

summer of each hemisphere is in perihelion or in aphelion. This, in consequence of the precession of the equinoxes, will occur at intervals of about 25,000 years. That is to say, if in either hemisphere the summer is now in perihelion, at the end of 12,500 years its summer will be in aphelion, and in 12,500 years more it will be in perihelion again. Mr. Croll maintains that glaciation occurs in the hemisphere where there is perihelion summer and aphelion winter, because of the intense cold of such a winter. I think, on the contrary, that the facts of climate which come under our observation show that winter cold has little or no effect in producing glaciation; and that a cold summer, which leaves the winter snow unmelted, is the most favourable condition for glaciation. Such is the climate of the Antarctic continent now. It is obvious that a summer in aphelion, when the eccentricity of the earth's orbit was many times greater than now, must have been a very cold summer.

This theory of the glacial climate appears perfectly satisfactory. The astronomical cause is known to exist, the geological effects are known to exist, and the effect is that which the cause must necessarily produce.

Even if it were true that a glacial climate prevailed in both hemispheres at the same time, no geological evidence could prove such a fact. No geological evidence could tell whether glacial mounds in Norway and in Patagonia, for instance, were strictly contemporary, or separated in date by an interval of 12,000 years.

Dr. Neumayr appears to retain the old notion that changes of climate may be to some extent due to changes in the position of the earth's poles. I am no mathematician, and cannot speak on such a subject with any authority, but Sir William Thomson believes he has proved that the earth is for all dynamical purposes perfectly solid and rigid; and I should think that the axis of rotation of a perfectly rigid oblate spheroid is unchangeable.

Belfast, July 10.

JOSEPH JOHN MURPHY.

The American Meteor.

I RECEIVED the following observations from my son, G. S. Henslow, who witnessed the fall of the meteor referred to lately in NATURE. I forward it, as it may perhaps interest some of the readers of this journal.

"The meteor fell about 5 p.m., and divided in mid-air, part of it falling in Minnesota near a town called Kasota; this portion was not found. The other and larger piece fell near Butt City, Iowa. The two places are about a hundred miles distant. It exploded on reaching the ground into myriads of fragments, a number of which have been picked up and sold at fabulous prices. The State University of Minnesota bought the largest piece. It fell on the open prairie, but broke into such small fragments that the surrounding soil was scarcely disturbed at all. We all saw it fall here at Windom. It illuminated the southern sky, and left a cloud resembling the smoke from the funnel of an engine. On bursting, there was a sound like a sharp peal of thunder."

G. HENSLOW.

SPONTANEOUS IGNITION AND EXPLOSIONS IN COAL BUNKERS.

AT the Royal United Service Institution, on Friday, July 4, a paper on this subject was read by Prof. Vivian B. Lewes, Royal Naval College. Rear-Admiral N. Bowden-Smith was in the chair.

The lecturer, after premising that in the fast ocean steamers it is now becoming an event of frequent occurrence for the contents of the bunkers to spontaneously ignite, whilst in the Service such a thing as fire in the bunkers is practically unknown, and an occasional, although fortunately very rare, explosion of gas is the worst trouble which the coal stores of our naval monsters have given rise to, directed attention to the causes which give rise to the so-called "spontaneous ignition of coals," and traced the particular circumstances which tend to increase the tendency to it.

The pyrites or coal brasses present in the coal when exposed to dry air undergo little or no change, but when moisture as well as air is present they absorb oxygen and

combine with it, forming sulphates of iron, and the ordinary explanation of the spontaneous ignition of coal is that this process of oxidation causes a rise of temperature in the coal which determines its ignition; this, however, has of late years been much doubted, and it can now be proved that the pyrites when present in ordinary quantities are perfectly incapable of doing more than adding slightly to the general rise of temperature, although when present in very large masses they may increase the tendency of the coal to spontaneous combustion by swelling during oxidation, and causing the coal to crumble, and also by setting free sulphur, which, having a lower melting-point of ignition than coal (482° F., or 250° C.) would lower the temperature at which the mass would catch fire.

The real causes which give rise to heating and ignition in any large accumulation of coal are twofold. First, the absorption of oxygen from the air by the carbon; and secondly, the chemical action set up by the absorbed oxygen with the hydrocarbons of the coal.

The most important point to be noticed is the extraordinary effect which initial temperature has on the rapidity of chemical actions of this kind. At a low temperature, and indeed up to about 100° F. = 38° C., the absorption of oxygen, and consequent chemical action, will go on slowly with practically little or no chance of undue heating taking place, but directly the temperature exceeds 100° F., then, with some classes of coal, ignition is only a question of time and mass.

Although the ignition point of various coals lies above 700° F., yet if many of these coals are powdered, and are placed in perforated zinc cases in masses of 2 lbs. or upwards, and these are kept at a steady temperature of about 250° F. in an oven, ignition will generally follow in a few hours; whilst between this and 150° F. it will take days instead of hours for the same result to follow, and at ordinary English temperatures several thousand tons of coal would have to be stored in a very broken condition before any risk of heating or ignition would ensue. In considering this question with regard to coal bunkers, it must be remembered that, although the considerations which had to be taken note of in the case of coal-laden ships still exist, yet they are considerably modified by the smallness of the amount of coal carried, and by the methods of loading and storage employed.

Liability to spontaneous ignition increases with:—

1. *The increase in the bulk of the cargoes.*—Evidence given before the Royal Commission of 1875 showed that in cargoes for shipments to places beyond Europe the cases reported amount to $\frac{1}{4}$ per cent. in cargoes under 500 tons; in cargoes from 500 to 1000, 1 per cent.; 1000 to 1500, to 3.5 per cent.; 1500 to 2000, to 4.5 per cent.; and over 2000 tons, to no less than 9 per cent. Mass influences this action in two ways:—

(a) The larger the cargo, the more non-conducting material will there be between the spot at which heating is taking place and the cooling influence of the outer air.

(b) The larger the cargo the greater will be the breaking-down action of the impact of coal coming down the shoot upon the portions first loaded into the ship, and the larger thereby the fresh surface exposed to the action of the air.

2. *The ports to which shipments are made* (26,631 shipments to European ports in 1873, resulting in only ten casualties, whilst 4485 shipments to Asia, Africa, and America gave no less than sixty).—This startling result is due to the length of time the cargo is in the vessel, the absorption and oxidation being a comparatively long action, but a far more active cause is the increase of temperature in the tropics, which converts slow action into a rapid one.

3. *The kind of coal of which the cargo consists* (some coals being especially liable to spontaneous heating and ignition).—There is great diversity of opinion on this