

were made, and in the courses and character of the transporting currents and waves.

Further, the making of the geosyncline must have been attended in each case by a pushing aside of the rock material in the earth's mass existing beneath it, and an upward bulging, or a geanticline, over the region adjoining on one side or the other.

The more prominent theories of mountain-making now current are (1) the Gravitation Theory and (2) the Contraction Theory.

1. The Gravitation Theory.

The Gravitation Theory was brought forward in its simplest form by James Hall in 1859. According to it, the making of the preparatory geosyncline, in the case of the Appalachians, was due to the gravitation of the accumulating sediments, in accordance with the principle explained by Herschel, whose views he cites; and the making of the flexures over the region was due to the same cause; that is, to the subsidence and not to heating from below. In the same paper, the general conclusion already referred to is drawn that a geosyncline of accumulation, like that of the Appalachians, is a necessary preliminary in all cases of mountain-making. In 1847, Babbage published the important principle (included in a paper read before the Geological Society of London in 1834) that in deepening accumulations of sediments, heat rises from below into the pile as its depth increases, as explained on page 258, and that the subterranean heat causes changes of level through the expansion and contraction of the rocks.

T. Mellard Reade, after a study of the expansion of heated rocks of different kinds, adopting the views of Herschel and Babbage, attributes flexures, and other effects attending mountain-making, not merely to the heat from below indicated by the rising isogeothermals, but also to additional heat at intervals from a succession of intrusions of igneous rocks consequent on the conditions. He styles his theory "the origin of mountain ranges by sedimentary loading and cumulative recurrent expansion," — recurrent because of the successive igneous intrusions. He found for the rate of expansion of average rock 2.75 lineal feet per mile for every rise of 100° F. The igneous intrusions are said to occur generally along the axis or axes of the range in process of construction.

The principle that loading causes subsidence of the crust has been supplemented by C. King (1876) with its apparent complement that unloading by denudation causes elevation, — he holding at the same time that these effects take place in a solid globe. The elevation of the Rocky Mountain area, during Tertiary time, is accordingly attributed by him to the removal, through denudation, of a vast amount of material from the vicinity of the Colorado cañon, and from other parts of the mountains.

With regard to the view of King, and especially this example under it, Le Conte has observed that the weight of the rock material elevated in the rise of the great mountain area to a height of 4000 to 11,000 feet was vastly larger than the amount lost by denuda-