where a pure limestone is upturned at a high angle, — this position being evidence of its subjection at some time to heavy pressure.

The heat for the changes in granitic veins, like the Branchville, may have been produced by friction from an up or down movement along the vein; and the same is probably true for the bed of iron ore at Brewster, in eastern New York; for veins, and also ore-beds when they are nearly vertical, are planes of weakness. But whether the movement occurred at the epoch of mountain-making at the close of the Lower Silurian, or at some other similar epoch, is unknown.

Relations of metamorphic and igneous rocks. — The earth's interior source of heat has had much to do in geological history with metamorphism as well as with igneous ejections. The depth to the region beneath the earth's surface having a temperature near the fusing point of the rocks has increased with the progress of the geological eras; the amount of metamorphism has correspondingly decreased through the ages.

In early Archæan time the region of fusion was at the surface, and in the later part, before solidification was complete, it was not far below the surface. Great stratified formations had then already been made — 30,000 feet in thickness at least, and some have said twice this, or more. A temperature close to that of fusion may then have been within this pile of deposits (page 258, paragraph *c*), so that but little addition to the heat from subterranean movements would have produced not only ordinary metamorphic effects, but also fusion of portions of the sediments, making granite, gabbro, and other igneous rocks.

Metamorphic work was extensively carried on at the close of the Lower Silurian in eastern North America, and igneous rocks were among the metamorphic results; it was much less extensive at the close of Paleozoic time, and later than this it is not known to have occurred. In western North America, in California, however, the results of heat were large even in the later part of Mesozoic time. We may account for this difference between the two sides of the continent, perhaps, by the fact that the Pacific border had already become a region of extensive volcanic action, — evidence that the depth to great heat was unusually small.

On the contrary, volcanic action has increased through the ages. There is no good reason for believing that there was much volcanic or deep-seated igneous action in Archæan time. The earth had then its granites, its gabbros, its syenytes, and other igneous rocks; but no petrological study can show whether the fusion was among the results of metamorphic action or not.

In this connection it is an instructive fact that in eastern North America, at epochs when there was the greatest amount of friction and crushing, — those of the making of the Green Mountains and Appalachians, — no volcanoes were made, and little took place in the way of eruptions through fissures; the conditions were largely those of the past. But at an epoch in Mesozoic time, when there was almost no flexing of the rocks, and only low monoclinal uplifts, extensive dolerytic eruptions occurred at intervals for 1000 miles along the Atlantic border.