THE GEOLOGY OF THE STAINSBY HAGG OPENCAST COAL SITE, NEAR CHESTERFIELD, DERBYSHIRE

by

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Summary

The paper describes briefly the geology of the Stainsby Hagg opencast coal site, describes an anticline in the Top Hard Rock and associated faulting, and attempts an explanation of the structure.

Introduction

In the East Midlands Region of the National Coal Board Opencast Executive, formerly the North Midland Region of the Ministries (successively) of Works, Fuel and Power, and Power, 436 opencast coal sites, varying in size between under 20,000 tons and over a million tons, have been worked since 1942, giving a total coal production of 52 million tons to the end of December, 1968. (Note: since the paper was written the Region has been further reorganised and is now the Nottingham Area of the Central Region.)

Stainsby Hagg site has been selected for description because of the exposure of an anticline unsuspected before exploration, while additional interest is provided by the fact that the working of the site was designed, not only for the recovery of 130,000 tons of coal, but also, at the same time, to seal off the underground workings in the Top Hard coal seam from flood water from the adjacent River Doe Lea.

The site lies between the villages of Heath (N.G.R. SK.447670) and Doe Lea (SK.460663), about six miles south-east of Chesterfield and adjacent to the M.1 motorway. The Top Hard and Dunsil seams are being worked, and apart from ancient workings in the Top Hard, there are recent bord-and-pillar workings from the nearby Doe Lea drift mine. A general plan of the site is given in Text-Fig. 1, while the underground workings are shown in Text-Fig. 2. The ground surface within the site area slopes moderately and fairly evenly towards the south-east, down to the course of the River Doe Lea and its tributary joining it from the west. In the northern part of the site a bank, some 10-20 ft.. high, follows the southerly course of the central track and footpath.

The site was prospected by drilling in the normal way and the geological structure interpreted by contouring to the base of the coal seams. The contours - for the sake of clarity omitted from Text-Fig. 1 - indicated an anomaly in the area of the anticline, but until the ground was excavated the details of the anomaly were not appreciated.

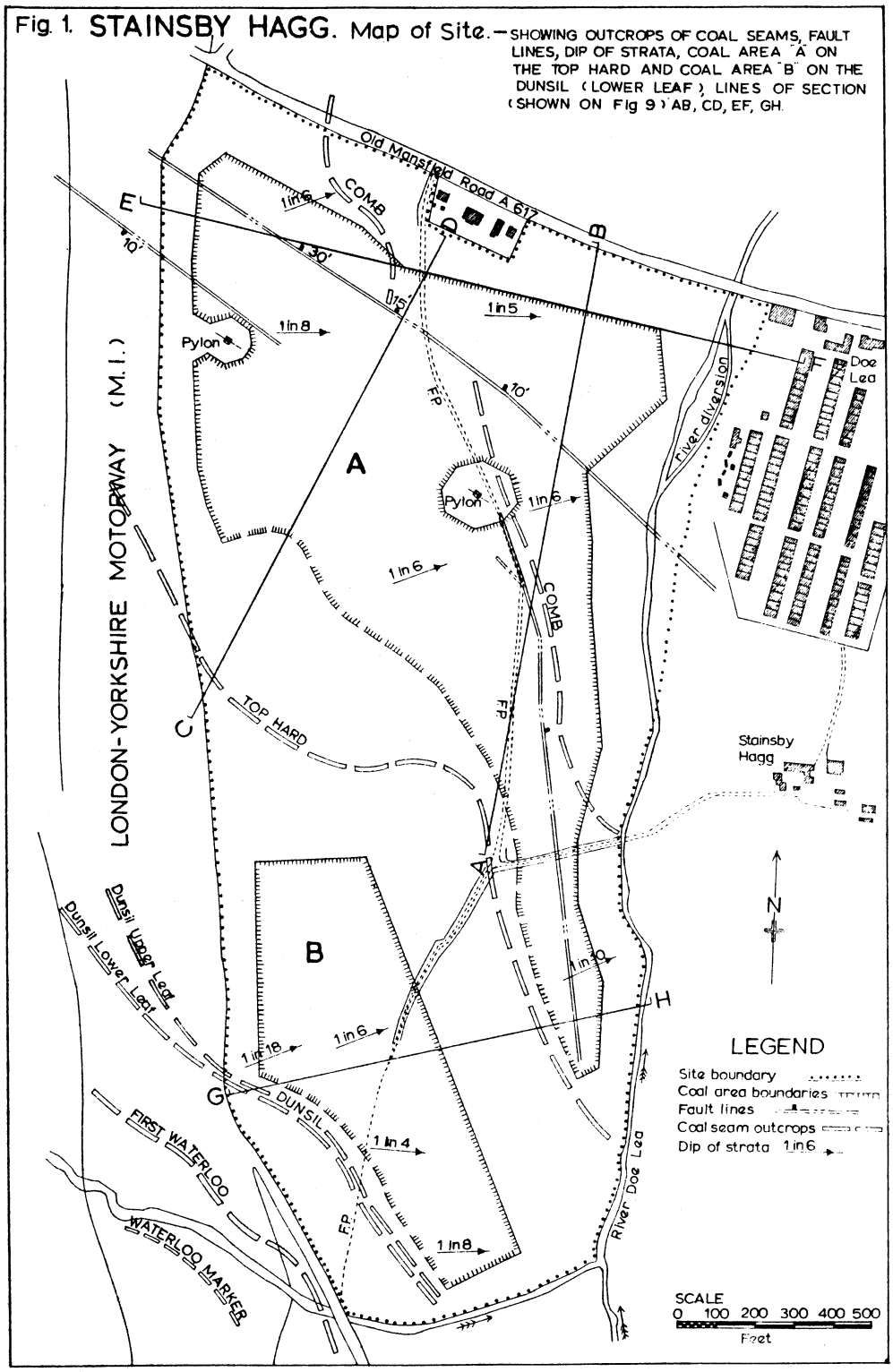


Fig. 1. STAINSBY HAGG. Map of Site. — SHOWING OUTCROPS OF COAL SEAMS, FAULT LINES, DIP OF STRATA, COAL AREA "A" ON THE TOP HARD AND COAL AREA "B" ON THE DUNSIL (LOWER LEAF) LINES OF SECTION (SHOWN ON Fig 9) AB, CD, EF, GH.
Old Mansfield Road A 617
COMB
1 in 6
E
10'
30'
15'
1 in 5
Pylon
1 in 8
F
Doe Lea
River diversion
F.P.
10'
A
Pylon
1 in 6
1 in 6
COMB
LONDON-YORKSHIRE MOTORWAY (M.1.)
C
TOP HARD
F.P.
Stainsby Hagg
D
N
B
1 in 10
H
Dunsil Upper Leaf
Dunsil Lower Leaf
1 in 16
1 in 6
G
DUNSIL
1 in 4
FIRST WATERLOO
WATERLOO MARKER
F.P.
1 in 8
River Doe Lea
LEGEND
Site boundary
Coal area boundaries
Fault lines
Coal seam outcrops
Dip of strata 1 in 6
SCALE
0 100 200 300 400 500
Feet

Fig.2. **STAINSBY HAGG.** Map of Site — SHOWING THE DOE LEA DRIFT MINE WORKINGS IN THE TOP HARD AND THE AXIS OF THE ANTICLINE.

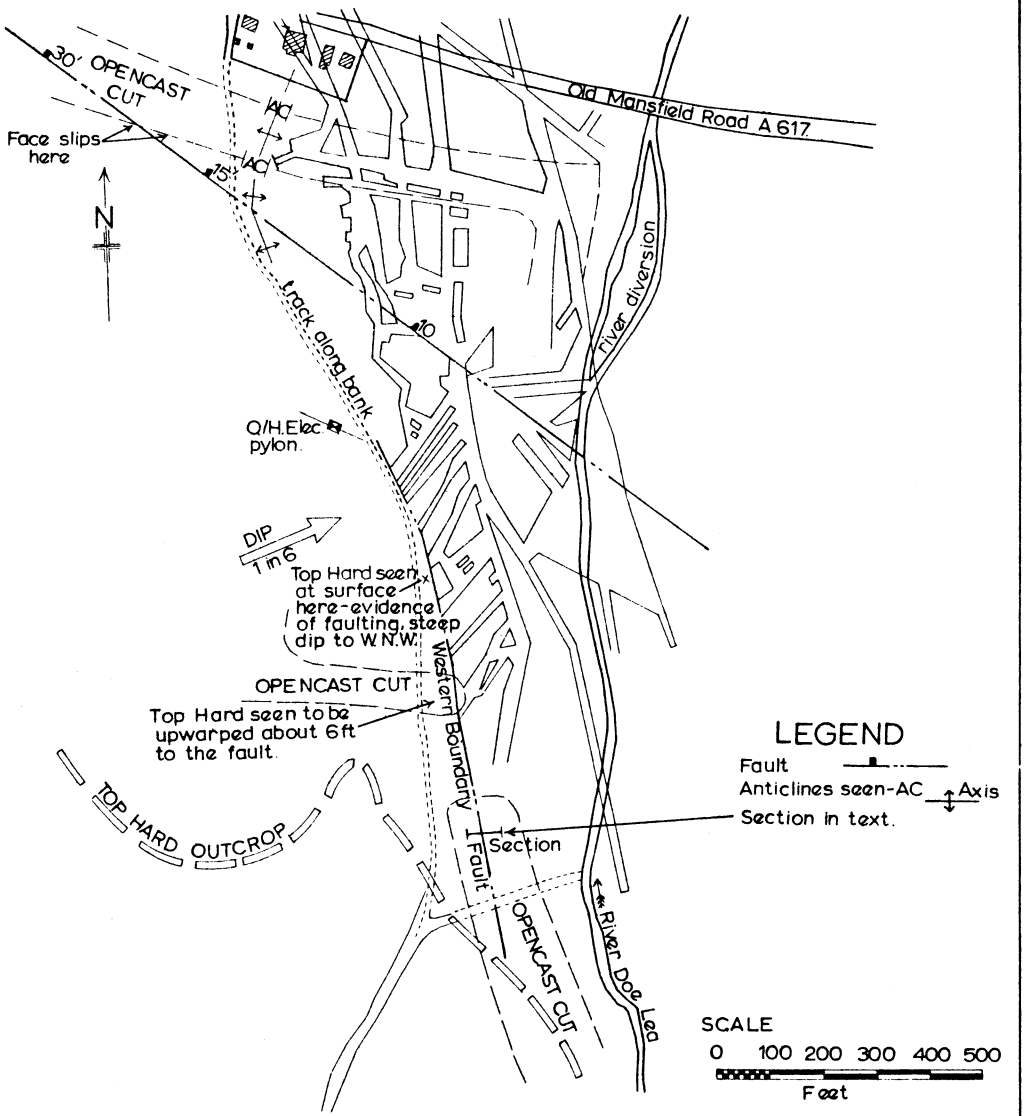
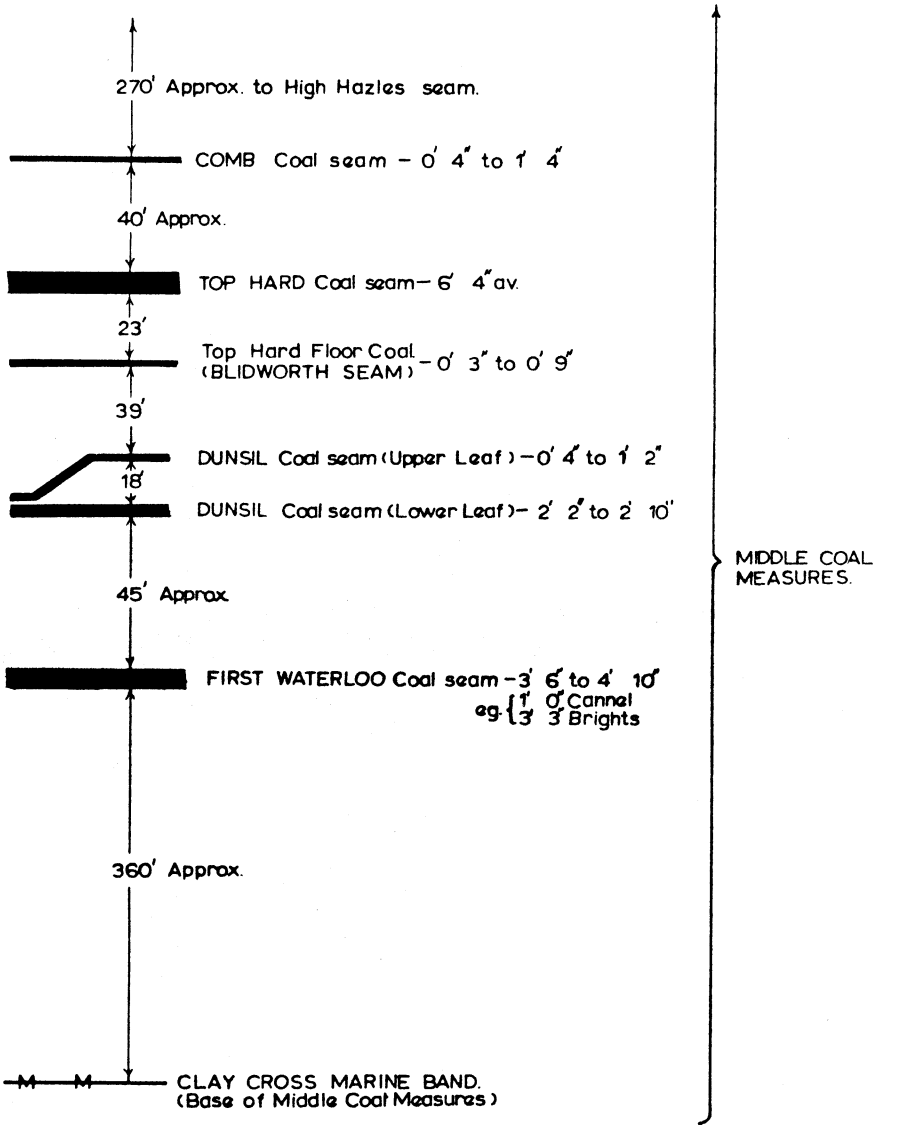


Fig. 3. GENERALIZED VERTICAL SECTION.



Geology

The site embraces an area of rocks of the Middle Coal Measures (a generalised vertical section being given in Text-Fig. 3) dipping to the east-north-east at an average rate of 1 in 8. Three coal seams outcrop within the site area, the Comb, Top Hard and Dunsil, in descending order of succession. The Comb in this particular locality is of little or no economic value, being but a few inches of shaly coal, and opencast working is restricted to the Top Hard and Dunsil. According to the new Geological Survey Memoir, "Geology of the country around Chesterfield, Matlock and Mansfield" (p. 173), the seam we are calling the Comb may not be the true representative of that horizon.

The Dunsil occurs in two leaves which are close together in the southern half of coal area "B", the parting of grey and black shales and mudstones varying between 8 in. and 3 ft. In the northern half of area "B" the parting thickens to 11 ft. 8 in., and, further still to the north and west, becomes as much as 18 ft. of grey shales and mudstones with stony nodules. The upper leaf of the Dunsil varies in thickness between 4 in. and 1 ft. 2 in. and is not being worked. The average thickness of the lower leaf is 2 ft. 6 in.

The Top Hard has an unworked average thickness of 6 ft. 4 in. and is of good quality, with low ash and sulphur content and negligible dirt partings. Cannel may form a central hard band or a top band, typical seam sections being:-

1ft. 1in. coal	2ft.8in. cannel
1ft. 6in. cannel	3ft.8in.coal
3ft.10in. coal	

(See Geological Survey Memoir referred to, pp. 169 and 171).

Immediately overlying the Top Hard throughout most of Area "A" is the Top Hard Rock, a sandstone varying in thickness between 10ft. and 42ft. (see Memoir, p. 172). Overlying the sandstone there is an alternating series of grey and black shales and mudstones. In Area "B" the Dunsil is overlain by grey and black shales, with a thin sandstone in the south-east of the area. (The section in Text-Fig. 3 may be compared with information in the Chesterfield Memoir already referred to, pp. 156 and 168 and Fig. 23).

The northern part of Area "A" is cut by a fault trending approximately north-west to south-east. The downthrow is to the north-east, decreasing from 30 ft. in the north-west to 10 ft. in the south-east. A smaller fault, with a 10 ft. downthrow to the south-west, runs parallel with and about 200 ft. south-west of the main fault. The Doe Lea colliery plan shows a fault at the western boundary of the drift mine workings, but no indication is given of the direction or amount of throw. Opencast Executive drilling suggests a fault with downthrow to the east of 10-20 ft.

Ancient workings for which no records are available were found in the west of Area "A". Before and during prospecting there was considerable evidence of subsidence in the eastern part of Area "A" and cavities up to 50 ft. deep, extending to the Doe Lea colliery workings in the Top Hard, had to be filled.

The anticline

The anticline was first exposed at the end of July, 1968, photographed by Mr. J.E. Metcalfe (Plate12 Fig. 1). A slightly later exposure revealed the Top Hard seam at

the base, and it is this later cutting which will be described. It proved impracticable to measure accurately the constituent parts of the exposure, as it was a sheer rock face some 50 ft. high. Many of the higher beds were measured where they dipped to the floor of the cutting further to the east and those thicknesses were used in estimation. A sketch of the later exposure is given in Text-Fig. 4, and following is a detailed description of the strata shown:

Grey shales, 5 ft.	Shales, rather than mudstone, as bedding planes visible. Occasional bands (2–4 in.) of clay ironstone.
Comb seam, 7 in.	Shaly coal with 1-2 ft. of poor greyish buff fireclay seatearth.
Dark grey mudstone, 10 ft.	(The thickness includes the fireclay below the Comb). Contains clay ironstone nodules (about 3 in.), pellets (1 in. or less) and bands (1-3 in.). The nodules often grade into bands and the pellets are often so numerous as to form pellet beds.
Massive sandstone, 8 ft.	Grey, hard, and showing joints and bedding planes. Fine grained. Thinner leaves more heavily iron-stained.
Grey mudstone, 4ft.	
Massive sandstone, 15 ft.	Grey, hard, fine grained, with joints and bedding planes, the faces having been impregnated with ferruginous solutions to give chocolate, purple and brown staining an inch and more deep. Many black carbonaceous streaks, $\frac{1}{4}$ - $\frac{1}{2}$ in. apart and parallel with bedding.
Top Hard seam, 6 ft.	Good, solid coal. Dirt partings negligible. Middle or upper part of seam usually cannel as described above. (In Text-Fig. 4 note old pit prop below seam, probably from adjacent old working).
Grey fireclay, 1 ft. 2 in. (average thickness).	

Strata below Top Hard

The following information on the strata below the Top Hard seam, obtained from boring, is given for the sake of completeness:

Grey sandy shale, 23 ft, but interval very variable.

Blidworth seam, 3-9 in.

Grey shale, 14 ft.

Sandstone, 15 ft. Fairly hard.

Grey shale, 10 ft.

Dunsil seam, upper leaf, 4 in. to 1 ft. 2 in.

Hard grey shale, 18 ft. Includes mudstone with nodules.

Dunsil seam, lower leaf, 2 ft. 2 in. to 2 ft. 10 in.

Grey shale, 20 ft. Includes mudstone with nodules.

Sandstone, 25 ft. Fairly hard.

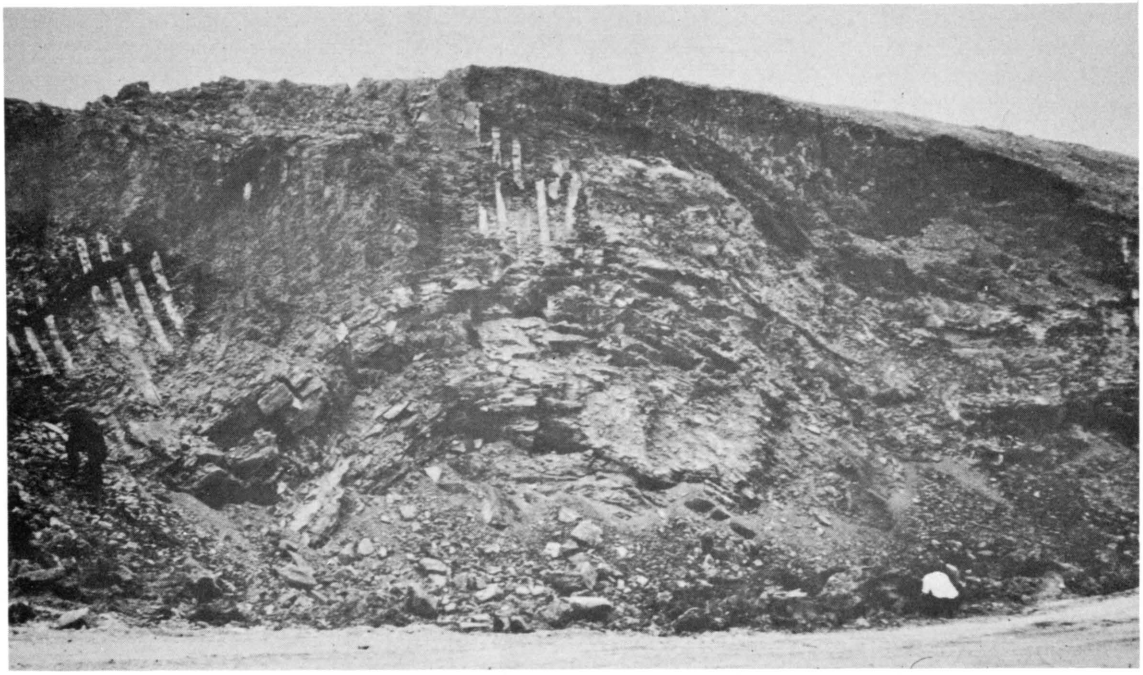


Fig. 1 Anticline in the Top Hard Rock at Stainsby Hagg Opencast Coal Site (for explanation see Text-fig. 4).

Fig. 2 Triple exposure of the Top Hard Seam at Stainsby Hagg Opencast Coal Site (for explanation see Text-fig. 5).

Fig. 4. **SKETCH OF EXPOSURE SHOWING ANTICLINE, DIMENSIONS APPROXIMATE.** Not to scale.

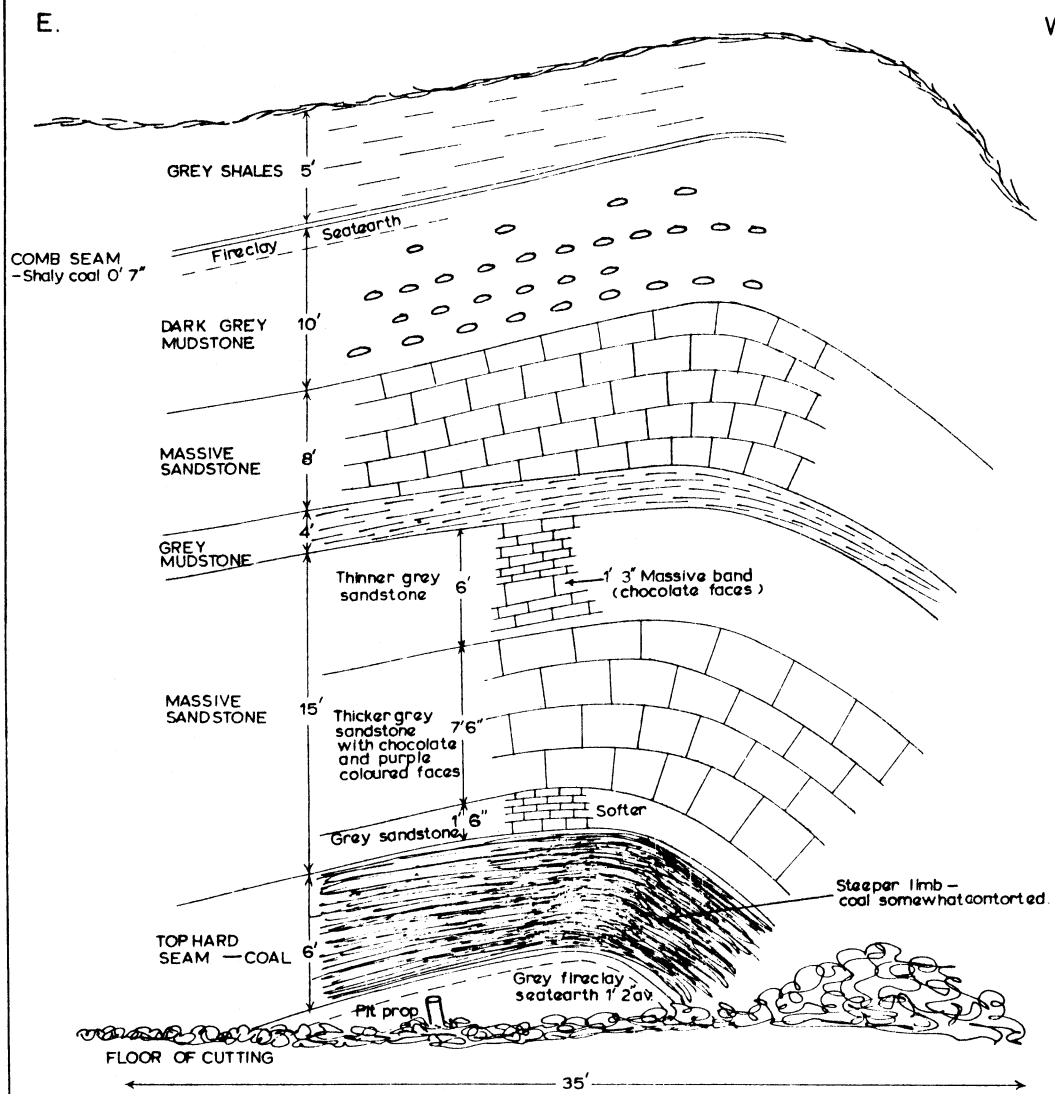
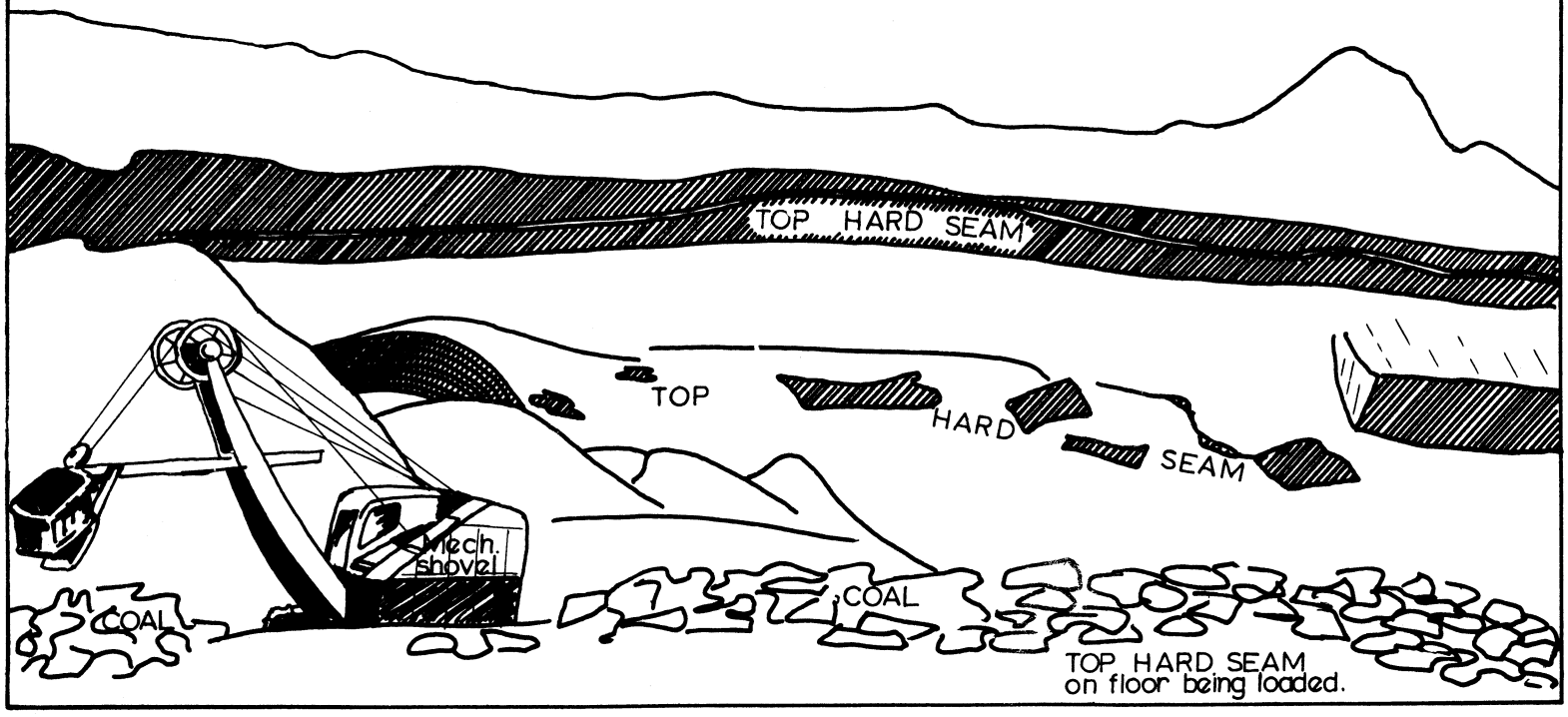


Fig. 5. Explanation of photograph.

FACE OF CUTTING SHOWING THREE EXPOSURES OF TOP HARD. See Text.



First Waterloo seam, 3 ft. 6 in. to 4 ft. 10 in.

Fireclay, 3 in.

Sandstone, 9 in.

Mudstone, 5 in.

Sandstone, 1 ft. 5 in.

Black shale, 4 in. With coal traces.

Sandstone, 2 ft. 10 in.

General consideration of structure

The pattern of faulting revealed within the site indicates that the area must have been subjected to east-west pressure at some period and possibly, at a different time, to thrusting from north-east to south-west. The fault at the western boundary of the mine workings is indicative of east-west pressure. In excavations at the southern end of the Dunsil coal area "B" (Text-Fig. 1), the seam and overlying rocks were observed to be crumpled into a minor nappe-like structure by similar forces.

The fault running from north-west to south-east in the north of Area "A" (Text-Fig. 1) appears to be a double reverse fault due to overthrusting from the south-west. At the point marked "Face slips here" in Text-Fig. 2, the face of the cutting often showed two and sometimes three exposures of Top Hard. Such duplication is uncommon in the Coal Measures, and a photograph (Plate 12 Fig. 2) is accompanied by an explanatory diagram (Text-Fig. 5). [Note: What appears to be a thin coal seam, in the central portion of the photograph, may well be the residual edge of the Top Hard, where the seam has been worked up to the fault plane. At that horizon, the seam floor was often seen to be hummocky and the seam, as exposed on the left hand side, can be seen to be contorted, perhaps due to proximity to the fault. A large fallen block showing Top Hard may be seen on the right, with the Top Hard outcrop below it.]

Duplication was further exhibited about 200 ft. to the west along the same face, where a portion of the Top Hard seam about 15 ft. wide had been let down some 10 ft. below the level of the southern upthrow side, which showed a 6 ft. ramp of coal where the seam had been upwarped to the first of the parallel faults. (This section was approximately at right angles to that depicted in Text-Fig. 5). A suggested sequence of events causing the duplication is shown in Text-Fig 6. The sections were examined whilst still exposed, and the author's views confirmed, by Mr. D.P. Williams, Mr.G. Jago and the Site Surveyor, Mr. B.G. Sheldon.

The position of the anticlinal structure, on the same southern face of the cutting, is shown on Text-Fig. 2. It was observed that the continuation of the anticline was visible in the northern face about 100 ft. away, where it appeared to be less acute and more symmetrical. This small anticlinal ridge runs in a north-south direction at the western boundary of the underground workings. Traced to the south, it appears to join the western boundary fault shown on the mine plan, following much the same course as the "track along bank" shown in Text-Fig. 2. The bank is 10-20 ft. high on the western side of the feature, the eastern side having suffered subsidence from underground workings.

Further excavation should prove or disprove these theories, but it is probable that a sharp anticlinal ridge, particularly if broken and contorted, would have the same effect as a fault in terminating underground workings. It is the author's view that this anticlinal folding increases in intensity towards the south, until the steeper limb becomes broken off and the fault

Fig. 6. SUGGESTED SEQUENCE OF EVENTS.
Not to scale.

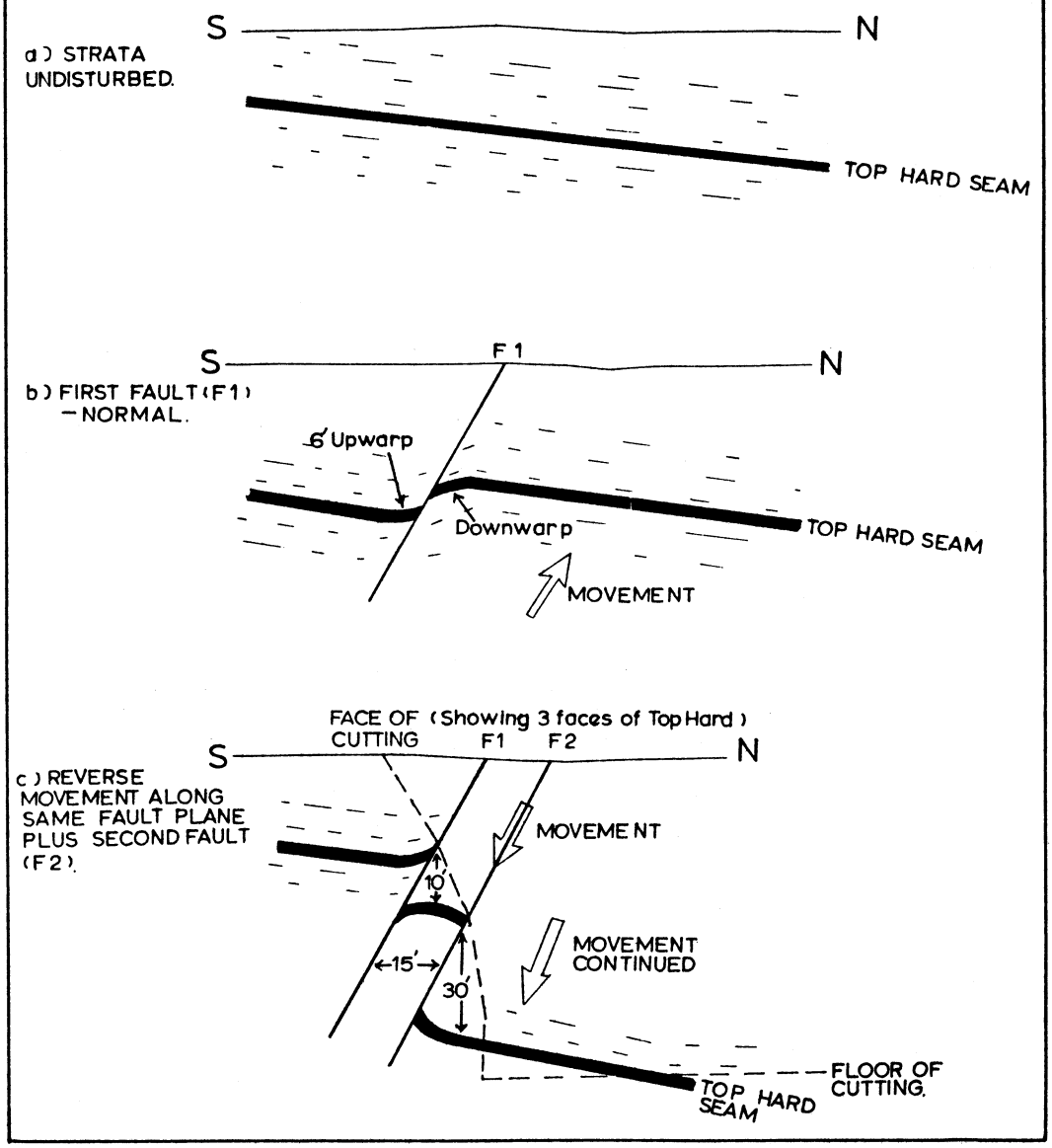
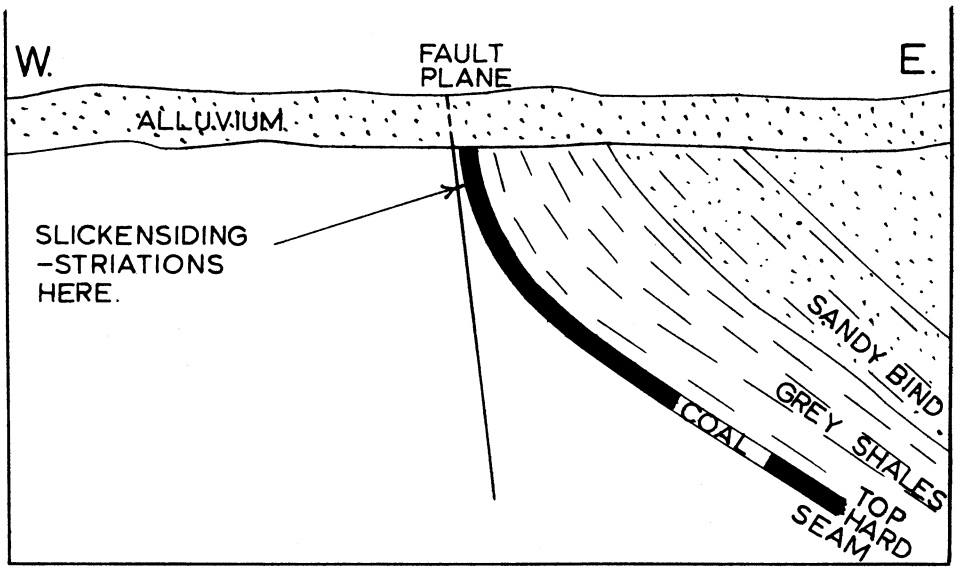


Fig. 7. SECTION SHOWING UPWARPING OF COAL SEAM NEAR FAULT.

Sketch of section. Not to scale.



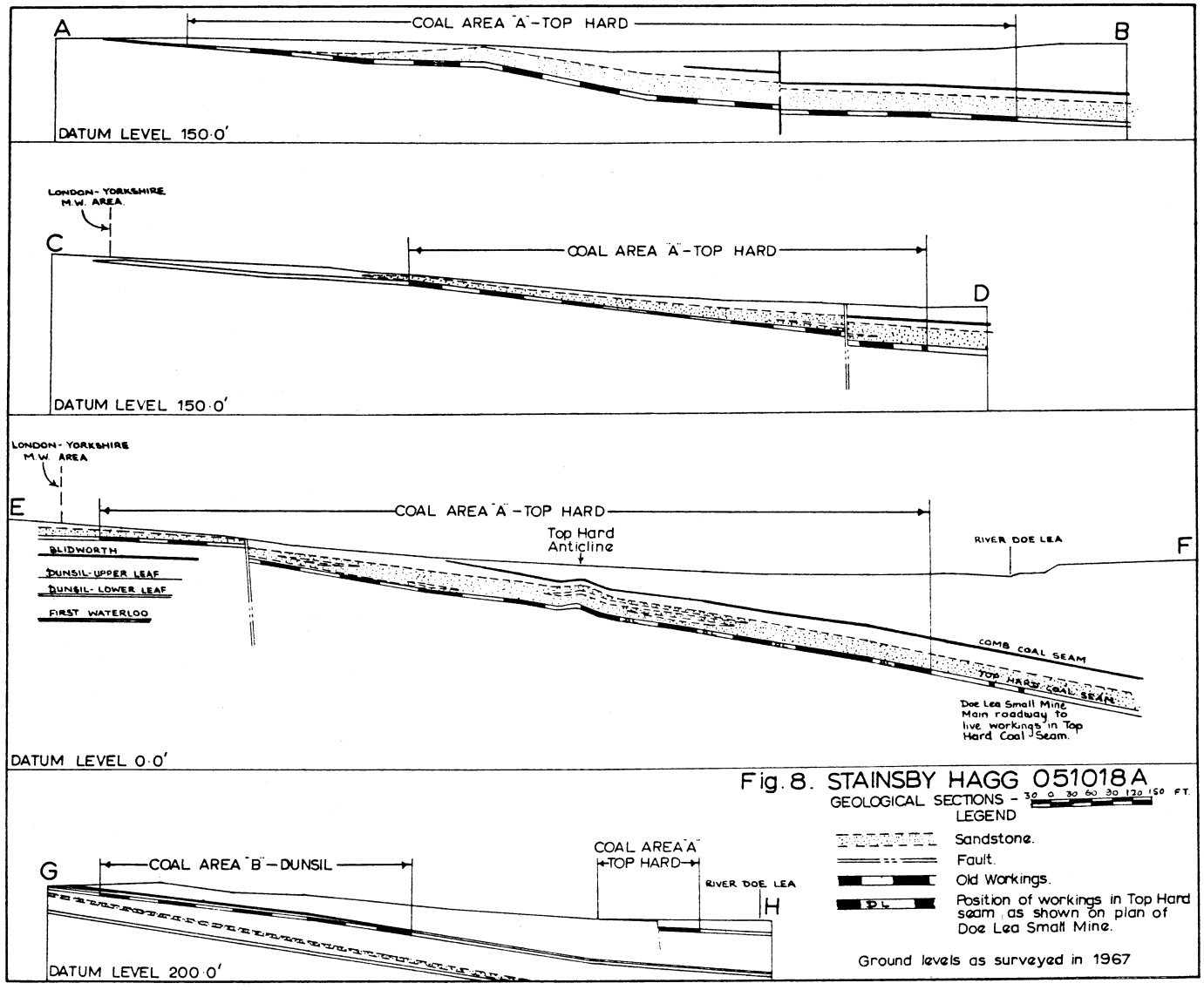


Fig. 8. STAINSBY HAGG 051018A

GEOLOGICAL SECTIONS - 30 0 30 60 90 120 150 FT.

becomes more prominent than the anticline. This is borne out by evidence from the cutting in the Top Hard immediately south of the drift mine workings, where (Text-Fig. 7) the seam was observed to be dipping very steeply at over 45 degrees. Where it reached the fault plane the seam curved upwards to the vertical, the vertical portion being just below the original ground level.

Additional evidence was furnished by an exposure of the Top Hard some 500 ft. north of the section, where the seam outcropped at ground level, having been brought to the surface by faulting. Dipping steeply to the west-north-west, it could represent the steeper westerly limb of the anticline, with the rocks shown in the section as a more accentuated easterly limb. A new opencast cutting to the south-west of the drift mine workings shows the Top Hard to be unwarped, about 6 ft. in thickness, where it meets the western boundary fault. The warped portion may well represent the same steeper westerly limb of the anticline.

For general interest, Text-Fig. 8 gives sections across the site, section E-F in particular showing the anticline.

Acknowledgements

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