

(87·62) per evening, or 1·9 cents per man. The economy is considerable, and the work can be done without danger and with a regularity which cannot be obtained by any other means.

The Perpetual Secretary remarked, that electro-lighting which could be very cheaply established on ship-board, and which is not, like other systems of lighting, liable to be extinguished during a storm, would be very advantageous for preventing those collisions by night which are so frequent, and generally so disastrous, and to which attention has been called by a recent event.—*Comptes Rendus*.

On Changes of the Sea-Level effected by existing Physical Causes during stated periods of time.

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Introduction.

The First Part of the ensuing paper is occupied with the details of the probable amount of the solid matter annually brought into the ocean by rivers and other agents, in suspension and solution; and the conclusion is arrived at, that the quantity of detritus thus distributed on the sea-bottom would displace enough water to cause an elevation of the ocean-level to the extent of at least 3 inches in 10,000 years.

In the Second Part an endeavour is made to compute the number of such periods of 10,000 years that must have elapsed during the accumulation of the immense mass of recent fresh-water strata said to exist in the valley of the Mississippi.

The calculation as to the latter is made from the *data* collected by observers in America, of the extent of the deposit in question; and 't is here supposed, first, that in former periods the *same* quantity of mud as at present has been annually carried into the Gulf of Mexico; and secondly, that the amount of sediment deposited on the delta and plains of the Mississippi does not exceed *one-enth* part of the solid material which has been carried out (suspended in the water of the river) into distant parts of the Gulf of Mexico, or into the Atlantic Ocean itself.

From recent accounts by Mr. C. Ellet, of the United States, it appears that a column of fresh water, 1½ mile wide and about 7 feet deep, is constantly entering the Gulf of Mexico at a speed of 2 to 2½ miles per hour, and floats on the surface of a stratum of salt water, to which it partially communicates its own velocity. And below this a stratum of sea-water is found to be flowing in an opposite direction to that of the two strata of fresh and salt water above it.

From the data submitted, it would appear that the accumulation of the alluvial deposit of the Mississippi must have occupied a great number of periods, during each of which an elevation of the sea-level of 3 inches may have occurred.

* From the Philosophical Magazine for April, 1853.

† "In formations from a few hundred to a thousand feet and upwards in thickness, the whole of which does actually belong to the same geological age and is therefore characterized by the same fossils, most curious and important results may be sometimes deduced if the position or relative heights at which the groups of fossils are imbedded be noted; and this is a point usually neglected. For, thanks to the researches of Professor E. Forbes, the depth of water under which a collection of shells lived can now be approximately told; and thus the

The general conclusion arrived at is, that the sea-level cannot be considered as stationary for practical geological purposes, since the operation of present physical causes would produce a considerable change in its height, even during the construction of a recent deposit like that in the valley of the Mississippi, which may be called small and local compared with those older formations familiar to geological observers.

But the subsidence and elevation of the crust of the earth would be accompanied by alterations of the area of the sea-bed; and the frequency of such movements would therefore furnish additional reasons for not considering the sea-level permanent for the lengthened periods requisite for the accumulation of sedimentary deposits of any magnitude.

In the Third Part of this paper an attempt is made to direct attention to the difficulty of finding any test by which to distinguish strata gradually accumulated during a long-continued upward movement of the sea-level, from those strata formed on a sea-bottom slowly subsiding while the ocean-level was stationary. In either case no change of depth of water may have occurred of sufficient importance to cause the removal of the Mollusca inhabiting the locality, and therefore the discovery of the *same species of organic remains from top to bottom of a thick deposit* is not an absolute proof (as has been supposed†) that gradual subsidence has occurred during that particular formation; because the condition of equal depth of water during any deposit might be produced either by subsidence of the sea-bottom or elevation of the sea-level, or by both conjointly.

In discussing these questions, the writer has not assumed that during gradual subsidences or gradual elevations, greater denudations or depositions would occur than when the level of the land and sea-bottom was stationary; because it is not certain, either that during such gentle oscillations the forces that would produce denudation are sensibly diminished or increased, or that the rocks which are brought within the reach of denuding forces are necessarily more easily worn away than those which were previously exposed to the same influences.

PART I.

It has long been acknowledged that the quantity of detritus annually carried into the ocean from various sources must displace an equal volume of water, and thus tend to raise the level of the sea. Many years since it was estimated by an Italian that this change might amount to one foot in a thousand years. The general opinion on this subject has been, that the effects produced by the present supplies of detritus would be too minute to be perceptible, and on geological enquiries the ocean-level has been considered as permanent for all practical purposes.‡ I here propose to offer the evidence of present denudation in certain countries where careful observations have been made, in order to show, that if such rapid destruction of land occurs in most localities, then the operation of present physical causes must be amply sufficient to effect a

movement of the crust of the earth, while the strata including the shells were accumulating, can be inferred.

"For instance if the bottom of a cliff, say 800 feet in height, a set of shells are buried which must have lived under water only 50 or 100 feet in depth, it is clear that the bottom of the sea must have sunk to have allowed of the deposition of the 700 feet of superincumbent submarine strata; subsequently the whole 800 feet must have been upraised." (Darwin.)

‡ Manfredi. See Lyell's Principles, edit. 1850, p. 270 and 542: