

the surface, occasionally branch, and rapidly lessen in dimensions till they disappear. They are formed by the actual fusion of the particles of the soil or rock surrounding the pathway of the electric spark. They have been most frequently found in loose sand. Abich has observed examples of such tubular perforations with vitreous walls in the porous reddish-white andesite at the summit of Little Ararat.<sup>4</sup> A piece of the rock about a foot long may be obtained perforated all over with irregular tubes having an average diameter of 3 centimetres. Each of these is lined with a blackish-green glass. As the whole summit of the mountain, owing to its frequent storms, is drilled in this manner, it is evident that the action of lightning may considerably modify the structure of the superficial portions of any mass of rock exposed on lofty eminences to frequent thunderstorms. Humboldt collected fulgurites from a trachyte peak in Mexico, and in two of his specimens the fused mass of the walls has actually overflowed from the tubes on the surrounding surface.<sup>5</sup>

Effects of changes of temperature.—Of far wider geological importance are the effects that arise among rocks and soils from the alternate expansion and contraction caused by daily or seasonal changes of temperature. In countries with a great annual range of temperature, considerable difficulty is sometimes experienced in selecting building-materials liable to be little affected by rapid or extreme

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<sup>4</sup> Sitzb. Akad. Wiss. Wien, lx. (1870), p. 155.

<sup>5</sup> G. Rose, Zeitsch. Deutsch. Geol. Ges. xxv. p. 112; Gümbel, op. cit. xxxiv. (1882), p. 647; A. Wichmann, op. cit. xxxv. (1883), p. 849. Fusion by lightning was observed by De Saussure in hornblende-schist on the summit of Mont Blanc (see also F. Rutley, Quart. Journ. Geol. Soc. 1885, p. 152); by Ramond in mica-schist and limestone on a peak of the Pyrenees; by J. S. Diller on the basalt of Mount Thielson, Oregon, and on the top of Mount Shasta, California, Amer. Journ. Sci. Oct. 1884; by J. Eccles in glaucophane schist on Monte Viso, F. Rutley, Quart. Journ. Geol. Soc. xlv. (1889), p. 60.