

gray, micaceous sandstones characterize the next 300 to 350 feet. This red-shale interval constitutes the Cattaraugus formation. In its upper part a second lentil, the Salamanca conglomerate, occurs. It lenses out eastward, but becomes prominent westward in the Salamanca region and is regarded as the same as the Pope Hollow and Panama conglomerates farther west. A third lentil, called the Kilbuck conglomerate by Mr. M. L. Fuller, occurs about 50 to 70 feet above the Salamanca. It is found in the Salamanca region only.

The next formation is the Oswayo, characterized by rusty olive colored, limonitic sandy shale, from 160 to 250 feet thick. Over this the Sub-Olean, or Shenango, conglomerate is found in some areas, usually 20 to 30 feet thick, but apparently cut out in other places, and on the Olean quadrangle losing its conglomeratic character and merging into a sandy shale similar to the Oswayo shale. Over it, when not apparently cut out also, are 30 to 50 feet of Sub-Olean, or Shenango, shale. This is overlaid by the Olean conglomerate, usually massive and round-pebbled, 50 to 90 feet thick. A few feet of thin, rusty, sandy Sharon shale overlies the Olean conglomerate at Rock City.

The shales below the Wolf Creek are Devonian. From the base of the Wolf Creek to the top of the Oswayo a mingling of Devonian and Carboniferous faunas makes it best to designate these rocks, for the present, as Devono-Carboniferous. Above the Oswayo the rocks are regarded as Carboniferous.

The rocks dip 25 to 30 feet per mile slightly west of south. Minor rolls causing local reversals of dip are known to occur.

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AUTHOR'S ABSTRACTS OF PAPERS READ AT THE WASHINGTON  
MEETING OF THE AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE. SECTION E.

*Geological Age of the West Indian Volcanic Formations.* By J. W.  
SPENCER.

THE Greater Antilles appear to be nearly devoid of volcanoes. The writer has seen only the remains of one in Jamaica (at Low Layton), and none in Cuba. But there are extensive underlying igneous formations in all these islands. However, in the inner zone of the Caribbean or Windward Islands there are many cones, and beneath these and the outer islands there is an underlying volcanic basement. In such of the outer islands as St. Martin, and better still in Antigua, and in St. Croix one gets some knowledge of the antiquity of the

older eruptive formations. In Guadeloupe the geological records are equally well preserved, on one side, while on the other there are the more recent volcanic cones, which can also be seen in St. Kitts, Statia, Dominica, Martinique, St. Lucia, St. Vincent, etc.

In St. Martin and Antigua the old volcanic basement forms mountains still uncovered by modern cones, as also in St. Croix. The rocks are essentially an andesite in form of both lavas and tuffs. Their surface topography is molded by atmospheric agents into low mountains and valleys. Overlying such a basement in St. Croix and St. Thomas, according to Cleve,<sup>1</sup> there is a conglomerate containing pebbles with Cretaceous fossils. In this region these basement rocks are so dissected that their remains constitute many of the islands of the Virgin group.

But in Antigua and Grande Terre of Guadeloupe the strata overlying the denuded igneous basement is a subaqueous redistributed tuff with some calcareous beds in the upper zone, over which rest conformably the white limestones, a marly deposit containing Oligocene corals and shells.<sup>2</sup> South of the Guadeloupe Archipelago and Monserrat, the outer islands disappear, and the writer is not aware of the occurrence of the early Tertiary limestones remaining so as to leave evidence of the age of the igneous basement, though by its lithological characteristics and the physical features of its ancient surface one can hardly be far astray in concluding that they are of the same age as the similar formations on the islands to the north. In Barbadoes the Oligocene limestones reappear, but here there are no igneous deposits. It thus seems that the whole Caribbean plateau beneath both the volcanic ridges and the limestone islands is underlaid by an igneous formation dating back to the commencement of the Tertiary periods at least, if indeed these rocks are not as old as those of St. Croix, that is, as ancient as the Cretaceous period.

In St. Martin, St. Bartholomew, and Antigua the mountain belts are entirely made up of the denuded rocks of this old igneous formation without a covering mantle. So also, part of Statia, St. Kitts, Monserrat, the southern end of Martinique, portions of St. Lucia, and the southern end of St. Vincent have their surfaces molded out of the ancient igneous accumulations; but elsewhere in these islands, as also

<sup>1</sup> "On the Geology of the Northeastern West India Islands," *Trans. Roy. Swedish Acad. Sc.*, Vol. IX., 1870-71.

<sup>2</sup> See "Geological and Physical Development of the Various Windward Islands," six papers by J. W. SPENCER, in *Quar. Jour. Geol. Soc. Lond.*, Vol. LVII (1901), pp. 409-543, and Vol. LVIII (1902), pp. 341-65.

in Guadeloupe proper and Dominica, they are covered with volcanic materials which constitute more or less of the cones and ridges, rising to a height of 3,000 to 4,000 feet. In these mountainous islands there is not merely a combination of late and ancient eruptive deposits, but there are several formations secondarily derived from the remains of the older basement, and here is room for more study than has been attempted.

The history of one is more or less the history of all of these conical islands. For instance, in Dominica there is the old andesitic rock, overlaid by volcanic breccia or conglomerate. At other points the age of the tuffs cannot at present be assigned, but some of them have been denuded into relatively large valleys, which have been partly refilled with still newer tuff (like that of the Roseau valley), containing an abundance of water-worn pebbles, often arranged in lines among the more angular material. Such may correspond to the early Tertiary subaqueous tufaceous beds of Grand Terre (Guadeloupe). And these beds have been subsequently tilted outward at considerable angles. As in St. Martin and Antigua and Grand Terre, there is nothing to show that there were any mid-Tertiary eruptions when the whole region was somewhat elevated and the denuding agents were molding the surface into rounded outlines. From the corresponding topography in the more volcanic islands, where not surmounted by the modern cones, the impression is left that the volcanic activity of the region was quiescent during much of the Miocene-Pliocene period, before the building up of the cones and ridges, which were constructed at a relatively late date, for we find the sea bed elevated along with these ridges. Thus we find in Statia and in St. Kitts volcanic cones raised by an upward thrust which carried along with it the sea-floor, covered by about thirty feet of marl now forming broken mantles surrounding the cones to elevations of from 400 to 900 feet. Elsewhere, however, we find fragments of a similar formation appearing with the volcanic rocks brought up by a general elevation of the island. These limestone marls contain practically a living fauna, thus showing the elevation to date no farther back than the end of the Pliocene period. Again, there are two series of gravel formations, one of which is older than the coralline strata just mentioned as interbedded with the volcanic ejectamenta; but this gravel formation had its surface greatly denuded before the formation of the marl. Again, both the marl and the gravel have been further subjected to erosion so as to be often left only in broken series. The newer gravel has not been subjected to so

much denudation. The youthful lavas have been seen both in Dominica and St. Kitts beneath the stratified gravel beds, but at present it has not been determined whether they belong to the older or newer series. The lower gravels in their succession correspond in position to the Lafayette of the continent, and the upper gravels to that of the Columbia. The eruption which raised the cones in St. Kitts and Statia, above referred to, appears to have occurred during the subsidence which gave rise to the upper gravels provisionally regarded as the equivalent of the Columbia series—a mid-Pleistocene formation—and the marl beds thus raised rest upon an incoherent bed of volcanic ashes, containing a living fauna. From all facts before the writer it seems that the volcanic ridges owe their origin to volcanic activity which recommenced about the close of the Pliocene period, and that the eruptions have continued with more or less interruption down to the present day; for we find that the cones and ridges have not become so deeply dissected by rains and streams as would be expected, had their growth not been continued more or less continuously from their rebirth at the close of the Pliocene period to the present year of recorded activity.

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*The Marl-Loess of the Lower Wabash Valley.* By M. L. FULLER AND F. G. CLAPP.

THE fine silts bordering the Wabash valley have in the past been correlated with the ordinary loess of the region by many geologists, including Owen, Collett, Wright, Chamberlin, Salisbury, and Leverett. The recent field work of the writers brought out many points of difference in the silts lying respectively above and below the 500-foot contour. The lower type, which we have termed "marl-loess," is coarse and frequently carries as high as 30 per cent. of  $\text{CaCO}_3$ , while the common or upland type carries less than 5 per cent. Numerous exposures of distinctly stratified silts, interbedded in a few instances with pebble layers, were noted. Fossils consisting mainly of land species abound, but are not in general regarded as indigenous, as the perfection of the laminæ in the fossil-bearing layers points to an absence of vegetation during its accumulation, and would indicate—if the deposit were eolian—the probable absence of both moisture and food, the two chief requisites of the molluscan life. Instead of forming a mantle conforming to surface inequalities, as does the upland loess, the marl-loess frequently occurs as extensive flats or broad, gently sloping terraces, usually burying a somewhat rugged