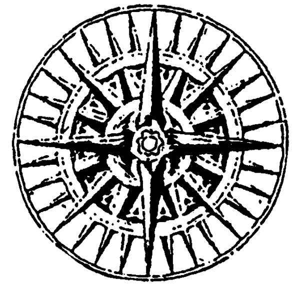

1 Essentials of Geography

Our study of physical geography begins with the foundations of this important discipline. The "Foundations of Geography" chapter contains the basic tools for the student to use in studying the content of physical geography. After completion of this chapter you should feel free to follow the integrated sequence of the text or treat the four parts of the text in any order that fits your teaching approach.

Most students have different notions as to what geography is and what geographers do. Some think they are going to memorize the capitals of the states, while others think that they are embarking on a search for lands and peoples or that they will be learning things for success with a popular *Jeopardy!* category. This uncertainty as to the nature of geography provides an excellent opportunity to review the state of affairs relative to geographic awareness. For information about geography as a discipline and career possibilities contact the Association of American Geographers and ask for their pamphlets, "Careers in Geography" by Richard G. Boehm (1996), "Geography: Today's Career for Tomorrow," "Geography as A Discipline" by Richard E. Huke (1995), and "Why Geography?" also revised in 1995. Order by phone (1.202-234-1450), or E-mail at gaia@aag.org, or see their home page at **http://www.aag.org**.

In my own physical and cultural geography classes I find that many students are unable to name all the states and provinces, or identify major countries on outline maps. When we add the complexity of the spatial aspects of Earth's physical systems (i.e., atmospheric energy budgets, temperatures, wind patterns, weather systems, plate tectonics, earthquake and volcano locations and causes, global ecosystem diversity, and terrestrial biomes), the confusion even among the best informed is great and therein lies our challenge!

These are certainly dramatic times, with an expanding global concern for the environment moving to the forefront of the political and scientific agenda. In 1992, the United Nations Conference on Environment and Development (UNCED) held an international gathering of scientists, political leaders, and citizens in Rio de Janeiro. A key portion of the conference dealt with issues central to physical geography and our human-environment theme: preservation of biological diversity, climate change and global warming, stratospheric ozone depletion, trans-boundary air pollution, deforestation, soil erosion and loss, desertification, permanent drought, freshwater resources, and resources from the ocean and coastlines. In addition to these environmental topics, issues relating to human societies also were addressed. Full international attention improves as negative feedback from Earth's physical environment continues to draw the world together—but this only can take root with a strong foundation in physical geography.

Outline Headings and Key Terms

The first-, second-, and third-order headings that divide Chapter 1 serve as an outline for your notes and studies. The key terms and concepts that appear boldface in the text are listed here under their appropriate heading in bold italics. All these highlighted terms appear in the text glossary. Note the check-off box (❑) so you can mark your progress as you master each concept. Your students have this same outline in their *Student Study Guide*.

The outline headings for Chapter 1:

- ❑ ***Earth systems science***

The Science of Geography

- ❑ ***geography***
- ❑ ***spatial***
- ❑ ***location***
- ❑ ***place***
- ❑ ***movement***
- ❑ ***region***
- ❑ ***human–Earth relationships***

Geographic Analysis

- ❑ ***spatial analysis***
- ❑ ***process***
- ❑ ***physical geography***

- ❑ ***scientific method***

The Geographic Continuum

Earth Systems Concepts

Systems Theory

- ❑ ***system***

Open Systems (or System)

- ❑ ***open system***

Closed System (or System)

- ❑ ***closed system***

System Example

System Feedback

- ❑ ***feedback loops***
- ❑ ***negative feedback***
- ❑ ***positive feedback***

System Equilibrium

- ❑ ***steady state equilibrium***

Mount Pinatubo—Global System Impact

Systems in *Elemental Geosystems*

Models of Systems

- ❑ ***model***

Earth's Four Spheres

- ❑ ***abiotic***
- ❑ ***biotic***

Atmosphere (Part 1, Chapters 2–4)

- ❑ ***atmosphere***

Hydrosphere (Part 2, Chapters 5–7)

- ❑ ***hydrosphere***

Lithosphere (Part 3, Chapters 8–14)

- ❑ ***lithosphere***

Biosphere (Part 4, Chapters 15–17)

- ❑ ***biosphere***
- ❑ ***ecosphere***

A Spherical Planet

- ❑ ***geodesy***
- ❑ ***geoid***

Measuring Earth in 247 B.C.

Location and Time on Earth

Latitude

- ❑ ***latitude***
- ❑ ***parallel***

Latitudinal Geographic Zones

Longitude

- ❑ ***longitude***
- ❑ ***meridian***
- ❑ ***prime meridian***
- ❑ ***global positioning system***

Great Circles and Small Circles

- ❑ ***great circle***
- ❑ ***small circle***

Prime Meridian and Standard Time

- ❑ ***Greenwich Mean Time (GMT)***

International Date Line

- ❑ ***International Date Line***

Coordinated Universal Time

- ❑ ***Coordinated Universal Time***

Daylight Saving Time

- ❑ ***daylight saving time***

Maps, Scales, and Projections

- ❑ ***maps***
- ❑ ***cartography***

Map Scales

- ❑ ***scale***

Map Projections

- ❑ ***map projection***

Properties of Projections

- ❑ ***equal area***
- ❑ ***true shape***

The Nature and Classes of Projections

- ❑ ***Mercator projection***
- ❑ ***rhumb line***

Remote Sensing and GIS

Remote Sensing

- ❑ ***remote sensing***

Active Remote Sensing

Passive Remote Sensing

Geographic Information System (GIS)

- ❑ **Geographic Information System *(GIS)***

Summary and Review

Focus Studies and News Reports

News Report 1.1: Frogs at a Tipping Point—Check the System

News Report 1.2: GPS: A Personal Locator

Focus Study 1.1: The Scientific Method

Focus Study 1.2: The Timely Search for Longitude

The URLs related to this chapter of *Elemental Geosystems* can be found at **http://www.mygeoscienceplace.com**

Key Learning Concepts

The following key learning concepts help guide your reading and comprehension efforts. The operative words are in *italics*. Use these carefully to guide your reading of the chapter and note that STEP 1 asks you to work with these concepts. The same key learning concepts open the chapter on its title page.

After reading the chapter and using the study guide, the student should be able to do the following:

• *Define* geography, and physical geography in particular.
• *Describe* systems analysis, open and closed systems, feedback information, and system operations, and *relate* these concepts to Earth systems.
• *Explain* Earth's reference grid: latitude and longitude, plus latitudinal geographic zones and time.
• *Define* cartography and mapping basics: map scale and map projections.

• *Describe* remote sensing and *explain* geographic information system (GIS) as tools used in geographic analysis.

Annotated Chapter Review Questions

• *Define* geography, and physical geography in particular.

1. What is unique about the science of geography? On the basis of information in this chapter, define physical geography and review the geographic approach.

Geography is the science that studies the interdependence of geographic areas, places, and locations; natural systems; processes; and societal and cultural activities over Earth's surface. Physical geography involves the spatial analysis of Earth's physical environment. Various words denote the geographic context of spatial analysis: space, territory, zone, pattern, distribution, place, location, region, sphere, province, and distance. Spatial patterns of Earth's weather, climate, winds and ocean currents, topography, and terrestrial biomes are examples of geographic topics.

2. In general terms, how might a physical geographer analyze water pollution in the Great Lakes?

There are many ways to answer here. First get map coverage of the Great Lakes Region (see the Focus Study on the Great Lakes in Chapter 19). Describe the lake elevations, flows, volumes, and annual mixing patterns as temperatures change seasonally. Locate population centers and point sources of pollution and using population concentrations estimate nonpoint sources of pollution. Map published data of water chemical analyses. Using a GIS model develop a composite overlay of all the above elements.

3. Assess your geographic literacy by examining atlases and maps. What types of maps have you used—political? physical? topographic? Do you know what projections they employed? Do you know the names and locations of the four oceans, seven continents, and individual countries? Can you identify the new countries that have emerged since 1990?

An informal quiz might be appropriate here, as in, Ouagadougou is the capital of Burkina, formerly Burkina Faso. Where are Kuwait and Iraq and how many live there? What is Burma's proper name today? What new nations have formed since 1990? What is the current spelling and name for Bombay, India? Where are warm and wet, hot and dry, cool and moist, cold and dry regions? Where are you right now in terms of latitude, longitude, elevation, etc.?

4. Suggest a representative example for each of the five geographic themes and use that theme in a sentence.

Suggestion: use Figure 1.1, text and photographs, as cues for discussion of this question. The Association of American Geographers (AAG) and the National Council for Geographic Education (NCGE), in an attempt to categorize the discipline, set forth five key themes for modern geographic education: location, place, human-Earth relationships, movement, and region.

5. Have you made decisions today that involve geographic concepts discussed within the five themes presented? Explain briefly.

This may be a good assignment for the first day of class. Most students can easily complete a history, or chronological list, of a day's activities. Have students do a geographic journal of their day so far. Listing locations they have been, how they got there and have them draw a map of their journey from home to school to work. This will also demonstrate how cartographers attempt to select information to include in their maps and how geographers attempt to select the most significant variables in a systems analysis.

• *Describe* systems analysis and open and closed systems, and *relate* these concepts to Earth systems.

6. Define systems theory as an organizational strategy. What are open systems, closed systems, and negative feedback? When is a system in a steady-state equilibrium condition? What type of system (open or closed) is a human body? A lake? A wheat plant?

Simply stated, a system is any ordered, interrelated set of objects, things, components, or parts, and their attributes, as distinct from their surrounding environment. A natural system is generally not self-contained: inputs of energy and matter flow into the system, whereas outputs flow from the system. Such a system is referred to as an open system: the human body, a lake, or a wheat plant. A system that is shut off from the surrounding environment so that it is self-contained is known as a closed system.

As a system operates, information is generated in the system output that can influence continuing system operations. These return pathways of information are called feedback loops. Feedback can cause changes that in turn guide further system operations. If the information amplifies or encourages responses in the system, it is called positive feedback. On the other hand, negative feedback tends to slow or discourage response in the system, forming the basis for self-regulation in natural systems and regulating the system within a range of tolerable performance. When the rates of inputs and outputs in the system are equal and the amounts of energy and matter in storage within the system are constant, or, more realistically, as they fluctuate around a stable average, the system is in a steady-state equilibrium.

7. Describe Earth as a system in terms of energy and of matter.

Most systems are dynamic because of the tremendous infusion of radiant energy from reactions deep within the Sun. This energy penetrates Earth's atmosphere and cascades through the terrestrial systems, transforming along the way into various forms of energy. Earth is an open system in terms of energy. In terms of physical matter—air, water, and material resources—Earth is nearly a closed system.

8. What are the three abiotic (nonliving) spheres that make up Earth's environment? Relate these to the biotic sphere (living): the biosphere.

Earth's surface is the place where four immense open systems interface, or interact. Three nonliving, or abiotic, systems overlap to form the realm of the living, or biotic, system. The abiotic spheres include the atmosphere, hydrosphere, and lithosphere. The fourth, the biotic sphere, is called the biosphere and exists in an interactive position between and within the abiotic spheres.

• *Explain* Earth's reference grid: latitude and longitude, and latitudinal geographic zones and time.

9. Draw and describe Earth's shape and size.

Sketch after Figure 1.10—an oblate spheroid or geoid.

10. How did Eratosthenes use Sun angles to figure out that the 5000 stadia distance between Alexandria and Syene was 1/50 Earth circumference? Once he knew this fraction of Earth's circumference, how did he calculate the distance of Earth's circumference?

See Figure 1.11 and label those parts that demonstrate the methods Eratosthenes used to do his calculation.

11. What are the latitude and longitude coordinates (in degrees, minutes, and seconds) of your present location? Where can you find this information?

Have students find a local or library source: benchmarks, atlases, gazetteers, maps, many software programs, such as Global Explorer, and locations on the World Wide Web.

12. Define latitude and parallel, and define longitude and meridian using a simple sketch with labels.

On a map or globe, lines denoting angles of latitude run east and west, parallel to Earth's equator. Latitude is an angular distance north or south of the equator measured from a point at the center of Earth. A line connecting all points along the same latitudinal angle is called a parallel. (Figures 1.12 and 1.14.)

On a map or globe, lines designating angles of longitude run north and south at right angles (90°) to the equator and all parallels. Longitude is an angular distance east or west of a surface location measured from a point at the center of Earth. A line connecting all points along the same longitude is called a meridian. (Figure 1.14.)

13. Define a great circle, great circle routes, and a small circle. In terms of these concepts, describe the equator, other parallels, and meridians.

A great circle is any circle of Earth's circumference whose center coincides with the center of Earth. Every meridian is one-half of a great circle that crosses each parallel at right angles and passes through the poles. An infinite number of great circles can be drawn on Earth, but only one parallel is a great circle—the equatorial parallel. All the rest of the parallels diminish in length toward the poles, and, along with other circles that do not share Earth's center, constitute small circles.

14. Identify the various latitudinal geographic zones that roughly subdivide Earth's surface. In which zone do you live?

Figure 1.13 portrays these latitudinal geographic zones, their locations, and their names: equatorial, tropical, subtropical, midlatitude, subarctic or subantarctic, and Arctic or Antarctic.

15. What does timekeeping have to do with longitude? Explain their relationship. How is Coordinated Universal Time (UTC) determined on Earth?

Earth revolves 360° every 24 hours, or 15° per hour, and a time zone of one hour is established for each 15° of longitude. Thus, a world standard was established, and time was set with the prime meridian at Greenwich, England. Each time zone theoretically covers 7.5° on either side of a controlling meridian and represents one hour. Greenwich Mean Time (GMT) is called Coordinated Universal Time (UTC); and although the prime meridian is still at Greenwich, UTC is based on average time calculations kept in Paris and broadcast worldwide. UTC is measured today by the very regular vibrations of cesium atoms in 6 primary standard clocks—the *NIST-7* being the newest placed in operation during 1994 by the United States. A newer clock for the US went into operation in 2000, designated *NIST-F1*.

16. What and where is the prime meridian? How was the location originally selected? Describe the meridian that is opposite the prime meridian on Earth's surface.

In 1884, the International Meridian Conference was held in Washington, D.C. After lengthy debate, most participating nations chose the Royal Observatory at Greenwich as the place for the prime meridian of 0° longitude. An important corollary of the prime meridian is the location of the 180° meridian on the opposite side of the planet. Termed the International Date Line, this meridian marks the place where each day officially begins (12:01 A.M.) and sweeps westward across Earth. This westward movement of time is created by the planet's turning eastward on its axis.

17. What is GPS and how does it assist you in finding location and elevation on Earth? Give a couple of examples where it was utilized to correct heights for some famous mountains.

The Global Positioning System (GPS) comprises 24 orbiting satellites, in 6 orbital planes, that transmit navigational signals for Earth-bound use (backup GPS satellites are in orbital storage as replacements). A small receiver, some about the size of a pocket radio, receives signals from four or more satellites at the same time, calculates latitude and longitude within 10-m accuracy (33 ft) and elevation within 15 m (49 ft) and displays the results. With the shutdown in 2000 of the Pentagon Selective Availability, commercial resolution is the same as for military applications and its Precise Positioning Service (PPS).

Scientists used GPS to accurately determine the height of Mount Everest in the Himalayan Mountains—now 8850 m compared to the former 8848 m (29,035 ft, 29,028 ft). In contrast GPS measurements of Mount Kilimanjaro lowered its summit from 5895 m to a lower 5892 m (19,340 ft, 19,330 ft).

• *Define* cartography and mapping basics: map scale and map projections.

18. Define cartography. Explain why it is an integrative discipline.

The part of geography that embodies map making is called cartography. The making of maps and charts is a specialized science as well as an art, blending aspects of geography, engineering, mathematics, graphics, computer sciences, and artistic specialties. It is similar in ways to architecture, in which aesthetics and utility are combined to produce an end product.

19. What is map scale? In what three ways is it expressed on a map?

The expression of the ratio of a map to the real world is called scale; it relates a unit on the map to a similar unit on the ground. A 1:1 scale would mean that a centimeter on the map represents a centimeter on the ground—certainly an impractical map scale, for the map would be as large as the area being mapped. A more appropriate scale for a local map is 1:24,000. Map scales may be presented in several ways: written, graphic, or as a representative fraction.

20. State whether each of the following ratios is a large scale, medium scale, or small scale: 1:3,168,000, 1:24,000, 1:250,000.

Small, large, and intermediate scales (see Table 1.2, p. 21).

21. Describe the differences between the characteristics of a globe and those that result when a flat map is prepared.

Since a globe is the only true representation of distance, direction, area, shape, and proximity, the preparation of a flat version means that decisions must be made as to the type and amount of acceptable distortion. On a globe, parallels are always parallel to each other, evenly spaced along meridians, and decrease in length toward the poles. On a globe, meridians intersect at both poles and are evenly spaced along any individual parallel. The distance between meridians decreases toward poles, with the spacing between meridians at the 60th parallel being equal to one-half the equatorial spacing. In addition, parallels and meridians on a globe always cross each other at right angles. All these qualities cannot be reproduced on a flat surface. Flat maps always possess some degree of distortion.

22. What type of map projection is used in Figure 1.13? Figure 1.17?

Figure 1.13: a Robinson projection; Figure 1.17: a Mercator projection (see Appendix A for discussion of maps used in this text).

• *Describe* remote sensing and *explain* geographic information system (GIS) as tools used in geographic analysis.

23. What is remote sensing? What are you viewing when you observe a weather image on TV or in the newspaper? Explain.

Our eyes and cameras are familiar means of obtaining **remote-sensing** information about a distant subject without having physical contact. Remote sensors on satellites and other craft sense a broader range of wavelengths than can our eyes. They can be designed to "see" wavelengths shorter than visible light (ultraviolet) and wavelengths longer than visible light (infrared and microwave radar).

Active systems direct a beam of energy at a surface and analyze the energy that is reflected back. An example is *radar* (*ra*dio *d*etection *a*nd *r*anging). Passive remote-sensing systems record energy radiated from a surface, particularly visible light and infrared.

A new generation of the Geostationary Operational Environmental Satellite, known as *GOES*, became operational in late 1994 providing frequent infrared and visible images—the ones you see on television weather reports. *GOES-10*, new in 1998, is positioned above 135° W longitude to monitor the West Coast and the eastern Pacific Ocean. ***GOES-8*** is positioned above 75° W longitude to monitor central and eastern North America and the western Atlantic. The television and newspaper weather images we see are from these platforms.

24. Describe *Terra*, *Landsat*, *GOES*, and *SPOT*, and explain them using several examples.

Key to NASA's Earth Observing System (EOS) is satellite *Terra*, which began beaming back data and images in 2000 (see **http://terra.nasa.gov/**), this followed by another satellite in the series called *Aqua*. Five instrument packages observe Earth systems in detail, exploring the atmosphere, landscapes, oceans, environmental change, and climate, among other abilities. For example, the Clouds and the Earth's Radiant Energy System (CERES) instruments aboard *Terra* monitor the Earth's energy balance, giving new insights into climate change (see Chapter 4). These monitors offer the most accurate global radiation and energy measurements ever available. Another instrument set, the Moderate-resolution Imaging Spectroradiometer (MODIS) sees all of Earth's surface every 1–2 days in thirty-six spectral bands, thereby expanding on AVHRR capabilities. There are 29 *Terra* images, out of 105 remotely sensed images in this edition of *Geosystems*.

Passive remote sensors on five *Landsat* satellites, launched by the United States, provide a variety of data as shown in images of river deltas in Chapter 14, the Malaspina glacier in Alaska in Chapter 17, and the Great Lakes in Chapter 19. Three *Landsats* remain operational (4, 5, and the newest 7) although *Landsat 4* no longer gathers images and is used for orbital tests. *Landsat 5* remains threatened with shut off due to budget cuts.

One of two commercial systems includes the three French satellites (numbered 1, 2, and 4) called *SPOT* (Systeme Probatoire d'Observation de la Terre; see **http://spot4.cnes.fr/waiting.htm**), that resolve objects on Earth down to 10 to 20 m (33 to 66 ft), depending on which sensors are used.

The *GOES* description is in the previous annotated question.

25. If you were in charge of planning for development of a large tract of land, how would GIS methodologies assist you? How might planning and zoning be affected if a portion of the tract in the GIS is a floodplain or prime agricultural land?

GIS enables you to gather, manipulate, and analyze vast amounts of geographic information from remote sensing or satellite technologies. The coordinates of a specific location may be digitized, and then geographers may add layers of remote sensing information to these coordinates. This allows geographers to overlay analytical information from more than one data plane and analyze complex relationships rapidly. This enables geographers to manipulate variables within their study very rapidly.

The usefulness of GIS in analyzing a floodplain would be that the user could examine the frequency of flooding, and the areal or monetary extent of damage in the last ten or more years. For agricultural land, the user could examine levels of salinity, soil fertility, crop production statistics for previous crops, and locate areas within their land that may need extra care or different methods of farming. GIS is applicable to urban and transport planning because it is able to consider and model areas of hazard, agricultural land values, and routes of intensive transport use.

Overhead Transparencies for Chapter 1

Tran-No.	*Elemental Geosystems* 6/e Figure Number	Figure Description from *Elemental Geosystems* 6/e
	Chapter 1	**Essentials of Geography**
1.	CO 1	Greensburg, Kansas, composite
2.	1.1	Five themes of geographic science
3.	F.S. 1.1.1	Scientific method flow chart
4.	1.2	The content of geography
5.	1.3 &1.4	An open system schematics, top; A leaf is a natural open system, bottom
6.	1.7	Global impact of Mount Pinatubo eruption
7.	1.8	The systems in *Elemental Geosystems*
8.	1.9	Earth's four spheres
9.	1.10 and 1.11	Earth's dimensions (top); Eratosthenes' calculation (bottom)
10.	1.12 and 1.14	Parallels of latitude (top); Meridians of longitude (bottom)
11.	1.13	Latitudinal geographic zones
12.	1.15 a,b, and c	Great circles and small circles
13.	1.17	Modern international standard time zones
14.	1.20	From globe to a flat map
15.	1.21 a,b,c,d	Classes of map projections
16.	1.22 a, b	Gnomonic, great circle routes; Mercator, true compass direction
17.	1.23	Remote-sensing technologies
18.	1.29 a,b,c	A geographic information system model