

Ms. rec. Jan. 31. 1945

## A SILURIAN "PIPE-ROCK" AT HADELAND

BY

HARALD MAJOR

With 2 figures in the text.

Working on a general petrologic survey of the Lower Llandoverian sandstone series in the northern part of the Oslo Region, I visited a section along the high-road at Klinkenberg, NE of Jevnaker railway station. The section cuts through an anticline, the axis of which dips slightly to the west. It forms a rather complete profile through the sandstone series, the total thickness of which in this place amounts to c. 120 m. — About a hundred metres above the bottom of the sandstone series some thin beds of a greyish-green, arenaceous shale occur; they are partly laminated by fine layers of dark-coloured sandstone, and filled up with vertical cylinders consisting of a similar-looking material. Approximately four metres downwards and eight metres upwards in the series the rock consists of similar dark-coloured, arenaceous beds, more or less irregularly mingled up with the greyish-green shale material, sometimes causing an indistinct stratification. The thickness of each bed may exceed half a metre, the bedding surfaces, however, are not everywhere quite distinct. A closer examination revealed an abundance of black cylinders in these rocks as well, though they could not easily be recognized, because of the slight difference in colour.

The shape and dimensions of the cylinders has been studied in several samples of which polished surfaces parallel and perpendicular to the stratification have been prepared.

1. Sections perpendicular to the stratification. On the polished surface (fig. 1) the longitudinal sections of the cylinders appear as somewhat irregular, darker ribbons. The ribbons are not always straight, but sporadically form sudden bends or zig-zags. This is especially striking when the cylinders pass through layers chiefly consisting of greyish-green shale material. One might assume that the irregular shapes had been induced by the different compressibility

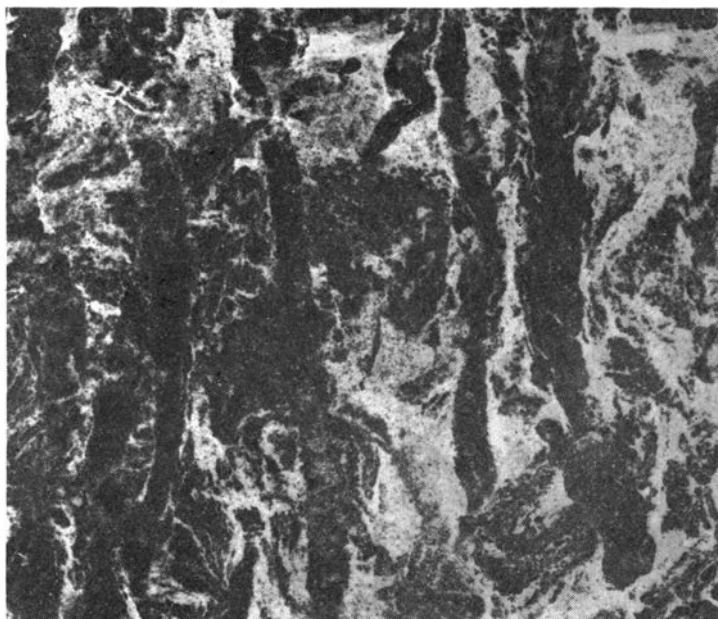


Fig. 1. Polished surface perpendicular to the stratification.  $\times 2$ .  
(Fot. Anker Iversen.)

of the cylinders and their environments. The different shapes of the various cylinders passing through one and the same layer seem, however, to exclude this possibility. Some cylinders pass straight through, while others are altogether crumbled.

The cylinders have a width not exceeding 5 mm. Smaller diameters are common, but are due to less central longitudinal sections. The density of the cylinders is illustrated by the presence of 29 of them on a section 14 cm long. In a few cases U-shaped structures indicate the connection of two separate cylinders (fig. 1). Judging from these two-dimensional sections only, there cannot be given any detailed description of the character of these connections (whether they form branchings, anastomoses or the lower parts of single U-shaped stems). The distance between the centres of two connected stems measured up to 10—15 mm. The length of a single vertical cylinder is found to be 90 mm, but since only a certain part of the stem is exposed in one section, this certainly does not represent the maximum value. The terminations of the cylinders cannot be distinguished with certainty, and funnel-shaped structures have not been observed.

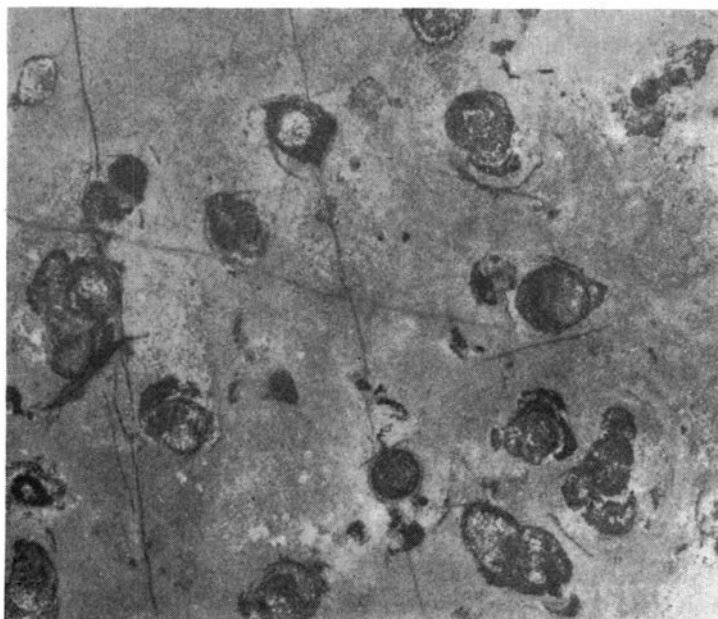


Fig. 2. Polished surface parallel to the stratification.  $\times 2$ .  
(Fot. Anker Iversen.)

2. Sections parallel to the stratification (fig. 2) show the cross-sections of the cylinders as oblong or round spots, more rarely as regular circles. The irregular shapes are due to the fact that the cylinders are not always perpendicular to the polished surfaces and, possibly, in some cases, to the U-formed shapes of the structures. The diametres of the circular spots, and the minor ones of the irregular spots, for the greater part amount to 5 mm, but some of them are smaller. 55 cross-sections were counted on an area of 60 square cm. These sections very often appear two by two, their central distances not exceeding 10 mm. This distance may also decrease, and so two connected sections merge into one oblong spot, this representing the turning point of a U-shape.

The cross-sections often consist of the following zones, taken from outside inwards:

a) A thin, dark-coloured border, the thickness of which varies for the several sections from less than 0.1 mm up to 0.8 mm.

b) Greyish-green shale material forming the next layer (c. 0.5 mm thick).

c) A more or less continuous margin usually starting with a distinct, darker-coloured, outer border. The central part of the sections differs from one spot to the other, the colour in general gradually approaching that of the greyish-green shale towards the centre.

Close to the glossy cylinder sections the green shale surface, not glossy in itself, appears mottled. It seems to be impregnated in some way or other. The mottled areas often connect pairs of cylinders.

A microscopic slide, which represents longitudinal sections of two cylinders, passing through a laminated, black and green rock, displays the following features:

The light, greyish-green layers consist of angular quartz grains, their main diameter being 0.02—0.08 mm, while small flakes of chlorite and sericite form a clayey matrix. Small, opaque grains, light-coloured by reflected light, are frequently to be seen.

The dark-coloured layers are built up by a somewhat more coarse-grained, arenaceous material with angular or subrounded grains, their diameters being 0.05—0.10 mm. Quartz and partly potash feldspar are the dominating minerals, with small flakes of muscovite and a pale green, slightly pleochroitic chlorite mineral as minor constituents.

The vertical structures, which pass through both layers, are filled with a similar, dark-coloured, arenaceous material, somewhat more coarse-grained, as the diameters extend to 0.15—0.25 mm. A fine-grained quartzitic matrix may be distinguished. Brown, pigmented quartz cement is quite common in optical continuity with the crystal structure of the clastic quartz grains, as well as a black, opaque cement material, that gives the rock its dark colour. Along parts of the verge of the cylinders the fine-grained, light-coloured rock can be seen to form a narrow strip, only separated from the surroundings by another narrow dark-coloured coarse-grained strip (corresponding to zones b) and a) mentioned above). A thin, brownish-grey, very fine-grained rim along the border may have been induced by a slimy secretion, which served as a cement when the structures were formed, though it does not appear quite continuously.

A lot of previous papers deal with similar vertical structures in sandstones, and several interpretations have been proposed. Olaf Høltedahl published nearly twenty years ago in this periodical a paper on "A 'Pipe-Rock' in the Carboniferous of Bear Island" (1925). Referring to the most important publications which had till then been

published on this topic, he discusses the principal theories given for the formation of similar structures, which are comprised by the common name *Scolithus*. As I cannot see that there has been brought forward any essentially new considerations since then, they will not be repeated here. — Rud. Richter, who as the first proposed their interpretation as dwellings of staying, planctoneating animals, has later on given additional details of recent “Sandkorallenriffe” (Natur und Museum, 57, 1927). Attention should also be paid to a paper by A. H. Westergård, which sums up facts about similar, vertical structures found in Sweden (Sveriges geol. unders. årsbok 25, 1931, no. 5).

In the case of the forms described here, the presence of U-shaped ones suggests that they may have been formed by *Arenicolithidae*. On the other hand the apparent impregnation of their borders might suggest that they have served as permanent dwellings and not only as the tracks of sandeating animals. A conclusive interpretation, however, cannot be put forward at present.

Dr. Leif Størmer and Dr. O. A. Høeg have kindly corrected the language of this paper, and for their ready interest I am very much indebted.

Trondheim, January 23, 1945.