too, had written that the observations of 1839 had been of the greatest service to scientific research. Now, however, from the use of protected instruments, the temperature was more accurately ascertained, and the Challenger explorations of 1868-70 had shown that the temperature, which at 500 fathoms had been believed to be 32°, had been subsequently found to be only 29°. In the South Atlantic the water over the bottom was generally as low as 32°, while in the North Atlantic it rarely fell below 35°. This problem of the low degree of water in the tropical area, where warm water might be expected, and a higher degree in the polar region, where one might look for a colder temperature, was a very curious one. The Red Sea had been known to rise in temperature, in summer time, as high as 100°, and never fell below 70°. Fresh water could not be cooled below 39°, and when congealed by a winter temperature it might be explained as the mean winter temperature of the locality. When warm water was below the surface it rose until it came within the local influence, and being cooled to 39°, sank, and gave place to other water. So it went on as long as warm fields of water existed, and when it froze it was when a uniform temperature had been established throughout. Any one could determine this for himself by observing the convection currents in water boiling over a fire, the lower field of water being first heated, rising to the surface, and giving place to cold, which became heated and rose in its turn. It was but a transposition of conditions. In the Swiss lakes the warmer temperature was at the surface, while in the artificially-heated water it commenced at the bottom. In the Mediterranean the water down to a depth of 2,000 fathoms at one part preserved a temperature of 55° throughout, but a cold body of water of 36.5° rose in the center close to the surface. In explaining this and how the application of cold to any part of a body of water would cool down the whole mass, Dr. Carpenter said that it had been called the downward hypothesis; but he felt it impossible to reconcile the temperature of the deep-sea basis to any other cause than that of gravitation. If it was only known what were the peculiar communications between the great polar areas it would be possible almost to predict what temperature to expect at the bottom of the deep sea in any parts.

HOW THE EARTH MAY BE DESTROYED.

THE catastrophe in the stellar system—the conflagration of a star—which caused so much commotion in astronomical circles a few months ago, is made the subject of an article in "Belgravia" (March) by Richard A. Proctor. He says that this catastrophe happened probably a hundred years ago; the messenger which brought the news to us, though traveling at a rate sufficient to circle the earth eight times in the course of a second, had traversed millions upon millions of miles before reaching us last November. If a similar accident happened to our sun the creatures on that side of the earth turned towards him would be destroyed in an instant, and the rest very quickly afterwards. The heavens would be dissolved, and the elements would melt with fervent heat. The question is asked whether the earth is in this danger, and whether warning would be given of the coming destruction. The answer may be gathered from the facts mentioned in the article. There have been other solar conflagrations before that which was made known last Fall. The first on record—observed by Hipparchus—occurred 2,000 years ago. It was seen blazing in full daylight, showing that it was many times brighter than Sirius, the blazing dog-star. It was called a new star because it had ever been invisible until its conflagration made its light temporarily visible. The next new star (or stellar conflagration) appeared in the region of the heavens between Cepheus and Cassiopeia three times, A.D. 945, 1264, 1572, and is expected to be seen on fire again before long. This star remained burning at its last appearance for sixteen months. It appeared larger than Jupiter and brighter than Sirius. It did not attain this lustre gradually, but shone forth at once in its full size and brightness as if it had been of instant creation. In 1596 Fabricius observed a new star in the neck of the "Whale" constellation, and in September, 1604, a new one was discovered in Ophiuchus. In 1670 a new star appeared in the constellation Cygnus, remaining visible for nearly two years. In 1848 another was seen, which has continued in existence since its apparent creation. By the aid of the telescope—an instrument combining the telescope and the spectroscope—it was found that the increase in the star's light rendering the star visible was due to the abnormal heat of the hydrogen surrounding that remote sun. But it could not be so easily decided whether this hydrogen was aglow with the heat of the star or whether absolute combustion was in process. In other words, was it as a red-hot piece of iron or like a red-hot coal? These star conflagrations, it is believed, are caused by contact with other heavenly bodies—meteoric flights traveling on eccentric paths, or those in attendance on the comets. The meteors attendant on a comet continue to follow in its path years after the comet has disappeared. The tail of the comet of 1843 must actually have grazed our sun. Newton's comet nearly approached it. At any time we might be visited by a comet mightier than either, traveling on an orbit intersecting the sun's surface, followed by flights of meteoric masses enormous in size and many in number, which, falling upon the sun, would excite his whole frame to a degree of heat far exceeding what he now emits. We have evidence of the tremendous heat to which the sun's surface would be excited in such a case. In 1859 two meteoric masses came into contact with the sun. The downfall of these two bodies only affected the whole frame of the earth at the very time when the sun had been thus disturbed. Vivid auroras were seen where they had never been seen before, accompanied by electro-magnetic disturbances all over the world. In many places the telegraph struck work, the signal-men received severe shocks, and at Boston a flame of fire followed the pen of Bain's electric telegraph, which writes the message upon chemically prepared paper. This was the effect of two meteors. The effect of a comet, bearing in flight many millions of meteoric masses upon the sun—should that take place—can be understood. Our sun seen from some remote star whence ordinarily he is invisible would shine out as a new sun for a few days, while all things living on our earth, and whatever other members of the solar system are the abode of life, would inevitably be destroyed. If a comet came out of that part of the constellation Taurus, arriving in such a time as to fall upon the sun in May or June, the light of the sun would act as a veil, and we should be instantly destroyed without knowing anything about it. If it fell in November or December, we should see it for weeks, and astronomers would be able to tell us when it would fall upon the sun. The disturbance upon the sun would be temporary, but there would be no students of science left to record the effects. The chances are largely against such an accident. Our sun is one among millions,

any one of which would become visible to the eye under such an accident, yet during the last 2,000 years less than twenty such catastrophes have been recorded. Mr. Proctor moreover reassures us in another way. He says in effect that all but one of these conflagrations have appeared in the zone of the Milky Way, and that one in a region connected with the Milky Way by a well-marked stream of stars; that the process of development is still going on in that region, but that if there be among the comets traveling in regular attendance upon the sun one whose orbit intersects the sun's globe it must have struck before the era of man, and that in our solar system we may fairly believe that all comets of the destructive sort have been eliminated, and that for many ages still to come the sun will continue to discharge his duties as fire, light, and life of the solar system.

THE PLANET VULCAN.

PROFESSOR DAVIDSON was at the summit of the Sierras on March 21st to 23d, on the look-out for the possible transit of Vulcan over the sun's disk; reports that the weather was favorable except in the afternoon of the 21st and late on the afternoon of the 22d, but no signs of a planet was visible, although one spot and disturbed area was seen on the 21st and 22d, and a second disturbed area appeared on the 23d. These were important as indicating what size of spot could be observed, and it is believed that had the planet appeared with a diameter of five seconds of arc it would very readily have been seen. The disk of the sun is reported to have been very sharply defined during the greater part of the time of observation. In this city, Mr. Pratt of the Coast Survey made similar search for the planet; and at San Bernardino, W. G. Wright of that place, with less favorable weather, observed through the three days. The former saw the spot on the 21st and the disturbance on the 23d, and the latter saw the spot on the 21st. These observations indicate that, at the time of observation on this coast, no planet was visible on the sun's disk. — *Mining and Scientific Press.*

GEOLOGICAL TIME.

By T. MELLARD READE.

PRESIDENTIAL ADDRESS BEFORE THE LIVERPOOL GEOLOGICAL SOCIETY.

In this paper, Mr. Reade has used the analyses of river waters to determine the amount of mineral matter carried in solution from the land. He finds that the amount of water run off the area of England and Wales annually is 68,450,936,960 tons, equal to 18.3 inches in depth out of 31,988 inches of mean rainfall, leaving 13.7 inches for evaporation. The amount of solids in solution is 8,370,630 tons, or 12.23 parts in every 100,000 of water—in which are about 9.50 parts of carbonate and sulphate of lime and magnesia, 1.66 of chloride of sodium, 0.08 of nitrates, and 0.99 of alkaline sulphates and carbonate of soda, silica and sesquioxide of iron. Estimating the solids in solution at 15 cubic feet to the ton, the amount of denudation by solution would be .0077 feet per century, or one foot in 12,978 years. Prestwich arrived at one foot in 13,200 years, for the amount of carbonate of lime which the Thames carries off from the Chalk, Upper Greensand, Oolitic strata and Marlstone. The Thames, estimating the discharge at 8 in. per annum, and the total solids at 29.26, as given by Prestwich, removes 147 tons per square mile per annum; and the denudation over England 143.5 tons.

Mr. Reade makes similar calculations for the rivers of Europe, and finds that the Rhine removes about 92.3 tons per square mile; the Rhone about 232 tons; the Danube about 72.7 tons; giving an average for the three rivers of 90 tons per square mile. The Garonne removes 142 tons per square mile; the Seine about 97 tons. From these data the conclusion is reached that probably over the world about 100 tons of rocky matter are dissolved by rain per English square mile per annum; of which, as near as can now be estimated, 50 tons may be carbonate of lime, 20 tons sulphate of lime, 7 silica, 4 each carbonate and sulphate of magnesia, chloride of sodium, and 6 alkaline carbonates and sulphates.

The amount of detritus brought down annually by the Danube is about $\frac{1}{1000}$ of the water, or three times the calculated amount of solids in solution; that of the Mississippi according to Humphreys and Abbott, $\frac{1}{1000}$ of the water. Mr. Reade adds:

"If we were to take the solids removed mechanically at six times those in solution, which is a very high estimate, we should have over the whole of the globe 600 tons of denuded matter annually per square mile. Taking the sedimentary crust of the earth at ten miles thick throughout—a moderate estimate—and allowing for the denudation of the sea and the amount added to sediments by volcanic ejections, matter equal to one-third that which is denuded from the land, we should have annually removed and deposited matter equal to 800 tons per square mile of land surface, or 40,800 million tons annually. The total surface of the globe is 197 millions of English square miles. A cubic mile of rock at 13½ feet to the ton would weigh 10,903,552,000 tons, so that to cover the whole surface of the globe one mile deep with sediment from the land at the rate of 800 tons per square mile of land surface, would take 52,647,052 years, or 526 million years in round numbers for ten miles deep."

COLORED HAIL AND SNOW.

By DR. A. T. MACHATTIE, F.C.S., etc.,
Lecturer on Chemistry, Glasgow.

DURING my residence in Canada, nine years ago, a fall of hail and snow of a peculiar character occurred, and the facts seem to me worthy of being recorded.

At London, in the Province of Ontario, the fall began between 8 and 9 P.M., on February 24th, 1868, and was accompanied by a violent storm of lightning and thunder, and a strong gale from the southeast. At Sarnia, in the same province, on almost the same line of latitude, and more than 50 miles distant from London, similar phenomena were observed, but the fall of hail and snow did not begin till about 7 A.M. on the 25th of February. The observations in London were made by me personally; in Sarnia, by a friend.

In some places the dark-colored shower seemed to consist of snow; in others, of hail; and my Sarnia correspondent described it as being more like "frozen rain" than either of the above.

One square yard of the dark hail or snow, when melted, deposited rather more than 5 grains of a dark grey (almost

black) powder. This amount is equivalent to almost exactly 1 ton per square mile. I could not learn with certainty over what extent of district the shower fell, as a sudden thaw very soon removed all traces of its presence. Considering, however, that it was observed at two places 50 miles distant from one another, and at one of them (Sarnia) it was known to extend over 10 miles square, I assume that a belt 50 miles long by 10 miles broad is not a very excessive estimate of the district covered; but, of course, it may have been much less or much greater, and the dark matter may not have been present in uniform quantity—most probably not. The above estimate would give no less than *five hundred tons* of the dark matter, and, at any rate, there is little doubt that the quantity was large considering the source.

On examination under the microscope, I found the dark substance to consist mainly of vegetable matter far advanced in decomposition. This result has since been corroborated by Dr. James Adams, of Glasgow, who further expressed the opinion that the vegetable matter consists principally of the remains of *cereals*.

From the circumstance that the surface of the ground and all shallow waters in Canada were frozen for months before the shower fell, it would appear that the dark matter could hardly have come from any local source. It is more likely that it came from some distant southern district of America, where the ground was neither frozen nor covered with snow; this, however, is mere conjecture.

It will be observed, from the above remarks, that the dark matter referred to in no way resembles the siliceous-shelled microscopic organisms which have been so often observed to fall on the Atlantic Ocean and elsewhere. It is this unusual character, as well as the quantity of the above dark shower, that induces me to draw attention to it. There was no difficulty in obtaining it *pure*, because the shower was deposited in three distinct strata: (1.) Pure snow. (2.) The layer containing the dark substance. And (3.) A layer of pure snow when the violence of the storm had abated. — *Chemical News.*

FERMENTATION.

DR. ANDREWS P. AITKEN, Chemist to the Highland and Agricultural Society, lately delivered a short address on the subject of fermentation. It was a process, he said, that had been known from the earliest times, but until recently it had been very little understood. Passing in review the various theories of fermentation, he dwelt especially on the two which a few years ago were so hotly debated between Liebig and Pasteur. Liebig maintained that fermentation was due to an instable chemical compound called a ferment, which in the act of splitting up or undergoing a chemical change, was able to communicate that molecular change to some other bodies capable of receiving it. These were called fermentescible bodies, and that the free action of the oxygen of the air was necessary to the process. Pasteur, on the other hand, declared fermentation to be the result of living germs, which multiplied in a saccharine liquid at the expense of the oxygen dissolved in it, but when that was used up they took oxygen from the saccharine liquid, and in so doing caused it to be decomposed into alcohol, carbonic acid, etc. When fungi, such as blue mould, grew on the surface of a liquid containing sugar, albumenoid matter, etc., it used the atmospheric air, and no sugar was decomposed; but if the fungi were then plunged beneath the liquid, it still continued, though with difficulty, to live, and in doing so, decomposed the sugar into alcohol and carbonic acid. Fermentation was therefore due to the prolonged vital activity of the fungus, which was cut off from a supply of free oxygen. This was an exhausting process, and the vitality of the ferment required to be restored by occasional admission of air, which enabled it to multiply rapidly, and thereafter produce a more vigorous fermentation.

The lecturer then described a few of the more common ferments, and explained the condition of their vitality, and the methods employed to study their character and history.

In the course of his address he referred specially to the fermentation of beer, and as it contains some points of considerable interest to brewers, we quote it in full.

When barley has been steeped in water for some time, and then spread, damp, on a floor at ordinary temperature, it germinates. From three to seven little rootlets appear, and the embryo within the seed begins to grow. During this time the starchy matter in the seed is being converted into sugar. The barley is then dried in kilns, and is called malt.

The malt, when crushed and dissolved in water, yields the sweet wort or malt liquor of the brewers.

It has long been known that if this wort is exposed for some time to the air it begins to ferment, *i.e.*, it puts on an appearance of boiling; bubbles of carbonic acid gas continually rise in it, and the sugar of the wort is converted into alcohol. This process of fermentation immediately stops if the liquid is boiled. If wort is boiled in a tube or flask, and if the vessel is hermetically sealed, or even plugged with cotton wool, while boiling, the wort may be allowed to cool, and will never ferment, but remain quite unaltered for any length of time. In the latter case there is free access of air to the wort through the cotton wool, so that it cannot be the air alone which causes the wort to ferment.

A little examination of a fermenting liquid will show a sediment, or scum, which, when examined through the microscope, will be found to consist of cellular bodies, having a definite shape and in an active state of growth. The most familiar substance of that kind is the yeast plant (*Torula cerevisia*), composed of small, roundish, nucleated cells, which when put into fresh wort immediately bud and grow with great rapidity, the wort in the meantime entering into brisk fermentation.

A minute germ of *Torula* is sufficient to begin the process, and as these germs are floating abundantly in the air, they cannot fail to alight on wort when exposed to the open air. This is the cause of spontaneous fermentation.

When the yeast plant alone is added to wort, either spontaneously or otherwise, the products of the decompositions of sugar are alcohol and carbonic acid, along with notable quantities of succinic acid and glycerin.

In all commercial beer there are found, however, lactic acid and a little acetic acid. These are impurities, and Pasteur, in his beautiful research on the maladies of beer, has traced their origin.

They are caused by the action of other germs than that of the yeast plant—the lactic and acetic ferments, which, floating in the air, have sown themselves in the sweet liquid along with the yeast, and have set up fermentations different from that of the yeast plant. Sour beer turned beer,