

33). The description of the section in this highly-perplexing district shows a remarkable similarity lithologically between the beds of the Lammermuirs and those of Gala. It seems to be present also in the cuttings of the Caledonian Railway above Moffat, and the rise of the sea bottom, in the upper part of the series, seems even to have extended to Barlae.

From a consideration of all these facts I am of opinion

1st. That the Gala Group forms a well-marked continuous subdivision of the Lower Silurian of Scotland.

2nd. That it is immediately superior to the Moffat schists in the order of these Lower Silurians.

3rd. That, in virtue of this position, and by its peculiar fauna, it is proved to represent part of the Caradoc formation of Siluria.

I have gratefully to acknowledge repeated encouragement and help from Dr. Page and Mr. D. J. Brown, and also the obligations I am under to Dr. H. A. Nicholson, for assistance, not only from his published writings, but also in personal correspondence.

NOTICES OF MEMOIRS.

ON THE MODE OF ACCUMULATION OF THE DRIFT-DEPOSITS OF THE
WEST RIDING OF YORKSHIRE.¹ By D. MACKINTOSH, F.G.S.

After describing the general characteristics of the Drift-deposits, Mr. Mackintosh gave a minute account of about forty sections which he had examined during the previous six months. Upon the varied phenomena presented by these sections he founded his explanations of the derivation and mode of accumulation of the Drifts. He described the deposits in ascending order, and first the "Greyish Blue Clay." This has a very uniform character. The greater part of it is evidently crushed or washed shale and broken limestone. At least seven-eighths of it would appear to have been manufactured out of what may be called the raw shale and limestone of the plain of Craven and ramifying valleys. It must have been principally derived from the Lower Yoredale and Upper Limestone Shales. The boulders would appear to have come chiefly from the low-lying limestones of the Craven district. Most of the stones found in this clay are much rounded, as if they had been rolled, and not merely rubbed on one side. Ordinary wave-action on a sea beach would appear to have been a principal cause of their attrition. Comparatively few of them are uniformly striated. The scratches run *all round* the stones, and the small grooves cross each other at all angles. The striations, along with the polished surfaces exhibited by these stones, can be easily explained by the irregular and repeated action of coast-ice. To coast-ice, laden with boulders, stones, and debris, and floating on the surface of oceanic currents, we may likewise attribute the distribution of the

¹ Read before the West Riding Geological and Polytechnic Society, at their meeting held in Sheffield, 29th of April, Lord Wharnccliffe in the chair.

coarser part of the deposit, which presents the appearance of having been successively dropped down on a sea-bottom. Above and around the more stony accumulations, we often find a considerable thickness of rudely-stratified clay, with few or no stones, which may have been assorted by the ordinary action of the sea. The idea that the "blue clay" was deposited after the extreme rigour of the glacial climate had passed away, accords with the opinion of Mr. Searles V. Wood, Jun., that the drifts of the North-west of England are newer than those of the South-east. A rather shallow sea, as the land was gradually sinking, and a sea acting principally between about 300 and 600 feet above the present sea-level, would appear to have been the main cause of the distribution of the "blue clay." This sea could not have been much indebted to land-ice sliding down the hill-sides or along the valleys, for such ice would have brought down a supply of materials different from those composing the "blue clay." For the underlying rock and the rock forming the slopes and summits of the hills above it, for great distances, is often Millstone-grit. We are therefore driven to the conclusion that the ice which undoubtedly had a share in shaping the stones and boulders found in the "blue clay" was sea-ice, coast-ice, or ground-ice. Patches of a dark clay, probably of the same age, with a greater or less per centage of limestone boulders, may be found in the Wharfe valley; near Ripon; around Leeds; filling up abrupt hollows between Wakefield and Doncaster, in a railway cutting near Royston, &c.

The Yellowish-brown and Variegated Clay.—It is not difficult to understand that after the land had subsided beneath the level which cut off the low-lying source of supply of the "blue clay," the shales and sandstones of the upper Yoredale and Millstone-grit formations composing the sides of the valleys and table-lands, would furnish materials for the "yellowish-brown clay" with its boulders. This clay extends from the bottom of the valleys up to the highest summits of the moors. It contains very little limestone, generally speaking; and that little, from the positions in which it is found, would appear to have been floated by ice. Nine-tenths of the "yellow clay" formation is local, and must have been principally washed out of the hill-sides where it is found. At the bottoms of the valleys, as at Bingley, it graduates into well rounded boulder-gravel. During the accumulation of this Drift, the table-lands and moors must have been completely submerged.

Stratified Sand and Washed Gravel.—The "blue clay" would appear to have undergone a certain amount of denudation before the "yellow clay" was thrown down above it, as its surface is generally uneven, and apparently eroded. The yellow clay presents indications of its having been denuded before the deposition of the sand and gravel. A part of the sand may have been derived from the "yellow clay," which is often more or less arenaceous, and apart from the direct denudation of the local Carboniferous grits and sandstones. The sand seldom rises higher than about 350 or 400 feet above the present level of the sea. In the Aire valley, it is

evidently of the same age as the great sand formation of the vale of York, though in the vale of York the distinction between the sand and stratified gravel is generally better defined. Both the sand and washed gravel contain boulders, and from their position it is evident that they must have been dropped in. The action of floating ice, therefore, could not have ceased during the deposition of the sand. During the deposition of the sand there would appear to have been rapid currents in a shallow sea. The deflected and eddying action of these currents in peculiar situations would be likely to leave an undulating surface, varied by abrupt eminences. But the undulations left by deposition must have been modified by contemporaneous or subsequent denudation; for on a very uneven surface of sand (a surface unconformable to its stratification) an *upper Boulder-clay* was deposited. It may either have been derived from the denudation of the yellow Boulder-clay, or from a direct denudation of shale and rock; and it is difficult to explain its position above the sand, without supposing a slight reversion in the movement of the land, or a second partial subsidence.

Limits of River-Action.—Since the Glacial submergence, rivers have been occupied in cutting well-defined channels in drift-deposits. In most parts of the valley of the Aire they have not yet got down to the solid rock, and there is reason to believe that between Bingley and Skipton the drift in some places fills up hollows which at one time may have been lake-basins. The river-deposits consist of small pebbles, never spread out continuously for great distances, but confined to patches or ridges, and of a nearly stoneless sand and loam deposited over considerable areas. The rivers are not giving rise to boulder-deposits, or, with a few exceptions, to original drifts of any kind. A little investigation will show that where patches of pebbles are found in the river-channels, they have generally been washed out of boulder-drifts in the immediate neighbourhood.

REVIEWS.

I.—*FLINT-CHIPS*, a guide to Pre-historic Archæology, as illustrated by the Collection in the Blackmore Museum, Salisbury. By EDWARD T. STEVENS, Honorary Curator of the Blackmore Museum. 8vo., pp. 594. London: Bell and Daldy.

FEW men, however public-spirited, have shone out better than Mr. William Blackmore, the founder of the "Blackmore Museum," the contents of which have furnished the text and illustrations for the handsome and portly volume before us. Its author, Mr. Stevens, the Honorary Curator (who is also the brother-in-law of the Founder of the Museum), has been as ardent as Mr. Blackmore himself in carrying out the idea of founding a Pre-historic Museum in his native city, the birthplace of several generations of the Blackmore family.

Here, assembled under one roof, in a handsomely decorated room,