

the contours of the hills and valleys, the author considers that it is clear that the main physical features of this portion of N.W. Middlesex were moulded at a very early stage in the Glacial period, and before the so-called Middle sands and gravels and overlying Upper Boulder-clay with Northern erratics, were deposited. He believes that at this time there could have been no barrier of any importance to prevent these deposits from extending into the Thames Valley, and that the evidence clearly points to the conclusion that the implement-bearing deposits on the higher horizons in the Thames Valley should be classed as of contemporaneous age with the undoubted glacial deposits at Hendon, Finchley, and on the slopes of the Brent Valley, which they so closely resemble. The author is therefore satisfied that man lived in the neighbourhood of the Thames Valley in the early part of the Glacial period; probably, he thinks, in pre-Glacial times.

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### CORRESPONDENCE.

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#### CORRELATION OF QUATERNARY CHANGES OF LEVELS IN NORTH AMERICA AND THE CARIBBEAN REGION.

SIR,—Referring to Mr. Jukes-Browne's letter in this *MAGAZINE* for March (p. 143), and to his and my preceding articles and correspondence therein cited, I have to reply that the questions which he asks are manifestly very difficult; but certain points may be noted which partially answer them. If the end of the Tertiary era and beginning of the Quaternary were characterized by elevation of the greater part of the North American continent to such altitude as to give a much cooler climate, and by a contemporaneous depression of the West Indies and the Isthmus of Panama, allowing a large part of the equatorial Atlantic current to pass into the Pacific Ocean, the result of these combined conditions being the accumulation of the ice-sheets of North America and Europe, we should expect to find west of the Gulf of Mexico, as Mr. Jukes-Browne suggests, evidences of recent changes of levels. The subsequent depression of the continent north of the Gulf and the uplift of the West Indies and the Panama region, bringing the present relative heights of land and sea, may have produced the east to west line of fissuring and faulting which crosses Mexico near 19° north latitude, shown by the very remarkable series of volcanoes of Tuxtla, Orizaba, Popocatepetl, Ixtaccihuatl, Toluca, Jorullo, and Colima. Farther west, this line of disturbance in the earth's crust probably extends to the volcanic Revillagigedo Islands. Eastward, after crossing the base of Yucatan, it appears to be represented by the Great and Little Cayman Islands, and by the Sierra Maestra on the south shore of eastern Cuba, with the contiguous "Bartlett Deep," a very profound narrow trough of the Caribbean Sea, reaching from Honduras Bay to the Windward Passage; and thence the same orographic belt is continued by Santo Domingo, Porto Rico, and the Windward Islands, with the very deep oceanic troughs north, south, and south-east of Porto Rico (bathymetric map of the Caribbean region, A. Agassiz, *Three Cruises of the "Blake,"* vol. i. fig. 57).

The disturbances along this belt, however, have been of a different order from the uplifts and subsidences which have affected the whole continental area northward from the Gulf of Mexico, as known by the Pleistocene submergence of river valleys and fjords on the Atlantic, Pacific, and Arctic shores of North America. No less than twenty submerged valleys, some of them extending to depths of 2000 to 3000 feet, have been found by soundings on the coast of California by Prof. George Davidson, of the U.S. Coast Survey; and Prof. Joseph Le Conte has shown that the time of elevation during which they were eroded was the Pliocene and early Quaternary, which also included the plication of the Coast Range, the outpouring of the lavas forming the Cascade Range, and the faulting and tilting that elevated the Sierra Nevada, Wahsatch, and Basin Ranges to their present height (*Elements of Geology*, new ed. 1891; *Bulletin G.S.A.* vol. ii. 1891, pp. 323-330). On the Atlantic coast, too, the submerged valleys mentioned in previous articles were doubtless eroded during the same time. Excellent evidence of this is given by the submarine channel of the Hudson, partly a profound fjord, extending about 100 miles beneath the sea, and descending to the depth of 2844 feet; for samples of its bottom and banks, brought up by the sounding-lead, appear to belong to a continuation of the Tertiary sandy clays of New Jersey (*Am. Jour. Sci.* III. vol. xxix. pp. 475-480, June, 1885; vol. xl. pp. 425-437, Dec. 1890, with map). These deeply submerged, narrow river channels, and the similar Arctic fjords, together bear testimony of a late Tertiary and early Quaternary elevation of nearly all of North America to such altitude that the resulting colder climate would induce glaciation. So widely extended continental uplifting, and the later Pleistocene depression of the same area, belong to a class of the earth's crustal movements which Gilbert and White have called epirogenic, that is, continent-making, in contrast with orogenic or mountain-making upheaval and subsidence.

In the Caribbean region depressions succeeded by elevation during the Quaternary era, which are known from the raised coral reefs studied by Mr. Jukes-Browne and others, belong to orogenic movements, chiefly by faulting, uplifting, and tilting, which have taken place on a most grand scale in this era throughout the chain of the West Indies and Windward Islands, and along the entire Cordilleran belt from Cape Horn to Panama, to the Sierra Nevada and Great Basin, and to Mount St. Elias and the Aleutian Islands. These mountain-making disturbances have been closely related with the great epirogenic uplift and depression of North America, and with their duplication in two distinct Glacial epochs, divided by a very long interglacial epoch on this continent; but to attempt discussion of details of their correlation, or to speculate upon the condition of the earth's crust and interior permitting such changes of levels, would require too much space for a letter. Some notice of these matters will be found, respectively, in my article in the *American Journal of Science* for January, 1891, and in my appendix of Wright's "*Ice Age in North America.*"

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