

figure 1. One of the large limestone blocks which has fallen from the face of the cliff, exhibits the large clearly moulded ripple-marks shown in figure 2. The crests of these are two feet apart, and rise about one and one-half inches above their troughs. The ripples curve slightly in crossing the surface of the limestone. The rock on which they are impressed, is a comparatively pure non-magnesian limestone. The surface of the ripple-marks show great numbers of finely comminuted shell fragments. These small fragments of various kinds of molluscan shells, comprise a large share of the material composing the limestone in the middle third of the cliff section in which the ripple-marks occur. These broken shell fragments thus strongly supplement the evidence of the large ripple-marks in indicating vigorous disturbance by wave action of the sea bottom in which they originated. Beyond this fact, it is perhaps not safe to make any deductions regarding the physical conditions under which these ripple-marks were produced. It is clear that the water was of sufficiently moderate depth to permit wave action to agitate the bottom, but it does not follow on the other hand, that the sea was extremely shallow. Nor is any valid ground afforded for the assumption of beach conditions which the discussion of ripple-marks presented in some texts² might lead one to make. It has been shown by Mr. A. R. Hunt³ and others that "ripple-marks occur at much greater depths than is commonly supposed." Dana⁴ has stated that "ripple-marks may be made by the vibration of -3- waves even at depths of 300 to 500 feet." The unusually large size of these ripple-marks suggest water of greater depth than that which develops the ripple-marks seen along many beaches. Hunt's observations have shown that thousands of specimens of marine shells are sometimes killed in six fathoms of water by wave action. The same observer has found evidence of much damage to shells living in fifteen fathoms from the same cause⁵. The broken shell material in these limestones might therefore have been produced in water a few fathoms in depth. The limestones which immediately follow the ripple-marked beds in the cliff section of Snake Island show but little fragmental material, the fossils contained in them being in a good state of preservation. Ripple-marks appear to be absent from these upper beds.

² LeCont states (Elements of Geology 1888, p. 3a). "By means of these characteristics (ripple marks) of shore deposit, many coast lines of previous geological epochs have been determined."

³ On the formation of ripple marks: Proc. Roy. Soc. Lond., Vol. XXXIV, p. 8, 1883.

⁴ J. D. Dana, Manual of Geology 2d ed. p. 665.

⁵ Op. cit. pp. 8, 12.