

plate glass, at the Thames Glass Works, the contraction was 1.59 per cent, — 100 parts, by weight, becoming 98.41 (Mallet). In passing from the stone to the glass state, according to Delesse, granite decreases in density 9 to 11 per cent; syenite, 8 to 9; dioryte, 6 to 8; doleryte, 5 to 7; trachyte, 3 to 5 per cent. Cast iron loses in density on heating, and also on solidifying; trials gave a density of 7.214 when cold, 6.535 before fusion, and 6.883 when liquid (Hannay).

III. IGNEOUS ACTION AND ITS RESULTS.

Igneous action has its origin almost exclusively within the earth's heated interior. A few phenomena only are due to exterior agencies. Its chief direct results include: (1) the melting of rocks; (2) the eruption of melted or plastic rock from some subterranean source into or through fissures or spaces opened in the earth's crust, — thus making eruptive rocks; (3) the repeated eruption of melted rock, through long periods, from local vents, — thereby making volcanoes; (4) the imbibing by the melted rock, while on its way up, of vapors generated from ingredients encountered in the adjoining rocks, and especially of water-vapor, derived from the moisture of these rocks and from subterranean streams, — producing, in the melted rock, augmented mechanical and chemical powers; (5) the communication of heat and vapors to the adjoining rocks, — producing in these outside rocks chemical and physical changes. Earthquakes, solfataras, fumaroles, hot springs, geysers, and also mineral depositions and emanations in connection with the hot springs and fumaroles, are among the attendant results.

In the following pages the results of exterior agencies are first presented; and then those of interior origin, under the heads of Volcanoes, Non-volcanic Igneous Eruptions, and Geysers.

ACTION OF EXTERIOR AGENCIES.

Lightning, an electric discharge or a combination of them, occasionally leaves evidence of its intense heat on rocks and sand-heaps, by the fusion of the constituent minerals into a tube around its pathway, or in patches of glassy beads. The tubes, called *fulgurites*, have been observed in many places in the sands of dunes, descending to a depth of one to three feet; and one of ten feet is reported. They are one half to two or more inches across, often contorted, taper, and sometimes branch, downward. Tubes two feet long, found near Pensacola, Fla., consisted within of a bright clear glass almost free from grains of quartz (Diller, 1884). A fulgurite from the sand near Waterville, Me., has been described by W. S. Bayley (1872). The fulgurites in rocks occur especially about the summits of mountains. They have been observed in Mexico in the trachytic summit of Toluca (Humboldt); in Little Ararat, Caucasus, in augite-andesyte (Abich); on the top of Mont Blanc and at a dozen other points in the Alps; at many places in the Pyrenees; also in Oregon and Colorado.