

by Plateau: in Germany by Koch, W. Müller, and Zaddach, whose type species were very generously entrusted to Brady and Norman by Prof. Seeliger, of Königsberg. In France, the species have only quite recently been investigated by Moniez. Those of Great Britain are the only ones at all extensively worked out.

This monograph, which consists of 200 quarto pages, is illustrated with fifteen plates, and is published as Part II. of the fourth volume of the Transactions of the Royal Dublin Society.

The Harpur Euclid. Books I.—IV. By E. M. Langley and W. S. Phillips. (London: Rivington, 1889.)

THIS is an edition of the "Elements" "revised in accordance with the Reports of the Cambridge Board of Mathematical Studies, and the Oxford Board of the Faculty of Natural Science." The favourable impression made upon us by the two previous instalments of Books I. and II. is thoroughly confirmed by the additional matter now before us. We are not going to say that it is the best edition we have seen, for lately we have had under our notice two or three excellent works on much the same lines, but it is certainly not inferior to any of these, whilst for the arrangement of the text, the variety of type, and boldness and *correctness* of the figures, it is admirably adapted for school purposes. The editors, following on the lines of Mackay's interesting edition, have supplied ample store of illustration and historical matter, which will render the study of "Euclid" interesting to the intelligent boy. Not content with embracing within their net an account of Simson's line and the nine-point circle, Mr. Langley, in an article on the principal circles of a triangle, has given an excellent though brief description of the properties of symmedian lines and of the Brocard, cosine, and other modern circles, thus bringing the teaching of these circles within the range of the school curriculum. The exercises now reach the respectable total of 677, and to many of them useful hints for their solution are appended. We await the completion of the authors' task with interest, for a good work on elementary solid geometry is not altogether superseded by Nixon's admirable manual.

An Elementary Treatise on Mechanics. Part I. Statics. By Rev. J. Warren. (London: Longmans, Green, and Co., 1889.)

THIS is an elementary treatise intended for the use of schools and University students. The arrangement and methods of reasoning are best adapted for students who have made some acquaintance with trigonometry. At the same time a considerable portion of the book may be read by those students not possessing such mathematical knowledge. Each chapter contains a good selection of examples, some of which are worked out. This feature, together with the fact that the various theorems and results are very clearly established, will help to render the book a useful one. An experimental proof only is given of the parallelogram of forces, other proofs of which will be found in the second part of the work, which is devoted to dynamics. G. A. B.

LETTERS TO THE EDITOR.

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The Earlier Eruptions of Krakatão.

AT the time when a Committee of the Royal Society entrusted me with the preparation of a sketch of the geological facts bearing upon the great volcanic eruption of Krakatão in

1883, I was quite unaware that any reliable records concerning the early history of the East Indian Archipelago were in existence. I stated, therefore, that authentic history commenced only about three centuries ago, when the district began to be visited by the Dutch and Portuguese navigators; and that the earliest eruption of which we have any detailed account was that of 1680, described by Vogel and Hesse.¹

At the same time, however, I pointed out that the study of the geological structure of the district—so well described by Mr. Verbeek and by MM. Bréon and Korthals—especially when that structure was considered in the light afforded by other volcanic areas that have been investigated by vulcanologists, led to very definite conclusions as to what must have been the early history of the great volcano.

It was shown that Krakatão is situated on a fissure traversing the Sunda Strait and running at right angles to the great band of volcanic activity which traverses the islands of Java and Sumatra; and it was inferred that at a very early period a volcano of great height and bulk was built up at the point marking the intersection of the two lines of fissure; it was then stated that—

"At some unknown period this volcano became the scene of an eruption, or series of eruptions, which, judging from the effects they have produced, must have been on even a far grander scale than that which four years ago attracted so much interest. By these outbursts the whole central mass of the volcano seems to have been blown away, and only an irregular crater-ring left behind. The great crater thus formed must have had a diameter of three or four miles, and its highest portions could have risen but a few hundreds of feet above the present level of the sea."

After pointing out that this crater-ring became to a great extent filled up by a succession of smaller eruptions, I proceeded to say:—

"Whether the tract now constituting the Strait of Sunda was then dry land uniting the islands of Java and Sumatra, we have no means of determining; but I may point out that there are some grounds for believing that the formation of the depression occupied by the straits was subsequent to the evisceration of the volcano."

After stating what these grounds are, I added:—

"It seems not improbable that the depression between the islands of Java and Sumatra may have resulted from subsidences accompanying or following the ejections taking place at the great central volcanic focus of Krakatão" (*loc. cit.*, pp. 7-8).

I am greatly indebted to Mr. C. Baumgarten, of Batavia, who, through Dr. R. Rost, the Librarian to the India Office, has called my attention to some ancient records that seem to confirm, in a singularly striking manner, these conclusions arrived at by scientific reasoning.

Mr. Baumgarten writes as follows:—

"In a Javanese book called 'Pustaka Raja,' the 'Book of Kings,' containing the chronicles of the island, kept secret during centuries in the Royal Archives, and only recently made public, we find the following interesting and curious account of an eruption of the mountain Kapi:—

"In the year 338 Saka [*i.e.* A. D. 416], a thundering noise was heard from the mountain Batuwara,² which was answered by a similar noise coming from the mountain Kapi, lying westward of the modern Bantam. A great glaring fire, which reached to the sky, came out of the last-named mountain; the whole world was greatly shaken, and violent thundering, accompanied by heavy rains and storms, took place; but not only did not this heavy rain extinguish the eruption of fire of the mountain Kapi, but it augmented the fire; the noise was fearful, at last the mountain Kapi with a tremendous roar burst into pieces and sunk into the deepest of the earth. The water of the sea rose and inundated the land. The country to the east of the mountain Batuwara, to the mountain Kamula,³ and westward to the mountain Raja Basa,⁴ was inundated by the sea; the inhabitants of the northern part of the Sunda country to the mountain Raja Basa were drowned and swept away with all their property.

"After the water subsided the mountain Kapi and the surrounding land became sea and the Island of Java⁵ divided into two parts.

¹ "The Eruption of Krakatão and Subsequent Phenomena," Report of the Krakatão Committee of the Royal Society (1883).

² "Now called Pulosari, one of the extinct volcanoes in Bantam, and the nearest to the Straits of Sunda."

³ "Now called the 'Gedé' mountain."

⁴ "The most southern volcano of Sumatra, and situate in the 'Lampung' country."

⁵ "The Sanskrit *Yawa-dwipa*."

“The city of Samaskuta, which was situate in the interior of Sumatra, became sea, the water of which was very clear, and which was afterwards called the lake Sinkara.¹ This is the origin of the separation of Sumatra and Java.”²

Whether we are justified in accepting this date (A. D. 416) as that at which the very grand eruption of Krakatão, and the accompanying subsidence which led to the separation of Java and Sumatra, actually took place, I am not prepared to say. It may be that, as in many similar cases, the floating traditions of a grand catastrophe attached themselves to a subsequent event of a similar character. It is certainly very interesting to learn, however, that in the fifth century very grand volcanic outbursts were taking place in the district in question; and that a belief existed in the former connection of the islands of Java and Sumatra. Nor is it unimportant to discover that tradition is in complete harmony with scientific reasoning in assigning the separation of the two islands to actions occurring concurrently with great volcanic outbursts.

In concluding this note, I must express my great obligations to Mr. Baumgarten and Dr. Rost for bringing these important records under my notice.

JOHN W. JUDD.

On some Effects of Lightning.

PROF. McMILLAN'S interesting letter in NATURE of July 25 (p. 295) contains some minute details of the effects of a lightning-stroke on a house near Calcutta, on June 8 last. I agree with the writer that such cases are of value to electrical science, especially when reported by a competent observer. In Prof. McMillan's excellent letter there is one word to which I object, and that is “vagarie,” as applied to electricity at high potential. When lightning enters a house, it is as much subject to law as when it flashes from the cloud to the earth, and does not behave with the whim, caprice, or freak implied by the word “vagary.” In the absence of continuous conductors, the electrical discharge drags into its path light, conducting substances, which assist its progress, and by means of which it can strike through considerable distances and in various directions, as in the case before us. As to the effect of the discharge on the air of the house, Mr. McMillan appears to have made a real advance towards the solution of a difficult problem—namely, What is the origin of the powerful odour produced by a lightning-discharge within an inclosed space, such as a room or a ship? In most cases, the odour is compared to that of burning sulphur—“the ship seemed to be nothing but sulphur,” was entered in the log of the *Montague*, after having been struck by lightning. Now as far back as 1785, Cavendish's famous experiment proved that electrical discharges in a confined mass of air lead to the formation of nitric acid, and Liebig found that acid in seventeen samples of rain-water collected during thunder-storms. Nevertheless, with these facts before him, Snow Harris wrote: “From whence this odour arises is still an interesting problem in physics,” and he declines to discuss “those chemical views which some able philosophers have entertained of the nature of the odour emitted.” Arago also states that the odour is generally compared to that of burning sulphur; but he adds: “others compare it to phosphorus, others to nitrous gas”; and significantly remarks: “L'odeur de gaz nitreux seroit le plus facile à expliquer.” Now, Prof. McMillan has shown that nitrogen tetroxide, more or less diluted with air, was sufficient in the case so ably reported by him, to account for the colour and odour of the atmosphere produced within the house by the electric discharge. “The whole house seemed to be filled with an orange-coloured gas, mixed with clouds of dust affecting the breathing like fumes of burning sulphur,” is the description given by the occupier of the house.

Another point of interest in this valuable communication is the introduction of ball-lightning. Arago is sceptical as to the existence of ball-lightning (*éclairs en boule*), or that which moves through the air at a comparatively slow rate, appearing like a luminous ball or globe of fire. Faraday is also equally sceptical. But the well-attested cases of what we name ball-lightning, and the Germans *Kugelblitz*, are so numerous that they can no longer be termed, in Arago's language, “a stumbling-block (*pietre d'achoppement*) for meteorologists.” Snow Harris properly describes these luminous balls as a kind of brush or glow discharge. In the well-known case of the *Montague*, the

luminous ball was seen rolling on the surface of the water towards the ship from to windward; evidently a brush discharge, or St. Elmo's fire, produced by some of the polarized atmospheric particles, yielding up their electricity to the surface of the water. On nearing the ship, the point of discharge became transferred to the head of the mast, and, the striking distance being thus diminished, the whole system returned to its normal state—that is to say, a disruptive discharge ensued between the sea and the clouds, producing the usual phenomena of thunder and lightning, described by the observers as “the rising of the ball through the mast of the ship.” In Prof. McMillan's case I do not understand his remark that “no second ball was seen to enter from the opposite side to meet the first, and so produce the apparent explosion.” Surely a second ball was not necessary to produce the effect described—namely, “an intensely brilliant ball of yellow fire, about 6 or 7 inches in diameter, which passed from one end of the room to the other at a pace just sufficiently slow to allow it to be readily followed by the eye: it appeared to be momentarily checked, then burst with a deafening report, which shook the whole house.” In other words, it passed from a brush into a disruptive discharge.

Lastly, we have another remarkable confirmation of the fact that a lightning-conductor does not afford protection to surrounding objects. According to the French theory, a lightning-rod affords protection over a circle equal to twice its radius. But there are numerous cases to prove that no such radius of protection exists. The *Endymion* frigate, at Calcutta, in March 1842, was furnished with a chain conductor on the mainmast, but the lightning struck the foremast, shivered the topgallant and topmast, and damaged the lower mast. The mast struck was not above 50 feet from the mainmast. A somewhat similar accident happened to the *Etna* in Corfu, in January 1830. So also in the case that excited so much discussion at the time, the Board-house at Purfleet was struck on May 12, 1777, at a point about 40 feet from the conductor. A similar case occurred at the Poor-house at Heckingham in June 1781. So also in the recent Calcutta case, there was a conductor at one end of the building, projecting 8 or 9 feet above the roof-level. But the lightning entered the house by an iron-covered hatchway, 70 feet from the conductor, and near to a shell factory, which bristled with conductors.

Prof. McMillan properly attaches great value to such cases as the one he reports, leading as they do to the conditions which should govern the protection of buildings. In the course of a long experience, I have noticed that the profession which should be the best instructed on the subject, is—I hope I may say—the worst. When the new buildings for the Cholmeley School at Highgate were being erected, the head master consulted me as to the erection of a lightning conductor, and asked me to see the architect. That gentleman called on me and said, “We never put up these things; we don't approve of them. I never erected one in my life, and don't know how.” I once visited a church in Rutlandshire, that had been restored by Sir Gilbert Scott. The rector took me to one of the gable ends, and said, “You see, we have a lightning conductor, properly insulated by means of glass rings.” I replied that on visiting the granite lighthouse at the end of the Plymouth breakwater, I noticed that Faraday, in fixing a lightning conductor, had caused a spiral groove to be cut inside the shaft from top to bottom, for the insertion of a massive copper band, so as to make the conductor an integral part of the building. Snow Harris's method of protecting a ship applies also to a building. At whatever part of the ship or building the lightning may strike, it ought to find an easy metallic path to the sea, or to the earth. The late Prof. Clerk Maxwell, writing to me as to the best method of securing a building, proposed to inclose it with a network of good conducting material, such as a copper wire, No. 4 British wire gauge, to be carried round the foundation of the house, up each of the corners and gables, and along the ridges. Further details would occupy too much space on the present occasion.

Highgate, N., August 1.

C. TOMLINSON.

SOME weeks ago, two trees were struck by lightning near St. Albans, in Hertfordshire, the effects of which are most unusual. The two trees stood near each other in a wood called Symonds Hyde Wood. Assuming that the lightning struck downwards, it is easy to see in one case where the damage began—namely, at a place where a branch had by some means been broken off formerly, leaving a ragged break, into which no doubt water had soaked. Thence for some feet downward the effect was

¹ “The well-known Lake of the ‘Menang-Kebo’ country.”

² See the “Krakatãu Eruption and the Javanese Chronicles” in *Trübner's Record* for August 1889 (third series, v. l. i. pt. 3).