By completing the template, EarthCachers will have gathered sufficient information to submit the EarthCache™ site for consideration on the international EarthCaching site, assuming it meets all criteria (see Official Guidelines following the form).

EarthCache™ Submission Form

Use this form in the field to prepare for an official EarthCache™ submission.

Review the Earth Caching Guidelines at www.earthcache.org (and appended to this document), and record your EarthCache™ site on the form below:

Your Name:..

Date of Visit:..

Date of Formal
Submission:..

What is the NAME of your EarthCache™ site?

What are the COORDINATES of your EarthCache?

Use Map Datum WGS 84, and DD M.MMM format. Make sure you include compass directions: N (+) or S (-) for latitude, E (+) or W (-) for longitude.

Latitude

:

| Direction (N,S, +, -) | Degrees | Minutes |

Longitude

| Direction (N,S, +, -) | Degrees | Minutes |

Essential question:

What, specifically, do you want to learn, know, or teach others about this site?

Content connection:

How is this project connected to the curriculum? List specific national and state standards you expect this project to address.

Short Description: A sentence describing your EarthCache.

Data collected:

Data sources:

(Additional) Questions raised:

Long Description: A detailed description for your EarthCache™ site.

_____

_____

_____

_____

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_____

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_____

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_____

_____

Educational task or question required of visitors.

Difficulty:

1 (easy) to 5 (hard)

1	1.5	2	2.5	3	3.5	4	4.5	5

Terrain:

1 (easy) to 5 (hard)

1	1.5	2	2.5	3	3.5	4	4.5	5

Name and Type of land:

Name: _____

National Park	**National Monument**
Local Park	**State Park**
National Forest	**Other**
Private	

Land Manager Name and Contact Information

Official Guidelines for EarthCache™ Site Submittal

The official guidelines for submittal are subject to change and revision. Please always check the official guidelines on the www.earthcache.org Web site before proceeding with the submittal form. The following guidelines were current as of March 7, 2007.

1. EarthCache™ sites must provide Earth science lessons. They take people to sites that can help explain the formation of landscapes or to sites of interesting phenomena such as folds, faults, intrusions or reveal how scientists understand our Earth (such as fossil sites, etc.) .

2. EarthCache™ sites must be educational. They provide accurate but simple explanations of what visitors will experience at the site. Cache notes must be submitted and assume no previous knowledge of Earth science. The educational notes must be written to a reading age of an upper middle school (14-year-old) student. Additional technical or scientific notes can be provided for the scientific community. Please note appropriate place on the submittal form for the technical notes. All notes can be submitted in the local language, but must also be in English.

3. EarthCache™ sites can be a single site, or a multiple virtual cache. No items, box, or physical cache can be left at the site.

4. EarthCache™ sites follow all the geocaching principles and adhere to the principles of Leave No Trace outdoor ethics www.lnt.org. Use waypoints to ensure cachers take appropriate pathways. Use established trails only. Do not create new trails to a site in order to concentrate use impacts. EarthCache™ sites will highlight the principle of collect photos — not samples. However, if there is no possible damage to a site which is outside of the public land system and approved by the site owner, small samples may be collected as part of the cache experience.

5. Logging of EarthCache™ sites must involve visitors undertaking some educational task. This could involve them measuring or estimating the size of some feature or aspect of the site, collecting and recording some data (such as time of a tidal bore), or searching and sending via email to the developer, some fact that they find from signage. Developers should try to involve visitors in learning from the site...rather than just logging a visit. Logs should show that the visitors have learned something by visiting your EarthCache™ site.

6. EarthCache™ sites developed on private and public land must have prior approval of the landowners before submission. EarthCache™ sites developed in association with National Parks, National Forests, or other public lands are encouraged. These must have verbal or written approval with the appropriate land-managing agency. The name and contact details of the person from who you received approval MUST be given.

7. All EarthCache™ sites will be approved by The Geological Society of America (to ensure appropriateness of the site and educational standard of the notes).

8. The Geological Society of America retains the right to edit, modify, delete or archive any EarthCache™ site that does not adhere to these guidelines, or for any other purpose, including for the promotion of sponsors for the EarthCache™ program.

For more information, please contact us at EarthCache@geosociety.org

Damage to the site, especially on public or private land, is unacceptable. Please be mindful of fragile ecosystems.

GPS and Geocaching Lesson Plans

The following lesson plans can be modified for use by teachers in their own location. Simply edit the latitude and longitude information to fit the area you are working in. The instructor will need to do a field reconnaissance of the area to be used in these GPSr activities, saving and recording the latitude and longitude of each waypoint to be used.

Please remember that additional lesson plans will be posted by teachers like yourself on the www.earthcache.org Web site. Please check the site to find more and to share your own lessons.

GPS navigation team members:

Getting To Know Your GPS

The GPS unit is a wonderful tool for saving a location where something of geological or geographical importance exists. You will practice saving waypoints in this exercise. Use the coordinates given below to find your way to spots that have been located in this area. Give a short description of the locations, save a waypoint at each spot, and continue through the list. When finished, meet at the spot designated by the teacher.

Make sure that the GPS unit is on. Once the satellites have been found and you are ready to navigate, use the page button to the compass or navigation page. Move around the area until the coordinates in the bottom of the GPS units match those on your worksheet. If the "location" window does not show on the bottom of the compass page, use the toggle down buttons on the left side to switch between windows.

Waypoint #	Describe this location	Latitude	Longitude
		<Enter points to search for >	<Enter points to search for >

Once you have reached each destination, save your waypoint by clicking and holding the "enter" button just below the toggle buttons until this screen appears.

Then click the enter button one more time to save it. Describe all the locations and return to this building by filling out the above table.

Make sure you are collecting coordinate information in decimal degree format.

Geocaching

SCIENCE OLYMPIAD

Steve Kluge - Event Coordinator

In this competition, you will visit 5 geocaches
placed around the campus. At each cache, you will find a plastic container ("A" containers are round, "B" containers are square) with the cache's name and a symbol drawn on the plastic container.

When you locate a cache, **BEFORE YOU TOUCH IT** note very carefully the placement of the cache so you can return it to the **EXACT** location and position you found it in!

Record the symbol and the time of your arrival in the appropriate space below. One of the caches will contain a "Travel Mandrill" (a 'travel bug'). Do what 'geocachers' do with travel bugs, and record the entry/entries you would leave at the cache(s) and online in the appropriate space(s) below.

	Time	**Symbol**
UTM COORDS ZONE 18 Map Datum NAD 27 6 16 412 E 45 69 787 N	"Trashed" Time:	
	"1 Step at a Time" Time:	
Map Datum WGS 84: Lat. 41.27264344463262 Long. -73.61105770196874	"Shhh…" Time	
	"Bright Idea" Time:	
	"Busted" Time:	

Your search will be most efficient if you visit the caches in the order or reverse order they are listed below (i.e. start at the top and work down, or start at the bottom and work up!).

Finally, there are 5 questions relating to GPS and geocaching. Answer them as you travel from cache to cache, or you can answer them here when you return.

_____   _____   _____
Map Datum   **Latitude**   **Longitude**

Questions:

1. Using either NAD 27 or WSG84, report the given location of "Bright Idea" in Latitude and Longitude format DD MM.MMM. Make sure you indicate which map datum you are using.

2. What general compass direction would you have to travel to get from:

Zone 18 6 16 365 E 45 69 534 N to Zone 18 6 16 260 E 45 69 534 N

Answer: _____ (2)

3. What is the exact, straight line distance (include units!) between

UTM Zone 18 5 99 845 E 45 32 734 N and UTM Zone 18 5 98 768 E 45 32 734 N

Answer: _____ (2)

4. How does your handheld GPSr calculate/measure its distance from a particular GPS satellite? (0 - 5)

5. If measurements from 3 satellites can locate a single position on Earth, what is the purpose of the 4th satellite needed in order to ensure the accuracy of a position calculated by your handheld GPSr? (0 - 5)

6. When using differential GPS, what information does the "reference receiver" send to the "roving receiver"? (0-3)

Collaboration Assessment Score Sheet

Each group, meeting together, will evaluate the individual members of the team. The team should reach consensus on a fair and equitable evaluation for each individual member of the team. If impasse occurs, the instructor should be invited to mediate.

	Time	Member Name	Member Name	Member Name	Member Name
Contribute	Research & Gather Information				
	Share Information				
	Be Punctual				
Take Responsibility	Fufill Team Role's Duties				
	Participate in Science Conference				
	Share Equally				
Value Others' Viewpoints	Listen to Other Teammates				
	Cooperate with Teammates				
	Make Fair Decisions				
	Total				
	Average				
	Score				

Include a brief written statement below:

Collaboration Rubric[1]

		Beginning	Developing	Accom- plished	Exemplary	
		1	**2**	**3**	**4**	**Rank**
Contribute	Research & Gather Information	Does not collect any information that relates to the topic	Collects very little information - some relates to the topic	Collects some basic information- most relates to topic	Collects a great deal of information- all relates to the topic	
	Share Information	Does not perform any duties of assigned team role	Relays very little information- Some related to topic	Relays some basic information - most relates to the topic	Relays a great deal of information- all relates to topic	
	Be Punctual	Does not hand in any assignments	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team role	
Take Re- sponsibil- ity	Fufill Team Role's Duties	Does not preform any duties of assigned team role	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team role	
	Participate in Science Conference	Doesn't speak during the science conference	Usuially doing most of the talking- rarely allows other to speak	Listens, but somethimes talks too much	Listens and speaks a fair amount	
	Share Equally	Always relys on others to do the work	Rarely does the addigned work-often needs reminding	Usually does the assigned work-rarely needs reminging	Always does the assigned work without having to be reminded	
Value Oth- ers' View- points	Listen to Other Teammates	Is always talking-never allows anyone else to speak	Usually doing most of the talking-rarely allowing other so speak	Listens, but sometimes talks too much	Listens and speaks a fair amount	
	Cooperate with Teammates	Usually argues with teammates	Sometimes argues	Rarely argues	Never argues with teammates	
	Make Fair Decisions	Usually wants to have things their way	Often sides with friends instead of considering all views	Usually considers all views	Always helps team to reach a fair decision	
					Sum Total	

[1]Unknown. The Collaboration Rubric. www.edweb.sdsu.edu/triton/tidepoolunit/Rubrics/collrubric.html

X

X

X

Lesson Plan: EarthCaching the Campus

The following lesson plan can be used as a template for an EarthCache™ adventure around the school campus.

X

Lesson Plan: EarthCaching the Campus

The following lesson plan can be used as a template for an EarthCache™ adventure around the school campus.

Regents Earth Science
EarthCaching the Campus

Introduction:

The trail system around our campus and the adjacent nature preserve brings hikers to several interesting points of geologic interest. In this EarthCaching activity, you will self-guide yourself through a tour of several of these features represented at six stops along the way.

Materials:

- This packet
- A GPSr with healthy batteries (and extras)
- A clipboard and something to write on (field notes!) and with
- Food and water for 3 days (only kidding, you'll be back by the end of the lab period!)

Procedure:

1. Make sure you know how to use your GPSr. You must be able to:
   - Set up your unit.
     - Display latitude and longitude in dd m.mmm (degrees and minutes, with the minutes displayed to 3 decimal places).
     - Set the Map Datum*(see end of lesson). We will be using WGS-84 on this tour.
   - Enter and label waypoint (or landmark) coordinates.
   - Navigate to waypoints (or landmarks).

2. Navigate to each of the stops on the tour listed below and on the following pages.

3. At each stop
   - Read the introductory material.
   - Explore the site for a few minutes, recording any observations you make (field notes) and any questions your observations may raise.
   - Answer the questions associated with the stop.

Tour of Local Geologic Features

Starting point: Northeast corner of K-Wing (latitude +XX° 11.517' longitude -XX° 40.688')

1. Navigate to the bottom of "Cable Hill" road (latitude +XX° 11.517' longitude -XX° 40.688') and head south, up the hill. Proceed to Stop 1 (next page).

Stop 1 (latitude +XX° 11.415' longitude -XX° 40.682')_____
DATE and TIME of arrival at Stop 1

Examine the rock outcrop on the left (east) side of the road here. The rocks are metamorphic gneiss, and they have been smoothed by the flow of glacial ice over them. Notice the ridges and valleys on the surface exposures of the rock. Record any observations and questions as field notes below:

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Stop 1 Question(s)

Notice and describe the color of the minerals that form the ridges and the valleys of the grooves on the exposed rock surface.

What do you suppose is the cause of the ridges and valleys on the exposed rock surface?

Stop 2 (latitude +XX° 11.323' longitude -XX° 40.716682')_____
DATE and TIME of arrival at Stop

Notice the water seeping from the ground on the right (west) side of the road. This small natural spring flows, at least a little, even during times of water budget deficit in August. Record any observations and questions as field notes below:

....

Stop 2 Question(s)

What do you suppose is the source of the water that seeps from the ground here?

What force (s) do you suppose drives the flow of this water?

Stop 3 (latitude +XX° 11.146' longitude -XX° 40.680')_____
DATE and TIME of arrival at Stop 3

Our school leases this small area of land to the local TV company. Describe what you are observing and record any observations and questions as field notes below:

Stop 3 Question(s)

Why do you suppose this particular location is well-suited for the location of this facility?

Stop 4 (latitude +XX° 11.138' longitude -XX° 40.663')_____
DATE and TIME of arrival at Stop 4

This stop marks the top of a steep trail down into the valley to the east of Cable Hill. Record any observations and questions as field notes below:

Stop 4 Question(s)

Notice and describe the vegetation on the slope below. Note particularly the difference in the appearance of the small trees (< 10cm (4 inches) diameter) and the larger trees (>30 cm (1 foot) in diameter).

What might be the cause of the difference in the appearance of the small and large trees? (Hint: Look up "creep" in your textbook!)

Stop 5 (latitude +XX° 11.131' longitude -XX° 40.597')⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯
DATE and TIME of arrival at Stop 5

Depending on the time of year, this little depression may be filled with water and breeding frogs (when it is called a 'vernal pool'), or bone dry and dusty. Record the condition of the depression during your visit today, and any observations and questions as field notes below:

Stop 5 Question(s)

What do you suppose is the source of water when this pool is filled?

During the summer, even after a heavy rain, the depression remains dry. Try to explain why that is so.

Stop 6 (latitude +XX° 11.219' longitude -XX° 40.622')⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯
DATE and TIME of arrival at Stop 6

This narrow valley follows the trace of a large fracture in the bedrock of this area. In what compass direction does the valley run? Record your answer and any observations and questions as field notes below:

Stop 6 Question(s)

Choose a letter of the alphabet that best describes the cross sectional shape of this valley. Back in the classroom, use your text to research valleys with that shape, and determine and record the agent that produced this valley.

Note the elevation of this stop, and record it here.

Returning to the classroom

Navigate to latitude +XX° 11.264' longitude -XX° 40.671'. You will be walking at about 700 feet above sea level along the north side of a hill.

From there, continue on at the same elevation to latitude +XX° 11.268' longitude -XX° 40.738 where you will meet up with Cable Hill road once again.

Turn to the north (downhill) and head back to the building entrance at latitude +XX° 11.517' longitude -XX° 40.688".

A Word on Map Datums

A map datum is a model of the shape of the Earth's surface used to match surface features with a coordinate system on a map. At various times and in various places, cartographers have used slightly different models of the Earth's shape, and slightly different projections, to draw their maps.

For that reason, identical coordinates in two different map datums might identify slightly different places on Earth's surface – or a single place on Earth's surface may be identified with slightly different coordinates in different map datums.

While there are many map datums used throughout the world, the GPS system uses the World Geodetic System 1984 (WGS 84), which was developed from and is virtually identical to the North American Datum of 1983 (NAD 83). EarthCaches™ ™ are identified by coordinates in the WGS-84 system, and most GPSrs' default settings report their locations in WGS 84.

Many USGS topographic maps, however, use the North American Datum of 1927 (NAD 27), and location coordinates in NAD 27 can vary by almost 40 meters from the same location coordinates in WGS 84. So using a map in conjunction with your GPSr may require that you adjust the GPSr map datum to match your paper map's datum. It is important, too, to know which datum a set of coordinates refers to.

Fortunately, your GPSr is capable of converting the location of a landmark/waypoint/point of interest in one datum to any other map datum supported by the GPSr. The GPSr user should be able to quickly switch the GPSr's display from one datum to another.

The following section describes how to set your map datum on two popular models of GPSr, one from Garmin and the other from Magellan.

Changing the Map Datum on the Garmin etrex GPSr

1. In the Main menu, Scroll to and Select "Setup".

2. Scroll down and over and Select "Units".

3. Scroll to and Select "Map Datum"

4. Scroll to and Select the map datum you wish to use.

EarthCaches™ are posted in WGS84, but many USGS topographic maps use the NAD27 datum. The map datum used is printed on the lower left hand margin of USGS topo maps. Once a waypoint is set on your GPSr, switching map datums will display landmarks in the new datum.

Changing the Map Datum on the Magellan 210 GPSr

From any Navigation screen, press Menu

Scroll to and Select "Preferences"

Scroll to and Select "Map Units"

Scroll to and Select "Map Datum"

And finally, Scroll to and Select the map datum you wish to use.

Pressing the "Nav" button will bring you back to the Navigation screen you left.

EarthCaches™ are posted in WGS84, but many USGS topographic maps use the NAD27 datum. The map datum used is printed on the lower left hand margin of USGS topo maps. Once a landmark ("Point of Interest") is set on your GPSr, switching map datums will display landmarks in the new datum.
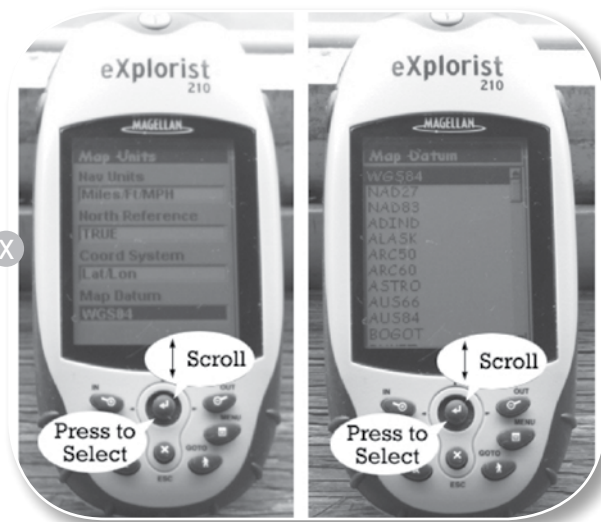
National and State Standards Mapping

Where does EarthCaching fit into school curriculum – both subject and level, and variations across states?

EarthCaching:

> (T) Technology — Use of GPS, maps, latitude and longitude, computer/web site use.

> (G) Geologic and Geographic — Places with geologic and environmental significance; how our planet has been shaped by geological processes, how we manage the resources, and how scientists and geographers gather evidence to learn about the Earth.

EarthCaching sites include — sedimentary, igneous, and metamorphic rock exposures and road cuts, fossil sites, volcanic features, canyons, overlooks, museums, mining sites, mineral sites, erosional features, caves/karst, coastal or river features, glaciers and glacial features, structural features (i.e. San Andres Fault, anticlines, synclines, etc.), aquifer springs, hot springs, historical sites, submerged forests and peat bogs, geomorphological features, impact crater sites, and even building stone tours if educational.

Geography Standard 1 – T

How to use maps and other geographical representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

> To support student understanding of maps and geography with the newest technology. To promote an understanding of longitude and latitude when using Geographic Positioning Systems. As such systems become increasingly common in the home, school, and workplace, people will learn to use them as comfortably and effectively as traditional printed materials.

> 5–8

> 1. How to make and use maps, globes, graphs, charts, models, and databases to analyze spatial distributions and patterns — know principal lines of longitude and latitude.

> 9–12

> 2. How to use technologies to represent and interpret Earth's physical and human systems — GPS, latitude, longitude.

Geography Standard 3 – T, G

How to analyze the spatial organizations of people, places, and environments on Earth's surface.

> 5–8 and 9–12

> 1. How to use the elements of space to describe spatial patterns…resources, terrain, climate, topography, soil, rocks.

Geography Standard 4 – G

The physical and human characteristics of places.

> 5–8

> 1. How different physical processes shape places.

> A. Use field observations, maps and other tools to identify and compare the physical

characteristics of places; hypothesize regarding locations of places shaped by natural hazards such as earthquakes, volcanoes, floods, etc.

9–12

2. The changing physical and human characteristics of a place.

A. Explain from a variety of points of views, as exemplified by being able to…explain why places have specific physical characteristics in different parts of the world (i.e. effects of tectonic or climatic processes).

B. Describe and interpret physical processes that shape places, as exemplified by being able to describe forces from within Earth influence the character of place; describe and analyze the importance of erosional processes in shaping places.

Geography Standard 7 – G

The physical processes that shape the patterns of Earth's surface.

5–8

1. How physical processes shape patterns in the physical environment.

3. How physical processes influence the formation and distribution of resources — fossils fuels, hydropower, and soils.

4. How to predict the consequences of physical processes on Earth's surface.

9–12

1. The dynamics of the four basic components of Earth's physical systems — the atmosphere, biosphere, lithosphere, and hydrosphere.

2. The interaction of Earth's physical systems.

3. The spatial variation in the consequences of physical processes across Earth's surface — plate tectonics effects, earthquakes, and volcanoes.

Geography Standard 14 – T & G

How human actions modify the physical environment.

5–8

1. The consequences of human modification of the physical environment — analyze the consequences (pollution, dams, levees, etc.).

9–12

1. The role of technology in the capacity of the physical environment to accommodate human modification ….old mines, levees, canals, dams, and beach modifications.

2. The significance of the global impacts of human modification of the physical environment such as…sediment runoff, soil degradation, and mining.

National Science Education Standards (NSES)

NSES Content Standard D: Earth and Space Science – G

5–8

Structure of the Earth's system — land forms, crustal deformation, rock cycle, soils, and water.

Earth's history — fossils, Earth's processes.

9–12

Geochemical cycles

The origin and evolution of the Earth system — geologic time.

NSES Content Standard E: Science and Technology – T

5–8

Understandings about science and technology — science and technology are reciprocal.

NSES Content Standard F: Science in Personal and Social Perspectives – T & G

5–8

Natural Hazards

Science and technology in society — technology influences society through its products and processes.

9–12

Natural resources — human populations use resources in the environment; the earth does not have infinite resources.

Natural and human–induced hazards

Science and technology in local, national, and global challenges

Technology Foundation Standards for Students

1. Basic operations and concepts:

- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students are proficient in the use of technology.

2. Technology research tools:

- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.

Standards for the English Language Arts

Sponsored by the International Reading Association and the National Council of Teachers of English:

1. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound–letter correspondence, sentence structure, context, graphics).

2. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

3. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

4. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Mathematics Standards: Number and Operations Standard

Grades 6–8 Expectations:

In grades 6–8 all students should develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation.

X
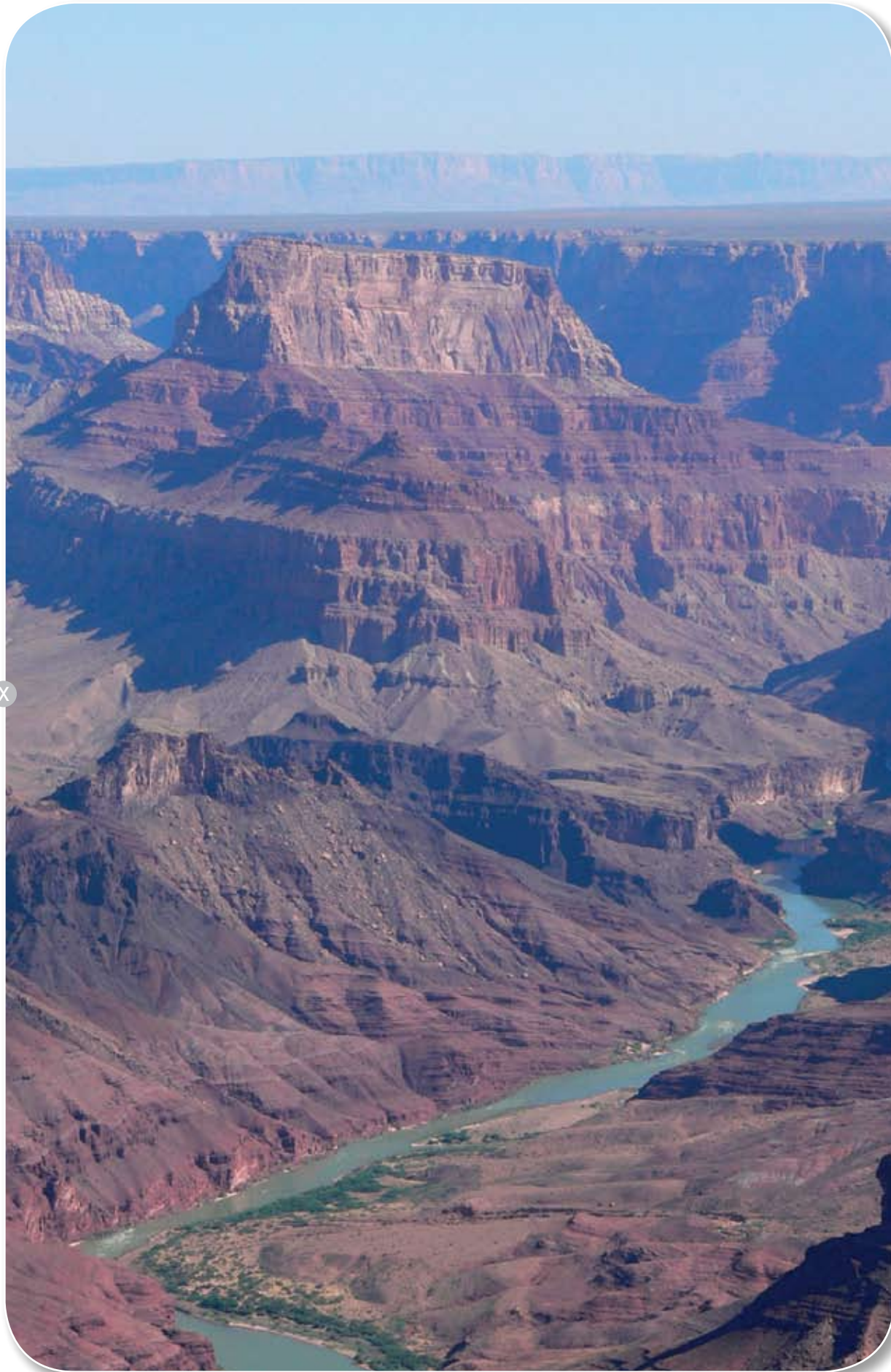
EarthCache™ Masters Program

The EarthCache™ Masters Program is your opportunity to get a physical reward for visiting EarthCaches™ and learning about Earth — a stylish EarthCache™ pin. You can wear these pins with pride. You will also receive matching bumper stickers for your car. There are four EarthCache™ Master levels:

Bronze EarthCache™ Master

Visit and log three (3) or more EarthCaches™ in two (2) or more states/countries.

Silver EarthCache™ Master

Visit and log six (6) or more EarthCache™ sites in three (3) or more states/countries and develop one (1) or more EarthCache™ sites.

Gold EarthCache™ Master

Visit and log twelve (12) or more EarthCache™ sites in four (4) or more states/countries and develop two (2) or more EarthCache™ sites.

Platinum EarthCache™ Master

Visit and log twenty (20) or more EarthCache™ sites in five (5) or more states/countries and develop three (3) or more EarthCache™ sites.

Please note that you cannot claim EarthCache™ sites that you have personally developed as a "logged EarthCache".

To receive your EarthCache™ Master pin, please complete the EarthCache™ Masters Application Form located at www.earthcache.org. Once checked and approved, GSA will send your pin to you by mail.

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