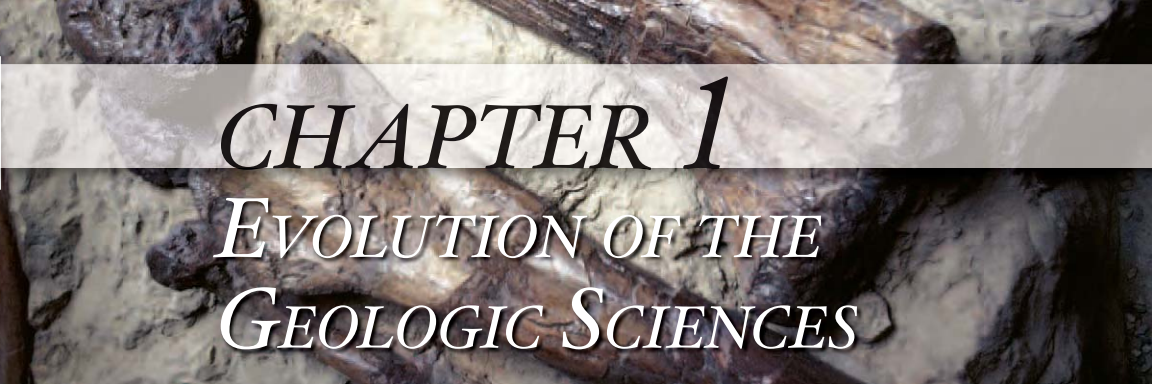

CHAPTER 1
EVOLUTION OF THE GEOLOGIC SCIENCES

The Earth sciences are made up of the fields of study concerned with the solid Earth, its waters, and the air that envelops it. The broad aim of the Earth sciences is to understand the present features and the past evolution of Earth and to use this knowledge, where appropriate, for the benefit of humankind. Thus the basic concerns of the Earth scientist are to observe, describe, and classify all the features of Earth, whether characteristic or not, in order to generate hypotheses with which to explain their presence and development. Earth scientists also devise means of checking opposing ideas for their relative validity. In this way the most plausible, acceptable, and long-lasting ideas are developed.

The geologic sciences constitute one division of the Earth sciences. Geology and its related subfields focus on the phenomena occurring within the planet or on its surface. The Earth sciences also include the hydrologic and atmospheric sciences.

It is worth emphasizing two important features that the geological sciences have in common with the other two divisions of the Earth sciences. First is the inaccessibility of many of the objects of study. Many rocks, as well as water and oil reservoirs, are at great depths in Earth, while air masses circulate at vast heights above it. Second, there is the fourth dimension—time. Geological scientists are responsible for working out how Earth evolved over millions of years. For example, what were the physical and

THE DIVISION OF EARTH SCIENCES

Today the Earth sciences are divided into many disciplines, which are themselves divisible into six groups. Although a few of the disciplines listed below fall within the scope of the hydrologic and atmospheric sciences, the majority relate directly to the science of geology and its related subdisciplines.

1. Those subjects that deal with the water and air at or above the solid surface of Earth. These include the study of the water on and within the ground (hydrology), glaciers and ice caps (glaciology), oceans (oceanography), the atmosphere and its phenomena (meteorology), and world climates (climatology). Such fields of study are grouped under the hydrologic and atmospheric sciences and are treated separately from the geologic sciences, which focus on the solid Earth.
2. Disciplines concerned with the physical-chemical makeup of the solid Earth, which include the study of minerals (mineralogy), the three main groups of rocks (igneous, sedimentary, and metamorphic petrology), the chemistry of rocks (geochemistry), the structures in rocks (structural geology), and the physical properties of rocks on Earth's surface and within its interior (geophysics).
3. The study of landforms (geomorphology), which is concerned with the description of the features of the present terrestrial surface and an analysis of the processes that gave rise to them.
4. Disciplines concerned with Earth's geologic history, including the study of fossils and the fossil record (paleontology), the development of sedimentary strata deposited typically over millions of years (stratigraphy), and the isotopic chemistry and age dating of rocks (geochronology).
5. Applied Earth sciences dealing with current practical applications beneficial to society. These include the study of fossil fuels (oil, natural gas, and coal); oil reservoirs; mineral deposits; geothermal energy for electricity and heating; the structure and composition of bedrock for the location of

bridges, nuclear reactors, roads, dams, and skyscrapers and other buildings; hazards involving rock and mud avalanches, volcanic eruptions, earthquakes, and the collapse of tunnels; and coastal, cliff, and soil erosion.

6. The study of the rock record on the Moon, the planets, and their satellites (astrogeology). This field includes the investigation of relevant terrestrial features—namely, tektites (glassy objects resulting from meteorite impacts) and astroblemes (meteorite craters).

With such intergradational boundaries between the divisions of the Earth sciences—which, on a broader scale, also overlap with physics, chemistry, biology, mathematics, and certain branches of engineering—researchers today must be versatile in their approach to problems.

chemical conditions operating on Earth and the Moon 3.5 billion years ago? How did the oceans and atmosphere form, and how did their chemical composition change with time? How did life begin, and how has life evolved?

ORIGINS IN PREHISTORIC TIMES

The origins of the geological sciences lie in the myths and legends of the distant past. The creation story, which can be traced to a Babylonian epic of the 22nd century BCE and is told in the first chapter of Genesis in the bible, has proved most influential. The story is cast in the form of Earth history and thus was readily accepted as an embodiment of scientific as well as of theological truth.

Earth scientists later made innumerable observations of natural phenomena and interpreted them in an increasingly multidisciplinary manner. The geological and other