chlorite schist and dioryte, and have jaspery bands. In 497, 499, from Essex County, N.Y., the associated rock is gneiss, and the ore-bed is interlaminated with quartz. At one Essex County mine, the ore-bed is 150 feet thick; at the Cranberry mine, on the borders of North Carolina and Tennessee, 400 feet. Grains of calcium phosphate (apatite) are often disseminated through the ore.

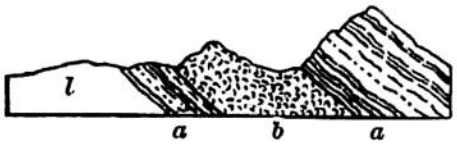
Iron carbonate is associated with the oxides south of Lake Superior. It occurs only sparingly to the eastward in Michigan, south of Lake Superior, at the Marquette mine, but more abundantly to the westward in Wisconsin. The metamorphism of the beds, correspondingly, is least to the westward. The carbonate is the ore originally laid down, and the hematite and magnetite are results of metamorphic change, in which the carbonic acid was expelled.

In eastern Canada and along the Archæan protaxis, southward through New York, New Jersey, and beyond, the carbonate is wholly absent, the iron ores being magnetite, hematite, or titanic iron. Moreover, the thickness of the ore-beds is far greater and the metamorphism of the region is of higher grade, — thick-bedded, massive, and schistose, crystalline rocks prevailing. Notwithstanding these differences, the eastern iron-bearing series *may be Huronian*, and unconformable to adjoining Laurentian, but the evidence of this has not been obtained. The same belts have their thick beds of crystalline limestone, often chondroditic, and in this respect rocks of the Appalachian protaxis differ from those of the Lake Superior region. The course of the Appalachian chain was the region in later time of thick sedimentary deposits, great upturnings, intense metamorphism, while, cotemporaneously, little change was in progress over the Mississippi Valley; and it may be that the same kind of difference distinguished the two regions in Archæan time.

STRUCTURE, THICKNESS, AND ORIGIN OF THE ROCKS.

As is implied in the preceding descriptions, part of the rocks are massive, as granite, syenyte, dioryte, gabbro; and a large part are schistose and distinctly stratified; and into the schistose the massive often graduate. The alternations of ore-beds with schists, quartzyte, limestones, in sections like those figured above, are evidence of stratification, and, therefore, of the successive formation of the beds, whether now crystalline or not. The quartzytes are old sandstones; the limestones deposited beds of limestone, either of organic or chemical origin; and the schists are fragmental beds in a metamorphic condition. In Fig. 500 a stratum of limestone, *l*, is overlaid by strata of gneiss, *a*, *a*, and steatyte, *b*. Such sections could be multiplied indefinitely. The following, by Logan, Fig. 501, which is partly ideal, but not untrue, represents white granular or crystalline limestone, *a*, many times folded and interstratified with gneiss and quartz rock, *b*; and the limestone has been traced over the same region (Grenville and the adjacent country, Canada), in the linear and curving bands of a series of great

500.



Interstratified limestone, St. Lawrence County, N.Y. Emmons.