

was little or no selective sorting action by water at the time of burial.

By comparing the fossil assemblages of various outcropping sedimentary layers with each other William Smith was able to recognize the relation of one layer to another, and thus to learn the relative ages of the various sedimentary formations. This was a discovery which soon became useful in the understanding and commercial development of the coal beds and other mineral deposits of England. William Smith spent 24 years making this extensive study and compiling a geologic map of England, Wales, and part of Scotland. By the end of these investigations he was strongly impressed with the wonderful order and regularity of the geologic strata, so that he wrote the following in 1815, as a part of the introduction to the map he was publishing:

(The) arrangement must readily convince every scientific or discerning person, that the earth is formed...according to regular and immutable laws, which are discoverable by human industry and observation, and which form a legitimate and most important object of science.<sup>5</sup>

At about the same time that William Smith was using fossil types to identify and correlate strata in England, Georges Cuvier and Abbé Giraud-Soulavie were observing the order of arrangement of fossils in France. Because of Cuvier's extensive knowledge of biological details, he noticed and was impressed with the systematic extinction of many of the species of animals, as one progresses to higher strata. By combining Cuvier's accurate observations of the systematic dying out of certain types of organisms (and the subsequent appearance of more modern fossil assemblages) with the geologic work of William Smith, geologists soon acquired the ability to compare and recognize detailed sedimentary sequences from widely separated localities. Sets of strata in two separate geographic locations can safely be considered to be of the same age if both sets contain essentially the same kinds of fossils, in the same order.<sup>6</sup> This type of comparison of fossils often makes it possible to determine the absolute age of a given stratum when such a stratum contains the same assemblage of fossils as does a layer of known absolute age. (The latter layer must of course be originally dated by some other method, such as sedimentation rate, growth rates of the fossils, or isotope ratios.)

#### Kinds of Fossils Which Appeared Late in Time

Another feature of nature's stratigraphic record, which enables us to recognize time, is the complete absence of some of the large and important groups of living organisms from the lower, older strata. Three of these great groups are (a) the diatoms, (b) the flowering plants which produce seeds enclosed in an ovary wall, and (c) the vertebrate animals (animals which have a backbone). Diatoms are microscopic, single-celled plants which make up a high proportion of the photosynthetic plant life in the oceans. They are so abundant that they are the major food source for many small marine animals. The diatoms are one of the great groups of algae, and are peculiar