He noticed that the stars moved in ellipses every year round a mean point. This fact of aberration, then, is a real thing. It has been said that the angle at which the tube had to be inclined to receive the weight depended upon their respective velocities, that the faster the tube travelled, the greater must be its inclination, and therefore the greater the angle the greater the earth's velocity with reference to the velocity of light. In the case of the majority of the stars what we get is an ellipse, and in an ellipse we have certain differences which have to be taken into account, the last difference of all being that an infinitely elongated ellipse is a straight line, and it is found that from one particular point of the heavens where, in consequence of this aberrational motion, the orbits of the stars round their mean places are almost circular, we at last get to a point where the motion is simply an oscillation of the star backwards and forwards to and from its mean place; we are dealing, in fact, with that form of the ellipse when it is in the form of a straight line. When we deal with an ellipse we no longer talk of the radius, but of the semi-axis major, which is half the greatest length. The angle of aberration of which I have spoken only amounts to 20″·4451, but though small, it is quite enough to prove that the earth does revolve, and that consequently the sun is the centre of the system to which the earth belongs. Now in order to show the importance of physical inquiry in this matter, there is another statement which must be made. If we consider this aberration question fully, we find in it what is perhaps the most perfect way of determining the distance of the sun from the earth, and it will be seen that it is perfectly simple, so simple in fact, that the wonder is that more attention has not been given to it in our text-books. We have first the fact that the inclination of the tube depends upon the relative velocities of the tube and falling body; in the case of light it will of course depend upon the relative velocities of the earth in its orbit and light radiating from a star. Knowing this latter to be somewhere about 186,000 miles per second, and the aberration angle to be 20″ and something, we can get the relation of the earth's motion to the velocity of light, and it comes out to be about 1 to 10,089.

Now we know that the earth completes a revolution round the sun in $365\frac{1}{4}$ days. If it travelled with the velocity of light it would complete a revolution in 52m. 8·5s.

Again, we may say, and this is only a rough statement, that the radius of a circle is 1/6 of its circumference, so that if it took the earth fifty-two minutes to go round its circumference, or, as we call it, its orbit, it would take 1/6 of that time to go along the radius if it travelled with the velocity of light; it would therefore take 8m. 18s. But this radius is the distance of the earth from the sun, and having this time 8m. 18s., we have only to multiply the velocity of light[1] per second, by that, and we get 92,628,000 miles as the distance of the earth from the sun.

J. NORMAN LOCKYER

(*To be continued.*)

THE ROYAL COMMISSION ON TECHNICAL INSTRUCTION

WE have just received from the Commission the two volumes of their second Report on Technical Education. We give this week the Recommendations with which the Commissioners conclude their Report:—

Having carefully considered what is desirable and practicable in regard to the general and technical instruction of the various classes engaged in industrial pursuits in this country, we humbly offer the following recommendations, which require the intervention of the Legislature or of public departments:—

I. As to public elementary schools:

(*a*) That rudimentary drawing be incorporated with writing as a single elementary subject, and that instruction in elementary drawing be continued throughout the standards. That the inspectors of the Education Department, Whitehall, be responsible for the instruction in drawing. That drawing from casts and models be required as part of the work, and that modelling be encouraged by grant.

(*b*) That there be only two class subjects, instead of three, in the lower division of elementary schools, and that the object lessons for teaching elementary science shall include the subject of geography.

(*c*) That, after reasonable notice, a school shall not be deemed to be provided with proper "apparatus of elementary instruction" under Article 115 of the Code, unless it have a proper supply of casts and models for drawing.

(*d*) That proficiency in the use of tools for working in wood and iron be paid for as a "specific subject," arrangements being made for the work being done, so far as practicable, out of school hours. That special grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums.

(*e*) That in rural schools instruction in the principles and facts of agriculture, after suitable introductory object lessons, shall be made obligatory in the upper standards.

(*f*) That the provision at present confined to Scotland, which prescribes that children under the age of fourteen shall not be allowed to work as full-timers in factories and workshops unless they have passed in the Fifth Standard, be extended to England and Wales.

II. As to classes under the Science and Art Department, and grants by the Department:

(*a*) That School Boards have power to establish, conduct, and contribute to the maintenance of classes for young persons and adults (being artisans) under the Science and Art Department. That in localities having no School Board the local authority have analogous powers.

(*b*) That the Science and Art Department shall arrange that the instruction in those science subjects which admit of it shall be of a more practical character than it is at present, especially in the "honours" stage; that payment on results be increased in the advanced stages of all subjects, at least to the level of those now made for practical chemistry and metallurgy, and that greater encouragement be given to grouping.

(*c*) That the examinations in agriculture be made to have a more practical bearing.

(*d*) That metallurgy, if it be retained, be divided into groups, as (1) the precious metals, (2) those extracted from metalliferous mines, as copper, tin, lead, &c., (3) iron and steel. That mining be similarly divided into (1) coal and (2) metalliferous mining.

(*e*) That the inspection of science classes by the Science and Art Department, with a view to ascertain the efficiency of the instruction, and of the apparatus and laboratories, be made more effective, with the assistance, where necessary, of local sub-inspectors.

(*f*) That it shall not be a requirement of the Science and Art Department that payment of fees be demanded from artisans for instruction in the science and art classes.

(*g*) That in the awards for industrial design more attention be paid by the Department, than is the case at present, to the applicability of the design to the material in which it is to be executed, and that special grants be made for the actual execution of designs under proper safeguards.

(*h*) That the limits of the building grants, under the Science and Art Department, to 500*l.* each for schools of Art and of Science should be abolished, and the conditions attached to them be revised.

(*i*) That, in addition to the loan of circulating collections and the grant of art reproductions at reduced cost, contributions be made to provincial industrial museums of original examples tending to advance the industries of the district in which such museums are situated.

III. Training Colleges for elementary teachers:

(*a*) That the teaching of science and art in Training Colleges, and its inspection by the Science and Art Department, be made efficient, and that arrangements be made for giving to selected students in those Colleges greater facilities and inducements for the study of art and science in the National Art Training School and the Normal School of Science at South Kensington, the Royal College of Science for Ireland, and other institutions of a similar class approved of by the Government.

IV. Secondary and technical instruction:

(*a*) That steps be taken to accelerate the application of ancient endowments, under amended schemes, to secondary and technical instruction.

(*b*) That provision be made by the Charity Commissioners for the establishment, in suitable localities, of schools, or departments of schools, in which the study of natural science, drawing, mathematics, and modern languages, shall take the place of Latin and Greek.

(*c*) That local authorities be empowered, if they think fit, to establish, maintain, and contribute to the establishment and

[1] The exact value is 186,380 miles according to Michelson, with a possible error of thirty-three miles.

maintenance of secondary and technical (including agricultural) schools and colleges.

V. Public libraries and museums:

(*a*) That ratepayers have power, by vote, to sanction the increase of the expenditure, under the Public Libraries Acts, beyond its present limit, and that the restriction of the Acts to localities having 5,000 inhabitants and upwards be repealed.

(*b*) That museums of art and science and technological collections be opened to the public on Sundays.

VI. Special recommendations in regard to Ireland:

(*a*) That steps be taken at the earliest possible moment for the gradual introduction of compulsory attendance at elementary schools in Ireland.

(*b*) That payments be made by the National Board, under proper regulations, on the results of the teaching of home industries to children, young persons, and adults; as well as in aid of the salaries of industrial teachers.

(*c*) That systematic instruction be given to primary school teachers, qualifying them to teach the use of tools for working in wood and iron, in the primary schools.

(*d*) That steps be taken by the Commissioners of National Education in Ireland for the provision of books calculated to assist the teachers of primary schools in giving graduated lessons in rudimentary science.

(*e*) That grants-in-aid be sanctioned by the Treasury to approved agricultural schools, and to approved schools for instruction in local industries.

(*f*) That practical evening science classes for artisans form part of the instruction in the Royal College of Science of Ireland, in Dublin.

(*g*) That the Board of Intermediate Education take steps to insure the provision of adequate means for the practical teaching of science in the schools under their direction.

In addition to the preceding recommendations which necessitate action on the part of the Legislature or of the public authorities, or of both, your Commissioners make the following recommendations, requiring no such action, by way of suggestions for the consideration of those in whose power it is to comply with them:—

I. That it be made a condition by employers of young persons, and by the trade organisations, in the case of industries for which an acquaintance with science or art is desirable, that such young persons requiring it receive instruction therein either in schools attached to works or groups of works, or in such classes as may be available, the employers and trade organisations in the latter case contributing to the maintenance of such classes.

II. That the managers and promoters of science and technical classes should (*a*) so arrange the emoluments of teachers as to encourage them to retain their students for the advanced stages of subjects in which they have passed the elementary stage, and (*b*) that they should endeavour to group the teaching of cognate science subjects, as recommended by the Royal Commission on the Advancement of Science, and as provided for by the regulations of the Science and Art Department.

III. That scholarships be more liberally founded, especially for pupils of higher elementary schools, enabling them to proceed to higher technical schools and colleges.

IV. That the great national agricultural societies give aid to the establishment in counties of secondary schools or classes for teaching agriculture.

V. That those responsible for the management of primary schools in Ireland, in the districts where farming is defective, attach small example farms to such schools wherever it is possible; and that Boards of Guardians employ the plots of land attached to workhouses for the agricultural instruction of the children therein.

VI. That the subscriptions given by the liberality of the City of London and of the different Guilds, to the City and Guilds Institute, be made adequate to the fulfilment of the work which that Institute has undertaken, including the equipment and maintenance of its Central Institution.

In closing our Report we think it right to recall the fact that the first impulse to an inquiry into the subject of technical instruction was given by the important letter of Dr., now Sir Lyon, Playfair, K.C.B., of May 15, 1867, to the Chairman of the Schools' Inquiry Commission, in which he called attention to the great progress in engineering and manufactures abroad, shown at the Paris Exhibition of that year. In the course of our inquiry we have received much guidance from the letter on the subject by Mr. B. Samuelson, M.P., to the Vice-President of the Committee of Council on Education, dated November 16, 1867; from the Report of the Select Committee of the House of Commons on Scientific Instruction, 1868; the Report of the Royal Commission on the same subject; the papers by Mr. H. M. Felkin on Chemnitz, by Messrs. McLaren and Beaumont, and various other publications.

We desire also to express our thanks to the public authorities, to the owners and managers of industrial works, and to the numerous other persons, both at home and abroad, to whom we had occasion to apply for information, for the frank and courteous manner in which it was given to us; and also to acknowledge the prompt and valuable assistance which we received from the members of our Diplomatic and Consular services in the prosecution of our inquiry. All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) B. SAMUELSON
H. E. ROSCOE
PHILIP MAGNUS
JOHN SLAGG
SWIRE SMITH
WM. WOODALL

GILBERT R. REDGRAVE,
Secretary,
April 4, 1884

ON THE NOMENCLATURE, ORIGIN, AND DISTRIBUTION OF DEEP-SEA DEPOSITS[1]

II.

Globigerina Ooze.—We designate by this name all those truly pelagic deposits containing over 40 per cent. of carbonate of lime, which consists principally of the dead shells of pelagic Foraminifera—*Globigerina*, *Orbulina*, *Pulvinulina*, *Pullenia*, *Sphæroidina*, &c. In some localities this deposit contains 95 per cent. of carbonate of lime. The colour is milky white, yellow, brown, or rose, the varieties of colour depending principally on the relative abundance in the deposit of the oxides of iron and manganese. This ooze is fine grained; in the tropics some of the Foraminifera shells are macroscopic. When dried it is pulverulent. Analyses show that the sediment contains, in addition to carbonate of lime, phosphate and sulphate of lime, carbonate of magnesia, oxides of iron and manganese, and argillaceous matters. The *residue* is of a reddish brown tinge. Lapilli, pumice, and glassy fragments, often altered into palagonite, seem always to be present, and are frequently very abundant. The mineral particles are generally angular, and rarely exceed 0·08 mm. in diameter; monoclinic and triclinic feldspars, augite, olivine, hornblende, and magnetite are the most frequent. When quartz is present, it is in the form of minute, rounded, probably wind-borne grains, often partially covered with oxide of iron. More rarely we have white and black mica, bronzite, actinolite, chromite, glauconite, and cosmic dust. Silliceous organisms are probably never absent, sometimes forming 20 per cent. of the deposit, at other times only recognisable after careful microscopic examination. In some regions the frustules of Diatoms predominate, in others the skeletons of Radiolarians.

The *fine washings*, viewed with the microscope, are not homogeneous. The greater part consists of argillaceous matter coloured by the oxides of iron and manganese. Mixed with this, we distinguish fragments of minerals with a diameter less than 0·05 mm., and minute particles of pumice can nearly always be detected. Fragments of Radiolarians, Diatoms, and siliceous spicules can always be recognised, and are sometimes very abundant.

Pteropod Ooze.—This deposit differs in no way from a Globigerina ooze except in the presence of a greater number and variety of pelagic organisms, and especially in the presence of Pteropod and Heteropod shells, such as *Diacria*, *Atlanta*, *Styliola*, *Carinaria*, &c. The shells of the more delicate species of pelagic Foraminifera and young shells are also more abundant in these deposits than in a Globigerina ooze. It must be remembered that the name "Pteropod ooze" is not intended to indicate that the deposit is chiefly composed of the shells of these mollusks, but, as their presence in a deposit is characteristic and has an important bearing on geographical and bathymetrical distribution, we think it desirable to emphasise the presence of these shells in any great abundance. It may here be pointed out that there is a very considerable difference between a Globigerina

[1] A Paper read before the Royal Society of Edinburgh by John Murray and A. Renard. Communicated by John Murray. Continued from p. 88.