Milestones in Geology

Earth Science Since the Greeks

By Ruth A. Sparrow

The books on geology in the "Milestones of Science" collection of first editions being assembled by the Museum are described by Ruth A. Sparrow, Librarian, in this, the fourth in her series now running in *Hobbies*. These volumes include not only geology, "the science which investigates the physical history of the earth," but also paleontology, its allied subject, which "deals with the life of past geological periods." They are designed to give the outstanding works in the historical development of geological science, from the days of the Greeks and Romans to modern times.—*Editor's Note.*

● ● ● The vast amount of geological phenomena which has always been present during man's life on earth has been an awesome and impressive experience, and it was not strange that in his more primitive days his imagination should be fired by these stupendous and inescapable wonders. Earthquakes, volcanoes, tornadoes, tidal waves, and other devastating forces must have terrorized him. And, as always, man has been impressed and inspired by the beauties of nature —majestic mountains, deep canyons, the seashore, the desert, the deep rivers, the flat plains. And man wondered and marveled as to how these things could be.

In an attempt to view a volcanic eruption at close hand the elder Pliny lost his life in 79 A.D., when Vesuvius erupted for the first time, so we do not have his account of the historical event. We do, however, have recorded in his great compendium of ancient knowledge, *Historia Naturalis* (Venice, 1476) a fund of information on volcanoes and other subjects. Some of the chapter headings are enlightening: on the theories as to the origin of the earth; in what places the sea has receded; the mode in which islands rise up; what islands have been formed; lands which have been separated by the sea; islands which have been united to the mainland; lands which have been totally changed by the seas. Of the latter he writes: "The sea has totally carried off certain lands and first of all, if we are to believe Plato, for an immense space where the Atlantic Ocean is now extended." Two books are entirely devoted to the natural history of metals, another to the natural history of stones, and another to the natural history of precious stones.

From the fall of the Roman Empire to the Middle Ages, little progress was made in natural science. However, with the Renaissance, interest was again renewed. An old problem which had troubled the ancients was again studied — the origin of fossils and especially how they had become imbedded in the rocks in the interior of continents. The Church had become a great power, and men were not free to teach any doctrine they pleased. The Church taught: "And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear... And God called the dry land Earth; and the gathering together of the waters called he Seas And the evening and the morning were the third day." Thus was taught that the land and the sea had been separated on the third day of creation, before the appearance of any animal life. For it was not until the fifth day that "God said, Let the waters bring forth abundantly the moving creature that

hath life, and the fowl that may fly above the earth in the open firmament of heaven . . ." And to assert that dry land was made up in part of rocks that were formed in the sea was a challenge to the truth of the Bible.

So from the sixteenth century through the early days of the eighteenth century the discussion of the origin of fossils continued. The most prominent school was that which taught that this geological phenomenon was caused by the Flood of Noah or the Deluge.

One of the first to put the past history of the earth on a more scientific foundation was Leonardo da Vinci (1452-1519). He believed that fossils were the remains of plants and animals. He also maintained that they had actually lived in the strata in which they were found but that the condition of the land and sea had changed. (*The Literary Works of Leonardo da Vinci,* translation, London, 1883.)

The earliest printed works in the collection of geological milestones are by Gregorius Agricola. Agricola has been called the father of metallurgy and mining and was among the first to make a critical study of minerals. In 1546 he published a treatise which was one of the earliest attempts to classify minerals (*De Ortu et Causis Subterraneorum,* Basel, 1546). In 1556 there appeared one of the outstanding books on fossils, minerals, mining, and metallurgy (*De Re Metallica,* Basel, 1556). It also gives for the first time a full account of the chemistry of minerals. This classical work was translated into English in 1912 by Herbert Clark Hoover and Lou Henry Hoover.

Another early work on minerals is by Albertus Magnus (*De Mineralibus,* Padua, 1476). This describes the general properties of "medical minerals" which are used in prescriptions.

One of the earliest publications dealing exclusively with fossils was Conrad Gesner's *De Omni Rerum Fossilium Genera* (Zurich, 1565). He discusses and illustrates the fossils without going into their origin.

Nicolaus Steno in *De Solido Intra Solidum Naturaliter Contento* (Florence, 1669) laid the foundation of geology, paleontology, and crystallography.

Werner propounded the Neptunian theory that "in the beginning all the solids of the earth's present crust were being dissolved in the heated waters of a universal sea." His *Von den Ausserlichen Kennzeichen der Fossilien* (Leipzig, 1774) on the external character of minerals placed him among the greatest mineralogists.

René Just Haüy is called the founder of crystallography. The examination of a piece of calcareous spar resulted in the announcement of his geometrical law of crystallization. *Essai d'une Théorie sur la Structure des Crystaux* (Paris, 1784) is one of his important works.

James Hutton, a Scotchman, one of the founders of geology, was an advocate of the Plutonian theory that "the successive rocks of the earth's crust were formed by igneous fusion." In *Theory of the Earth* he expounds that geology is not cosmogony but must confine itself to the study of the material of the earth. This paper was read before the Royal Society of Edinburgh on March 7 and April 4, 1784. This is the basis for his more lengthy work of the same title.

Jean Baptiste Lamarck, a French scientist, has in *Systême des Animaux sans Vertèbres* (Paris, 1801) his first essay on fossils. Lamarck recognized the great length of geological time and the continuous existence of animal life through the ages. He opposed Cuvier and the catastrophic school and affirmed that the modifications of life forms in the organic and inorganic world are the result of a con-

tinuous process, not of sudden catastrophic events.

Cuvier, on the other hand, was an ardent catastrophic. However he is chiefly remembered as the founder of vertebrate paleontology. In *Le Règne Animal* (Paris, 1817) is embodied the results of the whole of his previous researches on the structure of living and fossil remains.

William Smith is known as the father of English geology and laid the foundation for the study of stratigraphical geology in England. His great contribution was *A Delineation of the Strata of England and Wales, with part of Scotland* (London, 1815). This is his great geological map on which subsequent ones have been modeled. It is one of the foundation works in geology and geological evolution. Accompanying it is *Strata Identified by Organized Fossils* (London, 1816-1819), a classical complement to the map. The map shows for the first time the distribution and succession of rocks in these countries.

The outstanding geologist of his time was Charles Lyell. His classical work *Principles of Geology* (London, 1830-1833), which Charles Darwin took with him on his voyage, is one of the greatest in geological literature. It was the first book to establish the fact of geological evolution, it exploded the theories of Cuvier and the catastrophic school, and it was the basis for the Darwin-Wallace theory of evolution and gave Darwin the basic principles for the origin of species.

There was a rapid development in the field of glacial geology during the nineteenth century. Louis Agassiz was the founder and established the theory of glaciation in *Etude sur les Glaciers* (Neuchâtel, 1840).

So the earth grows older, and the everchanging process goes on—tearing and wearing down and slowly but surely building up the geology of the future.

MILESTONES IN GEOLOGY

*De Mineralibus Liber Primus by Albertus Magnus, Padua, 1476

*Historia Naturalis by Plinius Secundus, Venice, 1476

†De Ortu et Causis Subterraneorum Libre V by Gregorius Agricola, Basel, 1546

†De Re Metallica Libre XII by Gregorius Agricola, Basel, 1556

De Omni Rerum Fossilium Genera by Conrad Gesner, Zurich, 1565

‡De Solido Intra Solidum Naturaliter Contento by Nicolaus Steno, Florence, 1669

‡Von den Ausserlichen Kennzeichen der Fossilien by Abraham Gottlob Werner, Leipzig, 1774

Essai d'une Théorie sur la Structure des Crystaux by René Just Haüy, Paris, 1784

†Theory of the Earth by James Hutton, read before the Royal Society of Edinburgh, March 7 and April 4, 1785

‖Système des Animaux sans Vertèbres by J. B. P. A. Lamarck, Paris, 1801

†A Delineation of the Strata of England and Wales, with part of Scotland by William Smith, London, 1815

†Strata Identified by Organized Fossils, 4 parts, by William Smith, London, 1816-1819

‖Le Règne Animal Distribué d'Après son Organization, 4 volumes, by Georges L. Cuvier, Paris, 1817

†Principles of Geology, 3 volumes, by Charles Lyell, London, 1830-1833

‡Etude sur les Glaciers by Louis Agassiz, Neuchâtel, 1840

§The Literary Works of Leonardo da Vinci, compiled and edited from the original manuscripts by J. P. Richter, 2 volumes, London, 1883

†De Re Metallica by Gregorius Agricola, translated from the Latin edition of 1556 by Herbert Clark Hoover and Lou Henry Hoover, 1912

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*On display in connection with the Cabana Hall of Man

†On display in the Hall of Geology and Paleontology

‡Present desiderata

§In the collection of Philosophical and General Works

‖In the collection of Biology