in the centre of a pit about five feet deep, called the ingot-pit. Around the circumference of this pit are arranged the cast-iron ingot-moulds, and the steel is drawn off from the ladle into them. A sample from each charge is tested by bending, punching, etc., and by analysis; so that an exact record is kept of each ten tons of steel. After a short interval, the ingot-moulds are lifted off: the ingots, which are approximately four feet long and twelve inches square, are taken from the pit, and loaded on cars, to be taken to the rail-mill. Thus far the methods are almost identical for all kinds of Bessemer-steel work.

The ingots arrive in the rail-mill at a dull red-heat on the outside, while the interior is at a much higher temperature. They are therefore placed in gas reheating-furnaces until at a uniform temperature, at which they can be easily worked. Following the course of one ingot, it is taken on a truck from the reheating-furnace to the rolls between which it is to be passed, and to emerge a long, perfectly shaped rail. The rolls are of cast-iron, and are in two sets, — the roughing-rolls and finishing-rolls. The first set consists of three rolls placed in a vertical row, and turning in a strong frame at each end. The ingot, or bloom as it is now called, is passed between the lower and middle rolls near one end, and is reduced in section, and lengthened. The platform on which it now rests is raised, and the bar is sent back between the middle and top rolls. The platform is lowered again; and, as it descends, a row of iron fingers, projecting up from beneath it, turns the bar, and moves it toward the middle of the rolls. Thus it is sent, through and up, back and down, moved from one end of the rolls to the other, being thereby reduced in section and correspondingly lengthened, until it finally leaves the roughing-rolls, having the approximate shape of a very large rail. As this bar goes through the roughing-rolls for the last time, another bloom is put on, and goes through for the first time at the other end of the rolls. Without a pause, the bar is carried along on revolving-rollers in a direct line to the finishing-rolls. These are two-high and reversing; being rotated first in one direction, and then in the other. The shape of the spaces between them is such that the last passage of the bar gives it the form and size of section required in the finished rail. After being sent through these rolls the necessary number of times, the finished rail-bar passes on in a direct line, as before, until it reaches a circular saw, which is swung up against it, and the rough or scrap end sawed off. The saw is swung to one side, and the bar moved along until the cut end comes against a stop-plate, which is at a distance equal to the length of one rail from the saw; and a slight motion of the saw cuts off the length. The stop-plate is swung to one side, and the rail is carried along to a large platform formed of rails laid at right angles to its direction. The rail is seized between a curved bar and a row of iron fingers which rise from beneath the platform or 'hot-bed,' and is bent. This is necessary in order that the rail shall be approximately straight when cold, as on account of the irregular shape of its section, if straight when hot, it would bend in cooling. After being bent, the rail is slid by the curved bar to either end of the hot-bed, where it is left to cool. When cool, any curves in its length are removed under a press; the rough edges left by the saw are removed with hammer, chisel, and file; the holes for the joints are drilled at both ends simultaneously; and it is loaded on a car close at hand, ready for shipment.

Each ingot makes four rails with two scrap-ends. The rail-bar, as it leaves the finishing-rolls, is thus about one hundred and twenty-two feet long. The weight of rail is regulated by adjusting the distance between the finishing-rolls, and gauging the length of the ingot in the mould. A different form of cross-section, of course, necessitates a change of finishing-rolls. From the time the ore is melted in the blast-furnace, until the rail is left on the hot-bed to cool, the temperature of the metal does not fall below that of a red-heat. ARTHUR T. WOODS.

THE GEOLOGICAL RELATIVES OF KRAKATOA AND ITS LATE ERUPTION.

Topographische en geologische beschrijving van een gedeelte van Sumatra's westkust. Door R. D. M. VERBEEK. Batavia, *Landsdrukkerij* (Amsterdam, *Stemler*), 1883. 20 + 674 p. 8°. Atlas of maps, and portfolio of plates. [Our figures, 1, 2, are from this work, with slight alteration.]

Kort verslag over de uitbarsting van Krakatau op 26, 27, en 28 Augustus. Door R. D. M. VERBEEK. Batavia, *Landsdrukkerij*, 1884.

IT happens well, that, just after the attention of the scientific world is called to the Dutch East Indies by the eruption of last August, there should be published an important work on the geology of a part of Sumatra, in which the relations and structure of the great Javanese and Sumatran chain of volcanoes are described with much thoroughness. We must congratulate Mr. Verbeek on the opportune appearance of his volume and atlas on 'Sumatra's westkust,' as well as on his prompt action in gathering material for a history of the outburst of Krakatoa, of both of which we can give but too brief a mention in this notice.

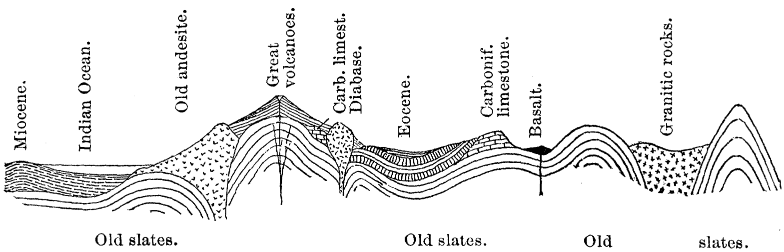
Introductory to these reports, one should read over K. Martin's review of the present knowledge of East-Indian geology,[1] which contains in an appendix a list of forty-seven publications on the subject; or the brief statements of the question by Verbeek himself that have been prepared for recent exhibitions;[2] and, in

[1] Die wichtigsten daten unserer geol. kenntniss vom niederländisch Ost-indischen Archipel. Bijdragen tot de taal-, land-, en volkenkunde van Neerlandsch-Indië, 1883.

[2] Descriptive catalogue of rocks, coal, and ores from the Dutch East-Indian Archipelago, prepared for the Melbourne international exhibition, 1880. (Batavia, Kolff.) Géologie des Indes néerlandaises, prepared for the international exhibition at Amsterdam, 1883.

the same connection, one should consult Verbeek's earlier report on southern Sumatra, which contains descriptions of Krakatoa itself before the eruption.[1]

Fig. 1 is taken from a series of generalized profiles illustrating the geological history of Sumatra. Archaean rocks are nowhere seen.



S.W. FIG. 1. N.E.

The oldest members of the series are non-fossiliferous slates and limestones, in places holding quartz veins that are sometimes auriferous, and cut by eruptives of the granitic group: these are overlaid by limestones, well proved to be of carboniferous age, cut by diabasic eruptives. Mesozoic strata are absent, implying a general elevation to a broad land-surface, followed in eocene time by depression again, during which workable coals were formed. There are other tertiary strata, such as the miocene beds of the small islands to the south-west, succeeded by broad quaternary deposits over the lowlands. The early tertiary eruptives (basalt and hornblende andesite) are relatively scarce, and are but dwarfs among the gigantic cones that have been heaped up since the end of tertiary time. These are chiefly augite andesite, mostly in the form of ashes and sand, holding larger blocks, but sometimes as dikes or lava-flows. They reach almost 3,000 metres altitude, flattening from a slope of 30° or 35° at the summit, to an almost level plain at the base, with a curve of descent that is shown to be closely logarithmic in its form. Krakatoa (here called Rakáta) is one of these cones, standing on the most south-eastern transverse group of the great range of Sumatran volcanoes, of which sixty-six are given in a list, and seven among them (not including Krakatoa) are marked active. A considerable share of attention is given to lithology; and on the atlas sheets, the different classes of eruptive rocks are distinguished. There are also special descriptions of the several craters formed successively about the great volcanic centres, — as on the summit of Merapi (fig. 2, ideal section), where four concentric walls, almost unbroken, stand one within the other, a gigantic cone-in-cone structure, — and also of the formation of volcanic lakes, from the small ones in the well-preserved craters, to the large basins of Maniendjoe (100 □ kilometres in area), the result of a central caving-in of a great volcano whose remains are seen in the surrounding Danan Gebergte, or Lake Mountains; and the still larger Singkarah (112 □ kilometres), formed by eccentric subsidence.

[1] Topographische en geologische beschrijving van Zuid-Sumatra. Door R. D. M. VERBEEK (215 p., with geological map, profiles, etc.); Jaarboek van het mijnwezen in nederlandsch Oost-Indië, 1°, 1881. Our figures, 5, 6, 8, are from this work.

The theory illustrated by von Hochstetter[1] is quoted to account for the mechanism of these changes. His figures are therefore here reproduced, with slight alteration, as of additional

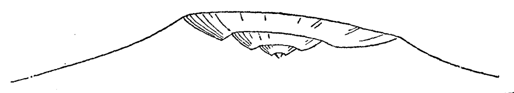


FIG. 2.

value from their acceptance by an observer practised in the study of volcanic phenomena on the largest scale. Fig. 3 shows the effect

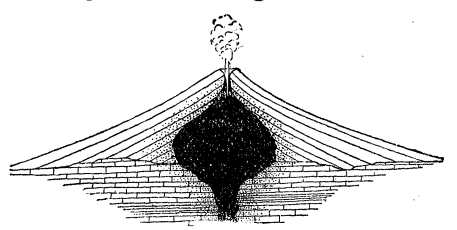


FIG. 3.

of continued eruption in melting the interior part of the cone previously formed: the volcano is here active. Fig. 4 shows the falling-

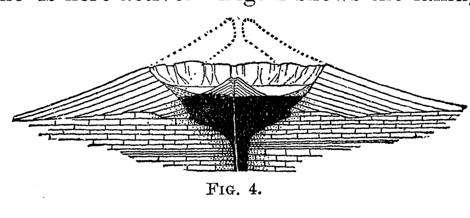


FIG. 4.

in of the cone when the molten interior is blown out, or allowed to sink, and, in this

[1] Ueber den inneren bau der vulkane. Neues jahrb., 1871, 469.

form, is applicable to the Oeloe-Danan volcano, shown in true proportions in fig. 5 (scale, 1: 20,000), or to Maniendjoe, and

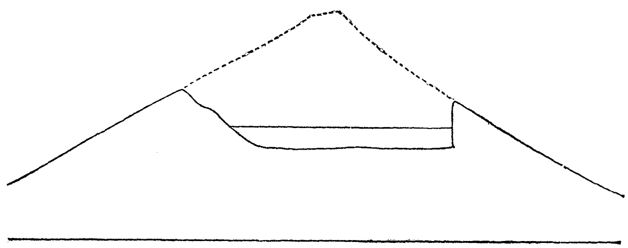


FIG. 5.

probably to Krakatoa: the volcano in this stage is dormant for a longer or shorter period. A renewal of eruptive action would build a new cone within the circular walls remaining from

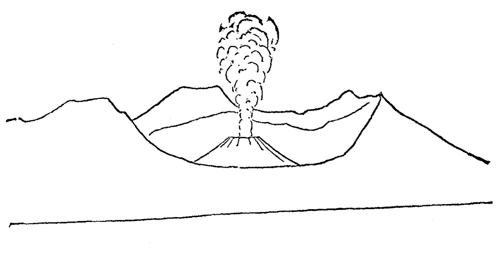


FIG. 6.

the old cone, like Vesuvius in Somma, or like the Vogelsang crater in the old Kaba cone, seen across the lower slope of the neighboring Tjoendoeng volcano in fig. 6: this has been three times repeated in Merapi, fig. 2. Finally, fig. 7 represents the molten interior, neither thrown out nor drained away, but allowed to stand and cool slowly into a solid crystalline mass, revealed in part by subsequent erosion: such a volcano is definitely extinct.

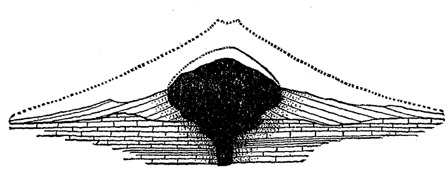


FIG. 7.

Mr. Verbeek shows himself to be one of the not very numerous geological writers who appreciate the needs of their readers. His reports open with brief abstracts of their results, from which these notes are in large part taken. On reading his abstracts, a general idea of the whole work is gained; then, by following the well-prepared table of contents, any special topic is easily discovered for closer study. The whole volume is very simply written, and well printed: it lacks only page-headings and index. The atlas sheets, on a scale of 1:100,000, are prepared with satisfactory neatness; but their topography is not so expressive as one might wish, nor are the profiles near enough a natural scale: but, apart from this, the work is most creditable to the Dutch colonial department.

The preliminary report on the eruption of Krakatoa gives a brief account of the results of the author's seventeen-days' trip in the region of the disaster, combined with general records of other observers. It is dated Buitenzorg, Feb. 19, 1884. The knowledge of the island before the eruption is based on the English and Dutch surveys, whose outline-maps have of late been frequently reproduced, and on sketches by Buijsken in 1849, and the author in 1880 (fig. 8). The northern, lowest summit threw out pumice in 1680, and, after two centuries' rest, began work again in May, 1883, continuing with irregular activity till Danan, the middle summit, joined it in the

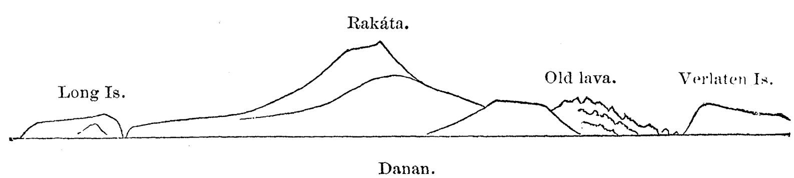


FIG. 8.—KRAKATOA FROM THE NORTH.

great explosions of August. The original area was $33\frac{1}{2}$ □ kilometres, of which 23 sank; leaving water 200 to 300 metres deep, except where a single rock rises 5 metres above the sea-surface. The remaining 10 □ kilometres — the background of fig. 8 — grew to $15\frac{1}{3}$ by addition of ashes on the south and south-west. In the same way, Long Island increased from 2.9 to 3.2; and Verlaten (Deserted) Island, from 3.7 to 11.8 □ kilometres. All these accumulations were made of ashes and dust; for, although molten lava doubtless existed in the crater, there were no overflowing lava-streams. The greater share of the erupted material fell within 15 kilometres of the island, where it attained depths of from 20 to 40 metres; rising even to 60 or 80 metres on the flanks of Rakáta (corrupted to Krakatau), the southern and highest part (822 metres) of the island. Fragments the size of a fist were thrown 40 kilometres from the volcano. Between Krakatoa and Sebesi, to the north, the ashes and pumice filled the sea at two points, forming low islands (Steers and Calmeijer), which have already been much broken and degraded by the waves. The sixteen little craters reported near where these islands stand have had no existence: they were only smoking heaps of ashes.

The precise hours of the heaviest explosions were not determined directly, but were based on the self-registering pressure-gauge of the gasometer in Batavia, as there was no self-registering barometer there. Making seven minutes allowance for the time of air-wave passage from the volcano to the gauge, the most violent eruptive action occurred at 5.35, 6.50, 10.5 (maximum), 10.55 A.M., Aug. 27, Batavia time. It was these air-shocks that were felt by barometers all around the world. In the May eruption, sounds were heard 230 to 270 kilometres; but in August the noise of the explosions was audible 3,300 kilometres from the island, or within a circle of 30° radius, equalling one-fifteenth of the earth's surface. The sounds spread irregularly; and it is suggested that the wind and the ashes in the air had much to do with the silence at points near which the eruption was distinctly heard. The eruption of Tomboro in 1815 was heard only half this distance; but the quantity of its ejected material (calculated from a correction of Junghuhn's data) was eight to eleven fold that thrown from Krakatau, which Verbeek determines to be close to 18 cubic kilometres. Two-thirds of this fell within 15 kilometres of its origin, as will be shown on an ashes-map, to be published in the final report. The ashes contain from sixty to seventy per cent of silica. Under the microscope, they show, 1°, glass in small, porous, irregular fragments; 2°, plagioclase felspar, with inclusions of glass, apatite, augite, and magnetite; 3°, pyroxene, probably rhombic as well as monoclinal, with inclusions of glass, apatite, and magnetite; 4°, magnetite in grains and octahedrons; this is the oldest component, and decreases in quantity on receding from the island. The great ten-o'clock wave, which it is thought resulted from the falling-in of the northern part of the island, following the most violent explosion, rose to heights of 30 and 35 metres on some of the neighboring coasts, and destroyed more than thirty-five thousand people. Maps, tables, and drawings are in preparation for a more detailed report; and this, in connection with the report we may expect from the sun-set committee of the Royal society, will form a most entertaining addition to the already interesting literature of volcanoes.

STOKES'S LECTURES ON LIGHT.

Burnett lectures on light. First course, on the nature of light. By GEORGE GABRIEL STOKES. London, *Macmillan*, 1884. 9+133 p. 24°.

THIS little book consists of lectures delivered at Aberdeen in November, 1883. They have their origin in an interesting manner, which is, perhaps, possible only in Great Britain. Just a century ago John Burnett, a merchant of Aberdeen, bequeathed a fund to establish prizes for theological essays. These prizes, a first and second, were to be competed for once in forty years; and awards have been made on two occasions since the foundation. In 1881, however, a new direction to the foundation was given by order of the secretary of state for the home department, in which it was provided that a lecturer should be appointed at intervals of five years, to hold office for three years. The subjects to be treated are, 1°, history; 2°, archeology; 3°, physical science; 4°, natural science. Professor Stokes was chosen as the first lecturer.

The lectures are unique, as far as our knowledge extends, in the effort to present the higher portions of optics without the employment of experimental demonstrations, diagrams, or mathematical language.

Whether the knowledge assumed in the reader, which does not include any thing of the theory or phenomena of interference, diffraction, double refraction, or polarization, is sufficient to enable him to understand every thing contained in the lectures, is problematical. But, at any rate, to those better equipped, the book gives a most concise and interesting review of the history of optics. A personal reminiscence of a conversation with Sir David Brewster (p. 15), the last great champion of the theory of emission, just after his return from Paris, where he had witnessed Foucault's crucial experiment regarding the velocity of light in air and in water, is highly interesting; for it shows us the singular motive which prevented even so acute a mind as Brewster's from yielding to overwhelming evidence: "he was staggered by the idea, *in limine*, of filling space with some substance merely in order