endurance of the miners. The heat in this case was of local origin, as the region is one of former igneous eruptions.

2. The wide distribution of volcanoes over the globe affords evidence of internal heat. Moreover, the ejection of melted rock through fissures has taken place over all the continents; in Nova Scotia, Canada, New England, New Jersey, and the states south, the region of Lake Superior, the Rocky Mountains, and western America; in Ireland, Scotland, and various parts of Europe; and so over much of the globe. Such facts favor the idea of an internal source of heat. The heat of the earth's interior has reached toward or to the surface for geological work in three ways.

(*a*) *By conduction outward attending the earth's cooling.* — The amount thus received at the surface may have been sufficient to modify somewhat the temperature of the oceans, and the earth's climates, during early geological time. At present it is inappreciable; and yet, according to Kelvin, the amount of heat now lost by the earth, as a consequence of cooling, is such as would melt annually a complete covering of ice 0·0085 millimeter thick, to water at 32° F., or bring 777 cubic miles of ice to the same state.

(*b*) *By fractures of the crust, and the escape of melted rock or hot vapors.*

(*c*) *By an accumulation of sedimentary deposits over large regions.* — It follows from the conditions of a globe having an internal source of heat, that equal temperatures will exist, as a general thing, at equal depths; in other words, that isothermal planes, or more precisely, *isogeothermal*, will be parallel to the surface; and that they will even bend upward to correspond with the general curve of the broader mountain regions, and downward beneath the oceanic depressions. Consequently, the isogeothermal planes will rise a thousand feet for every thousand feet in depth of deposits spread out over a wide area; and, as urged by Babbage, solidification, crystallization, and other chemical changes may thus be occasioned in the inferior beds, *provided* the accumulation reaches a depth adequate to raise upward the requisite amount of heat.

Again, the removal of rock-material from wide areas, as is done in the slow processes of erosion, will tend to produce an equivalent depression of the isogeothermal planes.

Chemical and Physical Changes and Mechanical Action as Sources of Heat.

Heat is evolved by *chemical changes* in which there is condensation, as in liquids becoming solids, or gases becoming liquids, and in oxidation, etc. It is often an effect of the natural decomposition of minerals, or vegetable or animal matter. The oxidation of sulphides, and especially of the most common of them, pyrite and marcasite, is a source of heat in many mines, and for many warm springs. In the formation of a pound of water from vapor, heat enough is given out, says Tyndall, to melt five pounds of cast iron.

The *heat of lightning* has also its effects among geological phenomena.