and a perpendicular to the horizontal line, which measures the "obliquity of trend," caused, as it will be observed, by the shadow-receiving plane being inclined to the horizon. If the plane be vertical, there will be no such obliquity.

O. Fisher.

RATE OF DENUDATION OF THE LAND BY RIVERS.

Sir,—In a paper published in April, 1853, in the Phil. Mag. I have calculated the mean denudation of the land by rivers and the sea to be equal to three feet in 10,000 years, taken over the whole surface of the land. I further corrected this in 1875, Appendix Geol. Mag. p. 433, *et seq.*, by taking into account the quantity of material not in suspension, viz. sand, etc., pushed out to sea by rivers. I find this equal to twice as much denudation as the material carried out to sea in suspension indicated by a new method.

I omitted this point in 1853, and Mr. James Croll, who followed my method of calculations, has always omitted it also.

This denudation would be nearly ten feet in 10,000 years, or one foot in 1000 years, with the present rainfall. But in the Pluvial period the rainfall would be 300 inches, or about ten times as great as the present. Belgrand afterwards suggested a twenty-fold rainfall.

By my formula of the increase of velocity of water at the same slope, according to increase of quantity, I found the velocity of streams would be enormously increased in the Pluvial period, particularly in the rainy seasons, as the quantity flowing in rivers would be enormous. If the quantity of rain increased eight times, the velocity of the stream would be double; but if the rainfall was very unequal, the mean velocity for the year might be much in excess, say three times the present velocity. In the Pluvial period, if the mean velocity may have been three times the present mean velocity of streams and rivers, Hopkins has shown the power of moving material increases in an enormous ratio with the velocity. If the moving force for removing strata is as the fifth power, and the velocity 3 times, then as 3^5 equals 729, the mean denudation in the Pluvial period would be 729 times the present. This would be equal to a mean removal of 9 inches in the year off the land, and a mean deposit of 3 inches in the sea, raising the sea-level to that extent.

The deltas of all great modern rivers are formed of thin stratified beds containing land plants, and always recent fresh-water shells that can only live in shallow fresh-water, or shells or animals living in estuaries. The surface of these modern deltas is always near the level of the sea at the shore-line, and must have always been so during their formation, as they are all shallow-water deposits. As the sea-level rose during the supposed period of 729 years, the deposits must all that time have exactly kept up with the elevation in order to keep marine deposits away. The depth of these delta deposits is from 500 to 1000 feet, as ascertained by borings.

In 3000 years, with a mean denudation of land of 9 inches a year,

and an annual rise of the sea of 3 inches of sea-level, a delta of 729 feet could have been formed by the deposits obtained by the overflow of the river-water, with the assistance of some material thrown back by the sea into the estuary or delta.

The deltas of all our great rivers are thus later than Post-Pliocene, and of the age of the Pluvial period. No part of any of these deltas has been uplifted by volcanic or subterranean agency above the general level of the delta; this is another proof of recent origin.

ALFRED TYLOR.

ROCK-BASINS IN GRANITE.

SIR,—In reply to the query of Mr. T. Cragor in your last number, I would refer him to a paper "On the Rock-Basins in the Granite of the Dartmoor District, Devonshire," by G. W. Ormerod (Quart. Journ. Geol. Soc. vol. xv. p. 16). In this paper the author brings forward reasons for considering that the Rock-basins were formed by atmospheric action, which commenced in irregularities on the surface of the granite and was probably assisted by a globular or spheroidal structure in the rock. H. B. W.

JOINT-STRUCTURE AT GREAT DEPTHS.

SIR,—Mr. Crosby (GEOL. MAG. Sept. 1881, p. 416) explains the absence of joint-structure at great depths by attributing the formation of these divisional planes to the cooling of strata from a temperature which prevented them from becoming jointed by contraction before they were thoroughly desiccated and consolidated. This appears to me to explain what occurs in jointed conglomerates, in which hard quartz and other pebbles are often "cut through by joints, as neatly as if they had been sliced by a lapidary's wheel." But, if this is the cause of jointing, why have we joint planes continuous in direction over wide areas, cutting rocks up into cuboidal or polygonal masses, and not division along planes of least resistance, such as would form the prisms so familiar in rocks which have cooled from fusion or from a high temperature like the columnar mud of Tideswell dale.

The conditions suggested by Mr. Crosby appear to me to be such as would produce columnar jointing, viz. slow, regular contraction in a more or less homogeneous rock; why then is not the jointing of this nature? Seeking purely for information on this head, I am yours, &c., W. W. WATTS.

SIDNEY COLLEGE, CAMBRIDGE,
October 11*th*, 1881.

DISCOVERY OF COAL-MEASURES UNDER NEW RED SANDSTONE AND ON SO-CALLED PERMIAN ROCKS AT ST. HELEN'S, LANCASHIRE.

SIR,—Permit me to point out that the author of this paper in the current number of the GEOLOGICAL MAGAZINE, in identifying the limestone bands met with beneath the New Red Sandstone at Winwick in 1879, with the Ardwick Limestones of the Manchester Coal-field, does not state that this identification was made by me