with many cuts.—C. E. Fritts, on the Fritts selenium cells and batteries. These cells, in which the light enters through a film of gold-leaf appear to have a much lower resistance than any other selenium cell.—Prof. E. J. Houston, on Delaney's facsimile telegraphic transmission. This number of the journal is also accompanied by reports of the Examiners of certain Sections of the late Philadelphia Exhibition, including electric telegraphs, dental appliances, and applications of electricity to warfare.

*Bulletin de l'Académie Royale de Belgique*, February 7.—Experimental and analytical researches on the action and concussion of gases at various temperatures, by M. Hirn.—A study of the physical aspect of the planet Jupiter, by F. Terby.—Researches on the spectrum of carbon in the electric arc in connection with the spectra of the comets and the sun, by Ch. Fievez.—Remarks on the application of electricity to aerial navigation, by MM. Gérard, Van Weddingen and Jacquet.—On the agreement between atmospheric variations and the indications of colours in stellar scintillations, by Ch. Montigny.—On the presence of chiastolite rocks in the Lower Devonian formation of the Belgian Ardennes, by E. Dupont.—A new formula applicable to the development of functions, and especially of integers, by Ch. Lagrange.—Remarks on Massy's Glossary of the Egyptian novel of Setna, by M. Wagener.—The death of Don Juan of Austria, by Baron Kervyn de Lettenhove.

*Engler's Botanische Jahrbücher*, Sechster Band (1885), Heft 1.—Œmilius Kœhne, Lythraceæ, der Bau der Blüthen. Though the majority of the plants of this order are clearly entomophilous, the author is compelled to regard certain species as cleistogamic, *e.g.* species of *Ammannia* and *Rotala*.—A. Engler, Beiträge zur Flora des südlichen Japan und der Liu-kiu-Inseln.—J. C. Maximowicz, *Amaryllidaceæ sinico-japonicæ*.—A. G. Nathorst, Notizen über die Phanerogamenflora Grönlands im Norden von Melville Bay.—Litteraturbericht.

Heft 2.—T. F. Cheeseman, Die naturalisirten Pflanzen des Provincial-Districts Auckland. The author is inclined to conclude that the struggle between the naturalised and the indigenous flora will result in a limitation of the distribution of the indigenous species, rather than in their actual extinction. It must be confessed, however, that some few indigenous species appear to have already become extinct.—A. Peter, Ueber spontane und künstliche Gartenbastarde der Gattung *Hieracium*, sect. *Piloselloidea*.—F. Hildebrand, Ueber *Heteranthera zosterifolia*. The plant develops differently according as it grows in shallower or in deeper water; in the latter case float-leaves are formed, which differ widely in form from the ordinary leaves of the plant (one plate).—Lad. Celakovský, Linné's Antheil an der Lehre von der Metamorphose der Pflanze. The author concludes, from careful study of the writings of Linnæus and his pupils, that Linnæus definitely laid down the fundamental principle of metamorphosis before Wolff and Goethe.—Litteraturbericht.

Heft 3.—Franz Buchenau, Die Juncaceen aus Indien (plates 2 and 3).—E. Hackel, Die auf der Expedition S.M.S. *Gazelle* von Dr. Naumann gesammelten Gramineen.—H. Dingler, Der Aufbau des Weinstockes (plate 4).—A. Engler, Beiträge zur Kenntniss der Araceæ, vi.—A. Engler, Eine neue Schinopsis.—Beiblatt, short notice of Apospory, and of Treub's discoveries on the sexual reproduction of *Lycopodium*.—Litteraturbericht.

*Journal de Physique*, March.—Prof. Mascart, on the employment of the method, of damping for determining the value of the ohm.—L. Bleckrode, experimental researches on the refraction of liquefied gases. These are determined by the method of De Chaulnes.—L. Cailletet, new apparatus for preparing solid carbonic acid.—M. Vaschy, note on the theory of telephonic apparatus.—G. Meslin, on the definition of perfect gases, and on the resulting properties. The author objects to the usual statement of the combined laws, because it rests upon the definition of temperature, which again rests upon the properties of perfect gases. He proposes to deduce all gaseous laws from the following definitions:—"A perfect gas is one which perfectly obeys the law of Mariotte at all temperatures, and for which there is no change in the (true) specific heat when the volume changes."—R. T. Glazebrook, on a method of measuring the electrical capacity of a condenser (abstract from *Phil. Mag.*).—C. R. Alder-Wright and C. Thompson, on the variation of chemical affinity in terms of electromotive force (from *Phil. Mag.*).—W. Hankel, on the electricity developed during certain processes evolving gases.—P. Kramer, Descartes and the law of refraction of light. A polemic to show that the accusation made against Descartes of having appropriated the discovery of Snell is unfounded.—A. Genocchi, on some writings concerning the deviations of the pendulum and the experiment of Foucault.

*Rivista Scientifico-Industriale*, March 15.—Some experiments made by Prof. Tito Martini with an accumulator of the Planté type modified by Antonio Trevisan.—Influence of the capacity of the condensor on electric sparks, and their duration in connection with the hypothesis which considers electricity as an incompressible fluid, by Dr. Pietro Cardani.—Remarks on the Trouvé universal incandescent electric lamps (continued; two illustrations), by the Editor.—Experimental researches on the action of boric acid in the human system in connection with epidemics and contagious diseases, by Prof. Philippo Artimini.—On a method for extracting chlorophyll, by E. Guignet.—On certain so-called "thunderbolts" of volcanic origin recently found on Mount St. Angelo, near Baccano, and in some other places east of Lake Bracciano, by Prof. G. Strüver.

## SOCIETIES AND ACADEMIES

### London

**Royal Society**, April 16.—"On the Agency of Water in Volcanic Eruptions, with some Observations on the Thickness of the Earth's Crust from a Geological Point of View, and on the Primary Cause of Volcanic Action." By Joseph Prestwich, F.R.S., Professor of Geology in the University of Oxford.

That water plays an important part in volcanic eruptions is a well-established fact, but there is a difference of opinion as to whether it should be regarded as a primary or a secondary agent, and as to the time, place, and mode of its intervention. The author gives the opinions of Daubeny, Poulett Scrope, and Mallet, and, dismissing the first and last as not meeting the views of geologists, proceeds to examine the grounds of Scrope's hypothesis—the one generally accepted in this country—which holds that the rise of lava in a volcanic vent is occasioned by the expansion of volumes of high pressure steam generated in the interior of a mass of liquefied and heated mineral matter within or beneath the eruptive orifice, or that volcanic eruptions are to be attributed to the escape of high pressure steam existing in the interior of the earth. The way in which the water is introduced and where is not explained, but as the expulsion of the lava is considered to be due to the force of the imprisoned vapour, it is, of course, necessary that it should extend to the very base of the volcanic foci, just as it is necessary that the powder must be in the breech of the gun to effect the expulsion of the ball.

The author then proceeds to state his objections to this hypothesis. In the first place he questions whether it is possible for water to penetrate to a heated or molten magma underlying the solid crust. The stratigraphical difficulties are not insurmountable, although it is well known that the quantity of water within the depths actually reached in mines decreases, as a rule, with the depth, and is less in the Palæozoic than in the Mesozoic and Kainozoic strata.

The main difficulty is thermo-dynamical. As the elastic vapour of water increases with the rise of temperature, and faster at high than at low temperatures, the pressure—which at a depth of about 7500 feet and with a temperature (taking the thermometric gradient at 48 feet per 1° F.) of 212° F., would be equal to that of one atmosphere only—would at a depth of 15,000 feet and a temperature of 362°, be equal to 10½ atmospheres, and at 20,000 feet and temperature of 467° would exceed 25 atmospheres. Beyond this temperature the pressure has only been determined by empirical formulæ, which, as the increase of pressure is nearly proportional to the fifth power of the excess of temperature, would show that the pressure, in presence of the heat at greater depths, becomes excessive. Thus, if the formulæ hold good to the critical point of water, or 773°, there would at that temperature be a pressure of about 350 atmospheres.

At temperatures exceeding 1000° F. and depth of about 50,000 feet, the experiments of M. H. St. Claire Deville have shown that the vapour of water, under certain conditions, probably undergoes disassociation, and, consequently, a large increase in volume. It would follow also on this that if the water-vapour had been subject to the long-continued action of the high temperatures of great depths, we might expect to meet with a less amount of steam and a larger proportion of its constituent gases than occurs in the eruptions. Capillarity will assist the descent, and pressure will cause the water to retain its fluidity to considerable depths, but with the increasing heat capillarity loses its power.

Taking these various conditions into consideration, the author doubts whether the surface-waters can penetrate to depths of more than seven to eight miles, and feels it impossible to accept any hypothesis based upon an assumed percolation to unlimited depths. That there should be open fissures through which water could penetrate to the volcanic foci, he also considers an impossibility.

But the objection to which the author attaches most weight against the extravasation of the lava being due to the presence of vapour in the volcanic foci, is, that if such were the case, there should be a distinct relation between the discharge of the lava and of the vapour, whereas the result of an examination of a number of well-recorded eruptions shows that the two operations are in no relation and are perfectly independent. Sometimes there has been a large discharge of lava and little or no escape of steam, and at other times there have been paroxysmal explosive eruptions with little discharge of lava.

There are instances in which the lava of Vesuvius has welled out almost with the tranquility of a water-spring. A great eruption of Etna commenced with violent explosions and ejection of scoriæ, which, after sixteen days, ceased, but the flow of lava continued for four months without further explosions. In the eruption of Santorin, 1866, the rock-emission proceeded for days in silence, the protruded mass of lava forming a hill nearly 500 feet long by 200 feet high, which a witness compared with the steady and uninterrupted growth of a soap-bubble. The eruptions of Mauna Loa are remarkable for their magnitude, and at the same time for their quiet. Speaking of the eruptions of 1855, Dana says there was no earthquake, no internal thunderings, and no premonitions. A vent or fissure was formed, from which a vast body of liquid lava flowed rapidly but quietly, and without steam explosions, for the space of many months.

On the other hand, paroxysmal eruptions are generally accompanied by earthquakes, and begin with one powerful burst, followed rapidly by a succession of explosions, and commonly with little extrusion of lava, although it is to be observed that a large quantity must be blown into scoriæ and lost in the ejections. Such was the eruption of Coseguina in 1835, and of Krakatoa in 1883. Sometimes in these paroxysmal eruptions there is absolutely no escape of lava, scoriæ alone being projected. A common feature in eruptions, and which indicates the termination of the crisis, is the stopping of the lava, though the gaseous explosions continue for some time with scarcely diminished energy.

There is thus no definite relation between the quantity of explosive gases and vapours and the quantity of lava. If the eruption of lava depended on the occluded vapour, it is not easy to see how there could be great flows without a large escape of vapour, or large volumes of vapour without lava. The extrusion of lava has been compared to the boiling over of a viscid substance in a vessel, but the cases are not analogous.

The only logical way in which it would seem possible for water to be present is on the hypothesis of Sterry Hunt who supposes the molten magma to be a re-melted mass of the earlier sedimentary strata, which had been originally subject to surface and meteoric action. But in the end the preceding objections apply equally to this view.

There is the further general objection to the presence of water in the molten magma, in that were the extrusion of lava due to this cause, the extrusion of granite and other molten rocks (which do not, as a rule, lie so deep as the lava magma) should have been the first to feel its influence and to show its presence. Yet although water is present, it is in such small quantities that these rocks never exhibit the scoriaceous character which lava so commonly possesses.

Nor is lava always scoriaceous, as it should be if the hypothesis were correct. Many lavas are perfectly compact and free from vapour-cavities, and so also are especially most of the great sheets of lava (basalt) which welled out through fissures in late geological times. These vast fissure eruptions, which in India and America cover thousands of square miles, and are several thousand feet thick, seem conclusive against water agency, for they have welled out evidently in a state of great fluidity, with extremely little explosive accompaniments, and often without a trace of scoriæ mounds. The general presence of non-hydrated rocks and minerals is also incompatible with the permeation of water which the assumption involves.

It has been suggested by some writers that large subterranean cavities may exist at depths in which the vapour of water is stored under high pressure, but the author shows that such natural cavities are highly improbable in any rocks, and impossible in calcareous strata.

The author proceeds to account for the presence of the enormous quantity of the vapour of water, so constantly present in eruptions, and which, in one eruption of Etna, was estimated by Fouqué to be equal to about 5,000,000 gallons in the twenty-four hours. He refers it to the surface-waters gaining access *during the eruptions* to the volcanic ducts either in the volcanic mountain itself, or at comparatively moderate depths beneath. He describes how the springs and wells are influenced by volcanic outbursts. By some observers, these effects have been referred to the influence of dry and wet seasons, but there are so many recorded instances by competent witnesses, as to leave little doubt of the fact. This was also the decision of the inquiry by the late Prof. Phillips, who asks, Why is the drying up of the wells and springs an indication of coming disaster?

The author then considers the hydro-geological condition of the underground waters. He points to the well-known fact, that on the surface of volcanoes the whole of the rainfall disappears at once, and shows that when the mountain is at rest, the underground water must behave as in ordinary sedimentary strata. Therefore, the water will remain stored in the body of the mountain, in the interstices of the rocks and scoriæ, and in the many empty lava-tunnels and cavities. The level of this water will rise with the height of the mountain, and he estimates that it has at times reached in Etna a height of 5000 to 6000 feet, while the permanent level of the springs at the base of the mountain seems to be at about 2000 feet. The water does not, however, form one common reservoir, but is divided into a number of independent levels by the irregular distribution of the scoriæ, lava, &c. These beds are traversed by vertical dykes running radially from the crater, so that, as they generally admit of the passage of water, the dykes serve as conduits to carry the water to the central duct.

Little is known of the sedimentary strata on which volcanoes stand. In Naples, however, an artesian well found them under the volcanic materials in usual succession, and with several water-bearing beds, from one of which, at a depth of 1524 feet, a spring of water rose to the surface with a discharge of 440 gallons per minute. When in a state of rest the surplus underground waters escape in the ordinary way by springs on the surface, or when the strata crop out in the sea, they then form submarine springs.

During an eruption these conditions are completely changed. The ascending lava, as it crashes through the solid plug formed during a lengthened period of repose, comes in contact with the water lodged around or, may be, in the duct, which is at once flashed into steam, and gives rise to explosions more or less violent. These explosions rend the mountain, and fresh fissures are formed which further serve to carry the water to the duct from which they proceed; or they may serve as channels for the sea-water to flood the crater, when, as in the case of Coseguina and Krakatoa, the volcano is near the sea-level. As the eruption continues, the water-stores immediately around the duct become exhausted, and then the water lodged in the more distant parts of the mountain rushes in to supply the void, and the explosions are violent and prolonged according to the available volume of water in the volcanic beds. When this store is exhausted, the same process will go on with the underlying water-bearing sedimentary strata traversed by the volcanic duct.

The author gives diagrams showing the position of the water-levels *before*, *during*, and *after* eruption; and describes the manner in which, if the strata surrounding the duct and below the sea-level become exhausted, the efflux of the fresh water which passed out to sea through the permeable beds, when the inland waters stood at their normal height above the sea-level, these same beds will in their turn serve as channels for the sea-water to restore the lowered water-level inland. Thus, the ex-current channels which carried the land waters into the sea-bed, and there formed, as they often do off the coasts of the Mediterranean, powerful fresh-water springs, now serve as channels for an in-current stream of sea-water, which, like the fresh water it replaces, passes into the volcanic duct. This agrees with the fact that fresh-water remains are common in many eruptions, and marine diatomaceous remains in others; also that the products of decomposition of sea-water are so abundant during and at the close of eruptions. With the fall of the water-levels, the available supply of water becomes exhausted, or the channels of communication impeded, and this continues until, with the ceasing of the extravasation of the lava, the eruption comes to an end.

The author then explains the way in which the water may gain access to the lava in the duct, notwithstanding heat and pressure. This he considers to be dependent upon the difference between the statical and the kinetical pressure of the column of lava on the sides of the duct. In the change from the one state to the other, when the lava begins to flow, and its lateral pressure is lessened, the equilibrium with the surrounding elastic high pressure vapour becomes destroyed, and the vapour forces its way into the ascending lava. As this proceeds, the heated water further from the duct, and held back by the pressure of the vapour, flashes into steam to supply its place. If that water should be lodged in the joints of the surrounding rock, blocks of it will also be blown off, driven into, and ejected with, the ascending lava, as have been the blocks in Somma and of other volcanoes.

It is the double action thus established between the inland- and sea-waters that has probably prolonged the activity of the existing volcanoes settled in ocean centres, or along coast-lines, while the great inland volcanic areas of Auvergne, the Eifel, Central Asia, &c., have become dormant or extinct.

But if water only plays a secondary part in volcanic eruptions, to what is the motive power which causes the extravasation of the lava to be attributed? This involves questions connected with the solidity of the globe far more hypothetical and difficult of proof. The author first takes into consideration the probable thickness of the earth's crust from a geological point of view, and shows, that although the present stability of the earth's surface renders it evident that the hypothesis of a thin crust resting on a fluid nucleus is untenable, it is equally difficult to reconcile certain geological phenomena with a globe solid throughout, or even with a very thick crust. The geological phenomena on which he relies in proof of a crust of small thickness, are:—(1) Its flexibility as exhibited down to the most recent mountain uplifts, and in the elevation of continental areas. (2) The increase of temperature with depth. (3) The volcanic phenomena of the present day, and the outwelling of the vast sheets of trappean rocks during late geological periods.

He considers that the squeezing and doubling up of the strata in mountain-chains—as, for example, the 200 miles of originally horizontal strata in the Alps, crushed into a space of 130 miles (and in some cases the compression is still greater)—can only be accounted for on the assumption of a thin crust resting on a yielding substratum, for the strata have bent as only a free surface-plate could to the deformation caused by lateral pressure. If the globe were solid, or the crust of great thickness, there would have been *crushing* and *fracture*, but not *corrugations*. Looking at the dimensions of these folds, it is evident also that the plate could not be of any great thickness. This in connection with the increase of heat with depth, and the rise of the molten lava through volcanic ducts, which, if too long, would allow the lava to consolidate, leads the author to believe that the outer solid crust may be less even than twenty miles thick.

That the crust does possess great mobility is shown by the fact that since the Glacial period there have been movements of continental upheaval—to at least the extent of 1500 to 1800 feet—that within more recent times they have extended to the height of 300 to 400 feet or more, and they have not yet entirely ceased.

With regard to the suggestion of the late Prof. Hopkins that the lava lies in molten lakes at various depths beneath the surface, the author finds it difficult to conceive their isolation as separate and independent local igneous centres, in presence of the large areas occupied by modern and by recently extinct volcanoes. But the chief objection is, that if such lakes existed they would tend to depletion, and as they could not be replenished from surrounding areas, the surface above would cave in and become depressed, whereas areas of volcanic activity are usually areas of elevation, and the great basaltic outwellings of Colorado and Utah, instead of being accompanied by depression, form tracts raised 5000 to 12,000 feet above the sea-level.

These slow secular upheavals and depressions, this domed elevation of great volcanic areas, the author thinks most compatible with the movement of a thin crust on a slowly yielding viscid body or layer, also of no great thickness, and wrapping round a solid nucleus. The viscid magma is thus compressed between the two solids, and while yielding in places to compression, it, as a consequence of its narrow limits, expands in like proportion in conterminous areas. As an example, he instances the imposing slow movements of elevation which have so long been going on along almost all the land bordering the shores of the Polar Seas, and to the areas of depression which so often further south subtend the upheaved districts.

With respect to the primary cause of these changes and of the extravasation of lava, the author sees no hypothesis which meets all the conditions of the case so well as the old hypothesis of secular refrigeration and contraction of a heated globe with a solid crust—not as originally held, with a fluid nucleus, but with the modifications which he has named, and with a *quasi rigidity* compatible with the conclusions of the eminent physicists who have investigated this part of the problem. Although the loss of terrestrial heat by radiation is now exceedingly small, so also is the contraction needed for the quantity of lava ejected. Cordier long since calculated that, supposing five volcanic eruptions to take place annually, it would require a century to shorten the radius of the earth to the extent of 1 mm., or about $\frac{1}{25}$ inch.

The author therefore concludes that, while the extravasation of the lava is due to the latter cause, the presence of vapour is due alone to the surface and underground waters with which it comes into contact as it rises through the volcanic duct, the violence of the eruption being in exact proportion to the quantity which so gains access.

**Geologists' Association**, April 9.—A short paper entitled Notes on the Oldhaven pebble-beds at Caterham was read by Mr. T. V. Holmes, F.G.S.. The workmen in the gravel-pits adjoining the Caterham Waterworks recently exposed a large cavity in the pebble-beds, which was visible when the writer and Mr. R. Meldola visited the spot in December last. It was cylindrical in shape, from ten to eleven feet in length, and from five to six in diameter, its axis being nearly vertical. Evidence of the existence of others was noted, and it was stated that similar hollows are by no means rare in these pits. These cavities doubtless owed their origin to the existence of pipes in the chalk beneath, which pipes, from the superior tenacity, here and there, of the upper strata of gravel as compared with the lower, had not been entirely filled up. Examples of similar hollows elsewhere were given. The existence of masses of unmodified "loam with flints" in the midst of the pebbles was also noted, and the writer explained how they might be accounted for without recourse to the hypothesis of glacial agency.—On the Glacial Drifts of Norfolk, by Mr. H. B. Woodward, F.G.S. After describing the general characters of the drifts in Norfolk, Mr. Woodward alluded to the difficulties in identifying the subdivisions in different areas, for the beds are variable and no infallible guides are furnished by lithological characters, fossils, or even by stratigraphical sequence. Looked at in a broad way, two divisions might be made out: (1) the Lower Glacial, including the Cromer Till, Contorted Drift, and the so-called Middle Glacial; and (2) the Upper Glacial, including the chalky boulder clay and cannon-shot gravel. These divisions are borne out in part by the evidence of superposition and by the character of the stones imbedded in the boulder clays, and in part by the evidence that the contortions in the Lower Glacial beds were produced by the agent which formed the chalky boulder clay. Mr. Woodward expressed his opinion that the shells found in the Middle Glacial sands did not belong to the Glacial period, but were derived in part from Pliocene strata north of Norfolk, now either entirely removed or buried up beneath the waters of the North Sea. The shells, which include forms that lived during the period of the coralline and red crags, were supposed by some authorities to have migrated from the Mediterranean area during submergence of the tract in Glacial times and at an interval when the climate was mild. Attention was drawn to the occurrence of boulder clay in the Middle Glacial deposits near Hertford; and it was pointed out that shells derived from the coralline and red crags had been found by Mr. T. F. Jamieson in the drift of Aberdeenshire, indicating that Pliocene deposits had formerly extended as far north as Scotland. Briefly alluding to the method of formation of the glacial drifts, Mr. Woodward passed on to notice the occurrence of Palæolithic implements. The mammalian remains associated with these belonged to the group which characterised the older Thames Valley deposits and were met with also on the Dogger Bank. When these deposits were accumulated, probably the Ouse joined the waters of the Thames and Rhine in the area now covered by the North Sea.

**Anthropological Institute**, April 14.—Prof. Flower, F.R.S., Vice-President, in the chair.—The election of J. G. Frazer, H. R. H. Gosselin, and J. Browne was announced.—Dr. J. G. Garson read a paper on the inhabitants of Tierra del Fuego. Three tribes inhabit the archipelago of Tierra del Fuego: they are called the Onas, who inhabit the north and east shores, and resemble the Patagonians in being a tall race, chiefly living by hunting, but supplementing their food with shell-fish and other marine animals; the Yahgans, who live on the shores of the Beagle Channel and southern islands, and are a short stunted race, subsisting almost entirely on the products of the sea and birds; the Alaculoofs, who dwell on the western islands and are very similar to the Yaghans. These last two tribes and their characters were chiefly discussed, being better known to us. They lead a very degraded life, wandering about from place to place, possess no houses, but construct shelters out of the branches of trees and build canoes of bark; they wear very little clothing of any kind. In stature they are short, the men averaging about 5 feet 3 inches and the women about 5 feet. In the character of their skull and skeleton they resemble the other wild native tribes of America, but by isolation have assumed certain characters peculiar to themselves. The population of the Fuegian Islands appears to be about 3000. Much information is still required regarding the people and their social customs. The osteological characters of the Yahgans were pointed out and discussed.

EDINBURGH

**Mathematical Society**, April 10.—Mr. A. J. G. Barclay, President, in the chair.—Mr. T. B. Sprague, F.R.S.E., contributed a paper, which was read by Prof. Chrystal, on the indeterminate form $0^0$; and Mr. John Alison discussed the properties of the so-called Simson line.

**Royal Physical Society**, April 15, Prof. John Duns, D.D., F.R.S.E., President, in the chair.—The President read a paper on Abnormalities of Development and the Reproduction of Lost Parts in Living Organisms, with exhibition of *Tiliqua fernandi*, and other specimens.—Mr. H. M. Cadell, B.Sc., H.M. Geological Survey, communicated notes on contorted shales below the Till in Craigleith Quarry. These were very fine examples, and he observed them below the boulder clay on the east side of the quarry in 1880. The non-bituminous shales overlying the sandstone were at some places turned up, and curled over as if by some heavy body, which might either have been the great ice sheet which moved from west to east across the country during the glacial period, or icebergs sailing along at a later part of the same period, and striking the bottom with projecting corners. The fact that the shales were twisted in different directions seemed to favour the iceberg theory in this instance. Mr. Cadell also referred to contortions of the edges of the same series of shales in the Suburban Railway cutting at Meggetland and near Craiglockhart Hill. Bending over of the edges of slates, &c., was sometimes seen in cases where the strata dipped at high angles into the face of a slope, and this might lead an inexperienced geologist into great perplexity. This kind of bending was due simply to gravitation, and had nothing to do with ice action. Mr. F. E. Beddard, M.A., F.R.S.E., F.Z.S., communicated a note on the anatomy of a new species of earthworm, belonging to the genus *Acanthodrilus*.—Mr. W. Ivison Macadam, F.C.S., referred to the presence of *Fragillaria* in enlarged quantities in the water supply of Elie, in Fife. The idatom was stated to be a somewhat rare one, and was found in the filter beds in such quantities as to form a complete coat, and to cause frequent renewal of the beds.

PARIS

**Academy of Sciences**, April 13.—M. Boulay, President, in the chair.—Theorems relating to the actinometric functions of movable plaques, by M. Haton de la Goupillière.—Remarks on the skeleton of a cave hyæna (*Hyæna spelæa*) discovered by M. Felix Regnault, and presented to the Academy by M. Albert Gaudry. These remains, recently found in the Gargas district, Upper Pyrenees, confirm the view already advanced by the author that the cave hyæna was merely a heavy variety of the *Hyæna crocuta* (spotted hyæna), still surviving in Central Africa.—On the pathogenetic and prophylactic action of the comma bacillus, by M. J. Ferran. From experiments made on several human subjects, whose names are given, the author concludes that by hypodermic injections of this germ, man, as well as the guinea-pig, may be infected with true cholera morbus, and that immunity from further attacks may be obtained by such injections in more or less graduated doses. He proposes to repeat the experiments here described in the presence of a Commission appointed by the Academy.—On the so-called "herpolhodie," a transformation on the fixed cone of the "polhodie," already described, by M. A. Mannheim.—Further results in the theory of matrices: their distribution into species, and formation of all the species, by M. Ed. Weyr.—A new method of determining the constants $\alpha$, $\gamma$, $\delta$, of the large mirror M of the sextant, by M. Gruey.—On the law of densities in the interior of the earth, in connection with M. Tisserand's theory of the figure of the earth, by M. R. Radau.—Resistance experienced by an indefinite circular cylinder immersed in a fluid to move as a pendulum in a direction perpendicular to its axis, by M. J. Boussinesq.—On the phenomena of diffraction produced by an opaque screen of rectilinear outlines, by M. Gouy. Two points are considered: the diffraction of light within the shadow of the screen when the ambient medium is more refringent than the atmosphere, and diffraction without the shadow of the screen.—On the phenomena presented by the permanent gases when evaporated in vacuum; on the limits within which the hydrogen thermometer may be employed, and on the temperature obtained by the explosion of liquefied hydrogen, by M. S. Wroblewski.—Influence of dilution on the coefficient of lowering of the freezing-point for substances dissolved in water, by M. F. M. Raoult.—On the vibratory forms of square plaques, by M. C. Decharme.—Description of some important improvements recently effected in the gas-heated thermo-electric pile invented in 1874 by MM. Clamond and J. Charpentier.—On a new electric pile acting with two fluids, by M. A. Dupré.—On the diurnal variation of the magnetic elements at the Parc Saint-Maur Observatory during the years 1883 and 1884, by M. Th. Morceaux.—On the depths to which the solar rays penetrate in marine water, by MM. H. Fol and Ed. Sarasin. From a series of experiments made in the month of March, 1885, at Villefranche-sur-Mer (Mediterranean) analogous to those previously carried out at the Lake of Geneva, the authors conclude that in fine weather the last rays of light are dissipated in the Mediterranean at a depth of about 400 m. below the surface.—On a remarkable deviation of the trajectory of a cyclone observed last February on the north-east coast of Madagascar, by M. Pelagaud. Almost for the first time since the Indian Ocean has been visited by Europeans—that is, the last four hundred years—a cyclone has visited the Island of Madagascar, causing great damage to the French fleet and other shipping along the north-east coast.—Note on the oxides of copper, by M. Joannis.—On the mutual attraction of bodies in solution and solid bodies immersed in the fluid, by M. J. Thoulet. In this second note the author shows that such mutual attraction exists that it is instantaneous, and that in the normal conditions it is directly proportioned to the surface of the immersed solid.—On a new process for preparing cyanogen, by M. G. Jacquemin.—Quantitative analysis of cyanogen mixed with carbonic acid, nitrogen, oxygen, and other gases, by the same author.—On the primary haloid derivatives of ordinary ether, by M. L. Henry.—On the existence of a nervous system in the Peltogaster: a contribution to the history of the Kentrogonides (Rhizocephals of Fritz Müller), by M. J. Delage.—On the nervous system of the Bothryocephalids, by M. J. Niemiec.—Notes on three new species of Ascidians from the coast of Provence, by M. L. Roule—A new contribution to the question of boric acid of non-volcanic origin, by M. Dieulafait. It is shown that boric acid is not always of volcanic origin, but that vast quantities exist in the salt lakes and saline marshes, all the elements of which are of a sedimentary character, and which amid more or less complex physical and chemical changes have still their first origin in the evaporation of normal marine basins.—On some specimens from a remarkable fossil forest in the Reserve of the Navajos Indians, Arizona, by M. E. Deste.—Note on the springs in the district of Gabes, North Africa, by M. L. Dru.—On the work being accomplished at the station of Kondoâ, established by the French section of the African International Society, by M. Bloyet.—On the influence of the nervous system on the temperature of the body, by M. Ch. Richet.—Studies on the inhalation of formene, and of monochlorurretted formene (chloride of methyl), by MM. J. Regnault and Villejean.—On the harmless character of the comma bacillus, and on the presence of its germs in the atmosphere, by M. J. Héricourt. The author finds that these organisms are normally present in all kinds of water, and in the form of spores or germs everywhere in the atmosphere. There are many varieties, some apparently identical with the comma bacillus of cholera.

BERLIN

**Physical Society**, March 6.—Dr. Kalischer described a new secondary battery intended to overcome the disadvantage of the usual accumulators, namely, that the sheet of lead used as anode got very soon destroyed. This object he attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided, as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As kathode a sheet of lead was used, but it was attended by two disadvantages. In the first place the lead, during the charge, separated itself at the kathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current). In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamising the kathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamised lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about 2 volts; after about six hours' discharge, however, the electromotive force sank to 1·7 volts, but, on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.—Prof. Schwalbe laid before the Society a piece of a piezometer which had burst under a pressure of ten atmospheres. The rather thick glass was traversed by longitudinal fissures, distributed with perfect regularity and exactly parallel to each other.—Prof. Schwalbe further spoke of the ice-outcroppings, resembling asbestos and glossy-like silk, which emerged on old, decayed twigs and branches, and which he had observed in former winters. He supposed that they originated in the crystallisation outwards of needles of ice from the water in the interior of the wood under moderate and slowly advancing colds. This winter also, as in former winters, he had succeeded in effecting these glacial outgrowths artificially on some twigs, by impregnating them with water and then exposing them to a slow increasing cold of from $-2°$ to $-3°$. To test the accuracy of this hypothesis, he instituted experiments with solutions of salt. A solution of nitre gave very satisfactory results. When a decayed twig was thoroughly saturated with a solution of nitre, and then left to evaporate, there then cropped out on it delicate glossy protuberances, perfectly similar to those observed in nature on moist pieces of wood. In this last case it was impossible that any increment could come from the outside; these crystal needles could have grown only from the interior. With the cube-crystallising kitchen salt, on the other hand, the experiment did not succeed. The speaker related that the first observations of these ice outcroppages were made by the Duke of Argyll. The pillar-like outgrowths which in recent times had been largely observed by English naturalists, and which he had formerly observed and described, were, in the opinion of the speaker, likewise excrescences from the interior.—Dr. Kayser read a paper, sent in by Dr. Müller-Erzbach, in which the latter endeavoured to refute some objections raised against his experiments, communicated to the Society at the last sitting, respecting the magnitude of the sphere of influence of molecular attraction.

March 20.—Dr. Gross, starting from theoretical considerations, instituted the following experiment:—Two iron electrodes overlaid with sealing wax, in such a manner a to leave only the terminal planes free, were dipped into solution of chloride of iron, closed by means of a galvanometer into a circle, and any inequalities there might happen to be adjusted according to the Poggendorf-Du Bois-Raymond method. When now one electrode was surrounded by a magnetising spiral, there was seen, on its being magnetised, an electric current passing from the magnetic electrode through the fluid to the non-magnetic electrode. It might be thought that the current was a thermo-electric one, produced by the warming of the magnetising spiral; but a delicate thermometer showed that the air within the magnetising spiral was but 2° warmer than the surrounding air. Besides, the electrode that was to be magnetised was surrounded by a double cylinder, through which water of a temperature 12° below that of the air, was constantly flowing; and yet, notwithstanding this powerfully cooling influence, the current always passed from the magnetic to the non-magnetic electrode, whereas a thermal current must have passed from the warm to the cold electrode. The electric current was therefore produced, not by a difference in temperature, but by the magnetisation of the one electrode. The current continued so long as the electrode was magnetised. If the electrodes were now brought into a tube, and so arranged as to lie behind each other in the axis of the tube, with their free terminal planes turned to each other, then, on the magnetisation of one electrode, an electric current again set in, passing now, however, from the non-magnetic electrode, through the fluid, to the magnetic electrode. The direction of the current was consequently dependent on the direction of the magnetic axis to the electrolyte and the second electrode. As conducting fluid only sulphates of iron could be used in these experiments, and of these only such as received the free terminal plane of the electrodes nakedly. Dr. Gross believed that the currents demonstrated by him in the experiments thus described were related to the thermo-electric currents between magnetic and non-magnetic iron wires, which were a subject of study to Sir William Thomson.

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