ARE THE MARYLAND TERRACES WARPED?[1]

ABSTRACT.

This paper takes exception to Dryden's use of the topographic contour lines of Southern Maryland as structure contour lines that indicate warping of the marine Pleistocene deposits.

The October 1935 number of the AMERICAN JOURNAL OF SCIENCE contains a paper by Lincoln Dryden on the "Structure of the Coastal Plain of Southern Maryland" in which appears the following statement: "There is no proof known to the writer that the Pleistocene beds of Southern Maryland were not laid down at a much lower elevation and warped up into the position now found,—that parts were elevated to some 300 feet or more, and that other parts, outside the area

[2] Which upon lithification will become arkoses, conglomerates and fanglomerates.

[3] Some publications on the subject in the English language are:

1) Brouwer, H. A.: "Geology of the Netherlands East Indies," 160 pp., New York, 1925. (Univ. of Michigan Scientific Series, v. III.)
2) Iddings, J. P., and Morley, E. W.: "Contributions to the Petrography of Java and Celebes," Jour. Geol., 23, 231-245, 1915.
3) Krynine, P. D.: "Arkose Deposits in the Humid Tropics, a Study of Sedimentation in Southern Mexico," this Journal, 29, 353-363, 1935.
4) Woolnough, W. G.: "The Influence of Climate and Topography in the Formation and Distribution of Products of Weathering," Geol. Mag., 67, 123-131, 1930.

of significant warping, remained essentially at the elevation of deposition."[2] The purpose of the present paper is not to discuss the evidence for my belief, expressed in several previous papers, that there has been little if any Pleistocene or Recent warping in Southern Maryland, but to point out a fallacy in the reasoning that led Doctor Dryden to make that statement.

Dryden states too simply my views as to the origin of the Pleistocene terraces of Maryland. He says (page 338): "Cooke believes that the Pleistocene deposits of the Atlantic Coastal Plain were laid down and are still preserved as sea terraces. Each terrace slopes slightly and gradually to the east or southeast until it is bordered in that direction by a sea-cut cliff, or scarp, over which a small but rapid descent is made to the next younger terrace." And again (page 339) he says: "Cooke pictures the terraces as seaward-facing features cut and filled by the sea during eustatic rises of level. They border the coast at a distance such that the requisite height of land is provided. If one were to approach such ideal terraces from the east he would expect to find a stair-like increase of elevations to the west, and would expect also that the contours (neglecting subsequent erosion) would run roughly parallel to the coast and to the Fall Line. In Southern Maryland, however, such a westward traveller would find some local deviation from the predicted state of things. He would see that the highest land in this area is near Washington, and that in all directions except north and northwest lower elevations are found as one travels out from this eminence." Dryden seems to have overlooked my statement[3] that "in Southern Maryland the terraces below the Sunderland are entirely estuarine. They form comparatively narrow fringes along the shores of the Potomac, Patuxent, and Patapsco Rivers, Chesapeake Bay, and their tributaries. The Sunderland terrace originally occupied more than half of Southern Maryland, but it is now greatly dissected. While it was being formed the seashore seems to have lain 10 or 12 miles west of the present shore of Chesapeake Bay (all the land east of Chesapeake Bay was submerged), and the

[1] Published by permission of the Director, U. S. Geological Survey, Washington, D. C.

[2] This Journal, 5th ser., vol. 30, p. 340, 1935.

[3] Cooke, C. W.: Southern Maryland: XVI Int. Cong. Guidebook 12, p. 3, 1932.

Potomac River from Washington to Charlotte Hall was a wide bay." Such a complex system of marine and estuarine terraces could not have evolved from an evenly sloping sea bottom.

On page 329 Dryden says: "It seems obvious that such an unbroken, thin sheet [of Pleistocene deposits], whose upper surface shows not the slightest trace of erosion, must preserve its *original* upper surface. * * * Therefore, the upper surface of most of the Pleistocene deposits [of Southern Maryland] represents a bedding surface, and at the same time it forms the present, or topographic, surface. If this be true, the present topographic contours are also structure contours, and they should tell us whether or not the Pleistocene beds have been disturbed since their deposition." He then constructs (his Fig. 4) an outline map of Southern Maryland on which are drawn very much generalized "structure-topographic contours" representing the supposed surface of the Pleistocene formations before dissection.

Such a topographic map can give little clue to the deformation of the Pleistocene deposits of Southern Maryland. Southern Maryland has been a region of drowned valleys since the beginning of Pleistocene time (except during the glacial stages, when sea level was temporarily lower), and its contours have therefore always been crooked. The agreement in trend between Dryden's "structure-topographic contours" of the Pleistocene and his contour lines drawn on a Miocene bed simply shows that pre-Pleistocene erosion had not destroyed all Miocene dip slopes, and that these dip slopes, when drowned beneath tidal waters, became blanketed by Pleistocene deposits. The unevenness of this Pleistocene blanket, whose slopes as mapped by Dryden rarely exceed ten feet to the mile, is comparable to the unevenness of the present sea bottom off the mouth of Chesapeake Bay as shown on coast charts.

Dryden is puzzled as to how the Miocene formations came to be warped into their present gentle slopes of four to 20 feet to the mile. He seems to have forgotten that Miocene time was followed by the Pliocene epoch—a time of crustal instability during which mountain ranges came into being and minor movements took place in many parts of the world. The first drowning of the Chesapeake Bay region apparently was caused by crustal movements at the close of the Pliocene, which doubtless were attended by warping of the Miocene deposits there.

The high-level (above 270 feet) gravel of Southern Maryland is probably early Pliocene or older. It is the source of the gravel in the surrounding Pleistocene terrace deposits. These high Pliocene (?) deposits were, perhaps inadvertently, called Pleistocene by Dryden, who says (page 340): "The first emergent Pleistocene material would have been that included within the 280-foot contour. . ."

Whether or not marine and estuarine terraces have been deformed can be proved only by investigation of their original shore lines, for the shore line is the only datum fixed with relation to the sea level with which it was associated. It is the only contour line that leaves a trace on the new land after emergence.

Study of emerged shore lines is more difficult in Southern Maryland than in Georgia or the Carolinas because the region is cut into long narrow peninsulas by estuaries that bring tidewater close to the highest terraces. Erosion has progressed much faster there than in regions with lower gradients and has destroyed parts of the terraces and obliterated much of the shore lines. Moreover, there are few adequate topographic maps of the region. The map of Washington and vicinity, which covers a small part of the region, is the only one having a 10-foot contour interval; the others are old 20-foot maps made before modern methods of mapping had been devised and when standards of accuracy were much lower than now. Such meager data as I have leads me to believe that the marine and estuarine Pleistocene terraces of Southern Maryland are not appreciably warped, but that their shore lines lie nearly horizontal and at the same altitudes as in the less dissected and better mapped regions farther south, with which I am better acquainted.

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