aid of electricity to assist in the decompositions and recompositions that result from volcanic agency. By this means the temperature of the uncombined metals is raised, so as to cause them to become oxidized more readily.

Against the universality, at least, of both these theories, may be brought to bear the type of volcanic action in Mauna Loa and Kilauea. It is a quiet, gradual overflow, not a sudden decomposition and recomposition of elements, evolving great heat with explosive accompaniments. The chemical theories suppose violent action.

OBJECTIONS TO THE DOCTRINE OF INTERNAL HEAT.

Objection 1. *It has been maintained that the high temperature of deep excavations may be explained by chemical changes going on in the rocks;* such as the decomposition of iron pyrites by mineral waters, the lights employed by the workmen, the heat of their bodies, and especially by the condensation of air at great depths.

Answer. In the experiments that have been made upon the temperature of mines, care has been taken to avoid all these sources of error except the last (which are indeed sometimes very considerable), and yet the general result is as has been stated; nor is there a single example on the other side to invalidate that result. As to the condensation of air in mines, Mr. Fox has shown that the air which ascends from their bottom is much warmer than when there; so that it carries away instead of producing heat.

Objection 2. *The temperature of the ocean.* The temperature of the ocean diminishes as the depth increases; at first rapidly, then very slowly. The deepest measurements do not indicate any increase of heat, but only a uniform coldness. From observations made by Lieut. Maury and others, it is found that the change of temperature in the ocean is as follows: for the first 2,500 feet the temperature diminishes 40°; from 2,500 to 14,000 feet the reduction is about 3°. The temperature at any lower depth is unknown.

Answer. There are many local exceptions to this decrease of temperature, especially in northern latitudes; yet, on the whole, we should expect that the temperature of the sea would decrease downwards, until it had reached a temperature below which it would rarely descend; after which we should expect a uniform temperature to the greatest depths. Moreover, it is a fact that the warmest particles of a liquid body always rise to the top, as is the case in a vessel of water that is heated over a fire; that is, the strata of water arrange themselves according to their specific gravities. Hence we should expect to find the warmer portions upon the surface. The temperature of sea-water, at great depths, can never be less than 25.4°, because that is the point of its greatest density. If it was colder than this, it would rise, in consequence of being specifically lighter by expansion.

Objection 3. *Circulation of the internal heat.* If the central heat were as intense as is represented, there must be a circulation of currents, tending to equalize the temperature of the resulting fluid, and the solid crust itself would be melted. For example, if the whole planet were composed of water, the exterior crust of fifty miles thickness being condensed to ice, and the interior ocean having a central heat about 200 times that of the melting point of ice, then the ice, instead of being strengthened annually by new internal layers, would be melted, and the whole spheroid assume an equable temperature throughout. This is the objection of Sir Charles Lyell.

Answer 1. It is not essential to the doctrine of central heat that a temperature very much exceeding that requisite to melt rocks (6,400° F.) should exist in any part of the molten nucleus. It may even be admitted that the whole globe was cooled down very nearly to that point before a crust began