of cementation are being observed today, as on the reefs described in the previous chapter, and are much better understood than formerly.

In contrast to the sometimes rather rapid laying down of layers of sand, gravel, and silt, the depositing of layers of shale in the earth is a slow process. This is because the particles (mainly clay) from which shale is formed are very small, being only 4 microns or less in diameter. (There are approximately 25,000 microns in an inch.) The clay particles from which most marine shales are formed do not readily cling together in clumps, and thus they settle only very slowly. However, in places where fresh water is coming into contact with salt water (as at a river mouth) the clay particles sometimes clump together and settle more rapidly. In either case the water must be relatively calm for the settling to occur, just as the clay and mud particles which we commonly see in mud holes in the road do not settle out, so long as passing cars frequently agitate the water.

Thus we begin to see that varying amounts of time, and the right kinds of conditions, are necessary for the formation of sandstones, conglomerates, and shales. We will wait until later chapters to point out the thicknesses of these deposits in various places, and something of the length of time required for their accumulation and cementation.

## Limestone and Dolostone Formation

Limestone and dolostone are familiar to practically all of us--at least in the crushed form, as road building material. Many recent studies, mostly made by petroleum geologists, have shown that most beds of limestone were formed gradually, in shallow marine environments, with the aid of marine organisms such as algae. This process of limestone formation, with the aid of algae to serve both as a secreting organism and as a binder for the calcium carbonate particles, has now been observed in numerous shallow marine environments off the coasts of North America and Asia, and in the Caribbean Sea. The buildup of such limestone deposits is thus dependent on the rate of growth of the algae.[10]

The remains of the algae which aided in the building of ancient limestone layers are still discernible in some limestone beds. Thus J. H. Johnson, in 1961, could describe numerous examples of such limestones;[11] and since that time a whole array of descriptive reports of algal limestones has been published in geological journals. The idea that the vast limestone beds of the world were formed rapidly is shown to be erroneous, not only by the characteristic algal laminations now seen in many limestones, but also by the fact that the calcium carbonate content of sea water is too small to provide the material for rapid formation by precipitation. These and other aspects of limestone and dolostone formation will be taken up in Chapter 7. (Dolostone is a modified form of limestone, containing magnesium combined with the calcium and carbonate. The pure form of the mineral is called "dolomite," with the formula $CaMg(CO_3)_2$.)