fluorine. When the mineral is broken up, a strong chlorine-like odour is perceptible; when heated with sulphur, an odour resembling that of sulphur chloride is evolved; the liquid in the mineral decomposes sodium chloride and iodide, with formation of chlorine and iodine respectively. On addition of dilute potash it yields a solution which instantly decolorises indigo solution. When the mineral is moistened with ammonia water, powdered, the liquid filtered off, neutralised with sodium carbonate and evaporated, a residue is obtained which, on addition of sulphuric acid, evolves hydrofluoric acid. Herr Löw thinks that the fluorine is produced by dissociation of cerium fluoride in the mineral.

THE application of potassium oxalate as a precipitant for many heavy metals, both in qualitative and quantitative analysis, is described by Herr von Reis in the *Berichte* of the German Chemical Society; the quantitative results obtained are very accurate.

THE reaction of bleaching powder on alcohol, which results in the formation of chloroform, is not thoroughly understood. M. Béchamp details experiments (*Annales Chim. et Phys.*), according to which no oxygen is evolved during the change, but only after the primary change is complete, and a secondary change begins when the reacting bodies have acquired a high temperature. The formation of chloroform is represented by M. Béchamp by the following equation, $2C_2H_6O + 4Ca(OCl)_2 = CaCl_2 + 2H_2O + 2Ca(OH)_2 + (HCO_2)_2Ca + 2CHCl_3$.

IN *Annali di Chimica* Signor Chiappe states that he has found spots of minium (Pb_3O_4) on various marble monuments, on parts of which bands of lead have been fastened. He supposes that by the action of the air and rain lead carbonate is produced, this is absorbed by the marble, and when exposed in places to the sun's rays it is decomposed with production of minium.

A VARIETY of coal, said to be the most highly-carbonised member of the coal series hitherto described, has been found near Schunga, on the western shores of Lake Onega (*Jahrbuch für Mineralogie*); it contains about 91 per cent. carbon, 7 or 8 per cent. water, and 1 per cent. ash. This coal is extremely hard and dense, has an adamantine lustre, is a good conductor of electricity, and has a high specific heat (0·1922). Although containing as much carbon as the best graphites from Ceylon, it is not a true graphite, inasmuch as it is not oxidised by potassium chlorate and nitric acid, but behaves towards those reagents like an amorphous coal.

FEDER AND VOIT have carefully repeated the experiments of Hallervorden on the effect of feeding with ammonium carbonate (*Zeitschrift für Biologie*). The results confirm the statement of the last-named author, that in dogs ammonium carbonate is converted into urea, and also show that ammonium acetate undergoes a similar change.

IT has been asserted that the employment of sodium nitrate in manures facilitates the solution and removal from the soil of plant-foods: Herr Fiedler has recently examined this subject experimentally, and he thinks himself justified in concluding that nitrates do not dissolve out any considerable quantities of plant-foods from the soil; that, within certain limits, absorption of phosphoric acid is favoured and absorption of potash slightly impeded by sodium nitrate; and that the same salt exerts a solvent action on *dibasic* phosphates of calcium, iron, and aluminium, but not on the *tribasic* phosphates of these metals.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday last, Lieut.-Col. C. E. Stewart, of the Bengal Staff Corps, read some portions of a paper which he had prepared on the country of the Tekke Turkomans and the Tejend and Murghab Rivers. Col. Stewart, it may be remembered, is one of the officers who was accused, in a recent official despatch from St. Petersburg, of "haunting the oases" in the Turkoman country: this paper was consequently looked forward to with much interest. He left Constantinople in April of last year, and proceeded in the first instance to Ispahan, where he spent two months and a half in the Armenian quarter of Julfa, making preparations for his journey, as he had determined to travel in the disguise of an Armenian horse dealer. On September 30 he went to Ardakan, where he assumed his disguise, and travelled in a north-easterly direction along the edge of the salt desert to Meshed, afterwards crossing the mountains to Mahomedabad. The account of this part of his journey, with its numerous adventures, Col. Stewart was unfortunately obliged to omit, owing to the length of his paper. Deregez, in which Mahomedabad is situated, is in the most northern part of North-east Persia beyond the mountains, and is some sixty-five miles long and forty broad; as it projects into the Turkoman country, it is a most favourable position for collecting information respecting the neighbouring country to the Caspian on one side, and to Merv on the other. Col. Stewart made Mohamedabad his head-quarters from November 25 to January 15, and during this time moved about in Deregez, but never crossing the Persian frontier, and obtained much interesting information by diligent inquiry among the Persian officials and the Turkomans whom he met. This particularly applies to the Merv district—for he denies the existence of a town of Merv—and the Murghab River. Col. Stewart also explained very clearly the Russian line of advance, and the present and future position of the railway question. It may be interesting to add that his disguise was completely successful, and entirely deceived even the Persian servant of Mr. O'Donovan, the enterprising correspondent of the *Daily News*, who is now detained in the Merv district.

THE fiftieth and last volume of the Geographical Society's *Journal* is chiefly occupied with Mr. C. R. Markham's history of the fifty years' work of the Society, which is at once valuable and entertaining. In it will be found detailed the actual circumstances attending the establishment of the Society, about which some misapprehension has hitherto prevailed. This took place in July, 1830, and the Society is therefore now fifty-one years old: after passing through many vicissitudes, which at one time threatened its very existence, it now numbers 3394 ordinary Fellows, and is the largest and wealthiest institution of the kind in the world. Mr. Markham, we may add, has been able to reproduce its first list of 460 Fellows, dated August 4, 1830. In a voluminous appendix, equal in length to the history, he furnishes complete lists of officers from the commencement, references to obituary notices of distinguished men, lists of explorers and geographers who have received medals, grants in aid of their work, &c., and of the papers and maps published by the Society. Lastly there is some interesting information respecting the Hakluyt Society. The few remaining pages of the volume contain notes on two maps of the Andaman Islands by Mr. E. H. Man and Lieut. R. C. Temple, and on the history and origin of the word "Typhoon," by Dr. F. Hirth, tables of altitudes in East Central Africa computed from 317 observations taken by Mr. Joseph Thomson during his recent East African expedition, and a narrative of a journey overland from Amoy to Hankow by Mr. E. F. Creagh. From a brief prefatory notice we learn that the issue of the *Journal* is to be discontinued, and that in future "elaborate papers of more than ordinary length and great value" will be published as supplements to the monthly *Proceedings*.

FROM the *Colonies and India's* Queensland notes we learn that Mr. Watson, in command of the Transcontinental Railway Survey, had crossed the Worna and Workingham Creeks in safety, and reported the soil magnificent and the grass splendid. The floods had however "sadly hampered the expedition," and this fully bears out the remarks made in NATURE, vol. xxiv. p. 114, as to the route for the line laid down on the Government map. It has lately been announced that General Fielding and Mr. J. Robinson, C.E., have gone out to make what is presumably an independent survey for a line, and we hope they may be able to find a more suitable route. The arrival of Mr. Watson's party at Point Parker, on the southern shore of the Gulf of Carpentaria, has since been announced by telegraph.

THE new *Bulletin* of the Bordeaux Society of Commercial Geography contains an address recently delivered before it by Capt. Gallieni, on his expedition, chiefly for surveying purposes, from the Senegal to the Niger. It is accompanied by a sketch-map of the region, on which the routes of the expedition are laid down.

PROF. ROWLAND'S NEW THEORY OF MAGNETIC ACTION

PROF. ROWLAND has lately published in the *American Journal of Mathematics* (vol. ii., No. 4; vol. iii., Nos. 1 and 2) a series of papers on "The General Equations of Electromagnetic Action with application to a New Theory of Magnetic Attractions, and to the Theory of the Magnetic Rotation of the Plane of Polarisation of Light." The papers, in addition to what is stated in their title, contain the mathematical consideration of that action of magnetism on electric currents which was lately discovered by Mr. Hall, and it is proved in them that, if Maxwell's theory of light be true, this action will explain the magnetic rotation of the plane of polarisation of light. These papers will no doubt be very extensively read, both on account of the interest of their contents and the great reputation of their author, and a brief discussion of them may therefore not prove uninteresting to the readers of NATURE.

We shall commence with the "New Theory of Magnetic Attractions." This theory is of the simplest kind, and obviously suggested by the mathematics of the subject. Since the magnetic induction is related to the distribution of the vector potential of magnetic induction in exactly the same way as the angular rotation of an element of fluid is to the distribution of velocity in the fluid, Prof. Rowland suggests that the magnetic field consists of a perfect fluid, whose velocity at any point is represented in magnitude and direction by the magnetic vector potential at the point, the vortex lines in this fluid are the lines of magnetic induction, and the velocity of angular rotation, is proportional to the magnitude of the magnetic force. Again, since 4π times the electric current is related to magnetic induction in the same way as magnetic induction to the vector potential, Prof. Rowland considers that an electric current consists of, as it were, vortices of vortices, or in other words, that certain irregular distributions of the vortices constitutes currents.

Maxwell has proved that the forces existing in the magnetic field could be produced by a certain distribution of stress in a medium filling the field. This stress in the simplest case consists of a tension along the lines of force equal to $\frac{H^2}{8\pi}$, along with a pressure at right angles to the lines of force equal also to $\frac{H^2}{8\pi}$, H being the intensity of the magnetic force.

Prof. Rowland goes on to show that this state of stress exists in the medium, which, according to his theory, fills the magnetic field; his proof is as follows:—"Conceive the fluid in a tube to be rotating around the axis with a certain velocity, and suppose the ends of the tube to be closed with movable pistons. Then, if the pistons are left free, there will be a centrifugal force against the sides of the tube proportional to the square of the velocity of angular rotation. If the walls are flexible and the piston immovable, then there will be a force tending to press the pistons in, and proportional also to the square of the velocity. According to our theory the magnetic force is the velocity of rotation, and so we have in the medium a tension along the lines of force and a pressure at right angles to them." Prof. Rowland does not seem to have noticed that this explanation requires the vortices to be of a finite size. It is easy to prove that in a cylindrical vortex of radius a, density ρ and angular rotation ω, the intensity of pressure on the circumference of the cylinder is greater than the mean intensity of pressure on the ends by $\frac{\rho\omega^2 a^2}{4}$; but if this is to explain the magnetic attractions the difference must be $\frac{H^2}{4\pi}$. Hence if $H = c\omega$, where c is a constant, we must have $\pi\rho a^2 = c^2$, $a = \frac{c}{\sqrt{\pi\rho}}$; we thus get a definite value for a, and the vortices must not be capable of division into bundles of smaller radius than a. Thus the fluid by which Prof. Rowland explains magnetic action cannot be the indefinitely divisible fluid treated of in theoretical hydrodynamics. It is worthy of remark that in the theory of magnetism put forth by Maxwell in the *Phil. Mag.* for 1861-62, and which agrees with the theory we are considering in explaining magnetic force by the angular rotation of a fluid, the vortices have a finite size, being done up as it were into cells, the space between the cells being filled with particles whose motion, according to Maxwell, constitutes electric currents.

Let us now go on to the explanation Prof. Rowland gives of the production of the magnetic field. He says: "Let the nature of electromotive force be such that it tends to form vortex-rings immediately round itself, not by action at a distance, but by direct action on the fluid in the immediate vicinity. The first ring will then move forward, another one will form, and so on until the whole space is filled with them, when there will be equilibrium." The consequences of this explanation, vague as it is, are somewhat startling. In the first place it is clear, from the properties of vortex motion, that every chain of particles of the fluid which possess rotation at any time must at some previous time have been in the immediate vicinity of the electromotive force; and since according to the theory there is rotation of the fluid at every point in the magnetic field, it follows that in the time taken to set up the field every particle of fluid in it has been in the immediate neighbourhood of the electromotive force. But magnetic disturbance is propagated, according to Maxwell's "Theory of Light" (which Prof. Rowland accepts), with the velocity of light; hence the streams of the fluid must be flowing with the velocity of light, and in addition every particle of fluid in the field must have rushed through the small space occupied by the seat of the electromotive force in the short time it takes to establish the magnetic field. Another difficulty which Prof. Rowland does not explain is the following: If we take a small element of electromotive force we know that to agree with the distribution of magnetic force all the vortex-rings must have the same sense of rotation; but if vortex-rings have the same sense of rotation they move through the fluid in the same direction, so that these vortex-rings when produced would all move off in the same direction, and thus leave one half of the field without rings, *i.e.*, without magnetic force. Again, the way in which these rings spread out so as to fill the field would seem to be in contradiction to the laws of vortex-motion; but as the author says he is investigating the dynamics of the subject, we may leave further comment on this point till the result of his investigation appears.

The explanation of the stress in the medium which we have referred to before is the only application of the theory worked out by Prof. Rowland. He does not explain by it any of the phenomena of induction, nor does he get from it any connection between statical and current electricity; yet he does not hesitate to speak of his theory "as one link in the chain, the first three links of which have been added by Thomson, Helmholtz, and Maxwell."

We must now leave this part of the subject and pass on to that portion of the paper which treats of the general equations of the electro-magnetic field. The mathematics of this is merely an application of the theory of the vector-potential to currents. The most important feature in the treatment of the subject is that Prof. Rowland always writes the product of the conductivity into the electromotive force instead of the intensity of the current, and claims that this is an important advance; but if there is any difference either Ohm's law must not be true, or Prof. Rowland must mean by electromotive force something different from that meant by ordinary users of the term. Prof. Rowland asserts that in an unlimited medium the action is not between magnets and currents, but between magnets and electromotive forces; he bases this assertion on the theorem that in an unlimited medium unclosed electric currents have no magnetic action. It is hard to see how this proposition can be true, for the current through any area is measured by the line integral of the magnetic force round the boundary of the area; but if the magnetic force is everywhere zero, then the line integral of it round any curve must vanish, and thus the current at any point must vanish. The proposition is based on reasoning of the following kind: the force between an electric point (by an electric point he means a point from which electricity is streaming, in fact what is usually called a source) and a magnetic pole must by symmetry be along the line joining them. But a magnetic pole of any size is always accompanied by one of the opposite sign, and the two form a vector quantity; and we think from the relation that one pole necessarily bears to another, it is not safe to reason about it as if it were a purely scalar quantity. Prof. Rowland himself acknowledges what is equivalent to this, for after saying that the force due to the unclosed currents on each pole of the magnet is zero, yet he says there is probably a force on the magnet as a whole tending to place it across the currents.

Although we think that the reasoning given for the assertion that the action is not between magnets and currents, but between magnets and electromotive forces, is unsatisfactory; yet we think that, understood in a certain sense, the proposition is mathematically true For we can prove directly from the ordinary expressions for the magnetic action of currents, that if we have a source and a sink of equal intensities ($4\pi m$) placed close together, the magnetic action of the currents produced is the same as that due to a current of strength *m* flowing along the short line joining the source to the sink. Now the current at any point produced by a source and sink placed close together at a distance *ds*, is exactly the same as the magnetic force at the same point produced by a magnet joining the source and sink, whose moment is *m ds*, and direction of magnetisation along the line joining the source and sink. Hence if we have any system of currents in the field, and find by the application of the methods given by Sir W. Thomson in his paper on "Inverse Problems" the distribution of magnetism which would produce a magnetic field such that the magnetic force at any point was equal in magnitude and direction to the current at the point, the magnetic action of the system of currents will by the proposition just stated be the same as that due to currents whose intensity and direction coincide with the intensity and direction of the magnetisation producing the said magnetic field. Thus instead of currents occupying the whole of the medium, we have only to consider currents occupying a limited portion of it. This is, we think, all that can be fairly stated about this point, and it will be seen that, to say the least, Prof. Rowland's statement that "the action in such a medium reduces itself to an action between magnets and electromotive forces instead of between magnets and currents," is not a clear way of putting it. Prof. Rowland in this part of the subject introduces a new term, viz., magneto-motive force; this is a force supposed to exist between two magnetic poles so as to cause the same number of lines of induction to pass between the points as to flow out of either of them; it is proportional to the magnetisation, and seems only introduced for the sake of making more evident the fact that currents are related to electromotive forces like lines of induction to magnetisation, or with the new terminology to magneto-motive forces. This was pointed out by Maxwell in his paper on "Faraday's Lines of Force" published in the Cambridge *Transactions* for 1856.

The last part of the paper, which is also the most interesting, contains the explanation, by means of the new action discovered by Mr. Hall, of the magnetic rotation of the plane of polarisation of light. By adding to the old expression of the electromotive force a term representing the force discovered by Mr. Hall, Prof. Rowland obtains an expression for the rotation of the plane of polarisation of exactly the same form as the one given by Maxwell in § 829 of the "Electricity and Magnetism."

J. J. THOMSON

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The report of the Botanic Garden Syndicate states that during the past year valuable additions have been made to the collections of ferns and orchids, and many choice stove and greenhouse plants have been received. The collection of hardy, herbaceous, and alpine plants has been much increased, and the rockery furnished with many rare alpine species. The genera Iris, Narcissus, and Helleborus have received special attention. During the year, 1594 labels have been written in large letters. The curator, Mr. Lynch, has extended the correspondence of the Gardens with botanic gardens, nurserymen, and private cultivators: 2600 plants have been received, and 1285 packets of seeds.

In consequence of the decision of the Duke of Devonshire in favour of the legality of the recent vote of the Senate admitting women to the Previous and the Tripos Examinations, the first lists in which the names of women who have passed the Previous and any Tripos Examination, have appeared in the University *Reporter*. In the Natural Sciences Tripos, Part 1, Class 2, is the name of Miss Anelay of Girton. In the Previous Examination twelve Girton students and two Newnham students have passed in one or more parts of the examination.

LOCAL LECTURES.—In spite of the removal of several important districts from the scope of these lectures by the establishment of local colleges, the numbers attending lectures during the past winter have been 4369 as against 5009 in the preceding winter; and the reduction in numbers is due to the absence of the South Wales centre from the lists, the Syndicate having been unable to make adequate arrangements for this district, owing to their engagements elsewhere. South Wales is again to be vigorously worked in the coming session. Dr. R. D. Roberts of Clare College has been appointed Assistant Secretary for the purposes of the local lectures. The courses of lectures on physical science subjects in the past winter have included Mr. Teall's on Early Man in Western Europe, and the Origin of Rocks and Scenery of the British Isles at Nottingham and Derby, Mr. J. E. Marr's on Geology at Carlisle and Penrith, Mr. E. Carpenter's on the Science and History of Music at Nottingham, and on Light at Chesterfield, Mr. Carr Robinson on Gases and on Chemistry at Hull, and by Mr. H. N. Read on Botany at the Crystal Palace.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, June.—The flight of birds and the mechanical principles involved, by A. C. Campbell.—Recent advances in photography, negative and positive, by J Carbutt.

Journal de Physique, June.—On registering apparatus for atmospheric electricity and terrestrial magnetism, by M. Mascart.—On radiophony (third memoir), by M. Mercadier.—On the contraction of galvanic deposits and its relation to Peltier's phenomenon, by M. Bouty.—Projection of the Lissajous figures with differences of phase variable at will, by M. Crova.—Production of electric currents in any system of fixed conducting wires, by M. Brillouin.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Vol. xiv. fasc. viii.-ix.—On the question whether American vines may be imported from phylloxerised or suspected districts without risk, by Count Trevisan.—Difference of longitude between the observatories of Genoa, Milan, Naples, and Padua, by Prof. Celoria.—On the stocking of Italian lakes with fishes, by Prof. Pavesi and Dr. Sulzer.—Toradelphia of a scorpion, by Prof. Pavesi.—Monstrosity of a fresh-water Crustacean (*Astacus fluviatilis*), by Prof. Maggi.—Cremation and legal medicine, by Dr. Biffi.

Rivista Scientifico-Industriale, No. 9, May 15.—Two new applications of the electric light, by Prof. Ferrini.—Mercury air-pump, by S. Serravalle.—New method of qualitative chemical analysis, by L. Mauri.

Atti della R. Accademia dei Lincei, vol. v. fasc. 12.—Description of a terrestrial *trombe* which occurred in 1456, by S. Blaserna.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 16.—"On the Reversal of the Lines of Metallic Vapours. No. VIII. (Iron, Titanium, Chromium, and Aluminium.)" By Professors Liveing and Dewar.

In their last communication on this subject the authors observed that iron introduced as metal or as chloride into the electric arc in a lime crucible in the way which had proved successful in the case of many other metals, gave no reversals. They succeeded however in reversing some ten of the brightest lines of iron, mostly in the blue and violet, by passing an iron wire through one of the carbons, so as to keep up a constant supply of iron in the arc. Considering the great number of iron lines, and that so many of them are strongly represented amongst the Fraunhofer lines, it seemed somewhat surprising that it should be difficult to obtain a reversing layer of iron vapour in the arc inclosed in an intensely heated crucible. A like remark might be made respecting titanium, which is almost as well represented as iron in the Fraunhofer lines, but has heretofore given no reversals. Almost the same might be said of chromium, except that the number of chromium lines is so much less than than that of either of the other two metals.

They have since found that most, if not all, of the strong lines of these three metals may be reversed by proper management of the atmosphere and supply of metal in the crucible. Indeed with regard to iron the method employed with other metals was successful so far as the ultra-violet rays were concerned, though it failed for less refrangible rays. When iron has been put into the crucible through which the arc of a Siemens' dynamo-electric machine is passing, and then fragments of magnesium dropped in from time to time, most of the strong ultra violet lines of iron are reversed. The magnesium seems to supply a highly reducing atmosphere, and to some extent carry with it the iron vapour. It also produces a good deal of continuous spectrum, at least in certain regions, and against this the iron lines are often depicted on the photographic plates sharply reversed. In this way the authors have observed the reversal of the strong