Al-Karkh University for Sciences
College of Remote Sensing and Geophysics
Geophysics Department

The Dynamic and Evolving Earth

Introduction

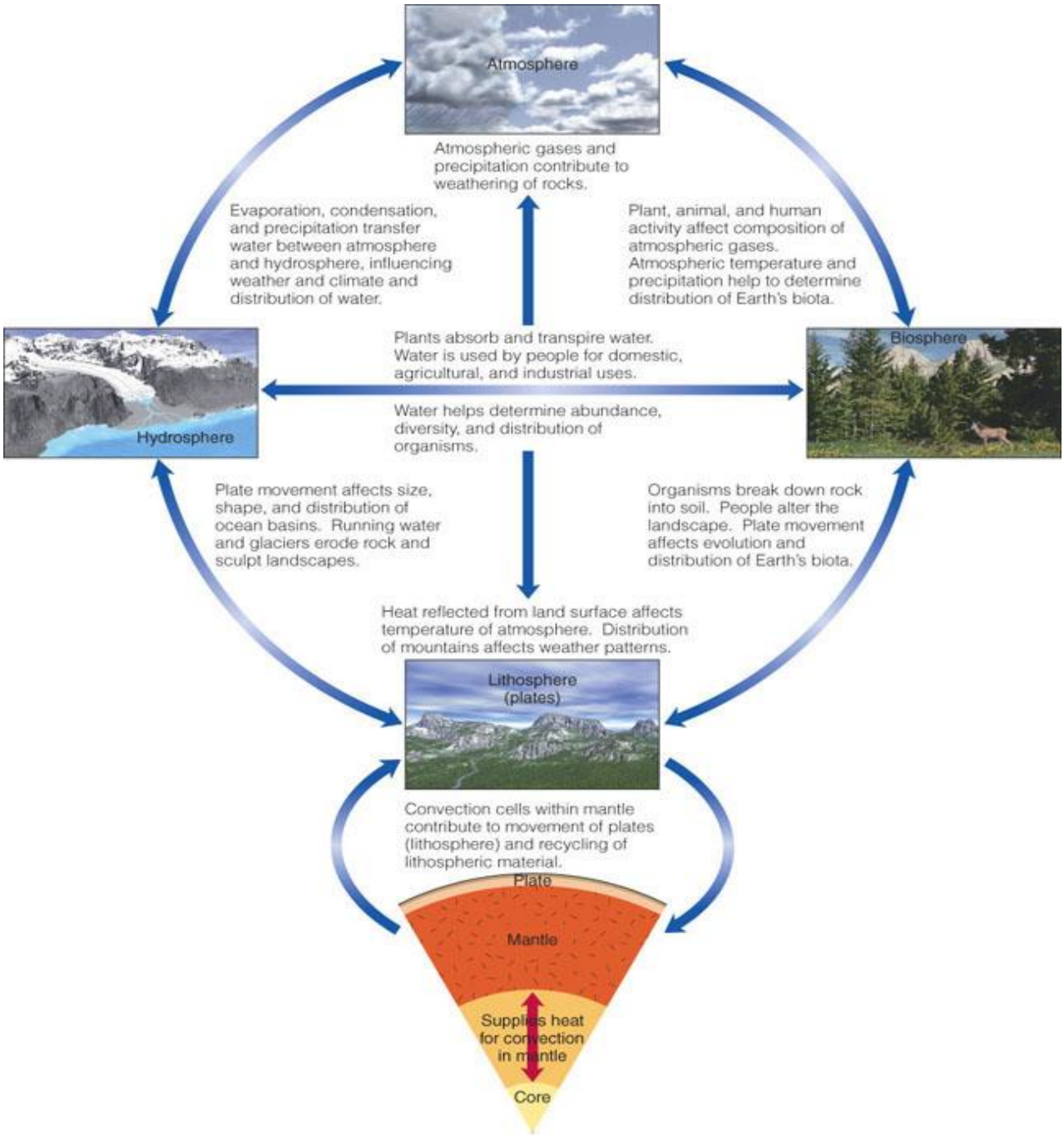
What kind of movie would we have if it were possible to travel back in time and fi lm Earth's history from its beginning 4.6 billion years ago? It would certainly be a story of epic proportions, with incredible special effects, a cast of trillions, a plot with twists and turns—and an ending that is still a mystery!

Every good movie has a theme, and the major theme of *The History of Earth* is that Earth is a complex, dynamic planet that has changed continuously since its origin some 4.6 billion years ago. Because of its epic nature, three interrelated sub-themes run throughout *The History of Earth*. The first is that Earth's outermost part is composed of a series of moving plates *(plate tectonics)* whose interactions have affected the planet's physical and biological history. The second is that Earth's biota has evolved or changed throughout its history *(organic evolution)*. The third is that the physical and biological changes that occurred did so over long periods of time *(geologic* or *deep time)*. These three interrelated sub-themes are central to our understanding and appreciation of our planet's history.

As you study and read the various topics covered in this book, keep in mind that the themes and topics discussed in this chapter and throughout the book are like the interconnected components of a system, and not just isolated and unrelated pieces of information. By relating each chapter's topic to its place in the entire Earth system, you will gain a greater appreciation of Earth's evolution and the role of its various interacting internal and external systems, subsystems, and cycles.

By viewing Earth as a whole—that is, thinking of it as a system—we not only see how its various components are interconnected, but we can also better appreciate its complex and dynamic nature. The system concept makes it easier for us to study a complex subject, such as Earth, because it divides the whole into smaller components that we can easily understand, without losing sight of how the separate components fit together as a whole.

A **system** is a combination of related parts that interact in an organized manner. We can thus consider Earth as a system of interconnected components that interact and affect each other in many different ways. The principal subsystems of Earth are the *atmosphere, biosphere, hydrosphere, geosphere, mantle,* and *core* (Figure). The complex interactions among these subsystems result in a dynamically changing planet in which matter and energy.



We must understand the science of how Earth works and how to effectively integrate scientific findings with the needs of society. Scientists collect data on natural phenomena such as tsunami, but it is often politicians (and, indirectly, the people who elect them) who determine what actions should be taken to protect the public. In *The Good Earth* we introduce you to the study of earth science. **Earth science can be broadly defined as the investigation of interactions among the four components of the earth system—the atmosphere (air, weather), hydrosphere (water, ice), biosphere (plants, animals), and geosphere (land, rocks)**. Together, these components form an elegant support

system for life. **In addition, the sun and assorted features from space, collectively termed the exosphere,** interact with the earth system and are sometimes considered a fifth earth system component. The historic 2004 tsunami involved three of the components— the hydrosphere, geosphere, and biosphere (Figure 1.4). Throughout this book, we will examine the characteristics of each of the components through the lens of human experience. After all, Earth is the only home we have, and we want to take care of it. We will also be interested in how these components interact and how changes in one component influence processes in the others. The second word in the term *earth science* is just as important to us as the first. Much of what you learn in college about science will happen in this and perhaps one other course. Therefore, we want you to have a firm understanding of what science are—and what it is not. **Science is not a list of facts to be memorized that have no relevance to your life.** So in this chapter, and throughout the book, we will give you lots of examples to show that science is a *process,* a way of thinking about the natural world.

Now we can define **Geology**: is a complex, integrated system of related parts, components, or subsystems. These systems and subsystems interact in an organized fashion, affecting one another in various ways.

Earth is being as dynamic system like engine. Its input is the materials, while their outputs are the external and internal processes on earth that make the target of geology.

Physical Geology

Physical Geologists are concerned with exploring the earth and its dynamicity. They seek to determine the earth materials, especially minerals and rocks and the interrelation between them in dynamic context. Equally the important is the relation of these materials and processes created to the humans as well as the development of natural resources and the environment impacts.

Historical geology is concerned with the origin and evolution of Earth's continents, oceans, atmosphere, and life.

Geologists are employed in diverse occupations, which include:

- Mineral and energy resource exploration
- Solving environmental problems
- Predicting natural disasters

Themes of Physical Geology:

1. Dynamic Earth: to put all the internal and external processes on earth in a unifying theory to explain its continuous changes since 4.6 billion years till now and in the future. Such phenomenon could be explained by the Plate Tectonic Theory and the Rock Cycle.
2. Earth Materials: These are mainly the molten magma, minerals, and rocks (igneous, sedimentary, and metamorphic) that could be placed in the context of rock cycle.
3. Earth Processes: these are earth internal and external processes that are essential for changing the state of a material, environmental impact, and natural resources development.

Uses and Applications of Geological Sciences

1. Exploration for minerals, oil, and gas.
2. Environmental problems: Hazards of flooding, Glaciations, Rocks stability, and Volcanicity.
3. Ground and underground water for irrigation and drinking water.
4. Pollution in soil, water, and gas. There are organic and chemical pollution.
5. Geologic engineers: location of dams and power plant.
6. Monitoring earth quakes and volcanicity.
7. Mining: extraction of sulfur, phosphates, iron, etc…..

Earth's Interior Layers

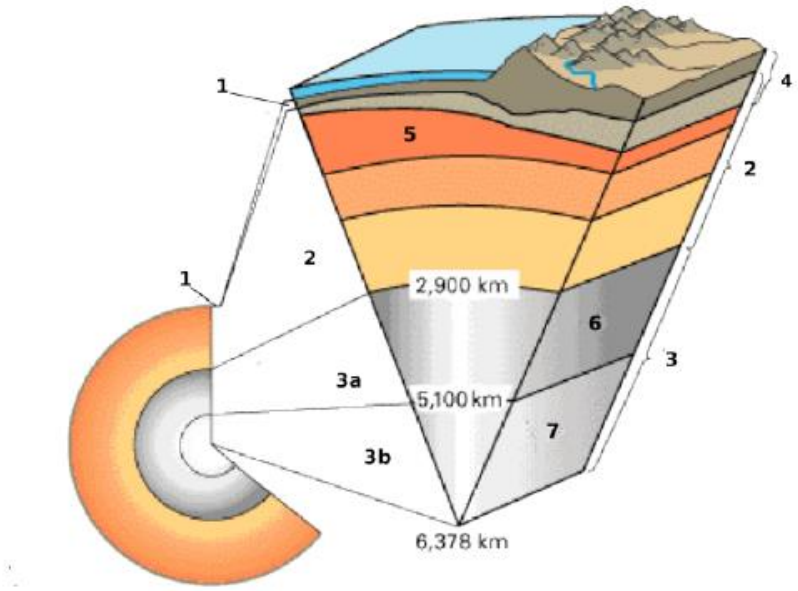
Core, mantle, and crust are divisions based on composition:

- The crust is less than 1% of Earth by mass. The oceanic crust is mafic (minerals with high levels of ferromagnesian), while continental crust is often more felsic (minerals that are primarily made of feldspars and quartz) rock.
- The mantle is hot, ultramafic rock. It represents about 68% of Earth's mass.
- The core is mostly iron metal. The core makes up about 31% of the Earth.

Lithosphere and asthenosphere are divisions based on mechanical properties:

- The lithosphere is composed of both the crust and the portion of the upper mantle that behaves as a brittle, rigid solid.
- The asthenosphere is partially molten upper mantle material that behaves plastically and can flow.
- The mesosphere refers to the mantle in the region under the lithosphere, and the asthenosphere, but above the outer core. The difference between mesosphere and asthenosphere is likely due to density and rigidity differences, that is, physical factors, and not to any difference in chemical composition.

This animation shows the layers by composition and by mechanical properties: http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_layers.html



A cross section of Earth showing the following layers: (1) crust (2) mantle (3a) outer core (3b) inner core (4) lithosphere (5) asthenosphere (6) outer core (7) inner core.

Note: Earth's lithosphere is made of several plates that move because of convection currents in the asthenosphere.

References:

McConnell, D., 2007. The Good Earth, Introduction to Earth Science-McGraw-Hill.

Utah State Office of Education, 2013. Earth Science.

Wicander, R., and Monroe, J. S. 2010. Historical geology-Books-Cole.