remove a misapprehension under which, it seems to me, that he was labouring, after perusing my report, with regard to the limit to which I suggest volumetric sizing. He seems to think I advocate that the grading of the sand, which has been separated, as far as feasible, from the slimes (which are to be subsequently classified separately in four Spitz-Kästen), should be effected through very fine sieves—60-mesh screens, or under. I quite agree that to attempt to do so would fail. Such, however, is not the meaning, or, I think, the construction which can be placed on the context of my report. A glance at the diagram illustrating the sequence of the methods of reduction, clearly shows, I submit, that it is only the *coarser sands issuing from the bottom of the slime separator*, that are subjected to "volumetric sizing" in a trommel, which classifies them into three grades, the finest being through a 40-mesh sieve, which is, I apprehend, practically, the most suitable grade for the Frue-vanners to do close work; the overflow from the concentrates flowing into the Spitz-Kästen.

I trust that these observations will dispel the misapprehension which your correspondent entertained on this point at the time when he wrote his article, as I respect his opinion, and would regret to be misunderstood by him. HENRY ROSALES.

I REGRET to have misunderstood Mr. Rosales, whose report is certainly entitled to most respectful and careful consideration. My mistake (a natural one, I think) arose from a statement made on p. 13 of the report. Here Mr. Rosales says, in speaking of the Johnson's Reef Gold Mines Company, Eaglehawk, that "the battery sand should previously be classified into different grades by 'sizing'. . . . Such could be accomplished by delivering it into trommels fitted with screens of different meshes. The mantel of the first trommel might be a sieve of 40 to 50 holes to the lineal inch, and the second trommel might be covered with *a screen of 64 holes to the lineal inch.* . . . This system of sizing would certainly be applicable." (The italics are my own.) On p. 50, where Mr. Rosales recurs to the subject of trommels, he does not mention any screen finer than 40-mesh, but, on the other hand, does not state that this is the finest that should be used, and refers to it merely in the following words:—"Supposing it [*i.e.* the trommel] to be covered with $\frac{1}{32}$ or $\frac{1}{40}$ wire gauze." Mr. Rosales' explanation will, I feel sure, be gladly received by others, besides myself, who have read his valuable report.

T. K. ROSE.

### Crush-Conglomerates in Ireland.

IN your issue of March 5 there is a letter from Mr. McHenry, in which he mentions the occurrence at Portraine and Lambay Islands, Co. Dublin, of conglomerates which he considers to be of the nature of crush-conglomerates. During the past two summers we have been examining these sections, and can corroborate Mr. McHenry's statements with regard to the presence of crush-conglomerates; but our investigations have not led us to conclusions altogether similar to his, with regard to the igneous rocks of the district. We hope to publish our results before very long. S. H. REYNOLDS.

C. I. GARDINER.

## *CLAUDIUS PTOLEMY AND HIS WORKS.*

CLAUDIUS PTOLEMY! What reader of the most elementary science is not familiar with his name, at least in adjectival form, in connection with the Ptolemaic system, and yet how little is known of him as a personality. That he lived in Egypt during the reigns of Hadrian and Antoninus Pius, and made astronomical observations chiefly on a terrace in Alexandria, sums up nearly the whole. But his works (addressed to Syrus, of whom also nothing is known) were the standards of authority in geography and astronomy for many centuries after his death; and though the tide of science has left them far behind, they can never be quite forgotten or cease to be of high interest in scientific history. His great astronomical work was translated into Arabic (changing its name in the process), and on the revival of learning in Europe was translated from that language into Latin, as it afterwards was from the original Greed. A French version was published by Halma at Paris in 1813-16, but no English rendering (except of small portions) has ever appeared. The British Museum Catalogue shows that our national collection contains a large number of Greek editions and Latin translations of the Almagest (as the Μαθηματικὴ Σύνταξις is always called, from the Greek for "greatest," with the Arabic definite article prefixed) and Geography of Ptolemy, as well as of most of his smaller works; Halma's editions of the Greek of the Almagest and Geography, with French translation in parallel columns; and Italian translations of the latter and of the Optics. Every student of Ptolemy must be under so much obligation to Halma, that it may be of interest to state that he was born at Sédan in 1755, and after being Principal of the college of his native town, became Professor of Mathematics at the Prytanée at Paris, where he held at various times other offices, one of them being that of librarian to the Empress Josephine. Besides his version of Ptolemy and of the not very lucid Commentary of Theon (father of the ill-fated Hypatia) on part of the Almagest, he published a French translation of the Phenomena of Aratus, and died in 1828. His edition of the Almagest is preceded by an elaborate and interesting preface, and has appended to it some Notes by Delambre. Two of Ptolemy's minor works, the Planisphærium and the De Speculis, appear to be extant only in Latin versions; the chronological table, however, of reigns up to his own time still exists in the original, whilst of the astrological work called "Tetrabiblos" or "Quadripartitum," we have not only the Greek, but Latin, French, and English translations.

The Almagest was so exhaustively examined and commented on by Delambre, that little can be added to his conclusions.[1] It is evident that Ptolemy's work is founded chiefly upon the observations of Hipparchus, which were made at Rhodes about three centuries before. Lord Macaulay's omniscient schoolboy probably believed that Ptolemy founded the system by which sun, moon, planets, and stars all moved round the earth, though the thought may have crossed his mind that this view was held before the appearance of the Alexandrian astronomer. This is, in fact, somewhat akin to the extensively-believed idea that Newton discovered the fact that external bodies are drawn or attracted to the earth. What is really due to Ptolemy as the author of the Ptolemaic system, is the reducing into a systematic form for explaining the planetary motions the ingenious imaginative machinery of epicycles and deferents. This is now so generally understood that we need not enlarge upon it here. It is almost remarkable that his discussion of the motions of the inferior planets, Mercury and Venus, did not lead him to the elaboration of the Tychonic system, something akin to which Vitruvius and Pliny seem to have had in mind, and which would in that case have held its ground for centuries; when actually started by the Danish astronomer, it was behind the age and soon stranded by the advance of science, his own contemporaries seeing that its cause was hopeless from the first. More credit is due to Ptolemy for his investigations respecting the motions of the moon, which led him to the discovery of the inequality known as the lunar evection. The inequalities he endeavoured to explain by epicycles, but for the latter he introduced in addition an eccentric, the centre of which turned about the earth in a direction contrary to that of the motion of the epicycle. A not inconsiderable portion of the Almagest is devoted to eclipses and their prediction; and we are indebted to Ptolemy for an account of three eclipses of the moon which were observed at Babylon in the years B.C. 721 and 720 under a king whom he called Mardokempados, but whose real name was Merodach-Baladan, and who, after a long contest, was completely crushed and de-

[1] A very able though shorter discussion is given in Narrien's "Historical Account of the Origin and Progress of Astronomy."

prived of his dominions by Sargon, the greatest of the Assyrian monarchs.

Ptolemy describes his method of attempting to determine the distances of the moon and of the sun. To the former he obtained a very fair approximation, making it equal to about fifty-nine semidiameters of the earth; but the sun's distance he thought to be only about 1210 of these semidiameters, or about twenty times the distance of the moon, which is in that unit only about the square root of its true amount. The eighth book of the Almagest contains the earliest extant catalogue of stars, founded upon that of Hipparchus. Six stars are marked red or reddish, one of which, Sirius, has ceased to be so, furnishing a remarkable instance of change of colour; the reading in Ptolemy was contested, but there is no real reason (as has been pointed out by Dr. See) to doubt its genuineness, and the red colour of Sirius in ancient times is confirmed by the testimony of several classical writers.

We must now turn from Ptolemy as an astronomer to Ptolemy as a geographer. If his work in the former department is founded principally upon that of Hipparchus, so does he take for the basis of his geographical system the work of Marinus the Tyrian, which in its latest form but little preceded his own. Those only who are ignorant of both can accuse Ptolemy of plagiarism in this, seeing how fully he recognises his obligations to his predecessor whilst pointing out the necessity of modifying some of his conclusions with regard to the most distant known regions of the world. But for Ptolemy, indeed, we, in these days, should never have heard of Marinus at all. "It is clear," says the late Sir E. H. Bunbury, "that he did not attempt to present his readers with a complete body of descriptive geography such as was furnished by the comprehensive work of Strabo. His object, like that of Eratosthenes at an earlier period, was simply to correct and reform the map of the world so as to adapt it both to the increased knowledge of distant countries and to the improved state of mathematical science, which were possessed in his day." Much more was then known than in the time of preceding geographers of the extent of Africa towards the south and of Asia towards the east; but, in applying this increased knowledge, Marinus exaggerated the extensions so greatly as to distort his map of the world almost as much as theirs, though in the opposite way. This led him to what was, to some extent, a retrograde step—the idea that Asia had an indefinite extension towards the east, similar to that entertained by Columbus when he expected to reach the Indies by a voyage to the west, little dreaming of another isolated continent between.

Ptolemy refers to his astronomical in his geographical work, so that the latter must have been composed subsequently to the former, and its date was probably near the end of the reign of Antoninus Pius, who died in A.D. 161. He fully appreciated the necessity, if positions in the world were to be accurately laid down, of determining their latitudes and longitudes and mapping them thereby. But, unfortunately, in his time the number of places for which this had been done was so small that he was obliged, to a very great extent, to rely upon results obtained from itineraries by the old rough method. These he places before us, both on his map and in extensive tables, as if they had been really founded upon scientific determinations. To quote Bunbury again: "He saw clearly the true principles upon which geography should be based, and the true mode in which a map should be constructed. But the means at his command did not enable him to carry his ideas into execution; the substance did not correspond to the form, and the specious edifice that he reared served, by its external symmetry, to conceal the imperfect character of its foundations and the rottenness of its materials." Some of the exaggerated conclusions of Marinus, particularly with reference to the distances of places in the east of Asia, he rejects, but can only suggest conjectural reductions of them. But even in lands within the bounds of the Roman Empire, few indeed were the places of which even the latitudes, still less the longitudes, had been scientifically determined. Hipparchus had suggested the observation of lunar eclipses at different stations as a means of finding the difference of longitude of these stations; but even in the time of Ptolemy, no such determinations had been actually made, though he refers to one which took place on September 20, B.C. 331, shortly before the battle of Arbela, or rather Gaugamela, which was observed, but not with sufficient accuracy to make it the basis of calculation. In inquiries of this nature, a remark made by the late Sir George Airy often comes into one's mind: "The first man who made good astronomical observations was the first man who made good clocks"—a graphic way of saying how essential was an accurate means of measuring time.

We have reserved but a short space to speak of what may be called Ptolemy's minor works. The principal of these are his Tetrabiblos or Quadripartite, which is in fact a treatise on astrology in the modern sense of the word, and his Harmonics, in which he gives an account of the theory of music. The former (as well as the Centiloquy, or hundred aphorisms, which forms a sort of supplement or summary to it) has been translated into English, the last time by J. M. Ashmand, whose version was published in 1822, and dedicated (like the Prince Regent's famous bumper in Scott's presence) to the author of Waverley. There does not appear any good ground for doubting its genuineness, though many have wished to do so from their admiration of Ptolemy, and feeling that it was unworthy of him. Great astronomers, however, in later times than that of Ptolemy, have believed in the delusive and imaginary "science" of judicial astrology, which still serves to charm some of the ignorant and foolish, and excite apprehensions in others of that still large family. The translator of the Tetrabiblos (who appeared before the public only in that capacity) had no feeling of this kind, and endeavours in a note to parry an objection to astrological predictions as old as the time of Cicero by citing a case of a man who, he tells us, was born within a few moments of George III., and in the same parish, went into business in the same month (October 1760) in which that king came to the throne, was married, like him, on September 8, 1761, and died, like him, on January 29, 1820, "coincidences," we are told, "highly remarkable." However, if any one can derive amusement from astrology, we need not object. Flamsteed drew the horoscope of the Royal Observatory, Greenwich, at the moment of its foundation, though he affixed a line from Horace asking who could forbear laughter. So we may take a few of Ptolemy's notions, one of which was that natural characteristics in different regions and climates was caused by the planets and constellations holding sway there, whence the inhabitants of Britain, for instance (and let us remember that by the argument this still applies), are, he tells us, wilder, bolder, and more ferocious than others.

Ptolemy's Harmonics was edited, with a Latin translation, by Dr. Wallis, in 1682, and an abstract of it is given in Rees's Cyclopædia. We cannot describe here his proposals for the reformation of the musical scale; but we cannot help regretting to find him, in the third book, going off into fanciful musical relations amongst the celestial spheres in a way which reminds us of some portions of his book on astrology.

Our author wrote a work on Optics, which is only known to us through Latin versions made from incomplete Arabic manuscripts. He is said to have discovered the fact of the refraction of the rays of light by passing through substances of different density; but, like

Descartes with regard to the law of this refraction, he was probably anticipated, and by a much longer interval. His Planisphere and other smaller works scarcely call for notice. On the whole, it may be said that Ptolemy was rather a collector and condenser of the scientific facts and methods than an original discoverer or investigator. And with all proper Baconian admiration for the wisdom of the ancients, we may be thankful that in our time, at least in the domain of natural science, the wisdom of the moderns has been added to it.

W. T. LYNN.

## *A VIEW OF KILAUEA.*

THE interest of Kilauea is perennial. Popocatapetls may arise in a night, or Krakatoas may be blown to shivers, and attention may thus be temporarily withdrawn from the great Hawaiian volcano. But such cataclysms are exceptional. Kilauea, on the other hand, is always available to the student of vulcanicity, while Dutton's beautifully illustrated memoir, and Dana's great monograph enable observers to use their opportunities to the fullest advantage. Dr. Benedict Friedlaender's papers in *Himmel und Erde* (Bd. viii. 1895) are the latest addition to the extensive literature upon this subject, and give a series of photographs, which are a useful supplement to those of the two American authors. Dr. Friedlaender's narrative shows that the mountain can now be studied without inconvenience. A good track runs from Kilo, on the north-eastern coast of Hawaii, to the summit of Kilauea. It passes first through plantations of sugar-cane and banana, and past clumps of screw-pine (*Pandanus*). At the height of about 1000 metres the tropical vegetation is left behind; trailing Freycinetias and great Cibotias give place to tree ferns and an undergrowth of plants of temperate affinities, such as cranberries (*Vaccinium*). On the north-eastern edge of the crater, at the height of 1230 metres, is a good hotel, in telephonic communication with the coast. Dr. Friedlaender's description of the mountain takes us over a good deal of old ground; but his account records recent changes, and his notes and views bring out several characteristic features of the volcano. In the first place he emphasises the fact that though Mauna Loa rises to the height of the Jungfrau, neither it nor Kilauea have any claim to be called mountains. Whereas some of the Italian volcanoes have slopes of 30°, that of Mauna Loa is only 6°, and that from the summit of Kilauea to the north-east cape of the island is only 1° 35′. The summits of the volcanoes are not mountain summits, but only a high plain. Orographically, Kilauea is only a lateral crater on Mauna Loa; but geologically they must be regarded as two distinct volcanoes, as eruptions sometimes take place on Mauna Loa, while the lava lake in the other is at rest. As Mauna Loa is 3000 metres higher than Kilauea, and the weight of a column of basaltic lava of that length is 900 atmospheres, this independence of the two volcanic centres appears at first sight to be in contradiction to the fundamental principles of hydrostatics. The author explains this by the assumption, that the lavas in the central pipe of Mauna Loa are of lower specific gravity than those of Kilauea, owing to the greater abundance of

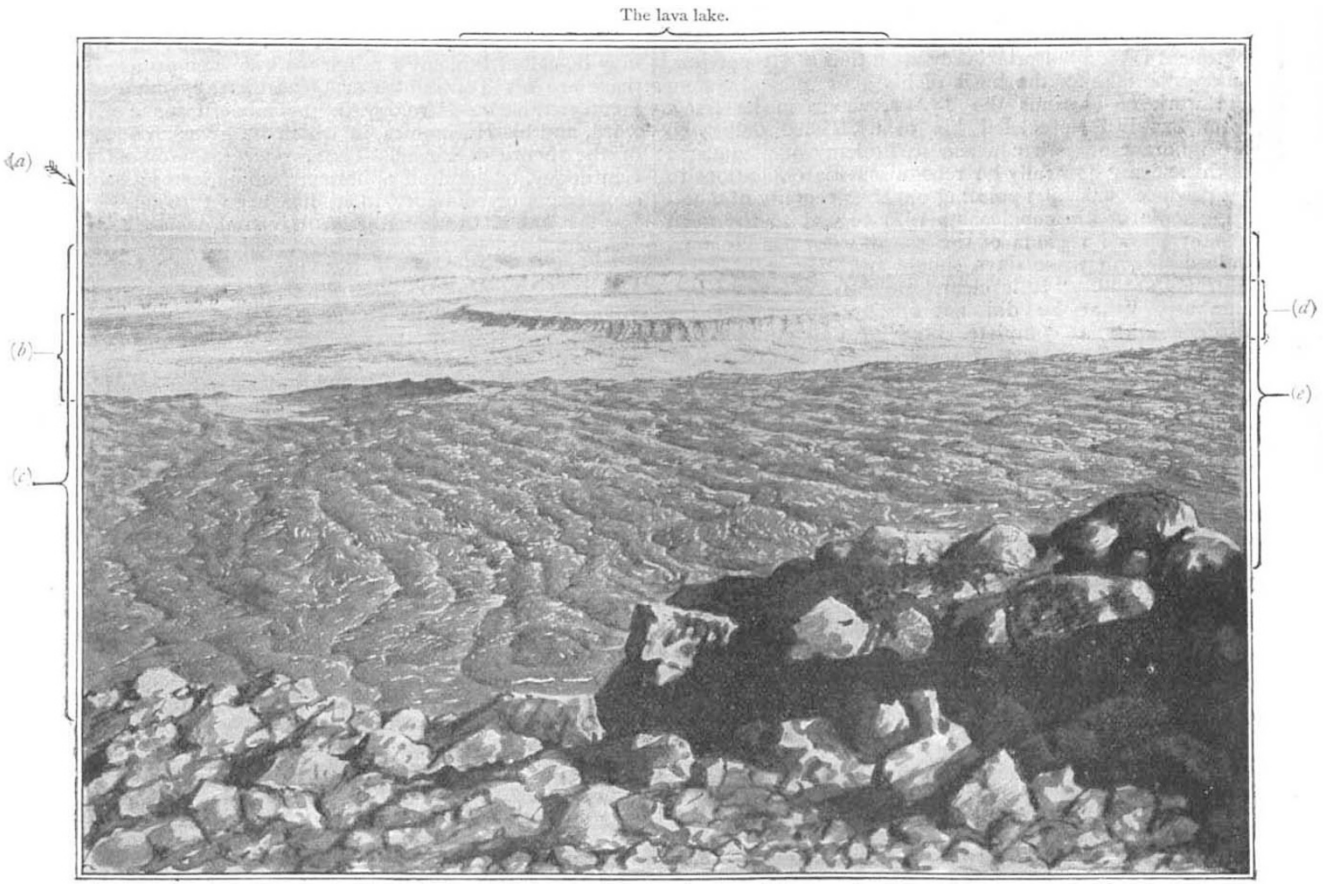


FIG. 1.—(*a*) Hut. (*b*) Margins of the secondary crater. (*c*) Margins of the primary crater. (*d*) Secondary crater. (*e*) Primary crater.