erosion. The ores themselves have also been dissolved, transported, and precipitated, perhaps several times.

In the discussion of the origin of the brown iron ores, three stages should be considered—the original source of the iron, the primary segregation, and the secondary concentration.

Original source of the iron.—The iron of the brown iron ores probably was present in the form of pyrite, magnetite, or some ferromagnesian silicate, original constituents of the igneous rocks that underlie all the sedimentary strata in which the bodies of ore now occur. When the Cambrian and Ordovician sandstones, limestones, and shales were deposited in the shallow waters of the Appalachian sea both pyrite and siderite were precipitated from solution to form part of these sedimentary strata. Consequently all the rocks of the region—gneisses, sandstones, limestones, and shales—have contributed material for the formation of the ore bodies. Not only have the rocks now present in the region yielded iron for these deposits, but much was also derived from a great thickness of rocks which once overlay the present strata and was removed in the long period during which the Appalachian province has been subjected to erosion. At least 10,000 feet of strata have been removed by erosion from the region since Ordovician time, and though most of the iron of these rocks doubtless was carried away, a considerable portion was dissolved and precipitated in the underlying rocks.

Primary segregation of the iron.—The most striking feature of the occurrence of limonite deposits in the limestones is their relation to channels of underground drainage. The abundance of water was a serious obstacle in the operation of almost every valley-ore mine that was more than fifty feet in depth though elsewhere in the limestone valleys wells must be sunk much deeper in order to procure enough water for household use. As these water channels are formed by the fractures in the rocks that were produced during the great earth disturbances at the ends of the Ordovician and Carboniferous periods, it is reasonably certain that the ground water has been flowing through them for millions of years.

The mountain ores also occur in regions where the rocks have been fractured and afford free passage for ground-water circulation. In every place in the region where the mountain ores have been mined, the Cambrian sandstones have been largely altered to jasper or chert. The metamorphism is believed to have taken place mainly at the end of the Ordovician period, when the region was subjected to intense dynamic forces that resulted in the intricate folding and faulting now so well exhibited. Post-Carboniferous movements also have been ef-