ordinary daily and seasonal changes of temperature suffice to produce considerable superficial changes in rocks (see p. 559). The much higher temperatures to which rocks are exposed by subsidence within the earth's crust must have far greater effects. Some experiments by Pfaff in heating from an ordinary temperature up to a red heat, or about 1180° C., small columns of granite from the Fichtelgebirge, red porphyry from the Tyrol, and basalt from Auvergne, gave the expansion of the granite as 0·016808, of the porphyry 0·012718, of the basalt 0·01199.[6] The expansion and contraction of rocks by heating and cooling have been already referred to as possible sources of upheaval and depression (p. 494). Mr. Mellard Reade concludes from his experiments that the mean coefficient of expansion for various classes of rocks may be taken as $\frac{1}{190192}$ for each degree Fahr., which would be equivalent to an expansion of 2·77 feet per mile for every 100° Fahr.[7]

Crystallization.—In the experiments of Sir James Hall, pounded chalk, hermetically inclosed in gun-barrels and exposed to the temperature of melting silver, was melted and partially crystallized, but still retained its carbonic acid. Chalk, similarly exposed, with the addition of a little water, was transformed to the state of marble.[8] These experiments have been repeated by G. Rose, who produced by dry heat from lithographic limestone and chalk, fine-grained marble without melting. The distinction of marble is the independent crystalline condition of its component granules of calcite. This structure, therefore, can be superinduced by heat under pressure. In nature, portions of limestone

[6] Z. Deutsch. Geol. Ges. xxiv. p. 403.
[7] "Origin of Mountain Ranges," p. 110.
[8] Trans. Roy. Soc. Edin. vi. (1805), pp. 101, 121. See note on page 511.