

I believe that if such a scheme as this were put forward as a compromise, those who declined to consider it as a way out of the present *impasse* would put themselves in the wrong, in the minds of straight-thinking people who know the history of the question and the requirements of science taken as a whole.

It must be remembered that these museums, to obtain their highest use, must be in close association with institutions in which teaching of the corresponding sciences is carried on, and reciprocally the institutions for higher teaching and research which are already housed at South Kensington require museums of the several sciences in the immediate neighbourhood. In view of these requirements, the removal of one or other of the museums to a distant site is not a practicable alternative. By the compromise here suggested a real Science Museum, in its widest sense, would be established, with two branches dealing respectively with the natural history and the physical and mechanical sciences, in immediate contiguity to the Imperial College. It only wants a consideration of the many memorials presented to the Government since 1858, and of the recommendations of the Duke of Devonshire's Royal Commission of 1874, to be perfectly certain that in the future the two museums will be under one master instead of two.

NORMAN LOCKYER.

EARTHQUAKES AND LUMINOUS PHENOMENA.

IN vol. xiv., No. 6, 7, and 8, of the *Bollettina della Societa Sismologica Italiana*, we find a very long paper by Dr. Ignazio Galli on the collection and classification of luminous phenomena observed at the time of earthquakes. After an introduction, he considers that which might be excluded and the difficulties first met with in the formation of a catalogue of the phenomena he discusses. The illustrations which he gives of luminosities and other strange phenomena which have appeared at or about the time of earthquakes are 148 in number. The date of the first is 89 B.C., and the last March 30, 1910. These descriptions occupy 184 pages. The various luminosities are classified under more than twelve heads, and to these are added the number of times that earthquakes have been associated with vapours, smoke, and odours of sulphur or bitumen.

Seismologists have known for years past that certain earthquakes are said to have been accompanied by appearances of the Aurora Borealis, glimmering lights in the sky, fire-balls, *ignis fatui*, lightnings, corrustations and emanations from the soil, but this is the first time so large a collection of these phenomena have been brought together for their consideration.

When resident in Japan the present writer made many experiments extending over some years on electrical and magnetic phenomena associated with seismic disturbances. He also collected material from all parts of the world which bore upon these associations. One conclusion arrived at is that it is an undoubted fact that at the time of certain large earthquakes, as, for example, the one which in 1906 destroyed Valparaiso, curious lights which, in this instance, were compared to those of chain lightning, have been seen playing across the hills in the epicentral region. Observations of this nature led the writer to make experiments at Shide, in the Isle of Wight, and at the King Edward VII. Mine at Camborne, in Cornwall. The object was to determine whether there was or was not at

the time of a large earthquake a practically instantaneous transmission of energy to distant regions other than that recorded by seismographs. It was observed, and still is observed, by many persons that the face of a very large chalk pit at Shide exhibits, after dull damp days, a flaring luminosity. In a chamber at the end of a tunnel in this pit, a cylinder carrying photographic paper was installed. This cylinder was enclosed in a box, one end of which was a metal plate containing three holes. The plate touched a flat chalk surface. The cylinder took one week to turn; therefore parts of the paper before the holes were very slowly exposed to a chalk surface about $\frac{3}{16}$ th of an inch distant. On certain weeks the results were nil. Other weeks, after the development of the paper, there were three dark bands corresponding to the position of the holes, suggesting that the chalk had acted like an extremely feeble light. Another experiment was to place small pieces of photographic paper in envelopes, a certain number of which had a small glass window; these were placed against the face of the chalk. The image of the windows was frequently obtained, but nothing more than the effects of damp was found upon the others.

The conclusion arrived at was that the photographic effects were in no way connected with radio-activity, but they were probably electrical. The effects obtained in the granite of Cornwall were very marked and, like those observed in the Isle of Wight, varied in their intensity. As to the possibility of these effects being due to micro-organisms, a number of investigations were made, but there were no indications that organisms obtained from the chalk surfaces were connected with luminosity.

Whether these observations throw light upon differences in climate observed at different places, even though they may be near to each other, is a matter for conjecture, but future researches may show that the well-being of living things on the surface of our earth is more dependent upon its radiations than has hitherto been imagined.

I venture to refer to these experiments to show that the outcome of observations similar to those catalogued by Dr. Galli have not been overlooked in this country.

The 148 detailed descriptions which he has collected are used as subject-matter for twenty-six analyses. For example, did lightnings, thunderstorms, meteors, beams of light, luminous clouds, hot vapours, and other appearances precede, accompany, or were they noted after an earthquake? Dr. Galli says that sixteen of these analyses are nothing but the analytical *résumé* of the various phenomena which have been observed, and they therefore possess a real value which cannot be sensibly altered by any report that is ill-founded or untrustworthy. The remaining ten are provisional conjectures which await the judgment of physicists and seismologists. They will be confirmed or contradicted by future observations. If they fail, either partly or entirely, they will at least have the merit of having put the question as to certain probable causes of luminous phenomena connected with earthquakes. At the same time, as one heartily wishes, they may suggest hypotheses which are better, broader, and more synthetic than those the writer of the paper has brought forward.

Dr. Ignazio Galli is to be congratulated on his work, which directs attention to a neglected branch of seismology. When a face of rock 100 or more miles square is rudely pushed over another face, equal in area, it seems reasonable to suppose that such an adjustment should be accompanied by luminous and other phenomena.

JOHN MILNE.