

the reduction, in the case of anthracite, would be to about one eighth, as above estimated. The average amount of ash in anthracite ought, consequently, to be nearly half greater than in bituminous coal.

The production of the anthracite of eastern Pennsylvania was referred to the action of heat on ordinary bituminous coal first by H. D. Rogers, on the ground of the upturned and flexed condition of the rocks in that part of the state. The upturning fades out to the northwestward, and the Wilkesbarre anthracite region is on its outskirts. The heat produced in the rocks by the upturning need not, for the result, have been either great or much prolonged; moreover, it would have spread laterally from the area of greatest disturbance, more or less far into the outskirts, as is well exemplified in various metamorphic regions. The following are other facts favoring this origin of the anthracite: (1) The coal of the upturned and more or less *metamorphic* Coal-measures of Rhode Island is the hardest of anthracite. (2) The coal of the Carboniferous Coal-measures of *western* Pennsylvania, and that of the states farther west, where the beds are nearly horizontal, is, throughout, bituminous coal and not anthracite. (3) Variations in the conditions of the coal-making areas over the globe have led to various kinds of coal without making anthracite. Brown coal, or that containing a large percentage of oxygen, is known to form where there is much access of air; and cannel coal, a kind rich in oil-producing hydrocarbons, and little oxygen, under conditions of prolonged steeping beneath a deep covering of sediments; for all the characters of the beds associated with cannel coal indicate, as Newberry held, the fact of such a steeping of the bed of vegetable debris. These are the extreme results, except that more remarkable extreme, the loss of all the oxygen through union with carbon, and thereby the making of hydrocarbon oil or gas as the substitute for coal. Anthracite is not known among the products so made, except in regions of upturned rocks, or in the vicinity of igneous rocks. Graphite, a grade beyond anthracite, is formed from the excessive heating of mineral coal, as is proved in the metamorphic coal regions of Rhode Island, Worcester, and elsewhere.

GENERAL OBSERVATIONS ON THE PALEOZOIC ERAS.

GROWTH OF THE AMERICAN CONTINENT.

1. *Facts connected with its growth.* — The facts which have been presented sustain the view that the American continent throughout Paleozoic time was gradually growing in its rock formations and dry land, and thereby extending from the Archæan nucleus southeastward and southward, but not much in a southwestward direction. It is manifest, also, that after the Lower Silurian era had passed, the growth took place mainly through processes at work over the great Continental Interior, — a vast American Mediterranean Sea, bounded on the north, northeast, and east, by Archæan confines. Moreover, the eastern areas of progress in New England and beyond had like-