LONG EXCURSION TO BELGIUM.

AUGUST 20TH TO SEPTEMBER 3RD, 1921.

REPORT BY L. DUDLEY STAMP, D.Sc., F.G.S.

PLATES 2 AND 3.

Foreword.

IN writing this report an attempt has been made to render it of practical value to anyone who wishes to study the geology of Belgium in the field. Taken in conjunction with the excursion pamphlet "The Geology of Belgium," it forms a self-contained excursion guide, though some general maps, especially the new "Carte géologique de la Belgique, au 160,000e" (approximately 2½ miles to the inch) will be found very useful. The latter is published in 12 sheets, price 60 francs complete, obtainable from the Institut Cartographique Militaire, Bruxelles.

The illustration of this report by numerous sketch-maps and sections is wholly due to the generosity of the participants in the excursion. The sketch-maps are for the most part based on the detailed maps of the Belgian Geological Survey (Scale of 1 : 40,000). For Figs. 11 and 20 I have derived assistance from Prof. M. Leriche's excellent little guide, "Livret guide des Excursions géologiques organisées par l'Université de Bruxelles"* The sections along the Meuse are based on the sheets distributed by Prof. Kaisin to the excursionists, with additions from his "Esquisse sommaire d'une Description géologique de la Belgique."†

It is absolutely essential that this report be read in conjunction with "The Geology of Belgium," as repetitions of descriptions are avoided.

SUNDAY, AUGUST 21ST, 1921.

The members assembled on the evening of Saturday, August 20th, in the Hotel des Négociants, Rue de la Fourche, Brussels. The first item on the official programme was a visit to the Musée royal d'Histoire Naturelle on Sunday afternoon. There the members were received by MM. L. Dollo and A. Rutot. M. Dollo delighted the party with an exposition of the vertebrate fossils of Belgium—especially the famous Iguanodons. M. Rutot then gave an account of the exhibited series of flint implements and prehistoric remains for which Belgium is justly famous. The Association deeply appreciated hearing from the lips of the great expert himself the story of the Museum's treasures.

* Published by Messrs. Weissenbruch, 49 rue du Poinçon, Bruxelles (1912-21).

† Published by Messrs. Uystpruyst, Louvain, and Messrs. Dunod and Pinat, Quai des Grands-Augustins, Paris (1919).

MONDAY, AUGUST 22ND.

Morning.—The Eocene Beds to the South of Brussels. *Director,* M. F. Halet, Professor at the Agricultural College, Gembloux, and member of the Geological Survey of Belgium.

From the Bourse trams were taken to La Barrière de St. Gilles and the party then walked up the Chaussée d'Alsemberg, turning to the right along the Rue de Hêtre. The hills on the right or eastern bank of the River Senne reach a height of about 100 metres and consist of Eocene Beds which were studied in descending sequence.

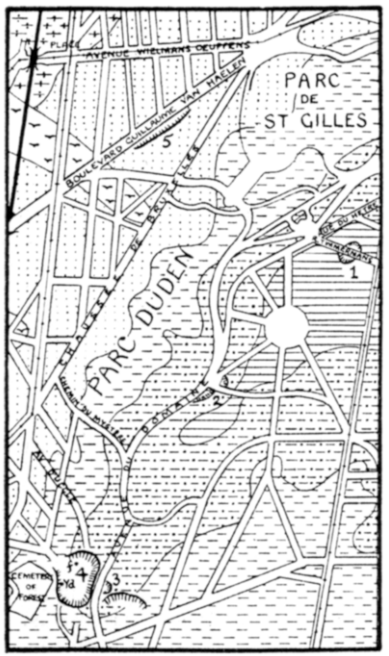


FIG. 7.—EOCENE SOUTH OF BRUSSELS, AUGUST 22ND (MORNING).
Scale 1 : 20,000.

1. A small pit showing:—
   - Loess with gravel of the Upper Terrace at the base 4 feet
   - Bartonian Clay (Argile d'Assche) becoming very sandy in the lower part seen for 7 feet
2. An old roadside section showing typical fine, soft, calcareous Ledian sands full of *Nummulites variolarius-heberti.* These sands are about 40 to 45 feet thick in the neighbourhood.
3. A roadside section showing the base of the Ledian full of rolled *Nummulites lævigatus* and other Lutetian fossils, sharks' teeth, tiny quartz pebbles, and fragments of Lutetian sandstones, resting on Lutetian (Bruxellian) sands. This basal bed is often cemented into hard masses (calcareous sandstone), formerly used for building. Just to the east is a large old sand-pit showing "pipes" (due to the decalcification of the Ledian sands), filled with Quaternary material.
4. The great sand-pit of Forest (Lutetian or Bruxellian Sands). Usually in the neighbourhood of Brussels the upper sands are calcareous and the lower siliceous

and extensively used for building. At Forest the sands are almost entirely siliceous, with a band of calcareous sand near the middle. Very marked false-bedding was noticed in the upper part, but great interest was aroused by the numerous siliceous concretions. Externally shaped like flints—of very varied and fantastic form—they are pale grey in colour and granular in texture when broken. They are known as "Pierres de grottes" from their use in rockeries. Blocks of the hardened basement bed of the Ledian, as well as lenticular masses of calcareous sandstone from the middle part of the quarry are also found lying about in the sand-pit. The Lutetian is rarely fossiliferous, but fragments of *Ostrea cymbula* were seen in an old part of the sand-pit to the north-west. Fish teeth also occur. The underlying Ypresian sands, with *Nummulites planulatus*, may usually be seen in the old western part of the pit, and when the face is sufficiently clear several step-faults (slip-faults down towards the centre of the valley) are visible.

5. A fine, though old, road cutting showing the fine-grained Ypresian sands with a bed about a foot thick, consisting almost entirely of *Nummulites planulatus-elegans*.

The floor of the valley of the Senne consists of alluvium resting on Ypresian Clay (= London Clay). Returned to Brussels by tram from the Place Wielemans-Ceuppens.

Afternoon.—The Porphyrite Quarries of Quenast. *Director*, M. F. Halet.

The train was taken from Bruxelles Midi to Quenast. The Quenast rock may be described as a quartz-porphyrite; it has phenocrysts of quartz (corroded), plagioclase and augite in a fine-grained groundmass, the whole highly epidotised. It occurs as an oval mass about $\frac{3}{4}$-mile long, intruded into Silurian shales. The first pit visited was that belonging to the Société anonyme des Nouvelles Carrières de Porphyre du Brabant, situated to the south-east of the station. On the east the contact with the Silurian shales was seen. The shales are curiously unaltered, a fact difficult to explain. Possibly (a) shearing may have brought unaltered shales into contact; (b) the shales may have been in the state of mud at the time of intrusion and hence were only slightly altered; (c) the temperature of intrusion may have been very low. The Quenast mass must have formed a rocky islet or submerged reef in the Eocene sea. In the present quarry it is covered by Ypresian Clay (= London Clay). At certain points the basement bed is a veritable bone-bed, consisting almost entirely of teeth of *Lamna*, etc. Many of the teeth are of Landenian species and hence are remanié.

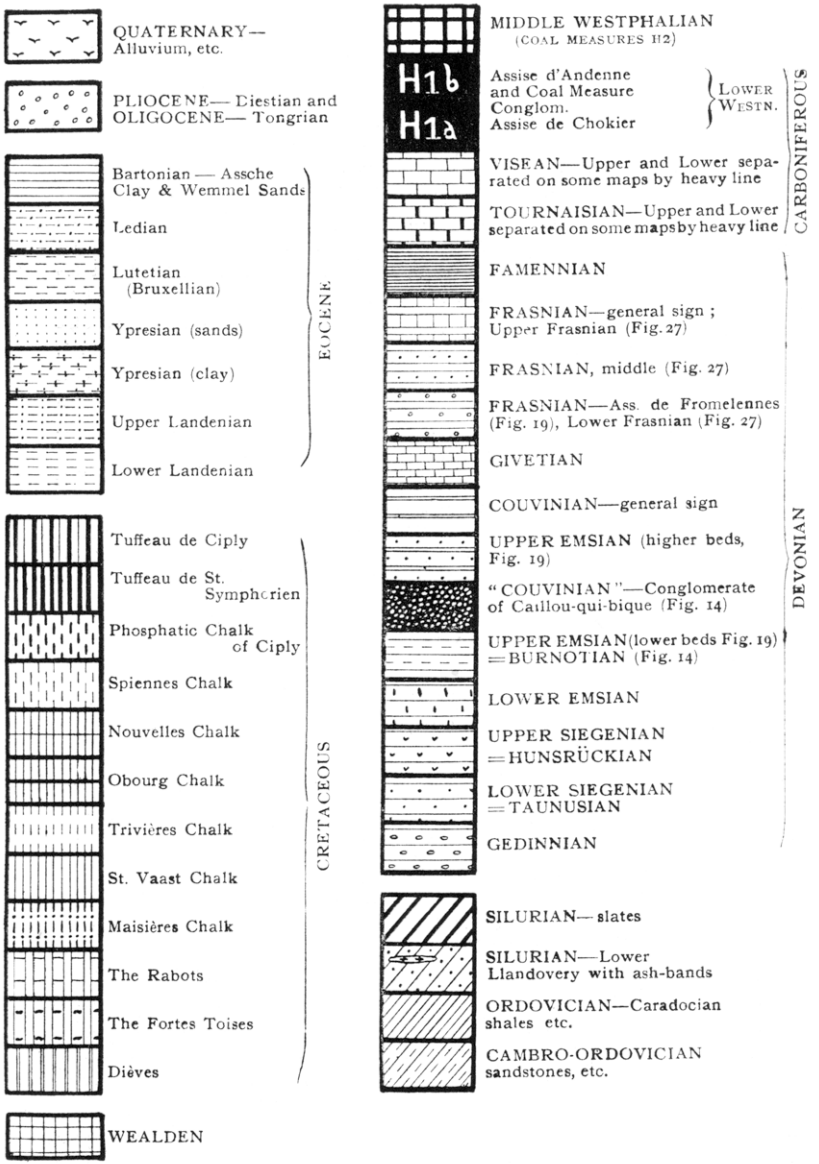
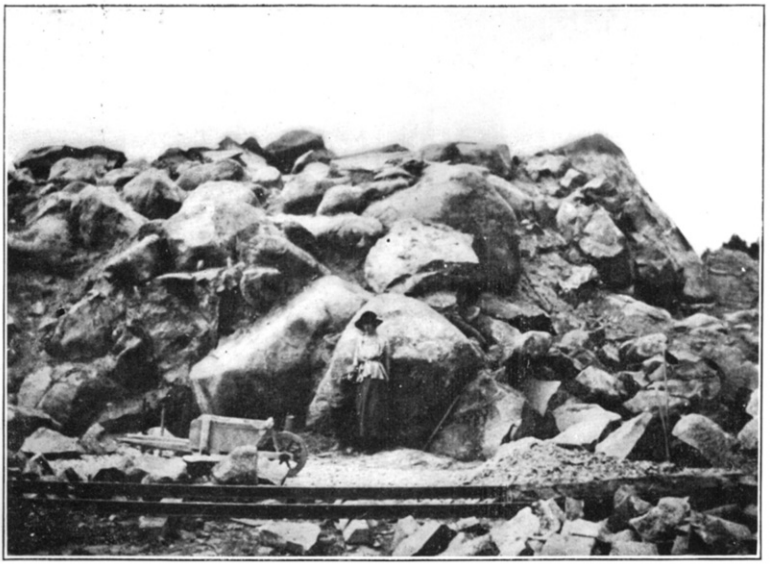


FIG. 8.—GENERAL KEY TO GEOLOGICAL SIGNS USED IN FIGS. 7, 10 TO 12 AND 14 TO 27.

Photo, L. Dudley Stamp.

A.—THE GREAT PORPHYRITE QUARRY AT QUENAST. EACH TIER IS ABOUT FORTY FEET DEEP.



Photo, L. Dudley Stamp.

B.—THE SURFACE OF THE PORPHYRITE MASS AT QUENAST, AFTER REMOVAL OF THE OVERBURDEN OF YPRESIAN CLAY.

[*To face page 42.*

A move was next made to the original western quarry (Société anonyme des Carrières de Porphyre de Quenast). The stone is worked in tiers and the lowest tier is well below sea-level (see Plate 2A). The stone has been worked for hundreds of years and the present quarry is of vast size. The removal of the overburden exposes the surface of the rock and presents a wonderful sight of great rounded boulders and huge smoothed rocks—some parts 50 or 60 feet higher than others (see Plate 2B). One could almost picture the Eocene sea dashing against these rocky masses. It was suggested that the initial rounding was due to atmospheric weathering and the final smoothing due to wave action.* In places the rock was bored by molluscs. In some of the deeper crevices (on the eastern side) quartz pebbles and sand occur—the remnants of Landenian sediments,—succeeded almost immediately by the Ypresian Clay with a few of the characteristic well-rounded black flint pebbles at the base. Especially on the southern side there are some interesting Quaternary deposits—of the higher terrace of the Senne—which cut down into the Ypresian and sometimes rest on the igneous rock. The Association were then hospitably entertained to a much appreciated tea by the owner, M. Hankar and his family, for which a very hearty vote of thanks was accorded.

From Quenast the party proceeded by train to Mons, via Soignies, and took up their headquarters in the Hotel d'Italie and Grand Hotel opposite the Station.

TUESDAY, AUGUST 23RD.

Cretaceous and Carboniferous of the northern border of the Mons Syncline. *Director,* Prof. J. Cornet, Professor of Geology at the School of Mines, Mons.

From Mons, Palais de Justice (just north of the Grand' Place), the light railway was taken to Maisières. (Fig. 10).

1. Large quarry showing the very glauconitic marl (Craie de Maisières), very fossiliferous, resting on a thick mass of flinty, greyish mottled fine-grained siliceous rock (the Rabots). The latter is extensively quarried for grinding-mills. The rock is shaped into blocks and made up into sets, each component block being carefully numbered. Exported all over the world, this material is used in those cases where the waste material from the wearing down of the mills must be pure silica. In one part (western) of the quarry the Maisières Chalk is covered by six or eight feet of Pleistocene sand which has yielded remains of Mammoth (*Elephas primigenius*).

* Some of the higher boulders no longer covered by the Ypresian Clay have been deeply altered in the ordinary way by percolating waters, and present a very different appearance.

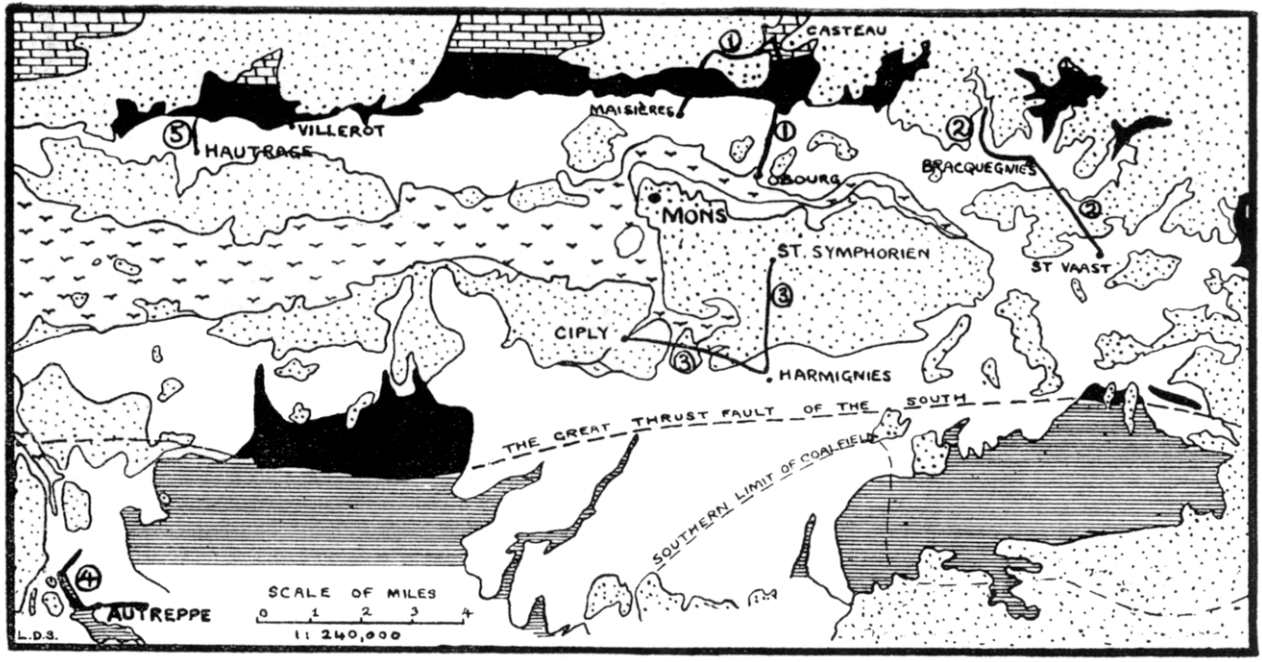


FIG. 9.—INDEX-MAP OF THE GEOLOGY OF THE MONS DISTRICT, SHOWING THE EXCURSIONS FOLLOWED ON EACH OF THE FIVE DAYS.

Key : Horizontal ruling=Pre-Carboniferous ; Bricks=Carboniferous Limestone ; Solid Black=Coal Measures ; Blank=Cretaceous ; Dotted=Tertiary ; Swallows=Quaternary.

It is a peculiarity of the northern side of the Haine Valley that sand takes the place of the usual loess.

From the quarry the path up the valley is not very clear. The exposures are close to the stream and on the eastern bank.

2. Rabots, seen resting on the glauconitic sands (decalcified marls) of the Fortes Toises with siliceous concretions.

3. Fortes Toises resting on the Upper Dièves, also decalcified.

4. Old quarries and stream sections in Wealden Beds—whitish fire-clays. The Wealden also comprises sands, pebble-beds and clays of all colours.

5. Sections in old trenches, etc., in Lower Coal Measures (Assise de Chokier) consisting of thin-bedded black siliceous shales, weathering white, and more massive, opaque siliceous beds (phtanites according to the definition of Belgian geologists). Fossils include *Posidoniella lævis* and *Posidonomya becheri*. Exact equivalent of the Pendleside Series. The shales exhibit curious pitting.

The party then walked south-eastwards across the Camp of Casteau and took the light railway to Casteau Village.

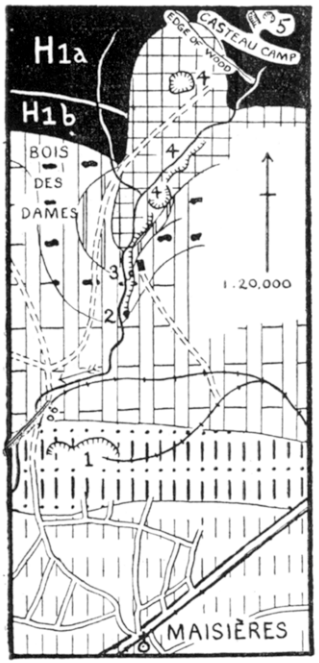
Casteau Village to Obourg. (Fig. 11).

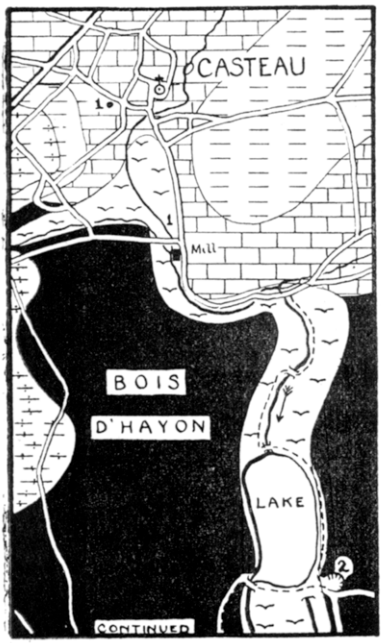
1. Sides of valley formed of Visean Limestone, *Dibunophyllum* zone, with *Productus giganteus*. Black limestone with siliceous nodules.

2. Quarry in Lower Coal Measures (Assise de Chokier, but higher horizon than at Casteau). Goniatites occur. A better section occurs in the lane some distance to the east.

3. Quarry, showing about 30 feet of grey and mottled Wealden fire-clay. The upper surface is irregular and the covering sediments include (1) Decalcified Dièves with pebble-bed at the base. The " pebbles " include huge boulders of quartzite of which the origin is doubtful. Up to 9 feet in thickness. (2) Landenian sands. (3) Pleistocene material. The whole is very disturbed and contorted, due to slipping towards the valley.

4. There are numerous quarries in the Rabots. In the principal one the Fortes Toises are just exposed in a cutting in the floor of the quarry. The Rabots are covered by a disturbed mass of Craie de Maisières, white chalk fragments and Landenian Sand.





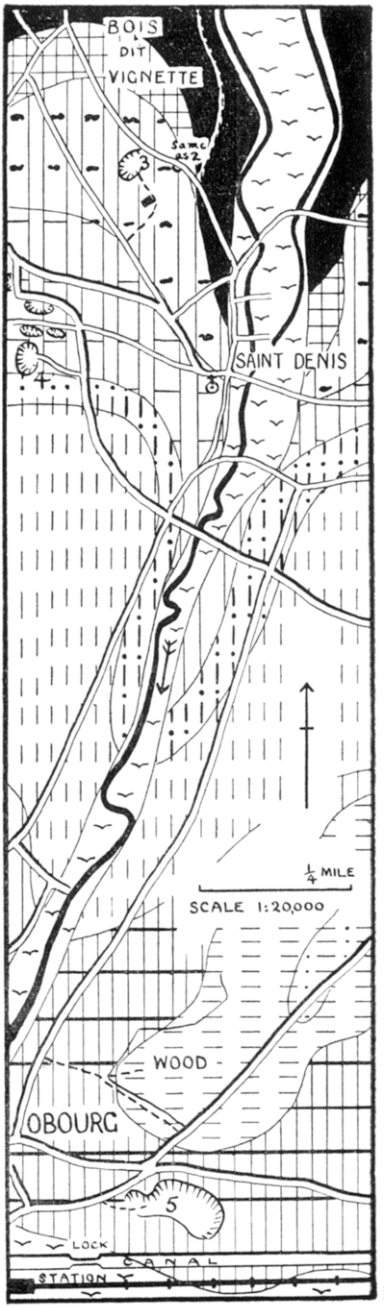


FIG. 10 (above) and FIG. 11 (below and right side) AUGUST 23RD
(Route 1 on **Fig. 9**).

5. Large chalk pit with pipes. Chalk of Obourg resting on the Chalk of Trivières with a fine fossilif rous conglomerate at the base of the former.

Returned to Mons from Obourg Station.

[Note: in Figs. 10 and 11 the signs used for the different beds are twice the size adopted in the other maps.]

WEDNESDAY, AUGUST 24TH.

The Cretaceous of the north-eastern part of the Haine Basin.
***Director*, Prof. J. Cornet.**

The party took the train from Mons to Bracquegnies, where, by an unfortunate accident, the tram (electrified light railway) to St. Vaast (" Bifurcation ") was missed and the party proceeded

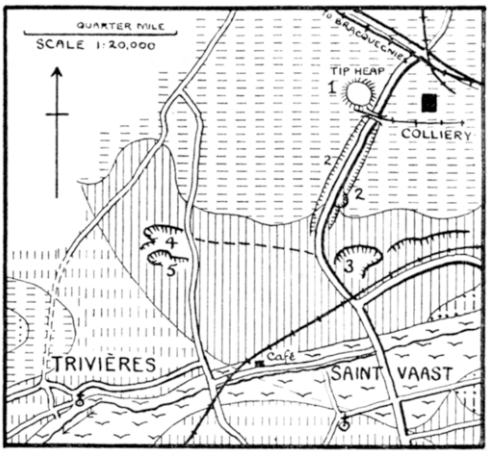


FIG. 12.—AUGUST 24TH (Route 2 on Fig. 9).

to St. Vaast on foot. This district is on the northern border of the Mons Syncline so that the beds dip to the south, but it is also towards the eastern end of the basin, so that the westward slope of the Palæozoic floor on which the Cretaceous beds rest caused a resultant dip to the south-west. The older beds are therefore to the north-east.

1. A tip heap from a colliery in the Assise de Charleroi.
2. A road cutting in the Upper Loess or Ergeron. A small pit on the eastern side of the road showed loess and Pleistocene gravel resting on pale green glauconitic sands (Lower Landenian). The latter become dark and very glauconitic in the lower part and rest on a bed two or three feet in thickness of Clay-with-flints

(Argile-à-silex) consisting of unworn flints (sometimes slightly green coated) in brownish clay. The Clay-with-flints is here definitely pre-Eocene and doubtless derived from solution and removal of the calcareous material of the Chalk. The beds in this section are disturbed and occupy a large pipe in the Chalk.

3. Large chalk pit, showing St. Vaast Chalk with typical mottled light and dark grey flints. Few fossils.

4-5. Chalk pits, showing Trivières Chalk (zone of *Actinocamax quadratus*) resting on St. Vaast Chalk (zone of *Micraster cor-testudinarium*. Although some 500-600 feet of our English Chalk are here missing, it is often difficult to separate the two zones. In the cutting leading to the southern quarry the junction can be examined. There is an inconspicuous conglomerate of chalk pebbles and marcasite nodules at the base of the upper bed.

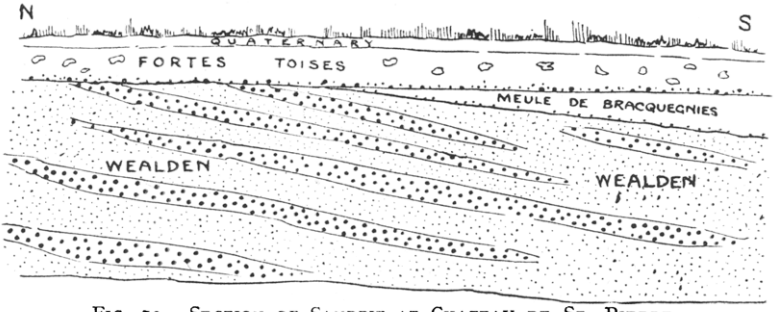


FIG. 13.—SECTION OF SANDPIT AT CHATEAU DE ST. PIERRE.
(For an account of the beds see the *Geology of Belgium*, pp. 31-2.)
Notice the overlap of the Fortes Toises. The Meule de Bracquenies is very fosiliferous; the Wealden consists of white sands with bands of well-rounded pebbles, mostly derived from the north. The height of the section is about 60-80 feet.

The party then walked back to Bracquegnies and took the light railway towards Casteau as far as the Chateau de St. Pierre. In the railway cutting the various beds of the Turonian were formerly exposed. Opposite the Chateau is a huge sand pit showing the section illustrated in Fig. 13.

The return to Mons was made via Bracquegnies. It s possible to return via Casteau by light railway.

THURSDAY, AUGUST 25TH.

The Cretaceous south of Mons. *Director*, Prof. J. Cornet.

The train was taken from Mons to Hyon-Ciply Station. (Fig. 15). On the way, just south-east of Cuesmes Station the huge pit

in the little hill of Mont Eribut, showing Ypresian sand, the whole thickness of the Ypresian Clay and a few feet of Landenian sand below, was noticed.

1. Sand pit, Landenian Sand, bed 5 of Cornet, decalcified.
2. Sand pit, loess and gravel with *Elephas primigenius* resting on Landenian sand. A good general view of the district is obtainable from here.
3. Cliff, formerly old quarry, showing Landenian (Tuffeau d'Angre) resting on Tuffeau de Ciply.
4. Huge quarry (Carrière Bernard), showing:
   Loess.
   Traces of glauconitic Landenian sands.
   Tuffeau de Ciply with Poudingue de la Malogne at the base.
   Unconformity.

Phosphatic Chalk of Ciply.		Hardened band at top.
	c.	Higher part with flints—northern corner.
	b.	Middle part, no flints.
	a.	Lower part with flints.

The phosphatic chalk is very fossiliferous and many fossils may be obtained on the tip heaps of washings from the mills. The flints are large and a curious grey or mottled, quite unlike ordinary Chalk flints. The " band dur " at the top is a curious band about two or three feet thick penetrated by long winding cavities which are filled with fragments of the overlying conglomerate. The Poudingue de la Malogne consists largely of phosphatised pebbles and has both remanié and contemporaneous fossils. Where the loess rests directly on the phosphatic chalk, as it does in a broad belt round Mons, one has pockets of " phosphat riche," now all worked out.

5. Old quarry (Carrière Solvay) Phosphatic Chalk of Ciply, covered by Landenian sand which is cut through by a Pleistocene channel. The latter is filled by: (1) Ergeron or brick-earth in the upper part; (2) " Limon ancien " of Dr. Commont in the lower part; (3) bed of gravel at the base, which has yielded Acheulian implements.
6. Roadside section (poor) base of Phosphatic Chalk of Ciply resting on the Spiennes Chalk.
7. Long succession of chalk pits. Western ones show the Spiennes Chalk (fauna same as that of Ciply Chalk, but less abundant) with a line of phosphatic nodules at the base resting on Nouvelles Chalk with *Magas pumilus*. The upper part of the latter is formed by a hardened yellow band. The dip is to the north-west, but the beds are repeatedly faulted so that the same succession extends a long way to the east.

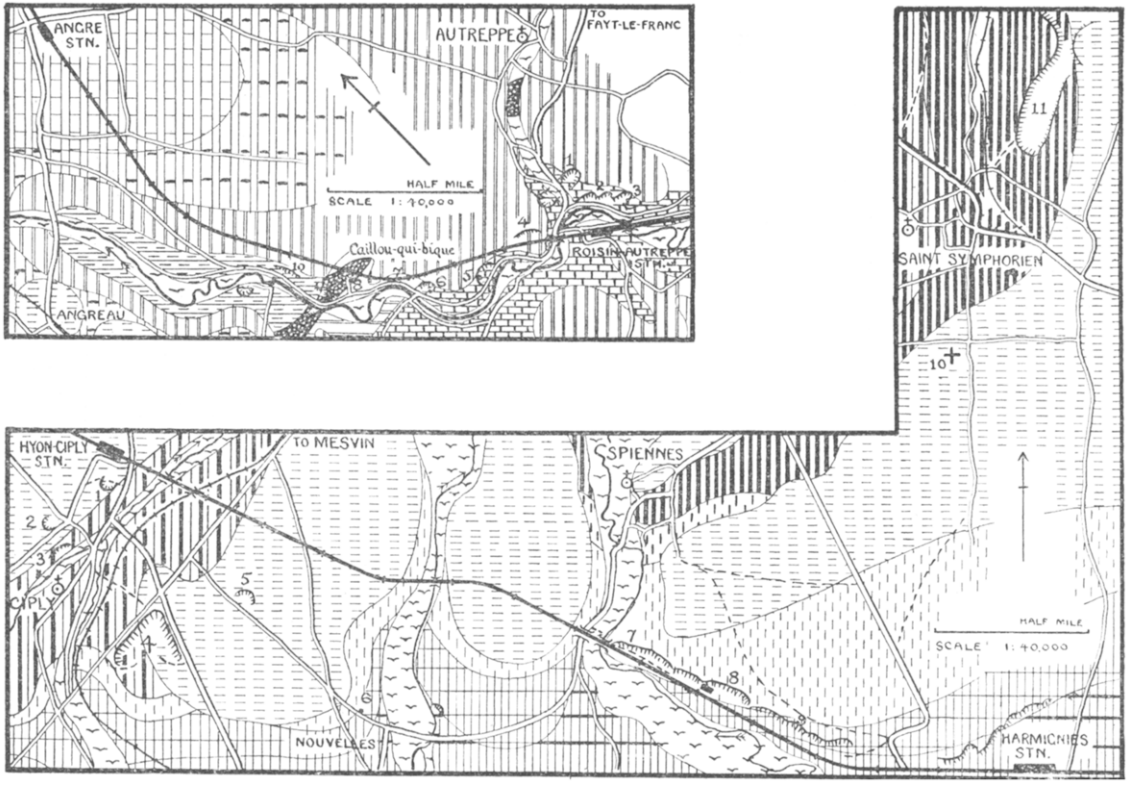
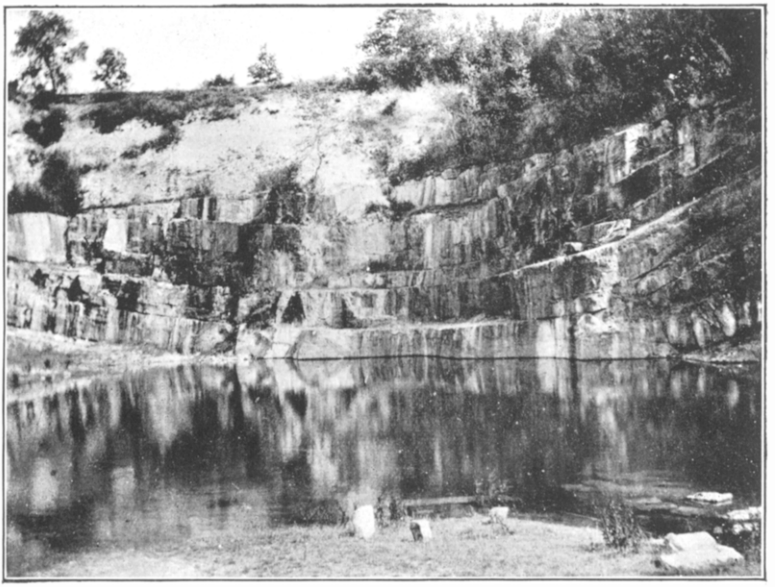
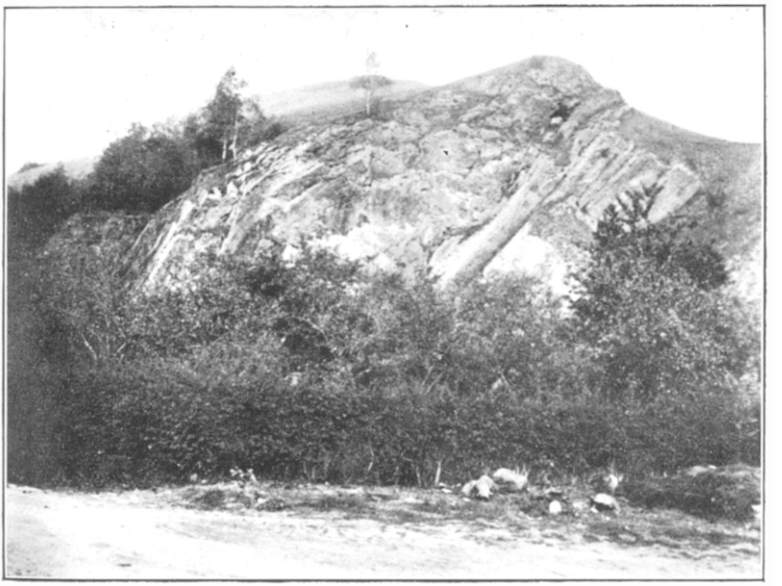


FIG. 14 (above)—AUGUST 26TH. FIG. 15 (below)—AUGUST 25TH (Routes 3 and 4 on Fig. 9).



Photo, Miss M. S. Johnston.

A.—QUARRY AT AUTREPPE, SHOWING GIVETIAN LIMESTONE UNCONFORMABLY OVERLAIN BY CRETACEOUS DEPOSITS.



Photo, G. M. Davies.

B.—VIEW OF THE END OF A CORAL REEF AT BOUSSU-EN-FAGNE, SHOWING DISPOSITION OF ASSOCIATED SEDIMENTS (*see page 57*).

8. Large chalk pit, being actively worked, same succession. The Nouvelles Chalk is a fine soft white chalk and used for making Paris White. It yielded many of the fossils characteristic of the *Belemnitella mucronata* zone of Norfolk—huge form of *Echinocorys*, *Epiaster gibbus* (= *Micraster glyphus*), etc.
9. Another chalk pit. The Obourg Chalk just appears in the south-east corner.

On the way to St. Symphorien a visit was paid to the Military Cemetery wherein lie the victims of the Battle of Mons, 23rd-24th August, 1914. (10.)

11. Huge quarry in Phosphatic Chalk (Hardenpont Quarry of St. Symphorien). The southern part showed:
Sandy loess.
Pleistocene sand passing gradually down into
Landenian Sand, bed 3 of Cornet, so glauconitic as to be almost black. Irregular junction with beds below—partly due to ravinement, partly to subsequent solution.
Tuffeau de Saint Symphorien with *Thecidea papillata*. Poudingue de la Malogne at the base.
Phosphatic Chalk of Ciply. Here the iron is in a ferrous condition and the rock is grey.

Returned to Mons by light railway from Saint Symphorien.

FRIDAY, AUGUST 26TH.

Valley of the Hogneau. Devonian of the northern border of the Dinant Synclinorium and superimposed Upper Cenomanian and Turonian. *Director*, Prof. J. Cornet.

The most convenient point for starting this excursion is Roisin-Autreppe Station. Owing, however, to the exigencies of the railway service, the party travelled by train to Boussu, thence by light railway to Fayt-le-Franc, then walking to Autreppe. The valley of the Hogneau is cut in the upper part of the Lower Devonian and the Middle Devonian. The regional dip is to the south, but there is much local folding. The whole mass is in reality thrust over the Namur Synclinorium. (Map, fig. 14).

1. A large quarry in Givetian Limestone—quarried for black marble—showing the following succession (see Plate 3A):—

Lower Turonian.	2.	Whitish marls with *Terebratulina rigida* (? = *T. lata*)—Upper Dièves.
	1.	Bluish marls with *Inoceramus labiatus* —Middle Dièves.
Cenomanian	2.	Bluish marls with *Actinocamax plenus* —Lower Dièves.

Very well marked plane of marine erosion.
Givetian. Hard black limestone, in thick beds.

The Givetian Limestone is here folded into a fine syncline. In certain places below the Lower Dièves are traces of the Tourtia de Mons—glauconitic marls with *Pecten asper*. Sometimes there are solution hollows in the surface of the Givetian Limestone and in these the lowest deposits are pebbly, glauconitic sands with *Terebratula depressa* (Tourtia de Montignies-sur-Roc). One such solution hollow was seen by Lyell and is figured by him in the *Manual of Geology*, 5th Edition (1855), Chap. V. A similar succession is seen in the quarry on the opposite side of the road.

2-3. The members walked a short distance to the south to see the minor folding in the Givetian Limestone. The folds are very varied, both symmetrical and asymmetrical, with axes E.—W., and one gains a very good idea of the minor folding in the Dinant Synclinorium.

4. A quarry in the Dièves by the side of the railway formed the best collecting ground for the three zones. The upper surface of the Givetian limestone was found to be riddled with the borings of lithophagous molluscs. The Dièves are used for the manufacture of hydraulic cement.

5. Quarry (Carrière Cordier) in Givetian Limestone. Every band of limestone in the Autreppe quarries has a special name and long experience has shown that each band is suitable for some special purpose. The presence of the black Givetian marble gave rise to a great marble industry and marbles were imported from all parts of the world. The industry continues, though the local stone is now very little used. Fossils are difficult to extract from the Givetian limestone, but various corals and numerous sections of *Stringocephalus* were seen.

6. Quarry, showing the western extension of the syncline observed in the first quarry. The fold pitches to the east, so that the lowest beds of the Givetian are here exposed. In the northern corner of the quarry are impure limestones with a mixture of Couvinian and Givetian fossils.

7-9. The Couvinian comprises the following beds :—

Calcareous Shales and impure limestones (6).

Shales, fossiliferous (7).

Decalcified sandstone, with fossiliferous bands (so-called grauwacke). *Spirifer cultrijugatus, Calceola sandalina*, crinoids (= *Cultrijugatus* zone). (8).

Conglomerate of Caillou-qui-bique. Three bands of very coarse conglomerate, of which the middle band is the thickest, separated by bands of shale (9).

Caillou-qui-bique (" the rock which projects ") is an imposing mass formed by the middle band of conglomerate. This

conglomerate is a very useful base for the Middle Devonian along the northern border of the Dinant Synclinorium, but it is doubtful whether it is always on the same horizon.

10. Cliff in red Burnotian shales (Emsian). By a trick of cleavage and jointing these beds appear horizontal, but in reality they dip southwards conformably under the Couvinian Conglomerate.

The party finished the walk along the delightful valley and proceeded to Angre Station, returning to Mons via Dour.

SATURDAY, AUGUST 27TH.

Coal Measures and Lower Cretaceous north-west of Mons. *Director*, Prof. J. Cornet.

By train from Mons to Villerot via St. Ghislain. (Fig. 16).

1. Small quarry in the Bois-de-Ville Sandstone, at the top of the Assise de Chokier (Coal Measures). This material is ground for mixing with Wealden Clay in the manufacture of certain bricks, sanitary earthenware, etc. Also seen in cutting by Villerot halt.
2. Pit in Wealden Clay. It is dark but weathers white and is stacked in heaps for that reason. Also some sand. In one part of quarry covered by Lower Landenian sand mixed with Pleistocene. Fossils of Wealden include wood, occasionally cones, and pit 4 has recently yielded ferruginous concretions with Wealden molluscs.
3. Small southernmost pit shows Dièves with *Ter. rigida*, still calcareous in places, with pebbles of polished phtanite, coprolites, etc., resting on lignitic Wealden Clays.
4. Pit in Weald Clay showing good dip (about 25° S.), with beds of sand above.
5. Pit in Weald Clay with lenticular bands of quartzitic sandstone. Clay is very pyritous in places, especially where lignitiferous.
6. Old coal pit, "Fosse St. Hubert." Formerly worked the poor pyritous coals near the base of the Assise d'Andenne.
7. Quarry in the pure white sandstone of Bois-de-Ville, resting on black siliceous shales like those of Casteau. Only indeterminable lamellibranchs in the sandstone. Dipping steeply to the south.
8. Quarry in Bois-de-Ville Sandstone, with shales of the base of the Assise d'Andenne above.

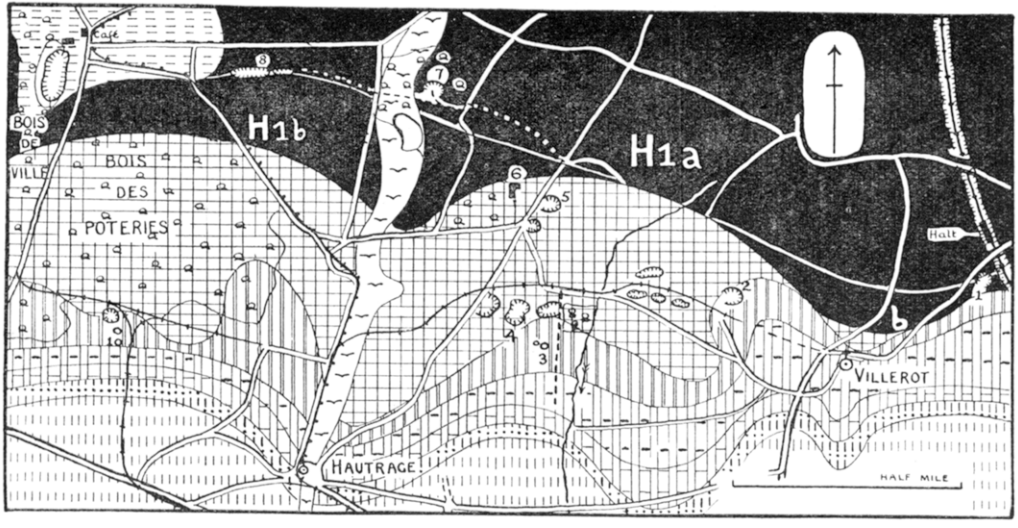


FIG. 16.—CRETACEOUS OF THE NORTHERN BORDER OF THE MONS SYNCLINE.—AUGUST 27TH.

An attempt has been made to show the wooded nature of the country. The conventional signs used for trees should not be confused with the geological signs

(Route 5 on Fig. 9).

9. Large quarry showing 40-50 feet of the Assise d'Andenne, resting on the Bois-de-Ville Sandstone. Between the last two quarries a strong north-south fold, which affects the whole of the coalfield to the south, has deflected the outcrop of the sandstone to the north and then back to the south, regaining its east-west alignment on either side.

10. Small pits in a little wood (just south of a pit in Weald Clay), showing Dièves with *Actinocamax plenus*, resting on the Tourtia de Mons. The latter is about three feet thick and consists of a gravel (of polished phtanite pebbles, etc.), full of fossils (*Pecten asper*), passing down into the decalcified glauconitic sand of the Meule de Bernissart, of which about 5 feet are exposed. It is here about 22 feet thick, elsewhere reaches 500 feet.

Returned to Mons by light railway from Hautrage to St. Ghislain, thence by tram from Quatre Pavés.

In the evening the return was made to Brussels.

MONDAY, AUGUST 29TH.

Morning.—The Tertiary Beds north-west of Brussels. *Director*, Prof. F. Halet.

From the south-west corner of the Place Rogier, opposite the North Station, the electrified light railway was taken in the direction of Wemmel as far as the entrance to the Avenue Houba-de-Strooper. (Fig. 17).

1. A small sand pit showing about 12 feet of the Wemmel Sands—very fossiliferous—succeeded by about 3 feet of Bartonian Clay.

2. A deep road-cutting showing the rather fine, ferruginous and unfossiliferous sands referred to the Tongrian (base of the Oligocene).

3. The banks of the sunken road exhibit sections in the coarse, highly ferruginous Diestian Sands. No fossils are known from the vicinity.

4. Small sections in the Bartonian (Argile d'Assche) are often visible in holes by the roadside.*

5. The old sand-pit, now partly overgrown, in the Wemmel Sands, from which most of the fossils of those sands in collections were obtained.

The hills capped by Diestian, such as the one visited in the

* The part of the lane traversing the clay is paved or cobbled ("pavé.")

present excursion, are orientated roughly east and west and have different slopes to the north and south. They are really cuestas.

Return from Jette, near Station, by tram to Brussels (Bourse).

In the afternoon the party left Brussels (Midi) for the Couvin

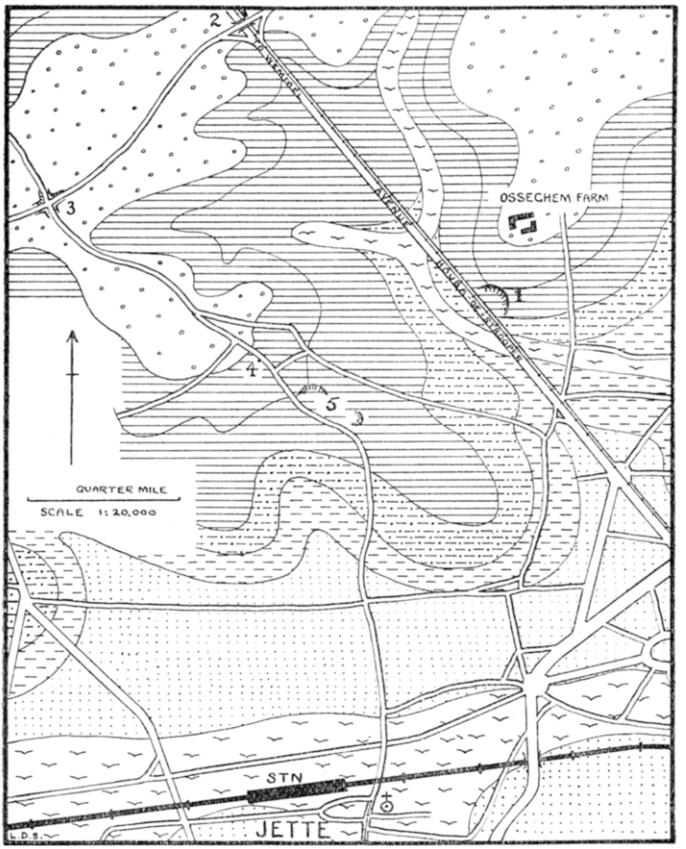


FIG. 17.—TERTIARY NORTH-WEST OF BRUSSELS.—AUGUST 29TH.

district, via Charleroi. Owing to the difficulty of obtaining accommodation in Couvin about 16 members stayed at the Hotel du Commerce, Mariembourg Station, the remainder—about 30—at the Grand Hotel at Nismes.

TUESDAY, AUGUST 30TH.

The Frasnian of the southern border of the Dinant Synclinorium. *Director*, M. E. Maillieux, Curator at the Royal Natural History Museum, Brussels.

Morning.—The two parties met half-way between Nismes and Mariembourg, and noted the large hills in the distance caused by coral reefs with *Pachystroma* and the small rounded hills in the immediate vicinity caused by small reefs with *Acervularia*. The Frasnian is here locally folded so that the reefs are horizontal (Fig. 4D, p. 17). The morning was then spent in the railway cutting about half-a-mile west of Nismes Station (shown on Fig. 19), which shows the upper surface of a reef with *Acervularia*, dipping eastward and toward the railway line (on the north side of the cutting). To the west one sees stratified limestone very rich in crinoids, to the east just above the reef are shales rich in *Spirifer pachyrhynchus* and heads of crinoids (*Melocrinus*). Further east are the Schistes de Matagne with *Buchiola palmata*.

The train was then taken from Nismes to Boussu via Mariembourg.

Afternoon.—Boussu-en-Fagne to Frasnes (Figs. 4E and 18).

1. Quarry showing upper part of a reef with *Pachystroma*, covered by shales with *Sp. pachyrhynchus*.
2. Débris from a reef with *Acervularia* (*A. davidsoni*), very rich in fossils. In the upper surface of the reef are pockets crowded with brachiopods (*Rhyn. cuboides*, *R. acuminata*, *Athyris concentrica*, *A. davidsoni*, etc.).
3. Cutting behind the Church. Schistes de Matagne which come above the last reef.
4. Fine section showing the lens-shaped end of a reef with *Pachystroma* (massive limestone) resting on originally horizontal beds and covered by gently curved beds of stratified limestone with *Stromatopora* (Fig. 4Ef, p. 17, and Plate 3B). Underneath are seen shales with *Camarophoria megistana*.
5. Underneath the last-mentioned shales are the shales with *Leiorhynchus formosus*. Both form a small valley, but a few hundred yards to the east are faulted out by a crush-fault.
6. Small section showing the end of a reef in red marble without *Acervularia*, surrounded by shales with *Gypidula* [*Pentamerus*] *brevirostris*.
7. Shales with *Receptaculites neptuni* (roadside).

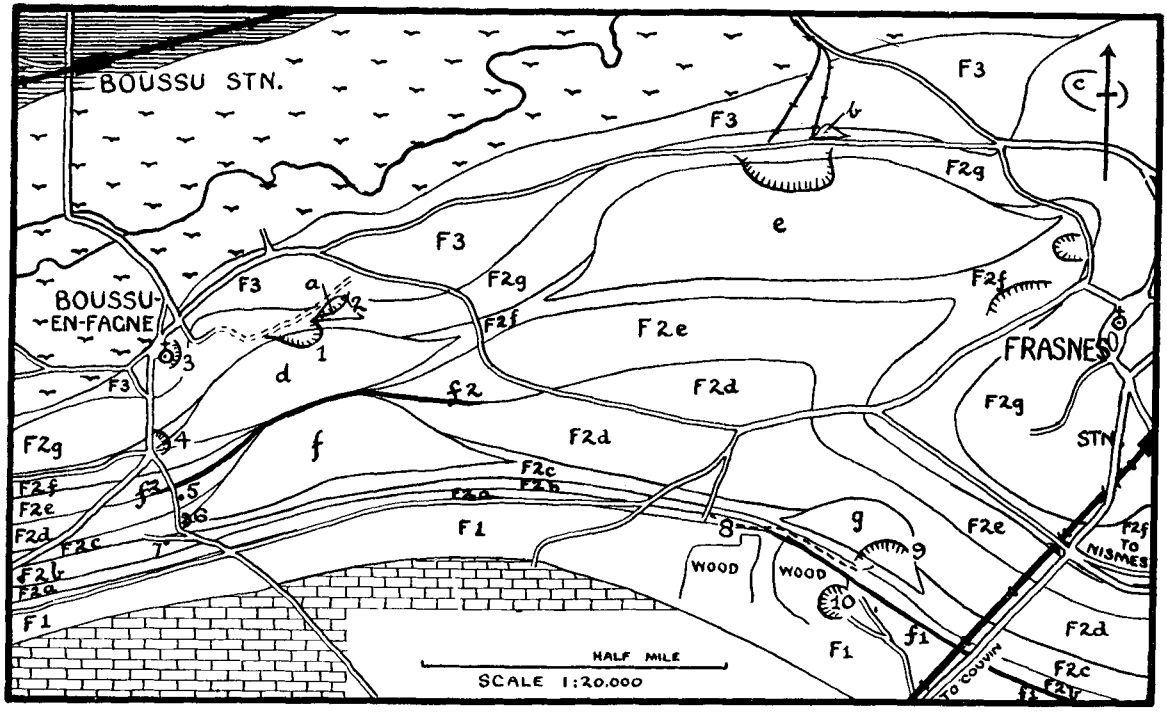


FIG. 18.—FRASNIAN BETWEEN BOUSSU AND FRASNES.—AUGUST 30TH.
This map was drawn up by M. E. Matthieux.

F3=Assise de Matagne; F2g=Shales with *Spirifer pachyrhynchus* and Reefs of Red Marble with *Acervularia* (a, b, c); F2f=Limestone with *Stromatopora* and Reefs of Grey Marble (d, e); F2e=Shales with *Camarophoria megistana*. F2d=Shales with *Leiorhynchus formosus*; F2c=Shales and Limestone with *Gypidula brevirostris* and Reefs of Red Marble without *Acervularia*; F2b=Shales with *Spirifer bisinus* and *Receptaculites neptuni*; F2a=Shales with *Spirifer orbelianus* (Zone des Monstres); F1=Assise de Fromelennes; f1–f1=Fault (Faille de la Vaucelle); f2–f2=Fault (Faille de l'Ermitage); F2a–F2g are all Assise de Frasnes; Givetian and Famennian shown as usual.

8. Fossils of the "Zone des Monstres," with *Spirifer orbelianus* found in a field. These beds are faulted out in the next section.

9. Quarry showing the base of a reef of red marble without *Acervularia* resting on shales—the upper part full of *Cyathophyllum cæspitosum*. The lower part of the reef is red and much prized, the upper part becomes paler and is less valued. A curious structure, called "*Stromatactis*" (very like *Eozoon*), was seen in the marble.

10. Quarry in Assise de Fromelennes, upper two beds.

From Frasnes, walked back to Nismes and Mariembourg or by train to the latter.

WEDNESDAY, AUGUST 31ST.

The Lower and Middle Devonian of the southern border of the Dinant Synclinorium. *Director*, M. E. Maillieux. (Map. Fig. 19).

The party started from Nismes.

1. Roadside section in the Shales with *Leiorhynchus*. Rich in trilobites.

2-3. Old quarries (formerly iron workings) in Givetian Limestone. In the upper part there are sometimes solution pockets filled with a dolomite sand in which fossils are very abundant (Upper Givetian, limestone with *Cyathophyllum quadrigeminum*).

4-5. Large natural or semi-natural pits in Givetian Limestone (Fonderie des Chiens, etc.). Some have been descended to a great depth.

6. Quarry in Couvinian (1b, b), grey stromatoporoid limestone.

7. Roadside section and heaps of material collected from the fields, fossiliferous Lower Couvinian (*cultrijugatus* Beds).

8. Roadside exposures of upper part of the Assise de Hierges (Upper Emsian), equivalent of the Obere-Coblenzschichten. Fossiliferous.

9. Roadside exposures in the red shales (schistes rouges de Winenne) of the lower part of the Assise de Hierges.

10. Large quarry in the Grès d'Anor—pale sandstone, very fossiliferous. (Lower Siegenian or Taunusian.)

11. Poor roadside exposures in the greenish or mottled shales of the Assise d'Oignies (Upper Gedinnian). (The

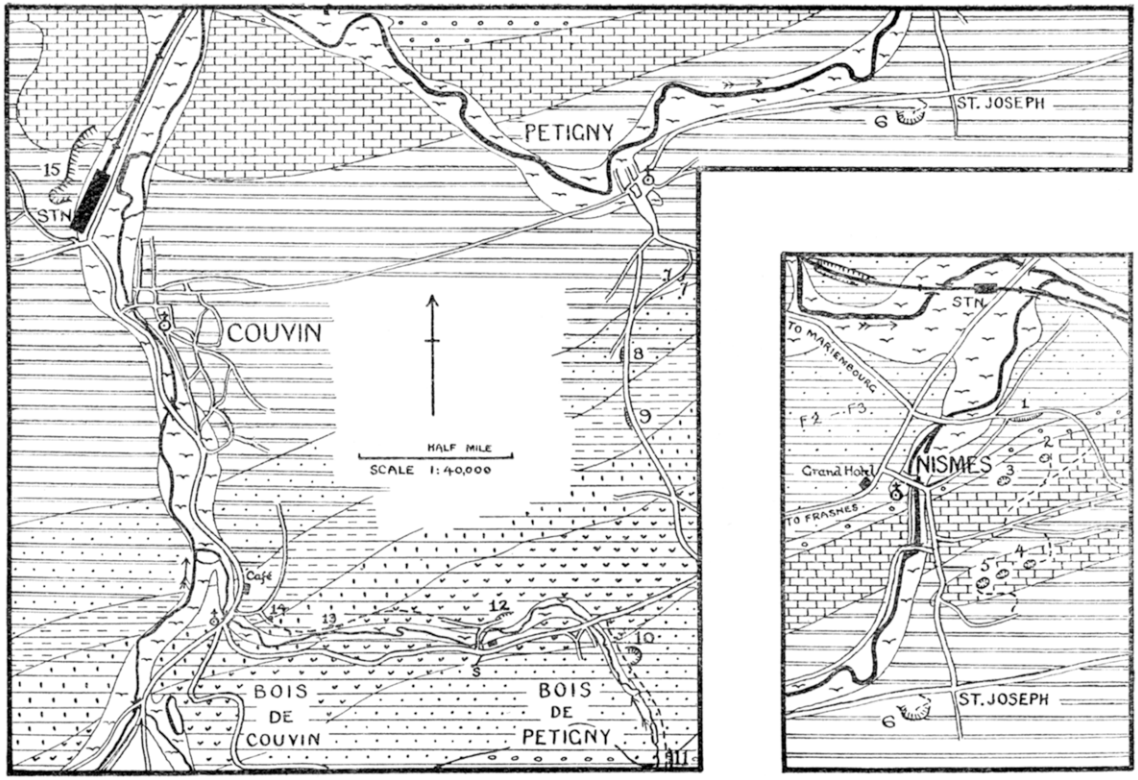


FIG. 19.—DEVONIAN OF THE COUVIN DISTRICT.—AUGUST 31ST.

section is a few hundred yards further south than indicated on the map).

12. Cutting by side of a path in the Assise de Houffalize (Upper Siegenian or Hunsrückian). Fossiliferous.
13. Cutting by side of a path in unfossiliferous shales of the Assise de Vireux (Lower Emsian).
14. Roadside cutting in the red shales of Winenne.
15. Time did not allow of a visit to the interesting quarry by Couvin Station, which shows the highest beds of the Couvinian (limestone with *Cycloceras nodulosum*), succeeded by 8-10 feet of the basal Givetian beds (Shales with *Spirifer undiferus*) and then by the Givetian Limestone with *Stringocephalus burtini*.

The return to Mariembourg was made by train and to Nismes by train to Frasnes and then on foot.

THURSDAY, SEPTEMBER 1ST.

The Carboniferous Limestone of Hastière and Yvoir. *Directors*, Prof. G. Delépine, Professor of Geology at the Catholic University of Lille, and Dr. Dumanet. Also the Section along the Meuse from Hastière to Namur, *Director*, Prof. F. Kaisin, Professor of Geology at the University of Louvain.

The party travelled from Nismes to Hastière via Mariembourg.

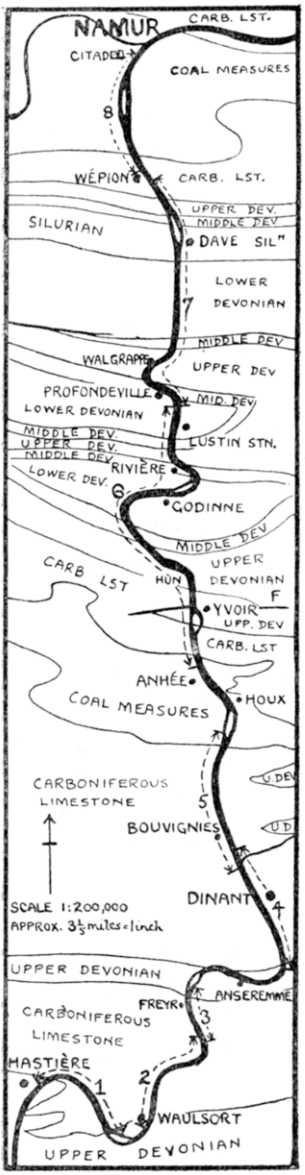
Hastière. Section across the southern limb of a syncline in Carboniferous Limestone. (Fig. 20).

1. Roadside section in Famennian Shales.
2. Road cutting in Hastière Limestone, succeeded by the Shales with *Spiriferina peracuta*. (T1a and T2b respectively in Fig. 22).
3. Landelies Limestone T1c succeeded by the Maredsous Calcareous Shales T1d and then by the Yvoir Limestone T2a, all nearly vertical. The great wall of rock to the north is formed of Waulsortian rocks better examined in

4, 5, 6. Cliffs of Waulsortian rocks of different types, representing the upper part of the Tournaisian. Fossils occur at 5, and the rocks extend right up to the next locality—a huge thickness.

7. Cliff, of finely brecciated limestone, forming the base of the Visean (S1).
8. Roadside exposure of S2.
9. Roadside exposure of the "Grand Brêche" (D1), which forms the centre of the Hastière Syncline.

The party then returned to Hastière and boarded the special boat which was to take them down the Meuse. A halt of ¾-hour was made at Yvoir to see another type of Carboniferous Limestone. In the two quarries immediately to the east of Yvoir



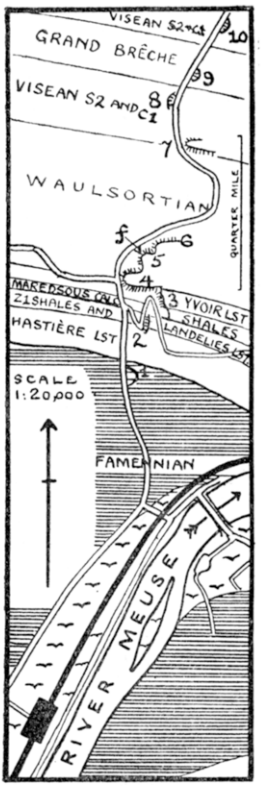


FIG. 20.—CARBONIFEROUS LIMESTONE OF HASTIÈRE.

FIG. 21.—SKETCH-MAP OF THE MEUSE VALLEY FROM HASTIÈRE TO NAMUR AND KEY TO THE SECTIONS (FIGS. 22, 23.)—SEPTEMBER 1ST.

Station, the beds are dipping very steeply to the south and the following section is seen from north to south :—Hastière Limestone, Shales with *Spiriferina peracuta*, Landelies Limestone, Maredsous Calcareous Shales (between the two quarries, not worked, but very fossiliferous), Yvoir Limestone, " Petit granite." Most of the time was spent in examining the latter. It is a highly crinoidal limestone, on the same horizon as the lower part of the Waulsortian rocks seen earlier in the day.

The voyage down the Meuse, enjoyable at any time, was rendered particularly delightful by the glorious weather. At the same time it was very instructive ; the large map which Prof. Kaisin had prepared, and the sheets of sections which he distributed to the party made the study of the section perfectly simple. Each point of interest on the sections was numbered and, as the boat approached each point, Prof. Kaisin put up the corresponding number on a card indicator. One gained a very good idea of what is meant by a synclinorium—the Meuse cuts right across of the minor folds in the great Dinant Synclinorium and into the Namur Synclinorium. The contrast between the symmetrical folds in the former and the asymmetrical in the latter was well marked. (Figs. 21–23).

Arrived at Namur, the party distributed itself between three hotels—Hotel d'Harscamp, Hotel de Hollande and Hotel St. Aubin.

FRIDAY, SEPTEMBER 2ND.

Morning.—Carboniferous Limestone east of Namur. *Director,* Prof. G. Delépine. (See page 21).

The party proceeded by train from Namur to Marche-les-Dames. (Fig. 24).

1. Cliffs of Carboniferous dolomite.
2. Quarry in C2 dolomite.
3. Quarry in S2 dolomite. S1 may be represented in the eastern corner. Half-way up the face *Lithostrotion* appears, followed by *Productus cora.* In the cliffs above is the Namèche Limestone.
4. Quarry in Black Limestone of Namèche (S2). Very fossiliferous, including *Lithostrotion martini, Dorlodotia briarti, Carcinophyllum vaughani, Productus cora, Seminula,* etc.
5. " Grand Brêche," not examined because not very typical here. Very well marked at Namur, it passes rapidly westwards into an oolitic limestone.
6. Quarry in D2 Limestone. Except at Visé, fossils are extremely scarce at this horizon, but this quarry formerly exhibited a lenticular bed full of brachipods.

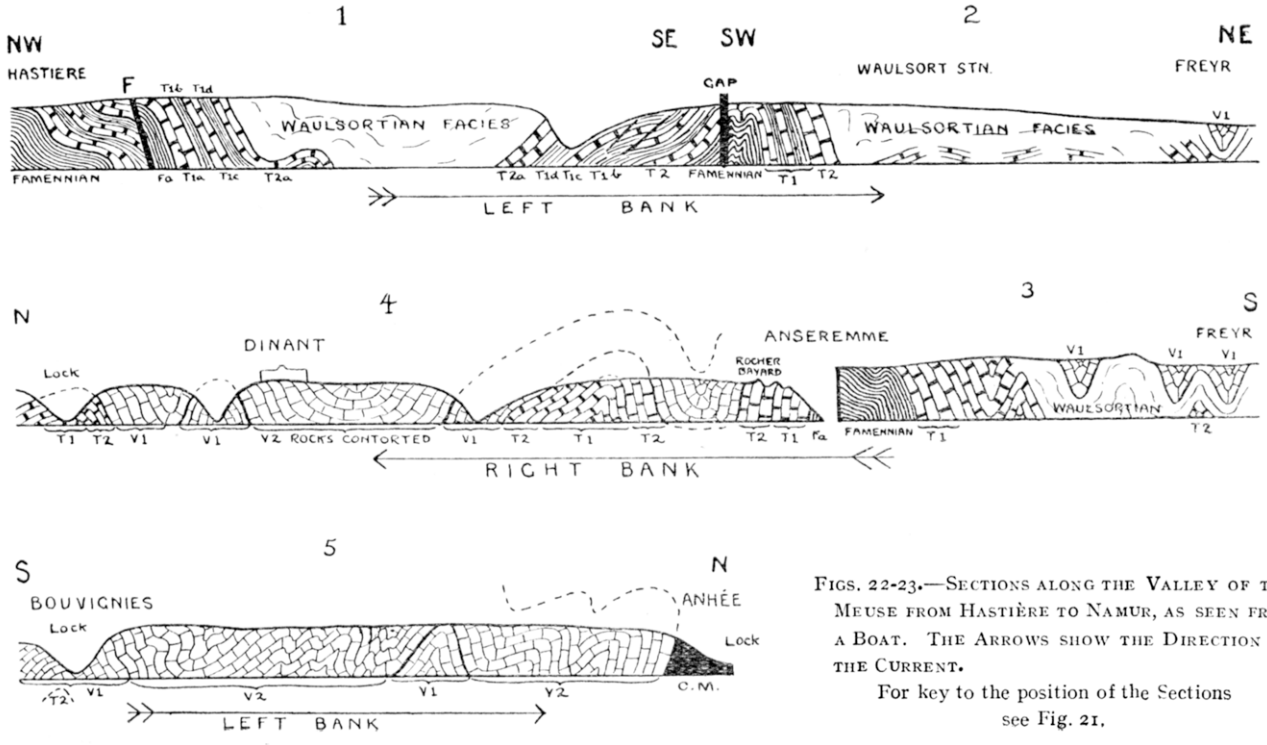


FIG. 22.

FIGS. 22-23.—SECTIONS ALONG THE VALLEY OF THE MEUSE FROM HASTIÈRE TO NAMUR, AS SEEN FROM A BOAT. THE ARROWS SHOW THE DIRECTION OF THE CURRENT.

For key to the position of the Sections see Fig. 21.

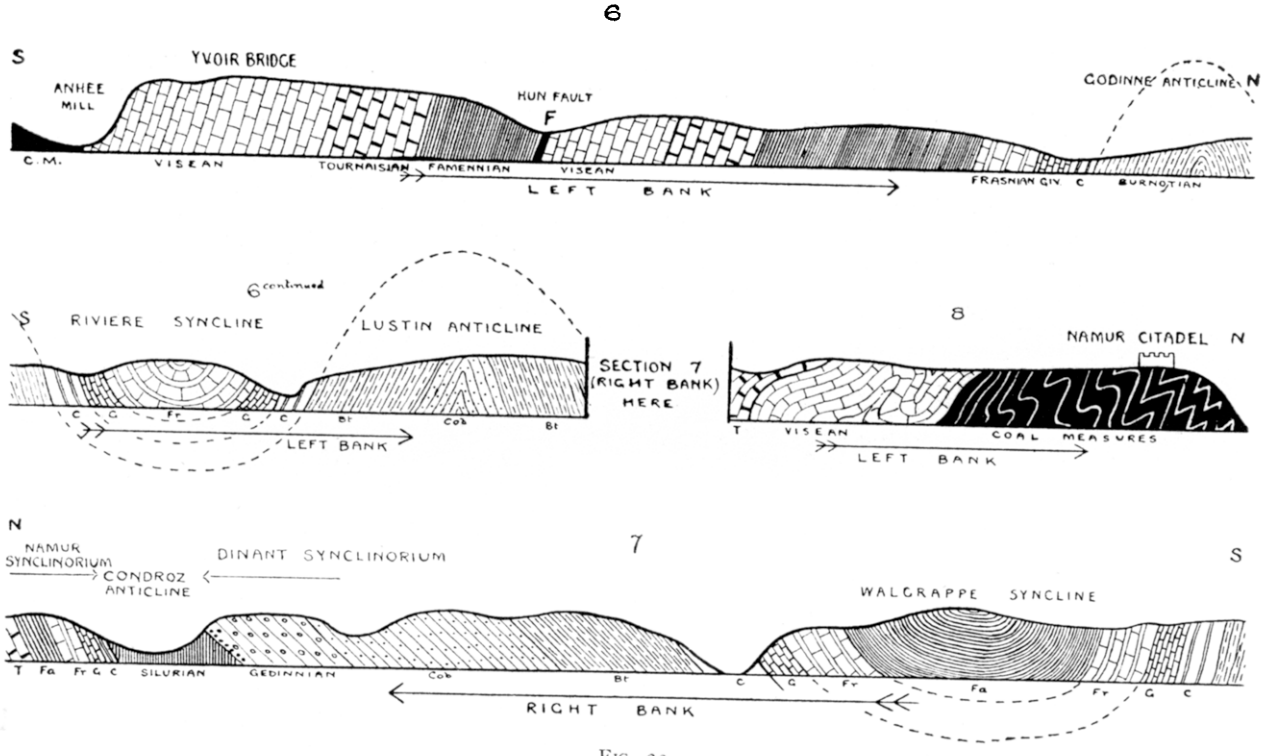

6
S
YVOIR BRIDGE
ANHEE
MILL
HUN FAULT
F
GODINNE ANTICLINE
N
C.M.
VISEAN
TOURNAISIAN
FAMENNIAN
VISEAN
LEFT BANK
FRASNIAN GIV
C
BURNOTIAN
6 continued
S
RIVIERE SYNCLINE
LUSTIN ANTICLINE
SECTION 7
(RIGHT BANK)
HERE
8
NAMUR CITADEL
N
T
VISEAN
COAL MEASURES
LEFT BANK
N
NAMUR
SYNCLINORIUM
CONDROZ
ANTICLINE
DINANT SYNCLINORIUM
7
S
WALGRAPPE SYNCLINE
SILURIAN
GEDINNIAN
RIGHT BANK

FIG. 23.

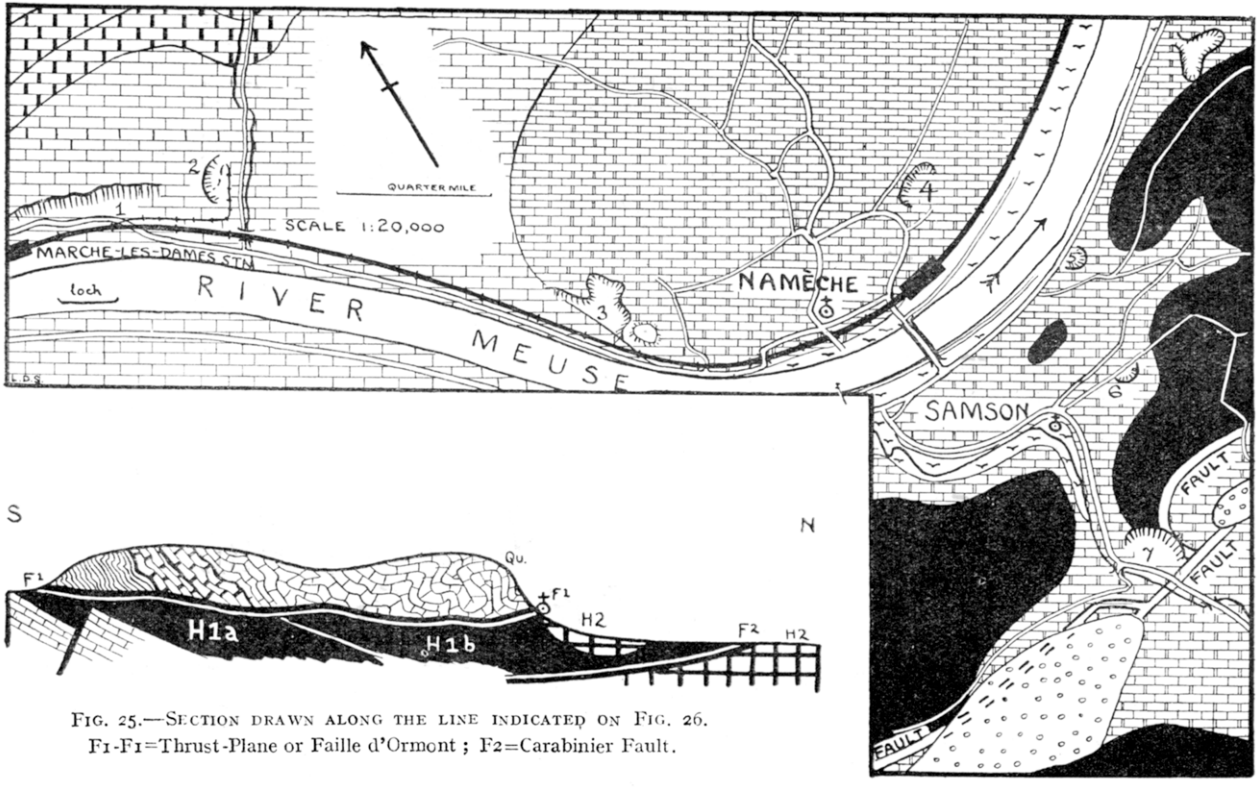


FIG. 25.—SECTION DRAWN ALONG THE LINE INDICATED ON FIG. 26.
F1-F1=Thrust-Plane or Faille d'Ormont ; F2=Carabinier Fault.

FIG. 24.—SEPTEMBER 2ND (MORNING).

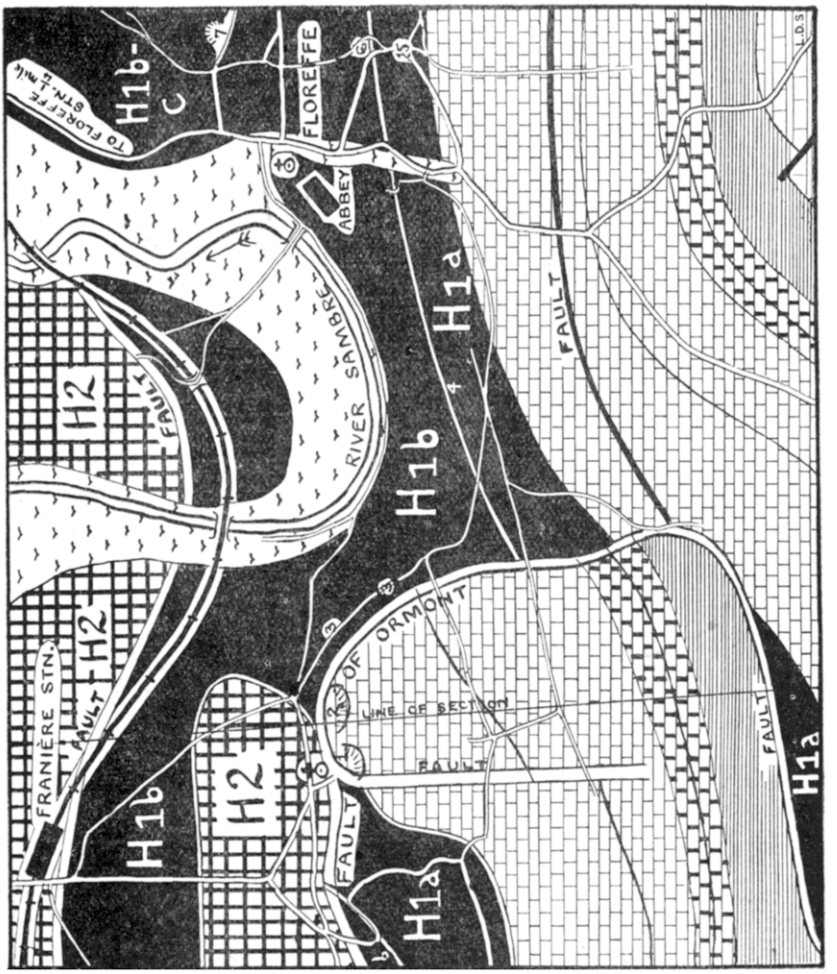


FIG. 26.—EASTERN END OF THE FAILLE D'ORMONT
SEPTEMBER 2ND (AFTERNOON).
Scale—1 : 40,000.

7. Large quarry, showing a truly marvellous section. The lower part is in massive D2 limestone, followed by a 1-foot or 18-inch band of black limestone rich in Radiolaria and with D2-3 fossils. This is succeeded by about 25 feet of Coal Measure Shales, into the midst of which, about 10 feet from the base, is thrust a great mass of Carboniferous Limestone, coming from the South. The northern termination of this " lambeau de poussée " is beautifully shown.

The party then walked back to Namèche and returned to Namur by train.

[Note: In Fig. 24 the Upper Visean—round Namèche, etc.—has been distinguished from the Lower Visean by the use of a sign not employed on any other map].

Afternoon.—The eastern end of the Faille d'Ormont. *Director,* Prof. F. Kaisin.

The Faille d'Ormont (Ormont Fault) is one of those thrust-planes which are frequent in the Namur Synclinorium. The thrust was from the south. The " plane " was probably originally nearly horizontal, but has been folded by later movements so that the contact of the overthrust mass and the underlying sediments is often very complex. The train was taken from Namur to Franière and the party walked a short distance south of the station. (Figs. 25, 26).

1 and 2. Two quarries in the overthrust mass of Carboniferous Limestone (Visean). The limestone exhibits the most marvellous contortions and faults. Good examples of the Grand Brêche were seen in the eastern corner of 2.

3. In the lane and adjoining fields, evidence of the existence of Coal Measures, over which the Carboniferous Limestone is thrust.

4. An excellent view-point, enabling one to see the main outcrop of Carboniferous Limestone to the south.

On the way to the station the succession of the Coal Measures was studied.

5. Roadside exposure in the Assise de Chokier.

6. Roadside exposure in the Assise d'Andenne.

7. Small quarry in the Coal Measure Conglomerate—here a rather fine sandstone.

The return to Namur was made from Floreffe.

SATURDAY, SEPTEMBER 3RD.

The Ordovician and Silurian Rocks of the Massif of Brabant and the Devonian and Carboniferous Rocks of the northern border of the Namur Synclinorium. *Director*, Dr. E. Asselberghs, of the Geological Survey of Belgium.

Train from Namur to Gembloux. The excursion consists of a walk from north to south along the valley of the Orneau, along which nearly all the beds are exposed. The oldest rocks—the Ordovician and Silurian—in the northern part of the valley are much folded and cleaved; the succeeding Devonian and Carboniferous rocks dip gently to the south so that one passes to successively newer rocks. (Fig 27).

1. Old quarry in shales and sandy shales of Caradoc age. The first locality in which Ordovician fossils were found in Belgium. They are fairly numerous and include *Orthis actoniæ*, *O. testudinaria*, *Leptæna* (*Plectambonites*) *sericea* and trilobites.
2. Old quarry in shales of basal Llandovery age. Contemporary volcanic rocks occur in this division; they were formerly called "Eurites" and regarded as lava flows, but are now considered to be ashes or tuffs. A band of this material—very much altered—was seen in the quarry.
3. Slates (more correctly greyish-blue phyllades) much cleaved and characteristic of the Silurian of the Brabant Massif. The beds at this locality are believed to be of Tarannon age, but a short distance to the south Wenlock fossils (graptolites) have been recorded. It is probable that the whole Silurian sequence occurs in this valley but the rocks are much folded and faulted and the fossils largely destroyed by the cleavage.
4. Silurian Slates, with bands of fine sandstone showing folding and cleavage. (Also visible in the railway cutting to the north). The cleavage tends to be nearly vertical, but may be inclined either to the north or to the south. The sequence of events seems to have been:
   (1) Folding of the strata.
   (2) Cleavage.
   (3) Later folding by the Armorican movements which folded the Devonian and Carboniferous.
5. Roadside cutting, showing Devonian rocks, dipping gently southward, resting unconformably on steeply inclined Silurian. The basal Devonian beds are Givetian in age (cf. diagram of transgression on page 5) and comprise:
   Red and green mottled shales.

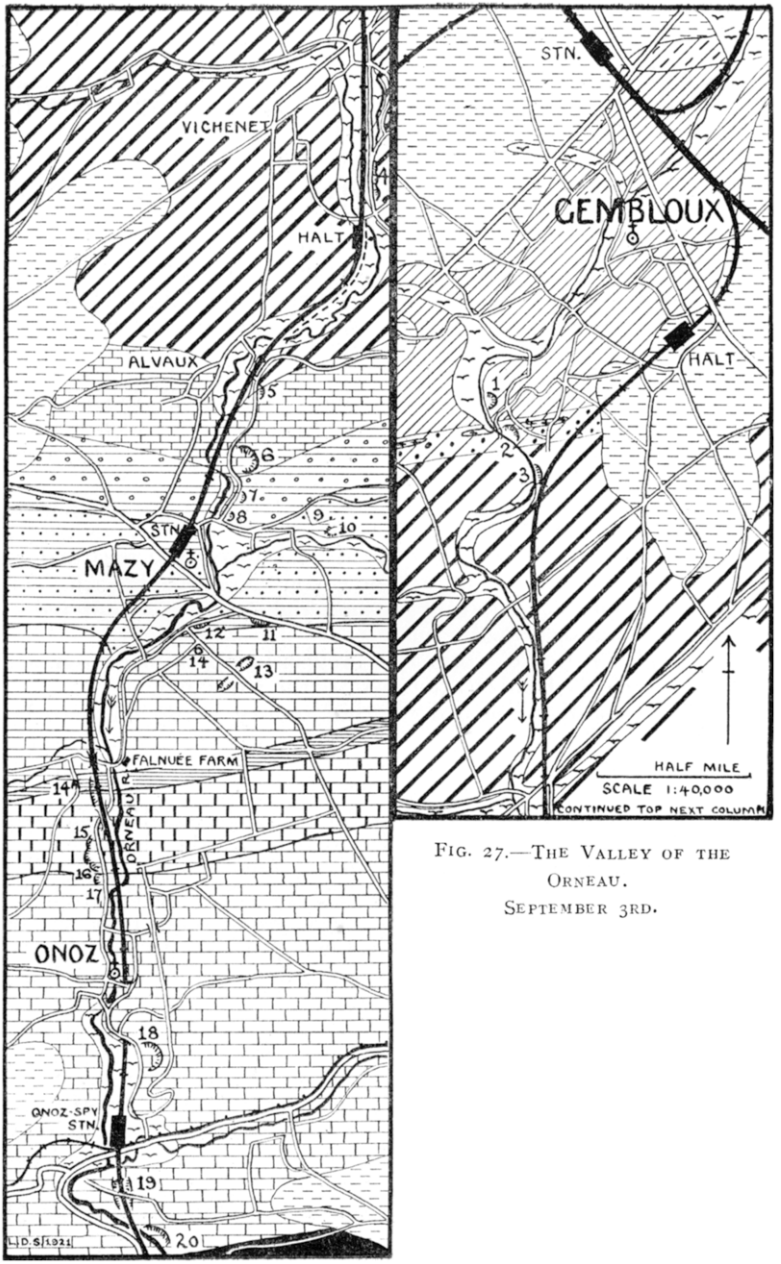


FIG. 27.—THE VALLEY OF THE ORNEAU.
SEPTEMBER 3RD.

Argillaceous sandstone.
Band of "macigno" (calcareous sandstone).
Sandstone with plant remains, becoming conglomeratic at the base (with large grains ot quartz).

This series of littoral beds (Assise de Poudingue d'Alvaux) passes up into the Givetian Limestone. The "macigno" and plant-bearing sandstone have yielded *Spirifer mediotextus* (recently found by Prof. Halet and the Director), *Macrocheilus arculatus* and imprint of *Stringocephalus burtini*. It was remarked that the succession is very similar elsewhere along the northern border of the Namur Synclinorium, as in the Boulonnais, where, however, marine fossils have not yet been found in the lowest beds.

6. Large quarry (Carrière Thibaut) in Givetian Limestone (Calcaire d'Alvaux), a well-bedded dark limestone. The upper part is very fossiliferous and abundant examples of *Spirifer mediotextus*, *S. pentameroides* and *Atrypa reticularis* are found weathered out on the spoil heaps. In the face of the quarry a thin band full of the tiny *Sp. tenticulum* and *S. unguiculus* occurs. *Stringocephalus burtini* and *Cyathophyllum hexagonum* occur more rarely.

7 and 8. Small quarries and roadside exposures in the red rocks of Mazy. The sea retreated at the end of the Givetian and these rocks represent the lowest beds of the Frasnian transgression (Lower Frasnian).

9. In the fields to the south of the lane one may find examples of *Spirifer malaisi*, the characteristic fossil of the *lower* part of the Middle Frasnian (Bovesse Shales).

10. Some rocks near the bottom of the little lateral valley consist of dolomite—a lenticular mass in the Middle Frasnian Shales. The harder dolomite forms a small ridge in the valley which is cut in the soft shales.

11. Limestone in the highest part of the Middle Frasnian exposed by thc roadside. *Spirifer verneuili*.

12. Another roadside exposure. The junction between the Middle and Upper Frasnian should have been drawn slightly further north on the map and this exposure shows the lower part of the Upper Frasnian.

13. Old underground workings in the famous Black Marble of Golzinne (Upper Frasnian or Calcaire de Rhisnes). A fine black marble, unfossiliferous.

14. Spoil heaps from some old trenches, full of *Spirifer verneuili* (Upper Frasnian).

15. Railway cutting in Famennian Beds. The Famennian usually consists essentially of shales and sandstones;

here it is exceptionally thin—only a few metres—and is calcareous in the upper part.

16. Fine craggy escarpment in Dinantian dolomite, crinoidal, representing the "Petit granite" of Soignies. The basal shaly beds were not seen.
17. A band, rich in *Syringopora* and accompanied by "phtanites," marks the top of the Tournaisian.
18. As one passes up in the Visean the dolomite becomes less crinoidal and bands of limestone alternate with bands of dolomite till one passes into well-bedded limestone with *Productus cora* as in the great quarry 18.
19. Railway cutting in the "Grand Brêche," just south of Onoz-Spy Station.

There are numerous caverns in the Visean limestone and one of them yielded the famous Spy skeletons of Neanderthal man.

On either side of the Orneau valley are patches of Lutetian (Bruxellian) sands.

The return was made from Onoz-Spy Station to Gembloux, whence some members returned to Namur, others proceeding to Brussels.

Conclusion.

This excursion to Belgium was planned by Dr. Stamp (who was also responsible for some of the generalised description and interpretation of the Directors' remarks during the excursion). The general programme was suggested by M. A. Renier, Director of the Geological Survey of Belgium, who also made the necessary arrangements with the Belgian Directors. Much of the onerous labour of the accommodation arrangements fell on the Excursion Secretary, Miss M. S. Johnston. The successful and even conduct of the excursion is a wonderful tribute to the organizing abilities of Miss Johnston. In Belgium she was assisted, on those occasions when the party had to divide, by Mr. R. S. Herries. Apart from the Directors, the Association, on several of the excursions, had the pleasure of welcoming Major C. Stevens of the Institut Cartographique Militaire and Dr. P. Pruvost, who wrote the account of the Coal Measures in the Pamphlet. M. Renier was also able to spare time from his numerous administrative duties to accompany the Association on several occasions. About 45 membe s of the Association took part in the excursion, including the President (Mr. Whitaker), and vice-president, Dr. A. Smith Woodward.

Note:—Visitors to Belgium will find in the "Indicateur Officiel des Trains" the times of all trains, both on the State railways and on the "chemins de fer vicinaux." The latter are here referred to as light railways.