ART. XL.—*Channel-fillings in Upper Devonian Shales;* by H. S. WILLIAMS.

IN the midst of the fine shales marking the passage from the Portage to the Chemung groups, as they appear in the neighborhood of Ithaca, New York, are found narrow beds of sandstone presenting several points of interest to the geologist.

The first example studied is seen at the mouth of the ravine opening where Junction, Elm and Hector streets meet at the foot of West Hill.

On the faces of the cliff on the north of the ravine are seen what appear to be wedge-shaped beds of sandstone of a few feet extent in the shales which form the main mass of the rocks. Upon a close examination these wedge-shaped masses are seen to be sections, formed at different angles (by the joint-structure of the rocks) of a continuous narrow bed of sandstone, convex on the bottom and nearly flat and horizontal on the top, running out to thin wedges at the sides, its longitudinal axis lying diagonally across both systems of joints.

By a reduction of the oblique sections as seen at several points of its exposure I determined the shape, size and direction of these sandstone masses, which I have called channel-fillings.

The first one studied is about six feet in width and nine inches thick at the center; the top nearly plane, while the under surface curves quite regularly from the center to each side.

The shales, in which the channel-fillings lie, are fine, evenly bedded, thin, fragile shales, the lines of stratification of which are uniform and horizontal.

Where they meet the channel-filling the shales are abruptly cut off, the former being solid, compact and showing no stratification. A fresh fracture of the sandstone shows faint horizontal lamination of color, but this lamination is scarcely at all recognized in any cleavage of the rock. At the upper surface a wavy lamination is seen in the coloration, and also in the cleavage planes an inch or so from the upper surface, which is continued in a more marked seam of arenaceous shale of uniform thickness indefinitely on both sides of the channel-fillings.

The material of the filling is nearly pure fine sand, while the enclosing rock is argillaceous shale with only slight admixture of arenaceous material. The dimensions (width and depth) do not appreciably vary for a distance of over one hundred feet (to the south side of the ravine where the section was discovered in the bank by following out the determined direction

across the ravine). The mass has its longitudinal axis in a line lying about 15° E. of N. and 15° W. of S.

The under surface of the sandstone masses present the appearance, frequently seen on flat flagstones from the Portage group, and called by Hall mud-flow or ripple marks.

In one case I thought I could *clearly* distinguish direction of flow of the runnels by the difference of degree of abruptness of the two sides of the two ridges and furrows. The abrupt side of the elevations seem to lie on the north side, and as these are casts I conclude that the flow which made them was in a southward direction.

In other cases I could not determine this point, and am still in doubt as to the cause of the inequalities on this lower surface.

Upon further examination of the ravines about Ithaca, I discovered that these channel-fillings are numerous, and distributed vertically through about twenty feet of shales.

The shale is well characterized by its fauna. Its termination is distinctly marked above by coarse arenaceous shales and sandstone, well known in the Chemung group, but these peculiar sandstone channel-fillings are not known to occur above or below this particular horizon.

Whenever, in the neighborhood the outcrop of the shales, with its characteristic fauna was discovered, careful search brought to light also the channel-fillings, everywhere running in a uniform direction, and varying in thickness from nine to eighteen inches, and in width from five and one-half to eight or nine feet.

The thicker beds were somewhat swollen in the center on top, and wrinkles, looking very much like the shrinkage wrinkles on the surface of a firkin of lard after it has cooled, were seen on the upper surface of these thicker masses.

The swollen center of these thick masses suggested the explanation, i. e., that subsequent to the original deposition of the rocks a certain amount of shrinkage took place in the shales which was not shared by the arenaceous channel-fillings, and thus the margins of the mass were borne down by the shrinking shales while the center of the mass, resisting the pressure, caused the center of the upper surface to bulge.

On the under surface of one mass of this kind, at the foot of Cascadilla ravine, I discovered the same fine lines trending in a general uniform direction which have been observed frequently on flat flags where they lie on argillaceous shales, resembling impressions of glacier scratches, and the trend of these lines is the same as that occurring on the Portage sandstones below, i. e., nearly due east and west. In the case mentioned the lines run diagonally down the one side the

channel across the bottom and up the other: some of the lines are fine and thread-like and appear entirely uninfluenced by the depth of the channel down and across which they swept.

These lines puzzle me much for explanation, and the only suggestion which appears to me worth offering is that of a swiftly moving tide or current trailing seaweeds or particles rapidly with it over the bottom.

To explain the channel-fillings there occurs to me only one series of events which begins to cover the facts. The uniformity, structure, directness and great number of the channels seems to preclude the idea of a rapidly flowing stream across a beach, and the continuity of the imbedding strata seems consistent only with under-water work.

The suggestion I have to offer is, that these channels were caused by the scratching of icebergs on the shoals represented by the imbedding shales: that the channels were then scooped cleanly out of the mud of the bottom; that the flow or runnel marks were caused by the same ocean current which bore along the icebergs, and perhaps increased in the wake of the berg.

The deposit of sand in the channels was due to the catching of the heavier sand (in the cavity thus formed) more rapidly than on the general surface represented by the thin arenaceous layers above; and I suppose it therefore to have been filled during the deposit of this thin stratum of arenaceous shale which is continuous with the upper layers of the channel-filling, and which it will be remembered is uniformly uneven with ripple-mark structure; showing that during its deposit there was considerable motion in the depositing medium, carried by tides or currents.

Before closing, it may be interesting to mention that the richest locality known of the commoner of the beautiful and graceful fern-like fronds, called *Lycopodites Vanuxemi* by Dawson, but considered to be allied with the graptolites, and named *Plumalina plumaxia* by Hall (see 30th Reg. Rep. N. Y., p. 255) is in the stratum immediately overlying one of the thickest of these channel-fillings. The stratum is a soft shale and for an inch or so in thickness is filled with these and other plant remains, with a few species of frail shells, avicula, lingula, etc., in greater or less abundance. The same stratum has yielded a large fish plate closely resembling the plate C of the ventral shield of Newberry's *Dinichthys Terrelli* from the Huron shale of Ohio (see Pal. Ohio, vol. ii, chart No. vi, and p. 31). The specimen found at Ithaca is about half the size of the Ohio specimen figured. The shales in which the channel-fillings are seen is characterized by the presence of a Lingula which I believe to be new, at least as a variety and probably as a species, and which I propose to describe at another time.