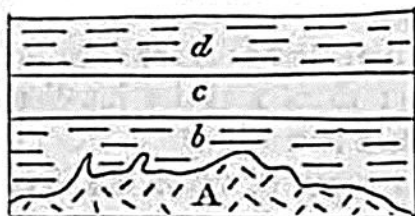


have occurred in the earth's crust within an equal quantity of time anterior to the Eocene epoch. They who contend for the more intense energy of subterranean causes in the remoter eras of the earth's history, may find it more difficult to give an answer to this question than they anticipated.

The principal effect of volcanic action in the nether regions, during the tertiary period, seems to have consisted in the upheaval to the surface of hypogene formations of an age anterior to the carboniferous. The repetition of another series of movements, of equal violence, might upraise the plutonic and metamorphic rocks of many secondary periods; and if the same force should still continue to act, the next convulsions might bring up to the day, the *tertiary* and *recent* hypogene rocks. In the course of such changes many of the existing sedimentary strata would suffer greatly by denudation, others might assume a metamorphic structure, or become melted down into plutonic and volcanic rocks. Meanwhile the deposition of a vast thickness of new strata would not fail to take place during the upheaval and partial destruction of the older rocks. But I must refer the reader to the last chapter but one of this volume for a fuller explanation of these views.

*Cretaceous period.* — It will be shown in the next chapter that chalk, as well as lias, has been altered by granite in the eastern Pyrenees. Whether such granite be cretaceous or tertiary cannot easily be decided.

Fig. 695.



Suppose *b*, *c*, *d*, to be three members of the Cretaceous series, the lowest of which, *b*, has been altered by the granite *A*, the modifying influence not having extended so far as *c*, or having but slightly affected its lowest beds. Now it can rarely be possible for the geologist to decide whether

the beds *d* existed at the time of the intrusion of *A*, and alteration of *b* and *c*, or whether they were subsequently thrown down upon *c*.

But as some cretaceous and even tertiary rocks have been raised to the height of more than 9000 feet in the Pyrenees, we must not assume that plutonic formations of the same periods may not have been brought up and exposed by denudation, at the height of 2000 or 3000 feet on the flanks of that chain.

*Period of Oolite and Lias.*—In the department of the Hautes Alpes, in France, near Vizille, M. Elie de Beaumont traced a black argillaceous limestone, charged with belemnites, to within a few yards of a mass of granite. Here the limestone begins to put on a granular texture, but is extremely fine-grained. When nearer the junction it becomes gray, and has a saccharoid structure. In another locality, near Champoleon, a granite composed of quartz, black mica, and rose-colored felspar, is observed partly to overlie the secondary rocks, producing an alteration which extends for about 30 feet downwards, diminishing in the beds which lie farthest from the granite. (See fig. 699.) In the altered