At the evening meeting Mr. Holmes, of Leeds, exhibited and explained a Safety Lamp, in which he had introduced a modification of the principle of Upton and Roberts' lamp, without being aware of what had been previously effected by other parties. Mr. Holmes's plan was, however, an improvement, inasmuch as it contained an apparatus for regulating the admission of air. The thanks of the Society were voted to Mr. Holmes for his communication, and he was earnestly recommended to continue his experiments.

The following paper was then read:

Observations on the Occurrence of Boulders of Granite and Other Crystalline Rocks in the Valley of the Calder, Near Halifax.—By Joseph Travis Clay, Esq., of Rastrick.

The subject of drifted boulders has latterly very much engaged the attention of geologists, and as there is great diversity of opinion regarding the means by which they have been removed into their present situations, every additional fact which may throw light upon the subject is valuable. I was therefore much interested in hearing from Dr. Alexander's paper on the geology of the parish of Halifax, that in prosecuting the works on the line of railway, some blocks of granite had been found near Hebden-bridge, and this has led me to an examination of the bed of the river Calder, at Cromwell Bottom, about eight miles below the above-mentioned locality.

At this place the valley expands considerably in width, and the river, winding from side to side, exposes a good section of the strata through which it passes. The stream has cut through a deep alluvial soil, about six feet in thickness, beneath which is a bed of large pebbles, containing some boulders of considerable size, the majority of which are of coarse-grained sandstone from the millstone grit series,
but mingled with these are many rounded fragments of granite and other crystalline rocks, whose original site is far distant. Some years since, the foundations of a mill were laid upon this gravel bed, but on its proving insecure, the gravel was found to be only a few feet in thickness and to be succeeded by a stratum of a soft peaty nature, so deep that a twenty feet pile did not reach the bottom.

This district of the West Riding is composed of very high ground, branching from the great summit ridge of England, and intersected by numerous deep valleys, whose general direction is nearly east and west. That the boulders could have been drifted over this mountainous country without leaving some traces of their course, is, I think, clearly impossible; and I may here remark, that on the adjacent hills not a pebble of any kind can be found. We must therefore look around for some other way of ingress; and before entering upon this branch of the inquiry I will briefly allude to those accumulations of drifted, or, as it is sometimes termed, diluvial matter, which over­spread many parts of England, as well as of the Continent of Europe, and which have long engaged the attention of geologists. This drift exists in great abundance in the central and eastern parts of Yorkshire, the regular strata along the whole coast line being generally surmounted by it to a considerable depth. It is also plentiful in Lancashire. The composition of the detritus is remarkable. The bulk is usually clay, with rounded masses of rock of the greatest variety of formation and diversity of size, interspersed throughout without the slightest degree of stratification, immense blocks being confusedly mingled with small pebbles.*

The action of water has usually been considered as the moving power; but as any current would naturally give

* For a minute description of this formation, see the 1st vol. of Professor Phillips's Illustrations of Yorkshire.
rise to some appearance of stratification, or at any rate to a sorting of the masses, the heavier parts first subsiding, recourse has been had to the theory of a violent rush of water, which, from the impetuosity of its course, would hurry onward in indiscriminate confusion every substance which came within its vortex. This has occasioned the use of the term diluvial, which has been used by many writers, but it is now rapidly giving place to the preferable appellation of drift.

There are many facts which militate against this theory. One fatal objection is, that the blocks have not always taken the same direction; for although it appears in general that they have a northern origin, which has given rise to the idea that the flood must have come from that point, yet this is far from being universally the case. Mr. Phillips, who has paid much attention to this subject, when describing the dispersion of the Shap Fell Granite, notices that at Stainmoor, directly east from Shap Fell, granite from Shap Fell and syenitic rocks from Carrock Fell have been drifted over the ridge. That barrier passed, the blocks are scattered to Darlington, Redcar, &c., and they have gone (south) down the vale of York. He then describes the course of the Cumbrian detritus northward to Brampton, and then eastward down the valley of the Tyne, though no streams now flowing there have any connection with the mountains from whence the materials came.

It is well known that after the last meeting of the British Association at Glasgow, M. Agassiz, in company with Professor Buckland, travelled through part of Scotland, where, as well as in the North of England, he detected many proofs of the former existence of glaciers of great extent. The large mounds of disturbed materials which abound in many of the valleys were pronounced by him to be moraines left by retreating glaciers, and in every respect similar to those now formed among the Alps.
I have carefully examined many of these mounds in the neighbourhood of Kendal, where they occur in great numbers; and in a short geological tour which I made into Teesdale a fortnight since, I saw them in still greater force; and I cannot think that any one, dispassionately viewing these heaps of unstratified matter, could attribute their origin to the action of running water.

The promulgation of M. Agassiz' theory has given rise to much discussion; and although some of the conclusions at which he arrives appear very doubtful, yet, so far as it supposes the existence of permanent snow and glaciers in the North of England and Scotland, it has met with the concurrence of many eminent geologists. Others, on the contrary, scout the idea of the climate of this country having ever been sufficiently rigorous to produce these effects. But when we refer to the actual condition of another part of the globe, in precisely the same latitude as England, this difficulty, in a great measure, vanishes.

To all who feel any interest on this question, I would recommend the careful perusal of the 13th chapter of Mr. Darwin's excellent work on the voyage of the ship Beagle, which was sent by the English government on a surveying expedition to the straits of Magellan and the coasts of South America. We there find accounts of glaciers of surpassing magnitude coming down to the water's edge in the latitude of Cumberland, and every means in constant activity which would be required to produce the effects under consideration.

It would be irregular at this time to enter fully into the consideration of the glacial theory; but I have thought it necessary to allude to it, in order to elucidate the opinions which I venture to express relative to the boulders to which I have called your attention.

That floating ice has been an agent in the transport of erratic blocks, is no new theory. It is distinctly laid down
in Mr. Lyell's Principles of Geology, a work which has been held in deserved estimation for many years. It only remains to be proved that we have grounds for attributing the appearances which I have described to its action.

There can be no doubt that some different conditions would be required to produce the alleged alteration in climate. The relative proportions of land and water are proved to have a great effect, not only upon the temperature, but also upon the humidity and transparency of the atmosphere; and that various causes combine to determine the limits of perpetual snow, is evident from many facts detailed by Mr. Darwin, in the work before alluded to.

Referring you again to the 1st vol. of Mr. Lyell's Principles, you will there find proofs that at the commencement of the tertiary epoch a large proportion of Europe was submerged: this is in strict accordance with the acknowledged fact of the gradual elevation of land. Now, supposing that at the period when the erratic boulders were removed from their original site, the land had not attained its present elevation, (say by only 200 feet) and the occurrence of recent shells at a great height above the level of the sea fully warrants that supposition, let us imagine what effect this change of level would have upon the contour of England, and more particularly of this district. All the lower parts of the country would be under water; the mountains of Westmoreland and Cumberland would form a centre, from whence elevated ridges would radiate; the range of which Blackstone-edge is a part, with all its numerous branches, would form a tract of high land, while the valleys of the Tees, the Swale, the Ure, the Aire, and the Calder, would be narrow arms of the sea, penetrating far into the land, for none of these rivers rise rapidly until they approach their sources. The vale of York would be a shallow channel, beyond which the Northern Moorlands and Wolds would rise above the waves.
A corresponding change in climate would accompany this diversity in the conformation of the land and water; and although the average heat of this quarter of the globe might not be much different from what is now the case, yet the change would have a tendency to promote the increase of permanent snow and ice in northern latitudes. In short, it would approximate to that now in existence in the southern hemisphere. Icebergs detached from the mountainous regions would float upon the sea, depositing their spoils as they gradually melted; while some being drifted up the narrow inlets, would convey the fragments into situations where their presence cannot otherwise be accounted for. That the boulders in question were transported by this means, I have no doubt, but further investigation is necessary satisfactorily to establish the point; and I hope at some future time to be enabled to adduce much additional evidence in support of this view.