and depths within the volcanic fissure;[1] which seems to be much the same thing, and is certainly no original idea. Again, Mr. Mallet contumeliously rejects the common notion that volcanic eruptions act as "safety-valves" to the force which would otherwise produce destructive earthquakes.[2] Yet he himself argues that his crushing mechanism for producing the heat at intervals, which gives rise to volcanic eruptions, obviates the occurrence of paroxysmal "Cataclysms" which would probably destroy all living things upon the globe's surface. And what can be meant in this connexion by "Cataclysms" but earthquakes of tremendous violence?

Mr. Mallet claims for his theory the special merit of explaining the intermittent action of volcanoes, as well as the shifting of the active vents from one point to another of the main volcanic bands (§ 218). But these characteristics of volcanic action have been far more reasonably accounted for by the fact that the violent discharge of steam and lava during an eruption exhausts the energy of a volcano for a time; the lava sinking within the vent, and through the outward loss of heat cooled down and caked over with a solid crust, which for a time resists any further expansion by decrease of heat from below—perhaps even seals up the vent so firmly that the intumescent lava and vapour find an easier issue in some other more or less distant and weaker point of the main line of fracture (See Volcanoes, p. 41 *et seq.*, 228, etc.)

On the whole, while I admit the plausibility of Mr. Mallet's suggestion that some local development of heat must attend the crushing and squeezing of rocky matter during the internal movements to which their fractures and contortions, as well as the slaty cleavage of many, prove them to have been subjected, it appears to me that the phenomena rather indicate as the true source of the heat which has evidently occasioned the eruptions of both plutonic crystalline rocks and of volcanic lavas, that intensely heated interior (or nucleus), the existence of which is the first postulate of Mr. Mallet's own theory. And to the lateral shifting of the wave of heat outwardly transmitted from this source,—shifting caused by the varying impediments offered to the outward escape of this heat by conduction through superficial deposits,—I prefer to ascribe the internal movements that are observable alike in earthquakes and volcanoes, in elevations and depressions of the crust, and extravasations of the internal heated matter.

NOTICES OF MEMOIRS.

On the Geological Conditions affecting the Construction of a Tunnel between England and France. By Joseph Prestwich, F.R.S., F.G.S., Assoc. Inst. C.E.

Being the substance of a paper read before the Institution of Civil Engineers on Tuesday, December 9th, 1873. T. Hawksley, Esq., President, in the Chair.

THE author, in this paper, reviewed the geological conditions of all the strata between Harwich and Hastings on one side of the Channel, and between Ostend and St. Valery on the other side, with

[1] § 114. [2] § 221.

a view to serve as data for any future projects of tunnelling, and to show in what directions inquiries should be made. The points considered were the lithological characters, dimensions, range and probable depth of the several formations. The London-clay, at the mouth of the Thames, was from 200 feet to 400 feet thick, while under Calais it was only 10 feet, at Dunkirk it exceeded 264 feet, and at Ostend it was 448 feet thick. He considered that a trough of London clay from 300 feet to 400 feet, or more, in thickness, extended from the coast of Essex to the coast of France, and, judging from the experience gained in the Tower Subway, and the known impermeability and homogeneity of this formation, he saw no difficulty, from a merely geological point of view, in the construction of a tunnel, but for the extreme distance—the nearest suitable points being 80 miles apart. The Lower Tertiary strata were too unimportant and too permeable for tunnel work. The Chalk in this area was from 400 feet to 1000 feet thick; the upper beds were soft and permeable, but the lower beds were so argillaceous and compact as to be comparatively impermeable. In fact, in the Hainault coal-fields they effectually shut out the water of the water-bearing Tertiary strata from the underlying Coal Measures. Still, the author did not consider even the Lower Chalk suited for tunnel work, owing to its liability to fissures, imperfect impermeability, and exposure in the Channel. The Gault was homogeneous and impermeable, but near Folkestone it was only 130 feet thick, reduced to 40 feet at Wissant, so that a tunnel would hardly be feasible. The Lower Greensands, 260 feet thick at Sandgate, thinned off to 50 feet or 60 feet at Wissant, and were all far too permeable for any tunnel work. Again, the Wealden strata, 1200 feet thick in Kent, were reduced to a few unimportant rubbly beds in the Boulonnais. To the Portland beds the same objections existed as to the Lower Greensands, both were water-bearing strata. The Kimmeridge-clay was 360 feet thick near Boulogne, and no doubt passed under the Channel, but in Kent it was covered by so great a thickness of Wealden strata as to be almost inaccessible; at the same time it contained subordinate water-bearing beds. Still, the author was of opinion that, in case of the not improbable denudation of the Portland beds, it might be questionable to carry a tunnel in by the Kimmeridge-clay on the French coast, and out by the Wealden beds on the English coast. The Oolitic series presented conditions still less favourable, and the lower beds had been found to be water-bearing in a deep Artesian well recently sunk near Boulogne. The experimental deep boring now in progress near Battle would throw much light on this part of the question.

The author then passed on to the consideration of the Palæozoic series, to which his attention was more particularly directed while making investigations, as a member of the Royal Coal Commission, on the probable range of the Coal Measures under the South-East of England. He showed that these rocks, which consisted of hard Silurian slates, Devonian and Carboniferous Limestone, and Coal Measures, together 12,000 feet to 15,000 feet thick, passed under the Chalk in the North of France, outcropped in the Boulonnais, were again lost under newer formations near to the coast, and did not reappear until the neighbourhood of Frome and Wells was reached. But, although not exposed on the surface, they had been encountered at a depth of 1032 feet at Calais, 985 feet at Ostend, 1026 feet at Harwich, and 1114 feet in London. They thus seemed to form a subterranean table land of old rocks, covered immediately by the Chalk and Tertiary strata. It was only at the southern flank of this old ridge that the Jurassic and Wealden series set in, and beneath these the Palæozoic rocks rapidly descended to great depths. Near Boulogne these strata were already 1000 feet thick; and at Hythe the author estimated their thickness might be that or more. Supposing the strike of the Coal Measures and the other Palæozoic rocks to be prolonged from their exposed area in the Boulonnais across the Channel, they would pass under the Cretaceous strata somewhere in the neighbourhood of Folkestone, at a depth estimated by the author at about 300 feet, and near Dover at about 600 feet, or nearly at the depth at which they had been found under the Chalk at Guines, near Calais, where they were 665 feet deep. These Palæozoic strata were tilted at high angles, and on the original elevated area they were covered by horizontal Cretaceous strata, the basement beds of which had filled up the interstices of the older rocks as though with a liquid grouting. The overlying mass of Gault and Lower Chalk also formed a barrier to the passage of water so effectual, that the Coal Measures were worked without difficulty under the very permeable Tertiary and Upper Chalk of the North of France; and in the neighbourhood of Mons, notwithstanding a thickness of from 500 feet to 900 feet of strata charged with water, the Lower Chalk shut the water out so effectually that the Coal Measures were worked in perfect safety, and were found to be perfectly dry under 1200 feet of these strata combined. No part of the Straits exceeded 186 feet in depth. The author, therefore, considered that it would be perfectly practicable, so far as safety from the influx of the sea-water was concerned, to drive a tunnel through the Palæozoic rocks under the Channel between Blanc Nez and Dover, and he stated that galleries had actually been carried in coal, under less favourable circumstances, for two miles under the sea near Whitehaven. But while in the case of the London clay the distance seemed almost an insurmountable bar, here again the depth offered a formidable difficulty. As a collateral object to be attained, the author pointed to the great problem of the range of the Coal Measures from the neighbourhood of Calais in the direction of East Kent, which a tunnel in the Palæozoic strata would help to solve. These were, according to the author, the main conditions which bore on the construction of a submarine tunnel between England and France. He was satisfied that on geological grounds alone, it was in one case perfectly practicable, and in one or two others it was possibly so; but there were other considerations besides those of a geological nature, and whether or not they admitted of so favourable a solution was questionable. In any case, the author would suggest that, the one favourable solution admitted, it might be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those considerations the attention and deliberation which the importance of the subject deserved.

Granting the possibility of the work in a geological point of view, there were great and formidable engineering difficulties; but the vast progress made in engineering science during the last half century led the author to imagine that they would not prove insurmountable, if the necessity for such a work were to arise, and the cost were not a bar.

REVIEWS.

I.—THE COAL REGIONS OF AMERICA: THEIR TOPOGRAPHY, GEOLOGY, AND DEVELOPMENT. With a Coloured Geological Map of all the Coal Regions, and numerous other Maps and Illustrations. By JAMES MACFARLANE, A.M. Royal 8vo. pp. 680. (New York: D. Appleton & Co. London: Trübner & Co. 1873.)

MR. MACFARLANE'S work forms a most important addition to the geological literature of coal, and being well posted up as regards all the latest Reports of the Government Surveys, conducted by the best geologists in the United States, it may be looked upon as a most valuable addition to, and even as superseding, to a great extent, those works on the subject published some years since—such, for instance, as Taylor's "Statistics of Coal," and Prof. Rogers' "Geology of Pennsylvania."

The author points out that in America, as in this country, both anthracitic or steam coal and bituminous coals occur; but the comparative abundance is very different, as is also the relative distribution.

By far the most important and the best known coal, says Mr. Macfarlane, is anthracite. It is the universal fuel for domestic use in the United States, in preference to all other kinds of coal (p. 7). The largest area for this coal is that of the Anthracite Coal-fields of Pennsylvania, the total extent of which is 472 square miles, having an average thickness of 100 feet of coal.

The other regions, as the first or Alleghany Coal-field, the Pennsylvanian bituminous regions, the semi-bituminous coal regions of Blossburg, etc. (which latter, with 53 working companies, produced in 1871 a yield of 2,714,790 tons), the bituminous coal regions of Western Pennsylvania, Maryland, West Virginia, Ohio, Eastern Kentucky, Tennessee, Alabama, Michigan, Indiana, Illinois, Western Kentucky, Iowa, Nebraska, Missouri, Kansas, Arkansas, and Texas, are treated at considerable length, carefully prepared sections and maps being furnished to each area, showing the extent and thickness of the seams.

Chapters are also devoted to the Triassic Coal of Virginia and North Carolina; the Cretaceous Coal of the Rocky Mountains, Colorado, Wyoming Territories, and the Pacific Coast; besides the extension of the Carboniferous series into Canada and Nova Scotia.

https://doi.org/10.1017/S0016756800001813 Published online by Cambridge University Press