THE
GEOLOGICAL MAGAZINE.

No. IV.—OCTOBER 1864.

ORIGINAL ARTICLES.

I. ON THE NATURE AND ORIGIN OF BANDED FLINTS.

By S. P. WOODWARD, F.G.S.

[Plates VII. and VIII.]

THE idler picking up pebbles on the sea-shore, and the geologist breaking stones in a gravel-pit, frequently meet with banded flints, which display their markings like a painting on the smoothly fractured internal surface, or, in other cases, in the form of lines more or less deeply engraved on the exterior by the action of the weather. The bands seen in section are often accompanied by discolorations of fanciful shape, in which imaginative people find pictures of their friends and others.

In the British Museum there are about fifty of these flints, chiefly Sussex specimens, from the collections of Dr. Mantell and Mr. Dixon; there are also examples from Germany and Poland; and they are most likely to be found wherever chalk-flint gravel occurs. Large numbers of curious gravel-flints have been collected by Mr. John King, of Norwich, Mr. J. W. Flower, of Croydon, and Dr. Bowerbank. But the most extensive and instructive collection is that of Mr. Wetherell, of Highgate, to whom we are indebted for the use of most of the flints now figured.

The origin of these flints has been a puzzle to stone-breakers for the last fifty years. Those with the furrowed surface were considered by Parkinson to be the wrinkled and petrified remains of the peduncle of the *Anatifa*, or Duck-barnacle. In the third volume of the 'Organic Remains,' (p. 241, pl. 16, fig. 18) he figures and describes such a flint as that represented in our Pl. VII., fig. 7, but quite irregular in its form. In the first Mantellian collection are two flints labelled in accordance with this view; but there is no reason to suppose their learned owner

latterly entertained such a belief. It is, however, well-known that Dr. Bowerbank considers them fossilized sponges,—an opinion which few will share with him. When slit and polished, the banded portions shew no microscopic peculiarity to distinguish them from the adjacent unbanded flint, and no organic structure save where they invade the texture of a Sponge, or envelope Foraminifera, so-called Xanthidia, and other minute organisms with their hazy shroud. I believe that I can now offer conclusive evidence that the coloured bands in flints are *produced by infiltration*, as taught by the late Professor Henslow; a view in which Mr. Wetherell coincides on the proof afforded by his own specimens.

All kinds of siliceous pebbles derived from gravel-beds are more or less affected by agencies to which those beds have been subjected, and especially they are liable to be stained by the penetration of water charged with iron or manganese, which has produced coloured zones and dendritic infiltrations in the most compact jaspers and agates as well as in the more permeable flints derived from the waste of the Chalk-formation.

The well-known pebbles of Egyptian jasper, when cut and polished, have a dark border of ochre and umber; the centre creamy, with one or many sets of parallel brown lines, encroaching upon and obliterating their precursors like successive waves. In the 'Crystallography and Mineralogy' of MM. Mitchell and Tennant (p. 509) there is a representation of one of the Egyptian jaspers in the British Museum, which has been considered to resemble the portraits of Chaucer! We here represent one of the mocha-stones in the same collection. These were probably formed, like other agates, in the vesicular cavities

Mocha-stone, in the British Museum; polished section, nat. size.

of trap-rocks; but, having been set free by the breaking up and decomposition of their matrix, they contributed to form the

beds of gravel from which they are now obtained. The stone is pellucid and stained with at least three sets of ferruginous lines and zones. Of these one set (*g*) evidently marks the successive stages of *endogenous* formation, as proved by the small drusy cavity remaining in the centre (*c*). They have been rendered visible by the infiltration of iron-oxide in waves, not coinciding with the layers of structure, but crossing them in various directions (*i*).

That some important change in the physical condition of the alternate layers has been produced by these infiltrations cannot be doubted, for in the case of our own banded flints the laminae are acted upon unequally by the weather. By those, however, who are familiar with the molecular changes produceable in mineral bodies this peculiarity is considered of less account.

Sometimes the pebbles of banded flint are small, and evidently formed by the breaking up and bouldering of larger flints, as in the example represented by fig. 2, Pl. VII.; and it is a rare thing to find a flint of any considerable size banded throughout with concentric laminae of colour, like the agates and Egyptian pebbles. The bands are for the most part local, and their form and direction bear no relation to the outline of the entire flint.

The newly broken black flints from the Chalk-pits near Gravesend are remarkable for the frequency of discoloured spots and markings before referred to, especially where a Sponge or other imbedded substance has afforded easier access to the bleaching agency. These light clouds are often zoned with dark lines which become fewer and further apart at each end of the discoloured tract, and when there is an axis running through it the bands are curved and sometimes crescentic as in fig. 6, Pl. VII. The bands appear to be *convex* in the direction from which the infiltration has proceeded. The axis of the banded tract is often merely a dark line, as in fig. 8, Pl. VII., where it incloses an angular fragment of the fibrous shell of *Inoceramus*; or it may be an open tube, drused with minute crystals, as in fig. 6; or a tube filled up by a succession of siliceous deposits traversed by the bands of infiltration, like the surrounding flint, as in figs. 4 and 3. In fig. 3 the upper part of the tube is filled with strings of oviform bodies (*o*) like those figured and described by Mr. Wetherell in the Mag. Nat. Hist.

Mr. Wetherell's cabinet contains several banded flints with a spongy axis, besides the four examples now figured. One of them is a funnel-shaped Ventriculite (Pl. VIII., fig. 1). Another, more slender, had two roots which have left cavities passing to the outside of the flint (Pl. VII., fig. 1). The small pebble, before-mentioned (Pl. VII., fig. 2), contains a segment

of a third form of Sponge, through which the bands pass unconcerned; and the critical example (Pl. VII., fig. 5) exhibits both in long and cross section a well-defined sponge, permeated by canals like the stem of a *Siphonia*, which appears to be equally unaffected by the passage of the coloured zones.

Equally conclusive of the inorganic origin of the banded tracts in flints are the specimens in which they are connected with ancient fractures formed while yet *in situ* in the Chalk. Flints thus broken, and subsequently re-cemented together, have been frequently noticed. In the one represented by Pl. VIII., fig. 2, there is a minute displacement, visible externally at either end (*x*). The flint is broken along the line of fissure, and shews the side of the vein of white flint filling it, while a second fracture at right angles shews the relation of the banded infiltration. Fig. 3 is a similar flint, broken so as to shew on each side, the banded tract bordering the plate of cementing flint, and also along the plane of this old fracture. Waterworn pebbles formed from flints of this description have been found by Mr. Wetherell in the gravel-pits of Muswell Hill.

I take this opportunity to give some account of another banded flint, which, though outwardly resembling some of those already mentioned, has had a very different origin. The specimen represented by Pl. VIII., fig. 4, is part of a vein from a fissure in the Chalk at Dover, and was presented to the British Museum in March 1862, by Mr. John D. Richardson, one of the contractors for the extensive works then in progress for increasing the fortifications on the west face of Dover Citadel. The Chalk-pits in some parts of England, as in Hampshire, exhibit more than elsewhere the phenomenon of inclined and vertical fissures filled with flint, which consists of two or more laminae separated partially by a central layer of chalky or ferruginous earth. These veins establish the fact of the deposition of flint by water flowing through it, like mineral springs, after the consolidation and movement of the Chalk. The fissure at Dover appears to be filled up chiefly with Chalk, and only in one horizon by a grey siliceous deposit, which has reunited a broken course of flints. It contains minute angular fragments of the black flint that seem to have occasionally fallen in and become imbedded. The current flowing through the fissure gave to its contents a laminated arrangement, and formed a deep central groove which appears to have been continuous in all the deposited layers, chalk and flint alike.

Mr. Richardson states in his letter that the vein of banded flint was met with in cutting through the Chalk-ridge that runs parallel with the coast, and about opposite the Shakespear

S.P.W. del.

M & S Harhart imp.

De Wilde lith.

BANDED FLINTS

BANDED FLINTS.

Cliff. The surface was much varied with 'pot-holes,' ranging from 5 feet wide and 20 feet deep to one of 30 feet across and 40 feet deep. The Chalk, where not disturbed, was very solid, with layers of flints about 5 feet apart. The vein with banded flint was slightly inclined with a drop, on the down-cast side, of about 2 feet. Eight to ten feet lower than the banded flint, and about 25 feet from the surface, there was a course of very compact yellowish chalk, about 3 feet thick and as hard as Portland stone; it was perforated with holes, as if by the *Pholas*, 1-1½ inches wide, through which water seems to have percolated; and 10 feet below this was a layer of flint not more than ¼ to ½ inch thick, as evenly laid and horizontal as a flag-paving, extending for more than a hundred feet through the cutting.

EXPLANATION OF PLATES VII. AND VIII.

PLATE VII.

- Fig. 1. Broken section of flint containing a *Ventriculite*; the upper part solid, but the branched root forming cavities in the stone. (Mr. Wetherell.)
2. Small flint pebble containing a segment of a fossil sponge (*Cephallites*), still showing the labyrinthic wall and angular meshes of sponge-fibre. (Muswell Hill, Mr. Wetherell.)
 3. Thin slice of a translucent yellow flint, containing a flexuous tube, filled up with curved deposits of similar flint, and containing strings of 'oviform bodies' (o) in its upper part. (Finchley, Mr. Wetherell.)
 4. Small fragment of black flint, with similar tube and bands. (Finchley, Mr. Wetherell.)
 5. Section of pebble, containing a Sponge enveloped by an irregular discoloured space, through which and the Sponge itself the bands of subsequent infiltration have passed. (Kent, Mr. Wetherell.)
 6. Fractured surface of a small black flint, with a tubular drusy cavity, bordered by coloured bands. (British Museum.)
 7. Flint pebble, much waterworn, and corroded by the weather; one portion showing ordinary flint; the other corrugated and resembling a Hamite. (Muswell Hill, Mr. Wetherell.)
 8. Polished section of a black Chalk-flint, from Gravesend, presented to the British Museum by the Rev. Norman Glass. The axis of the banded portion is stained with dark streaks, and contains an angular fragment of *Inoceramus* (i).

PLATE VIII.

- Fig. 1. Broken section of a flint-pebble, containing a *Ventriculite*, the whole zoned with coloured bands. (Finchley, Mr. Wetherell.)
2. Black flint, with thin plate or vein of white flint running through it, bordered on each side by a discoloured and banded space. (Finchley, Mr. Wetherell.)
 3. Similar flint, with more simple fracture. (Finchley, Mr. Wetherell.)
 4. Fragment of black flint from Dover, containing vein of banded flint and Chalk. *b.* Black flint. *g.* Grey flint. *c.* Chalk.