beds at Zwickau, which M. Gutbier has distinguished by the name of 'graues conglomerat,' are nothing more than the base of the Roth-liegende of Germany."

In a second letter to Sir Roderick Murchison, dated November 25, 1848, Professor Naumann says, "In reply to your letter of the 20th I hasten to inform you that I agree entirely with your idea, that the Roth-liegende and the Zechstein together constitute but one and the same formation, although in Germany these two members are very often distinctly separated from each other. It is for this reason that I shall always preserve this distinction in any description of the Permian system, such as it presents itself in our country. In reference to my assertion, that the coal-beds of Oschatz are separated from the Roth-liegende by porphyry, the term Roth-liegende was there used in a purely petrographical sense, as signifying a sandstone coloured red, and to indicate that the beds whose characters truly represent what may be called Roth-liegende commence in this section above the porphyry only. At all events, these red beds are only part of the same whole which includes the grey beds below the porphyry, the latter rock being intercalated in the middle of the Permian sandstone. This takes place both near Oschatz and Rohrlitz, though the phenomenon is more clearly seen near the last-mentioned town, as is exhibited in the 14th sheet (Grimma) of our geological map. Political troubles have interfered with the working researches near Oschatz, but tranquillity being restored, they will be renewed in the spring. In the mean time, M. Gutbier will give a description of the Permian flora of Saxony, the Saxon fauna of the same system having been already published by M. Geinitz."

December 26, 1848.

2. *On Change of Climate resulting from a Change in the Earth's Axis of Rotation.* By Sir JOHN LUBBOCK, Bart., F.R.S.

[Communicated in a letter to Charles Lyell, Esq., V.P.G.S.]

I HAVE thought a good deal upon phænomena indicative of a change in the climate of places on the earth's surface and of changes in the relative position of land and water, and as this is a subject to which you have devoted so much attention, I wish to know whether you think the following speculations of any value, or whether you think they have already been anticipated by any mathematician.

It follows from the theory of rotation of a solid body, as is well known, that, 1. If a body revolves about certain axes which are called principal, and no extraneous force acts upon the body, it will continue to do so for ever.

So in the case of the earth: if EQ is the equator and P the pole, if the earth, as is supposed, revolves at present about CP the axis of figure, as this is a principal axis, it will continue to do so for ever, and has done so since the origin. Hence the geographical latitude of any place on the earth's

surface remains unchanged; no change of climate can obtain except from a change in the internal temperature, or in the sun, the source of heat.

But a change in climate alone is not sufficient to account for geological changes, which indicate that water now covers land formerly dry, and *vice versâ*.

The preceding conclusions are not modified by the attraction of the moon, or by those causes which produce the precession of the equinoxes, so that at Greenwich for example the latitude remains, as Mr. Airy informs me, absolutely unchanged within those limits of which the errors of the observations are susceptible. If however we go back to the origin, it is unlikely that when the earth was first set spinning, the axis of rotation should exactly coincide with the axis of figure, unless indeed it were all perfectly fluid. We may however go back to some time less remote, and suppose the axis of rotation not coinciding with the axis of figure, and the earth in a semi-fluid state, or rather, in consequence of the different degrees of fusibility of different substances, partly solid in irregular masses and partly fluid. We then advance to another period more recent in which the earth consisted of land and water, and was suited for the support of animal life. We may if we please consider this as the original state. The only hypothesis I wish to insist upon as essential is, that the axis of rotation had not the same geographical position as at present.

In order to take the simplest case of the effect which a displacement of the axis supposed possible may have had upon the relative positions of land and water, suppose the solid part of the earth to consist of a spheroidal nucleus revolving about the axis CP. The effect of this would be to throw the water into the position IKML about the equator, the greater or less protuberance being caused by the greater or less velocity of angular rotation. It is evident that if the body after any length of time moved about any other axis of rotation, the water would occupy a position about the new equator, land would become sea and sea land, &c. &c.

Now suppose a point situated at D with latitude QCD, revolving about the axis CP and submerged, were after a lapse of time to revolve about an axis CP' and having latitude DCQ', it would cease to be submerged, but at the same time would be in a colder climate, which is consistent with what you find takes place in Europe (vol. i. p. 155); but if we consider what takes place at the point D' situated at a distance of 180° longitude from D, we find precisely the reverse: primitively dry the point D will become covered by sea, and will acquire a hotter climate. The countries differing in longitude from us by 180° are at present submerged by the Pacific.

The solid nucleus of the earth is not a sphere, but a spheroid; and if we suppose the axis of rotation at any time to have occupied a different place from that which it occupies at the present time, and not identical with the axis of figure, if any resistance exists, it would cause the pole of the axis of rotation to describe a spiral round the pole of the axis of figure, and finally it would become, as it is at present, identical with it. Moreover you would necessarily have a change in the relative positions of sea and land.

If the axis of rotation could suffer such a displacement by reason of the causes which produce the precession of the equinoxes, you would have another and a more natural way of accounting for the existing phenomena; but this has been held to be impossible.

If we admit the rotation of the earth to take place under such conditions that the surface experiences any friction (i. e. resistance, which Laplace did not consider), then the invariability of geographical latitude which exists otherwise, noticed by Laplace (vol. v. *Méc. Cél.* p. 268), is not a necessary consequence.

Great obstacles interfere, so as to prevent a complete elucidation of this question. Putting aside the great difficulty of an exact and finished solution of the problem of the rotation of a body in a resisting medium, we have no numerical data which would assist in determining the amount of such resistance. Still less do we know the structure of the strata underneath the earth's surface, or the history of the changes which have taken place during the process of cooling, which might enable us to trace the position of the axis of rotation in remote times. So that I think the utmost that can be accomplished by mathematics is to explain under what hypothesis a change of the position of the axis of rotation is possible or not.

In the *Méc. Cél.* vol. v. p. 14, Laplace lays it down, that it is impossible to account for the changes which have taken place on the surface of the earth, and in the relative positions of land and water, by a change in the position of the axis of rotation. But this dictum is founded upon the absence of two considerations, both of which appear to me to be essential:

1. The dislocation of strata by cooling;
2. The friction of the surface.

If the earth were at any remote epoch a homogeneous spheroid, formed for example of any one pure metal in a state of fusion, then, in the process of cooling, I doubt not that the mass would always be made up of concentric spheroids, so that it would always revolve about the same principal axis of rotation, which would never deviate from the axis of figure. But the condition of the earth which really obtains is so very far, as we know, from being that of homogeneity, that it seems to me quite within the limits of possibility, that in cooling the position of the axis of rotation may have changed, apart from the influence of friction at the surface.

With regard to the second consideration, although not alluded to in p. 14 of the *Méc. Cél.* vol. v., it is expressly referred to by Laplace at p. 254 of the same volume. The inequalities to which Laplace there alludes, and which he supposes and admits may have existed

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and may have become obliterated by friction at the surface, are proportional in amount to the sine of the co-latitude of the pole of the axis of rotation, and could not exist if the axis coincided, as it does now, with the axis of figure.

3. *An Elucidation of the successive Changes of Temperature and the Levels of the Oceanic Waters upon the Earth's Surface, in harmony with Geological Evidences.* By WILLIAM DEVONSHIRE SAULL, Esq., F.R.S.A., &c.

THIS paper commences with an investigation of matter in its various forms, and proposes a new view of the nature of heat and light. The author next states that the poles of the earth are not fixed and invariable in position, as astronomers generally suppose, but are in continual motion. From these various causes combined he then deduces a new theory to account for the alternations of climate and the changes in the relative level of sea and land observed by geologists.

MAY 17, 1848.

J. R. Logan, Esq., Singapore, and the Rev. John Thornton, B.A., Kimbolton, were elected Fellows of the Society.

The following communications were read:—

1. *On some Fossiliferous Beds in the Silurian Rocks of WIGTOWNSHIRE and AYRSHIRE.* By J. CARRICK MOORE, Esq., Sec. G.S.

THE difficulty of assigning to the great chain of rocks of the south of Scotland their true place in the geological series, arises from the rarity of fossil remains, and from the want of beds with such well-marked mineral character, as to enable the observer to determine their superposition. Part of this obscurity has been lately removed by Mr. Nicol's description of fossiliferous beds in the valley of the Tweed (Geol. Journ. vol. iv. p. 195); and as any additional information, however scanty, may be interesting, I shall briefly describe the localities in Wigtownshire and the south of Ayrshire where I have found fossils, commencing with some account of the general structure of the country.

The description given by Mr. Nicol of the physical structure of Peeblesshire applies in the main to Wigtownshire and the south of Ayrshire. There is the same prevalent strike in an E.N.E. direction, a system of valleys running parallel to the strike formed by the convolutions of the rocks, with another transverse system of valleys at right angles to the former, remarkably equidistant, and through which the principal drainage of the country is effected. The rivers Stincher and Finnart are instances of the former system; the Cree, the Bladenoch and the Tarf, the Luce, and the Piltanton of the latter. The bays of Loch Ryan and Glenluce form another instance