THE SEDIMENTOLOGY AND STRATIGRAPHY OF THE KINDERSCOUT GRIT GROUP (NAMURIAN, R_1) BETWEEN WHARFEDALE AND LONGDENDALE

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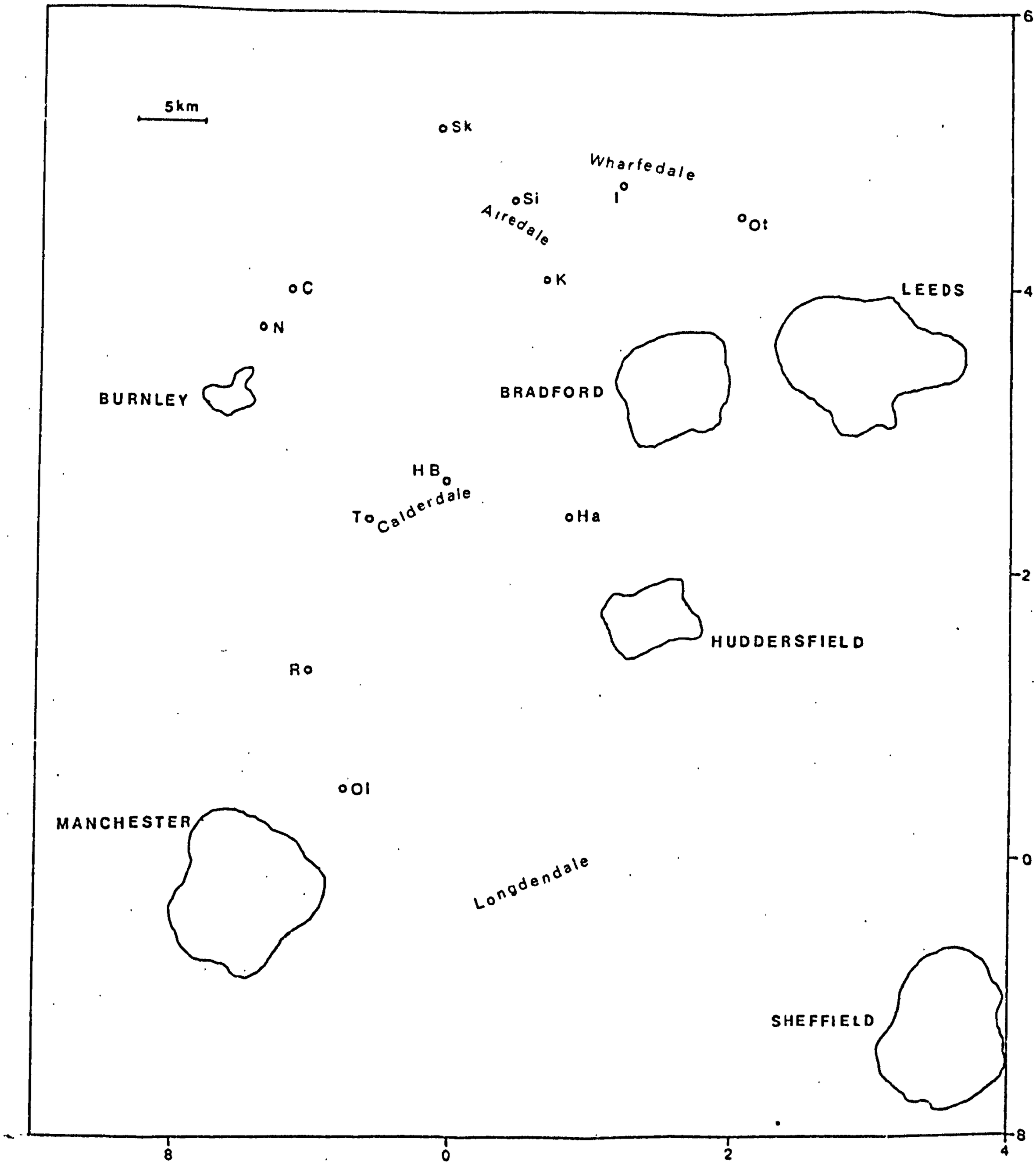
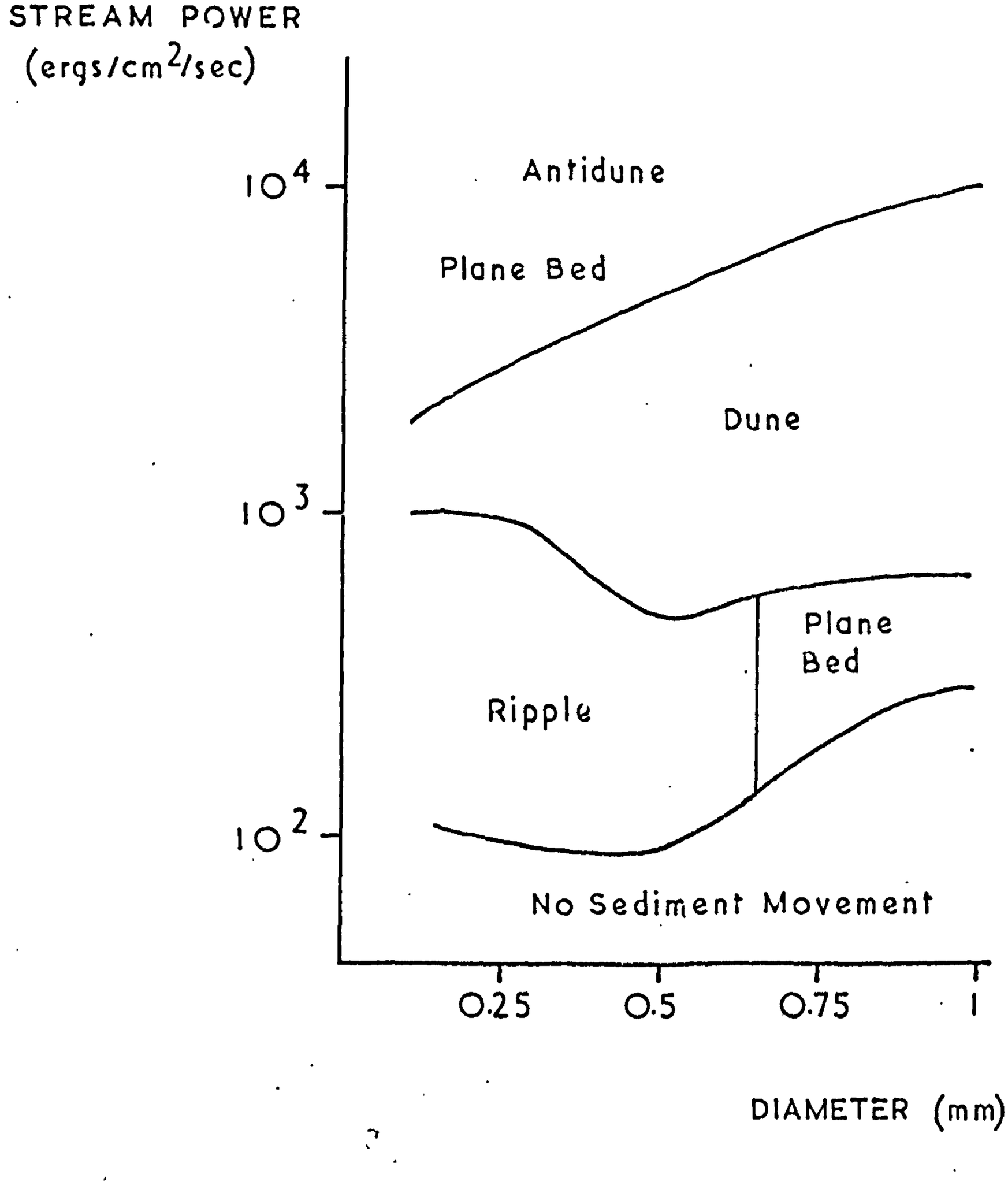
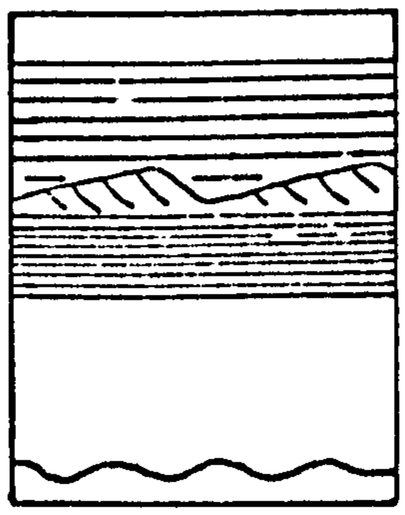

5km
oSk
Wharfedale
oSi
Airedale
oOt
oK
oC
oN
LEEDS
BURNLEY
BRADFORD
HB
To Calderdale
oHa
HUDDERSFIELD
Ro
oOl
MANCHESTER
Longdendale
SHEFFIELD
6
4
2
0
8
8
0
2
4

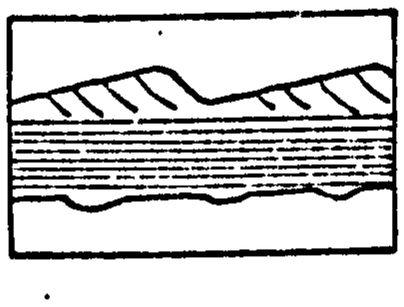

STREAM POWER
(ergs/cm2/sec)
10^4
10^3
10^2
Antidune
Plane Bed
Dune
Plane
Bed
Ripple
No Sediment Movement
0.25
0.5
0.75
1
DIAMETER (mm)



1

2

3



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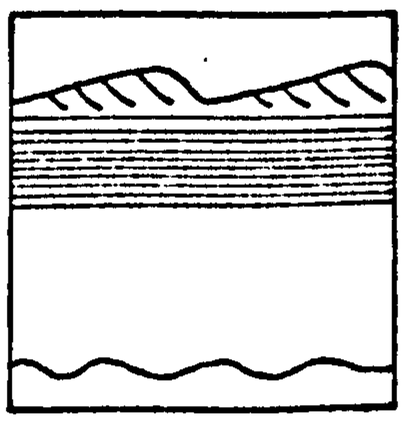

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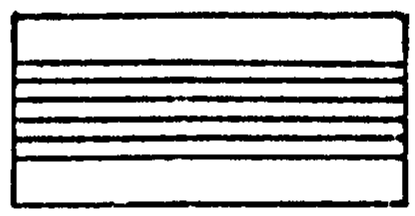

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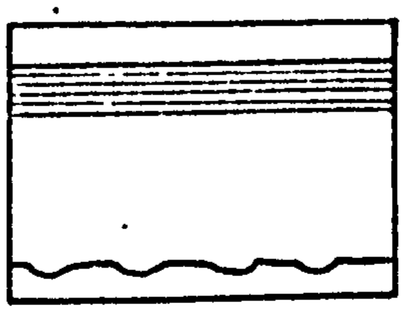

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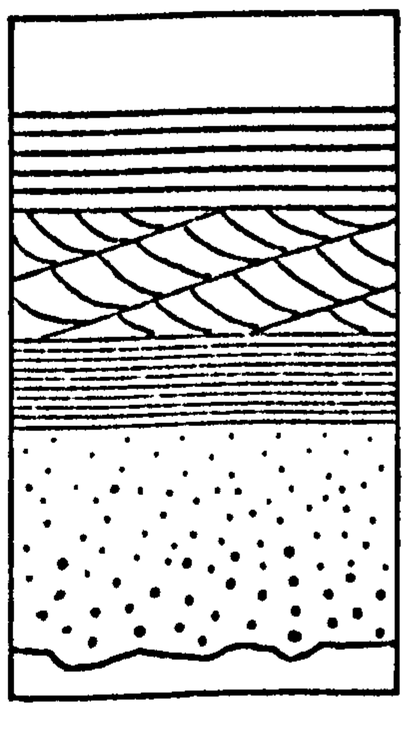

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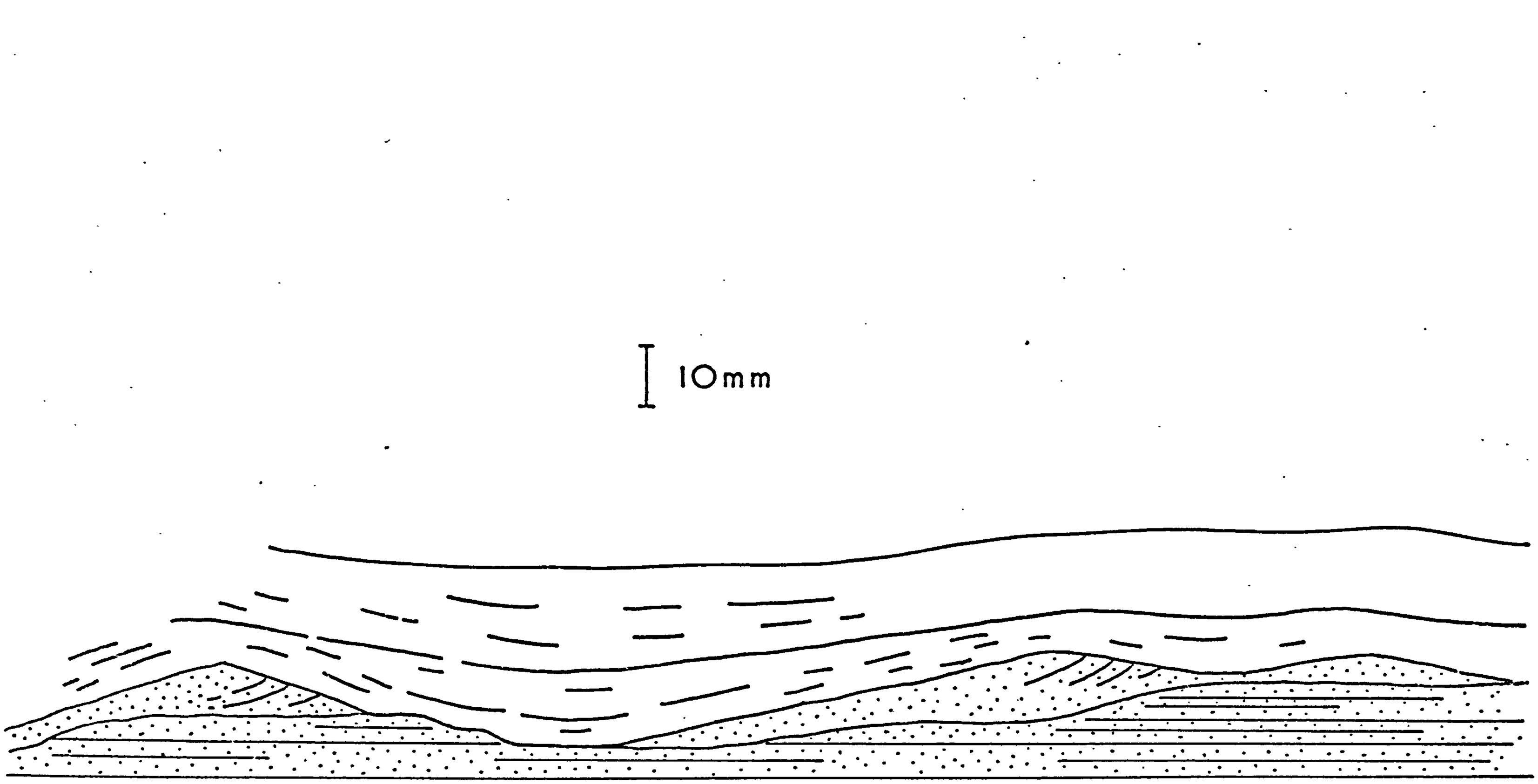
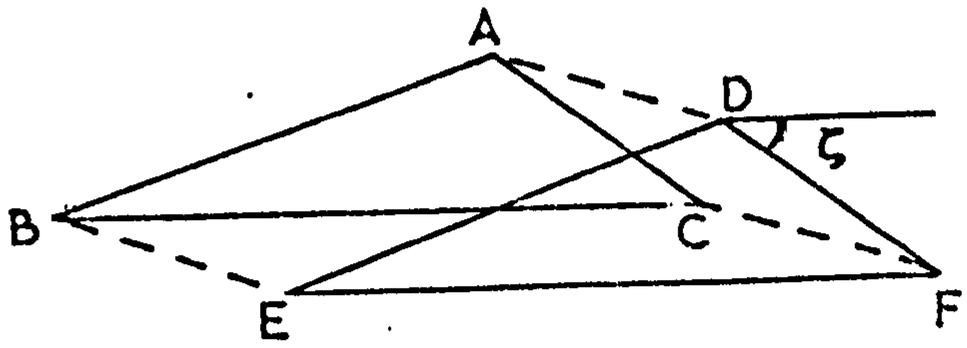

10mm



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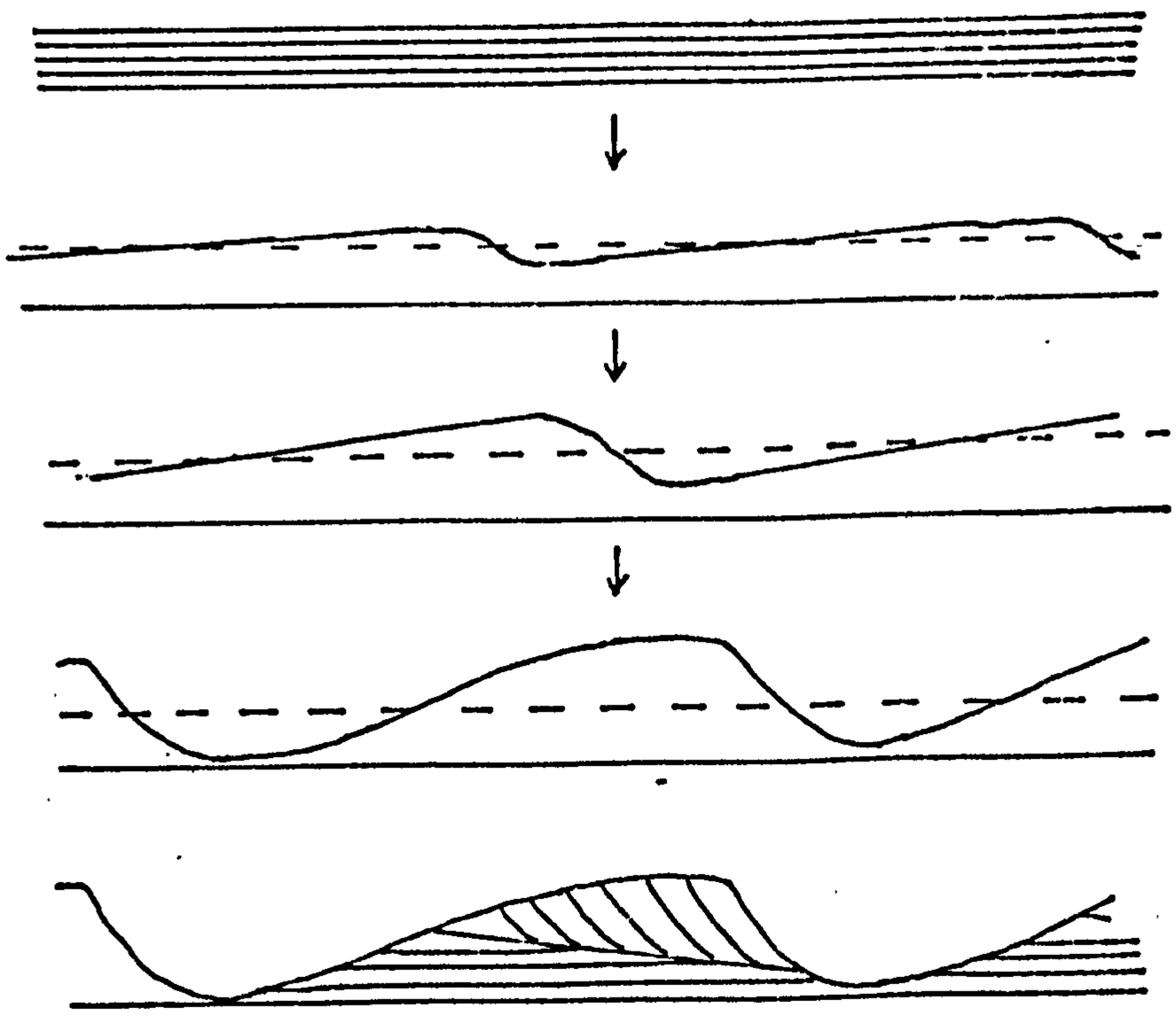

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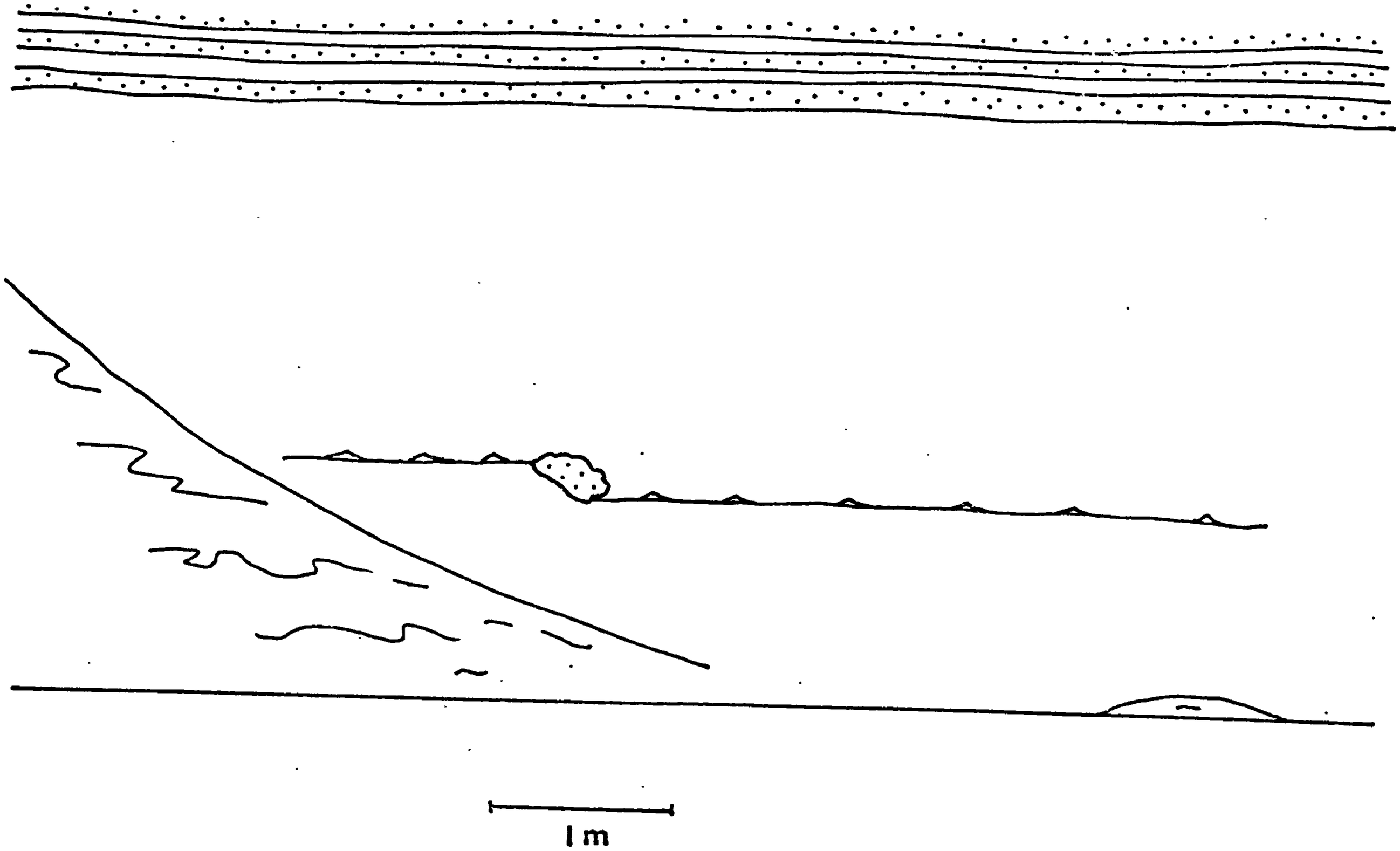
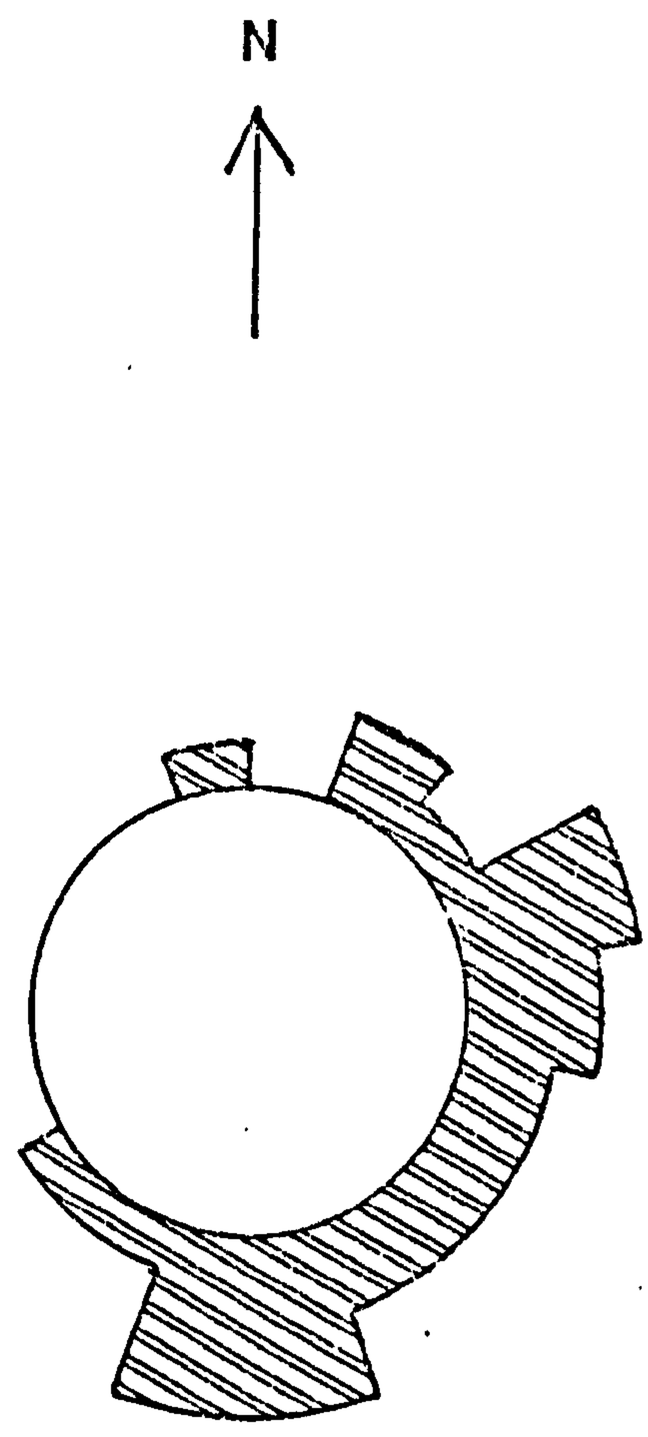

1 m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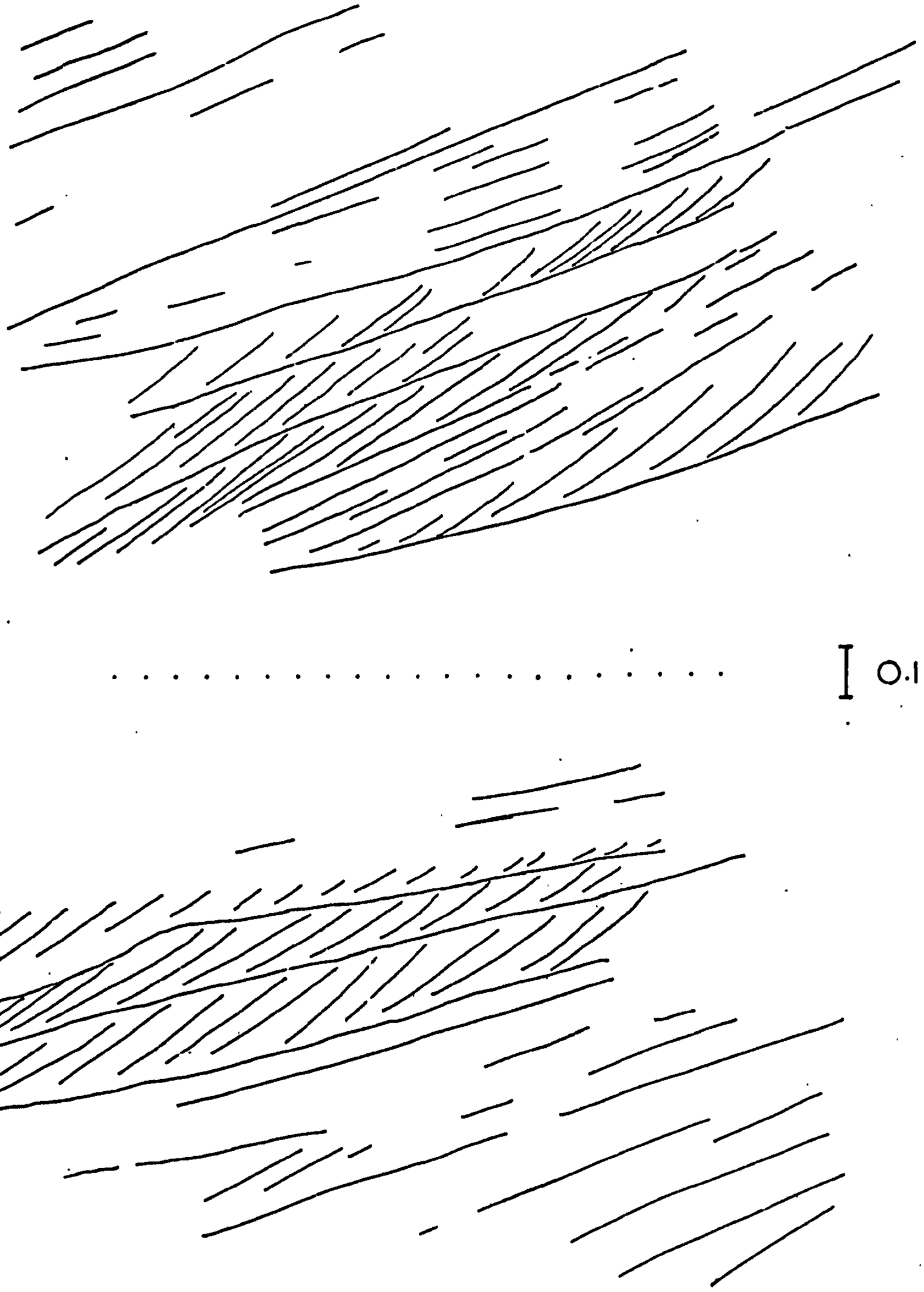
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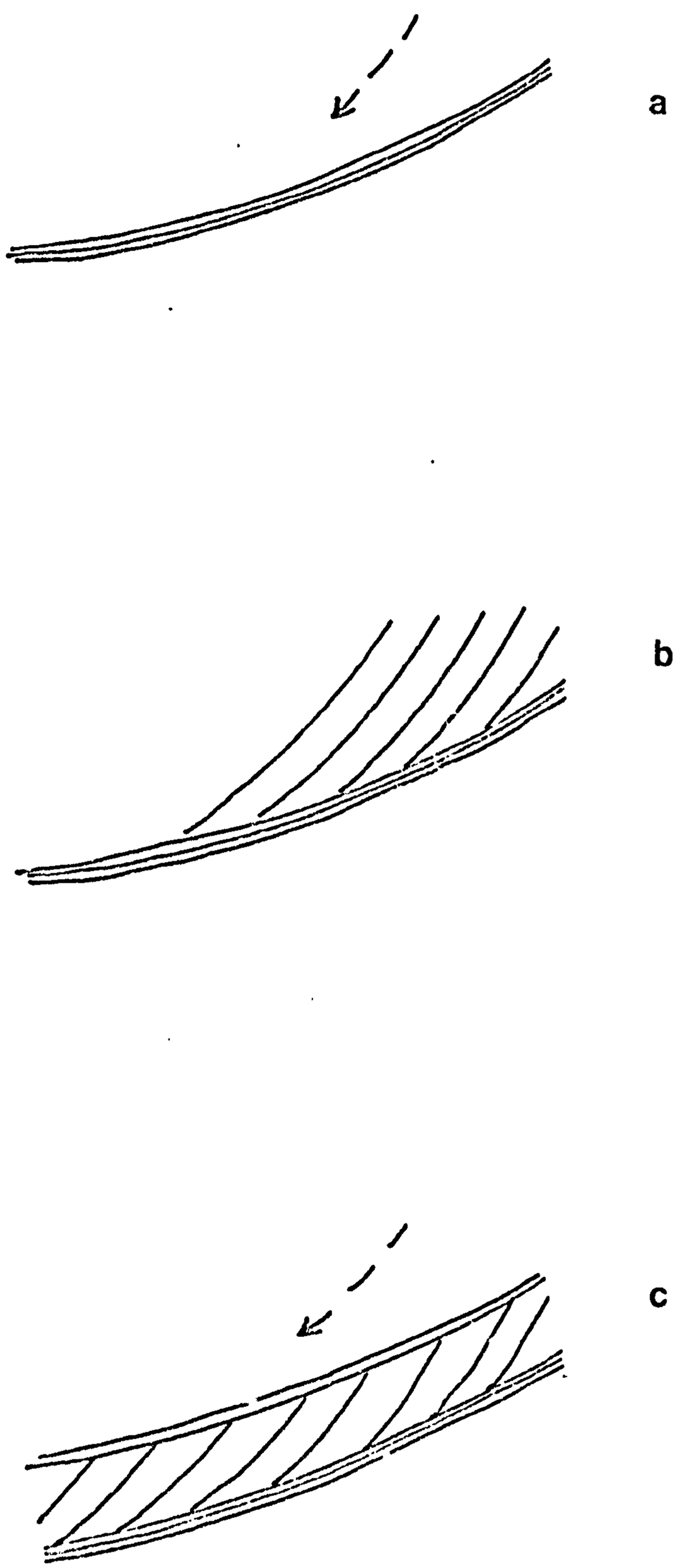
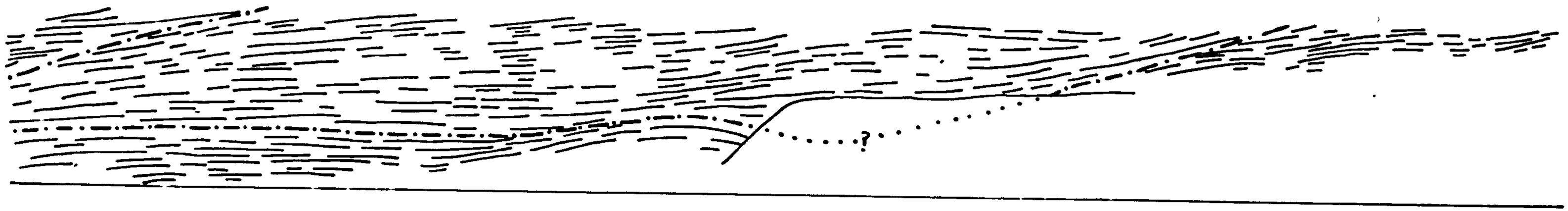

a
b
c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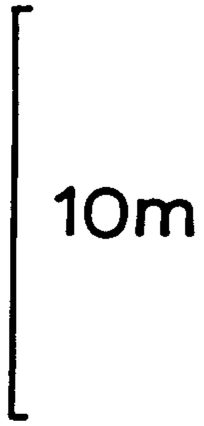
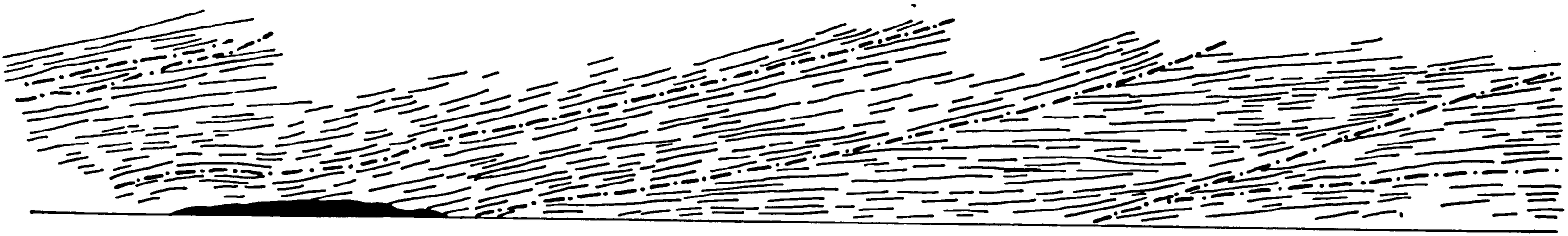
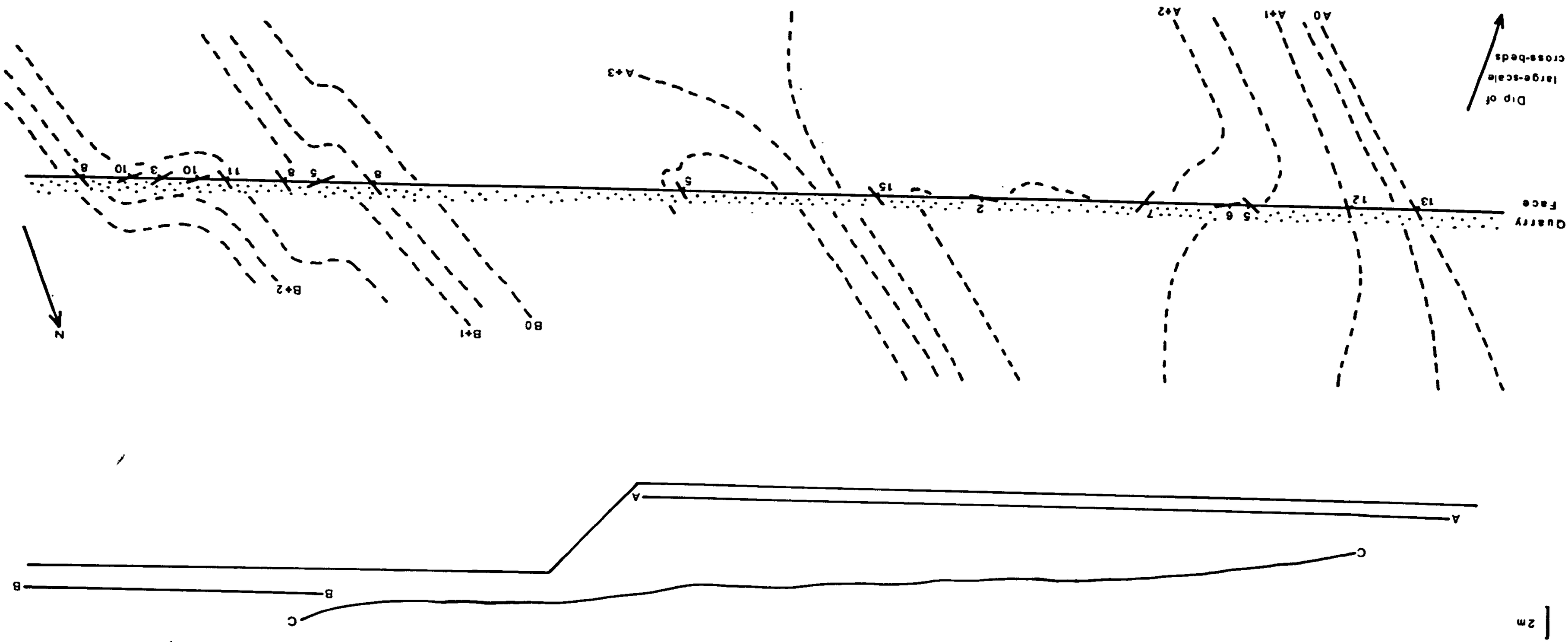
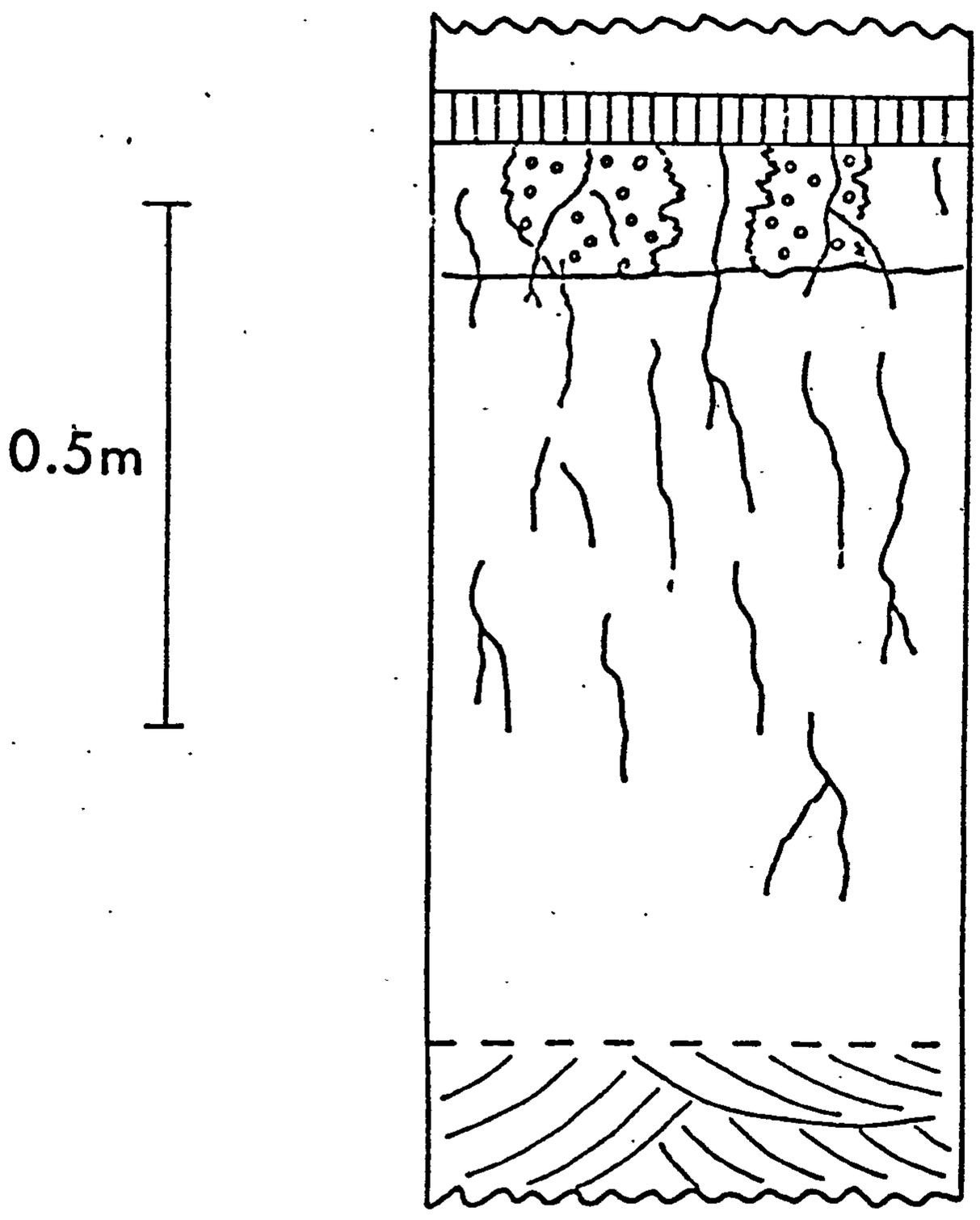
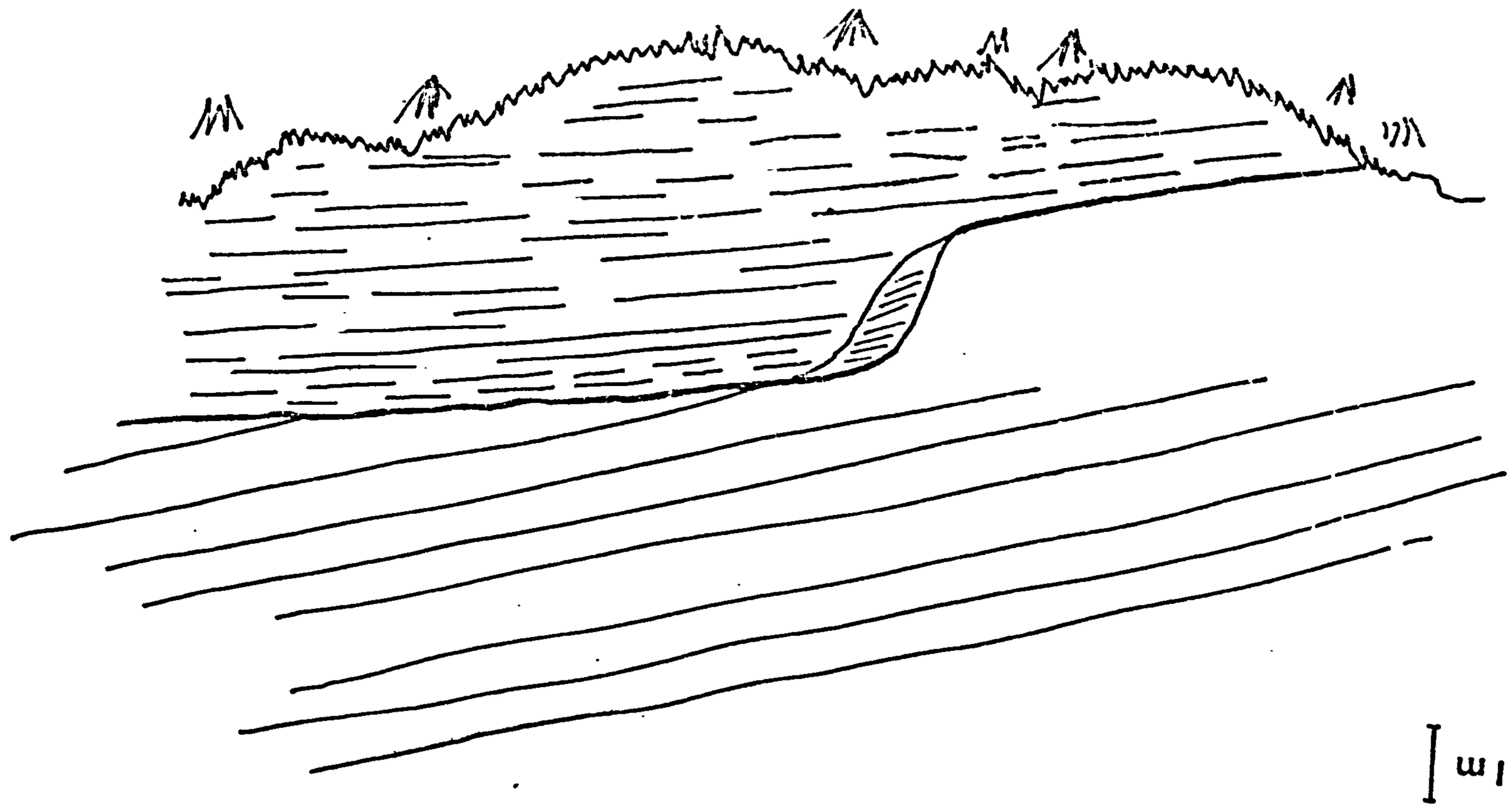
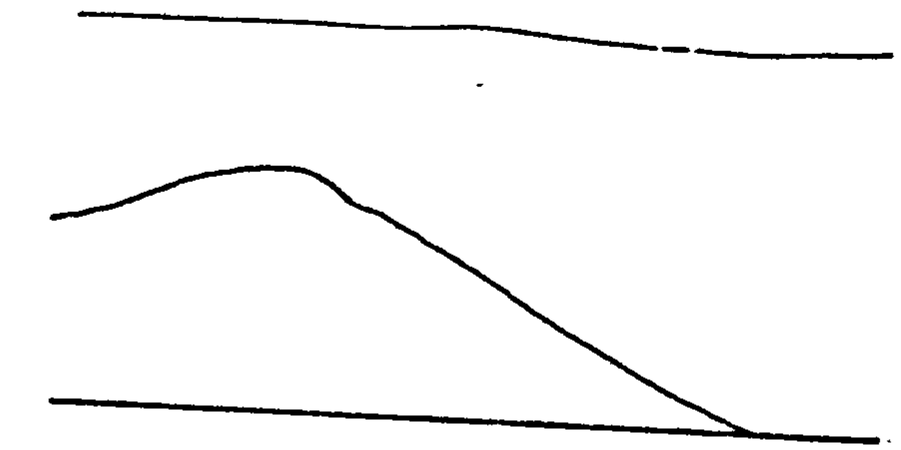

10m




Quarry face
Dip of large-scale cross-beds
A0
A+1
A+2
A+3
B0
B+1
B+2
N
2m


0.5m
Coarse Sandstone
Coal
Sideritic Sandstone with sphaerosiderite
Gannister: white coarse sandstone with rootlets
Cross bedded feldspathic coarse sandstone


1m



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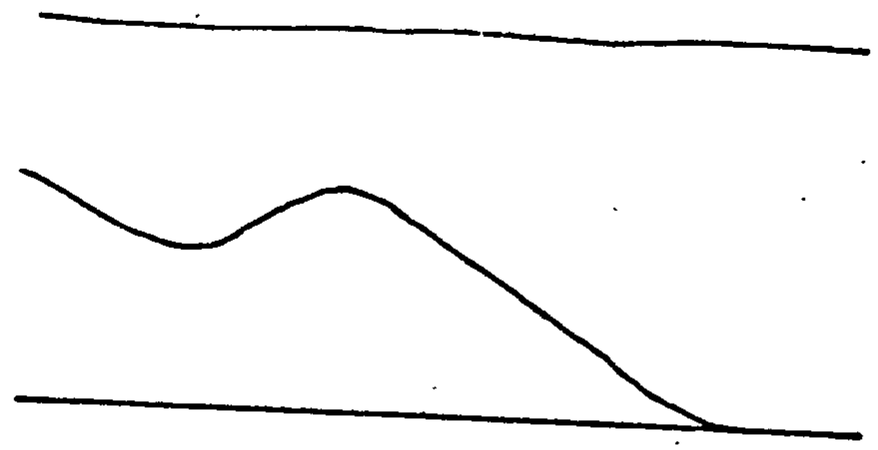

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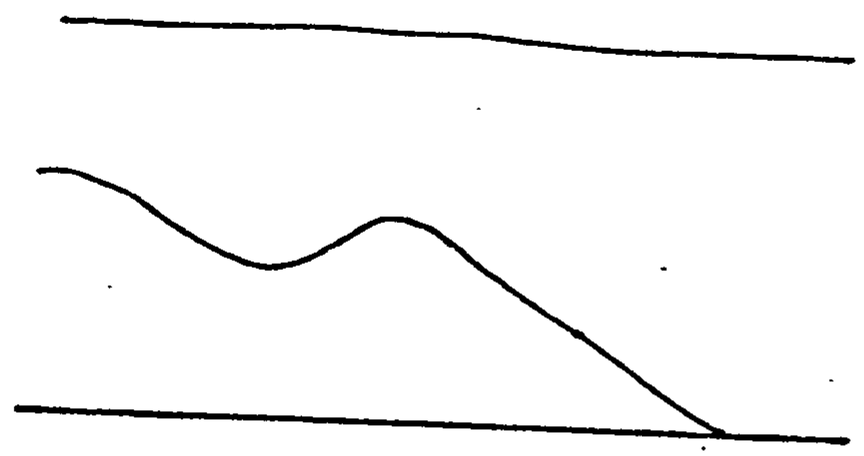

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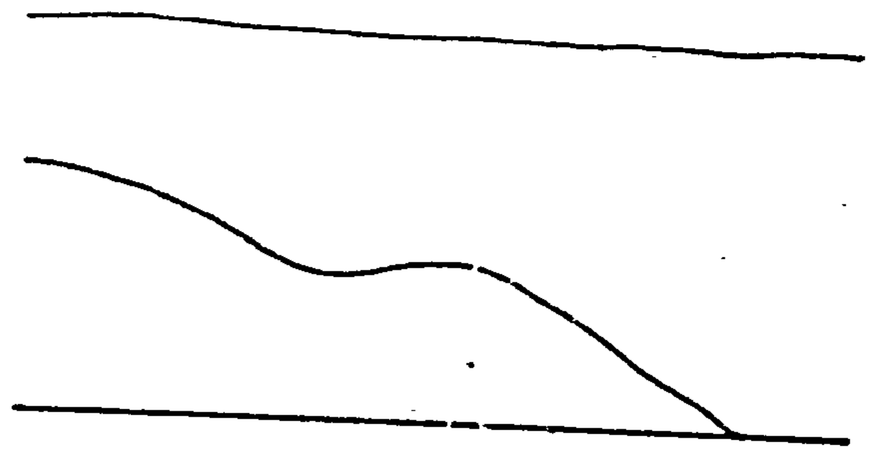

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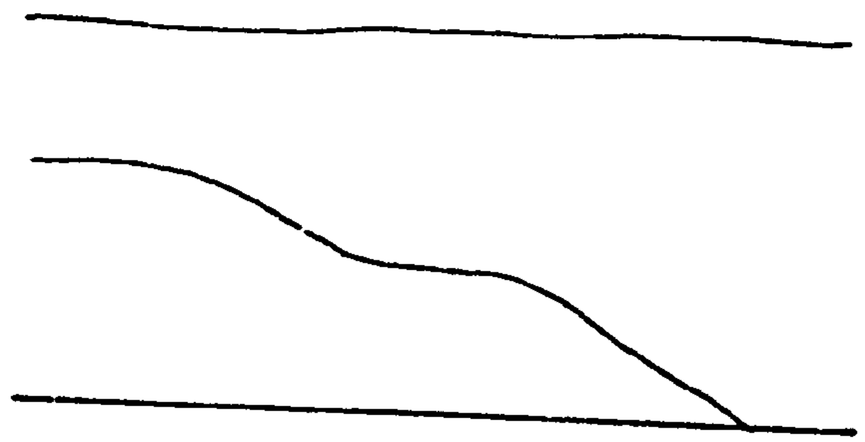

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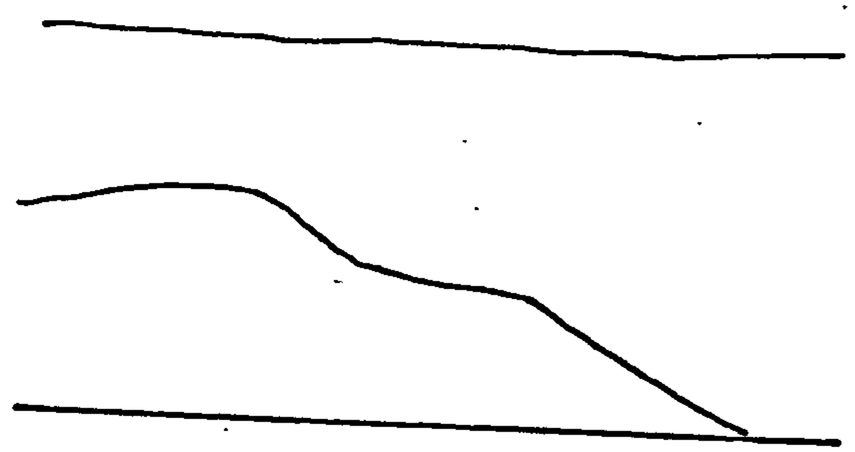

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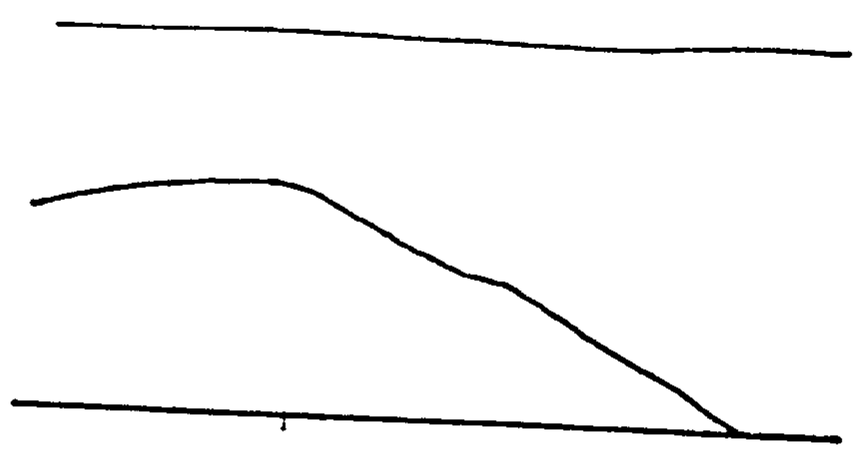

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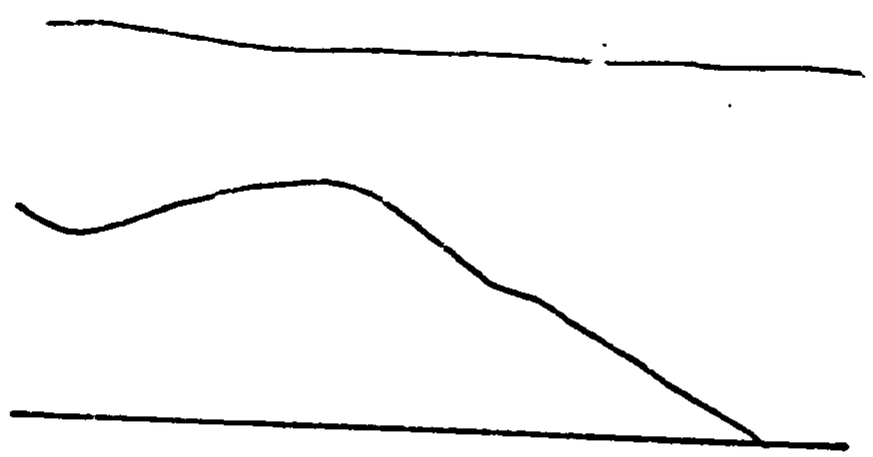

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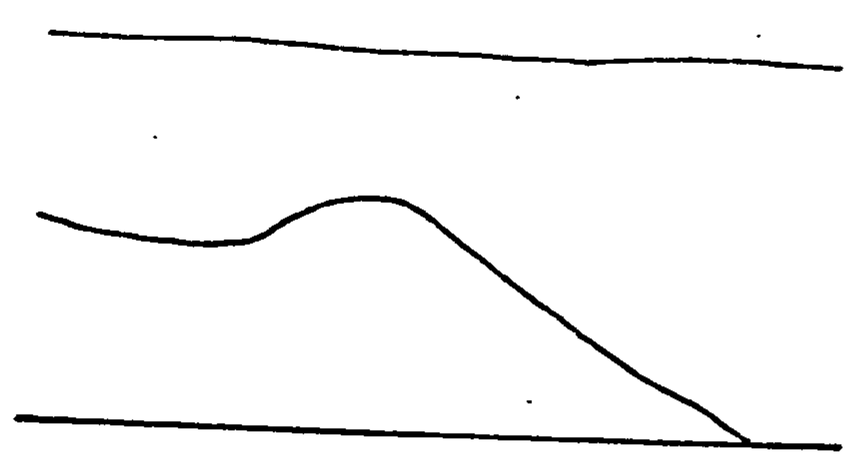
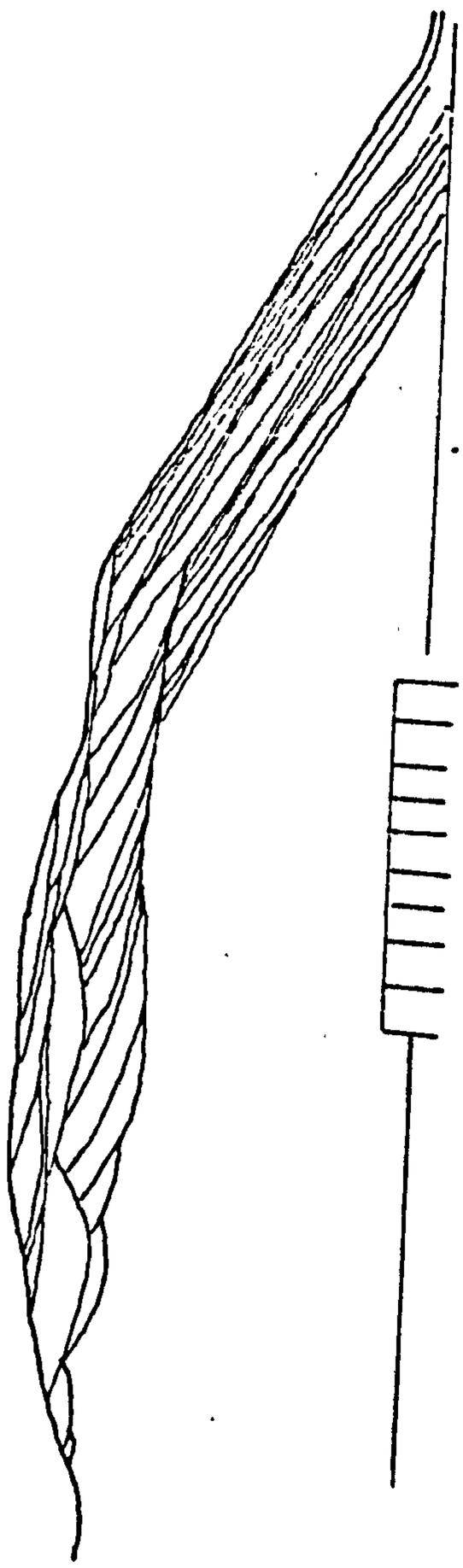
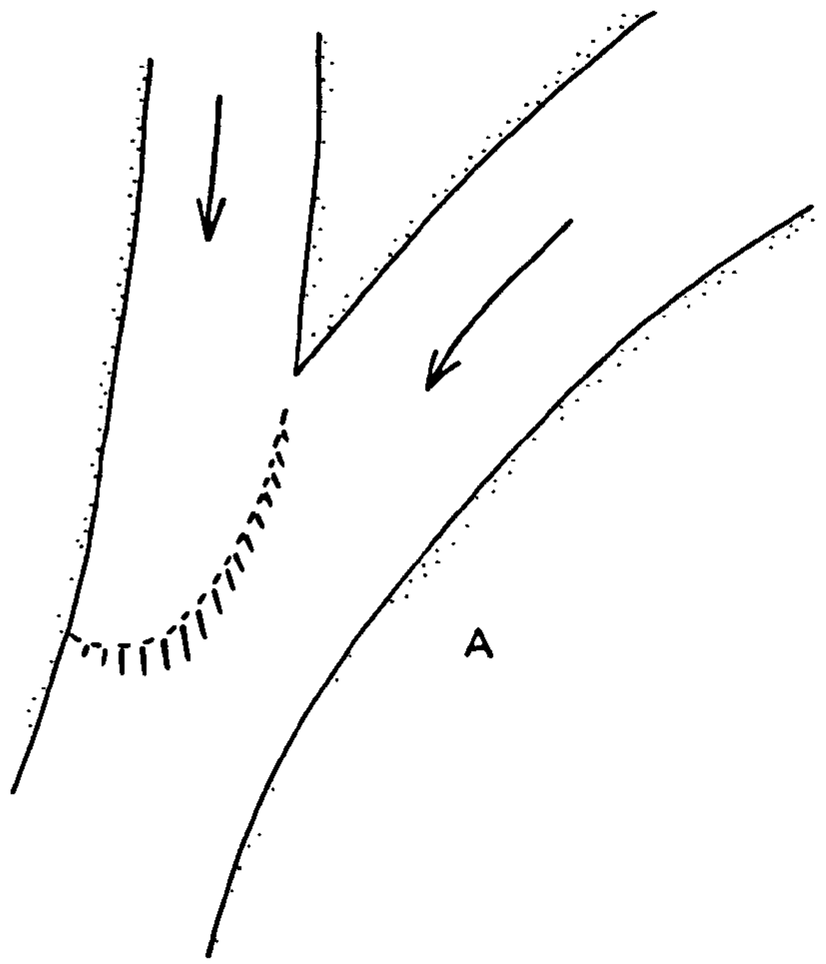
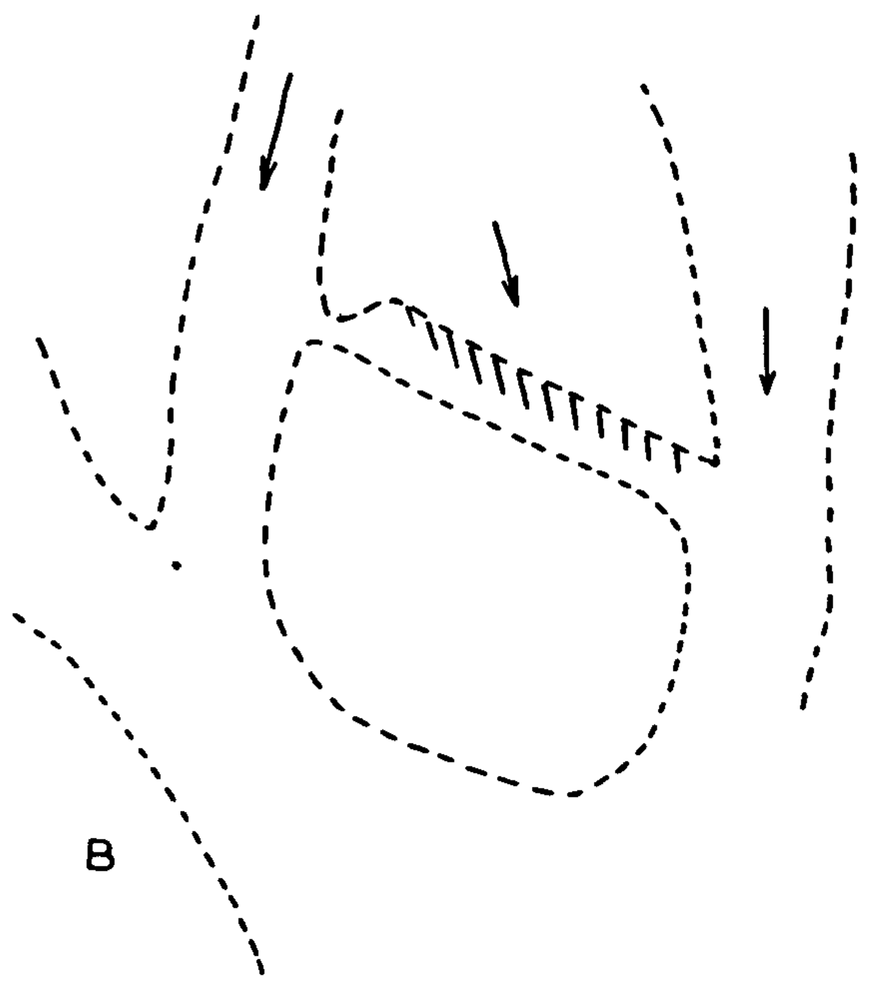


250

0.1m




A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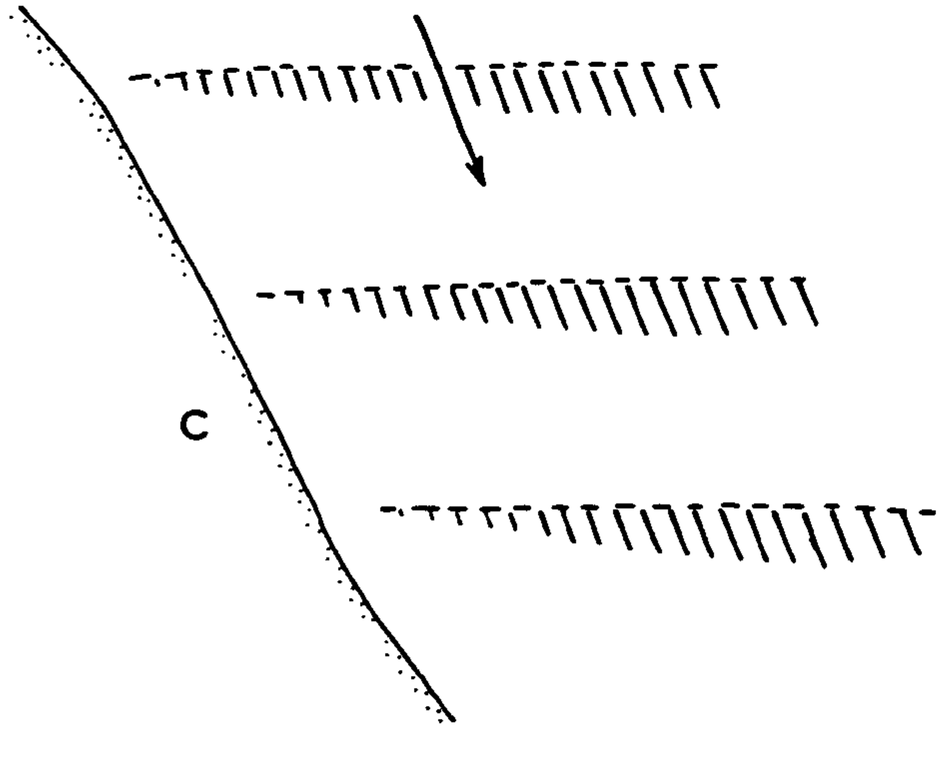
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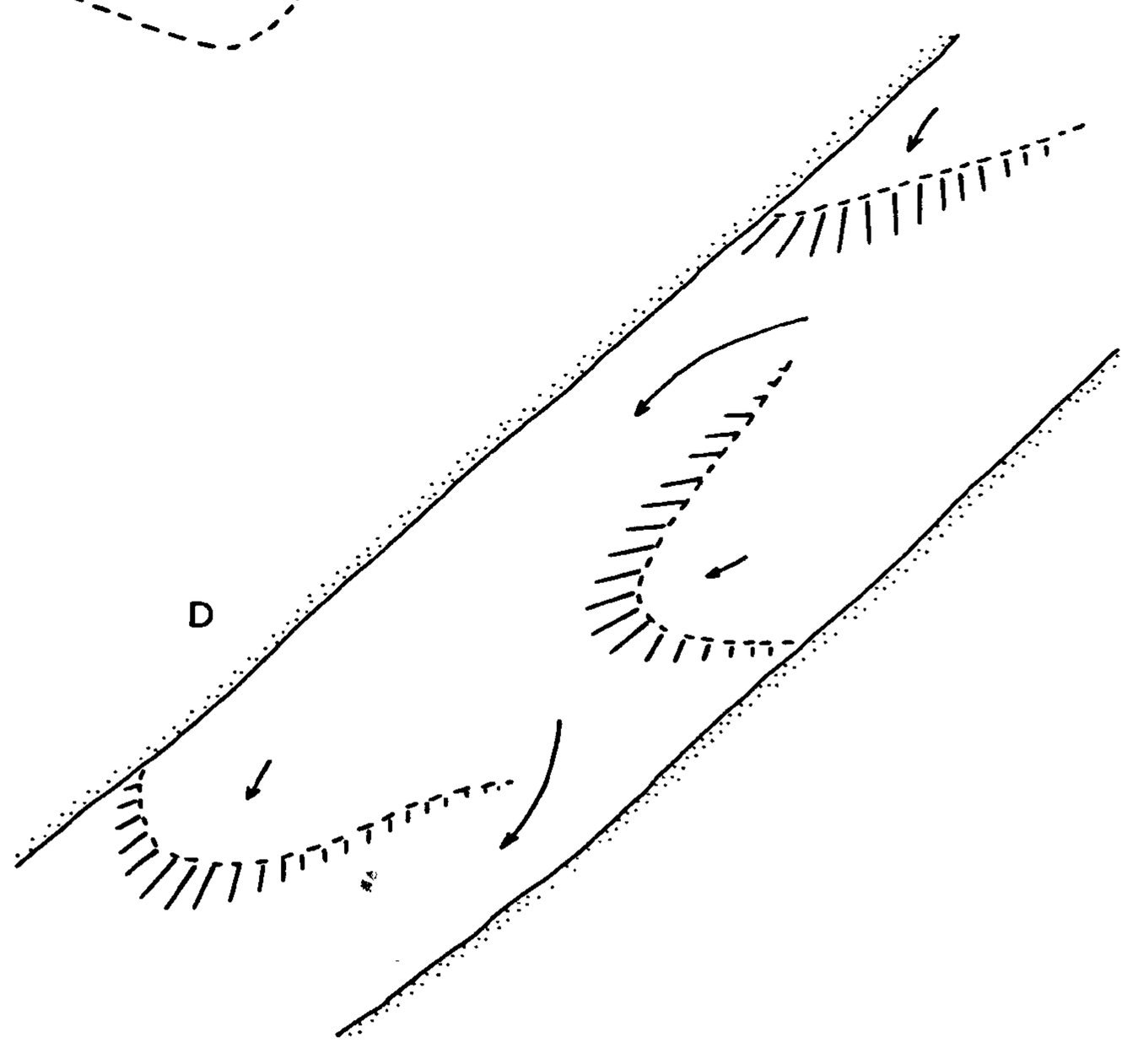
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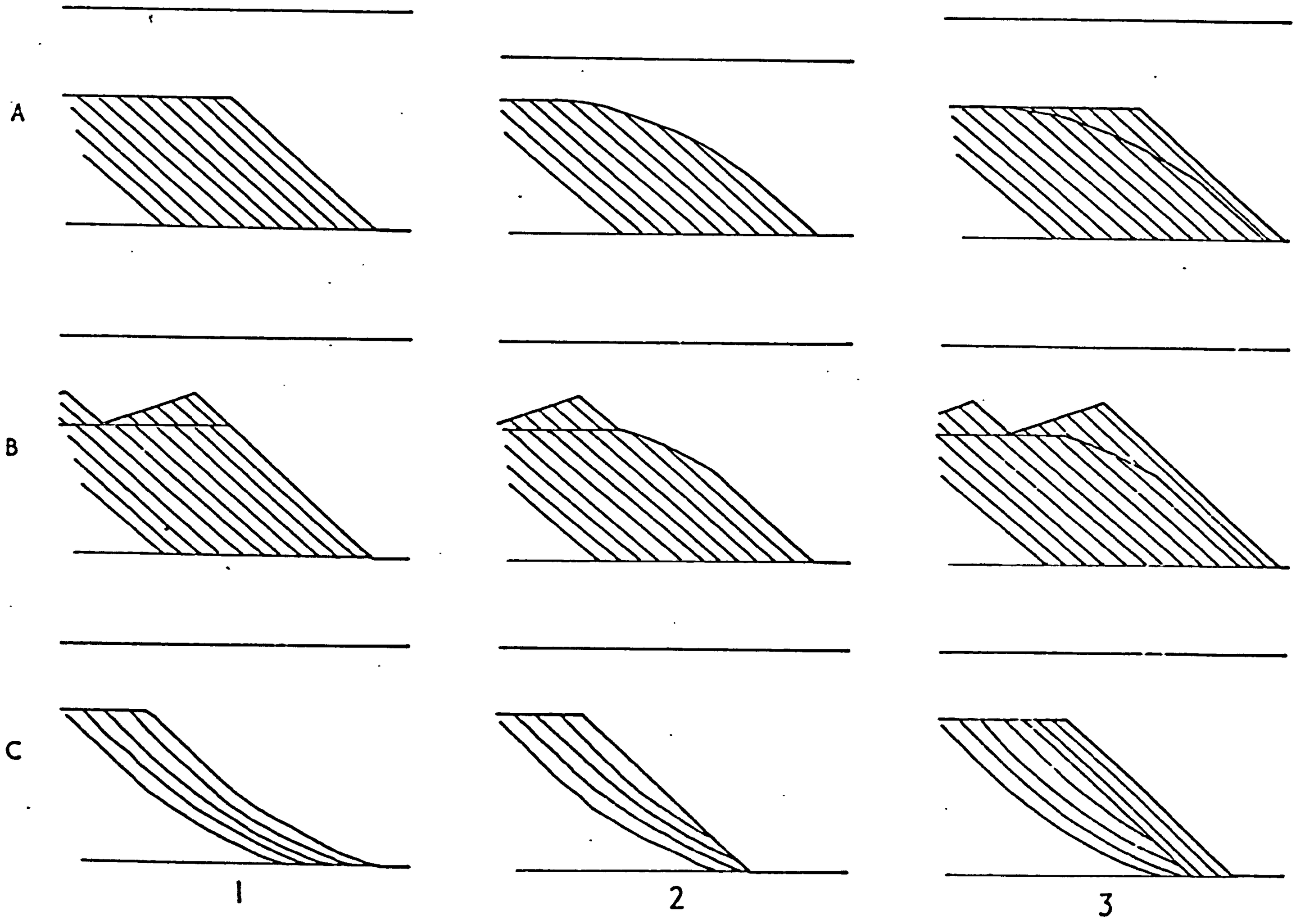
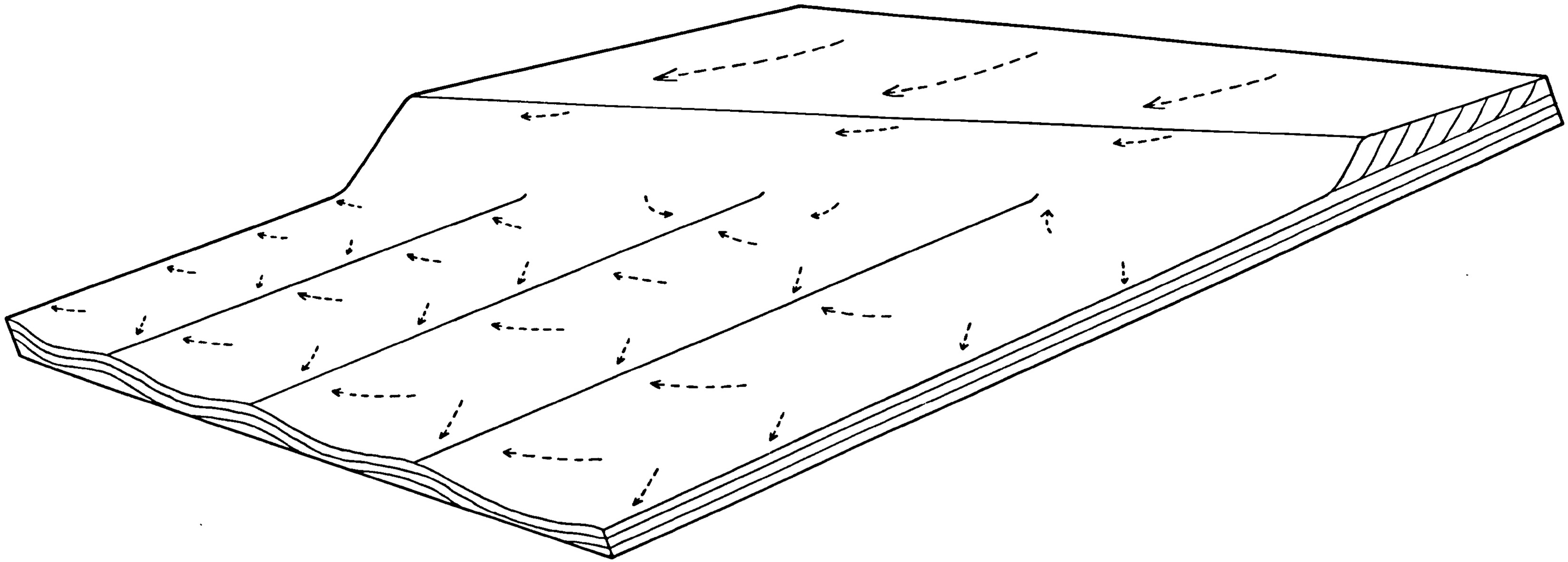
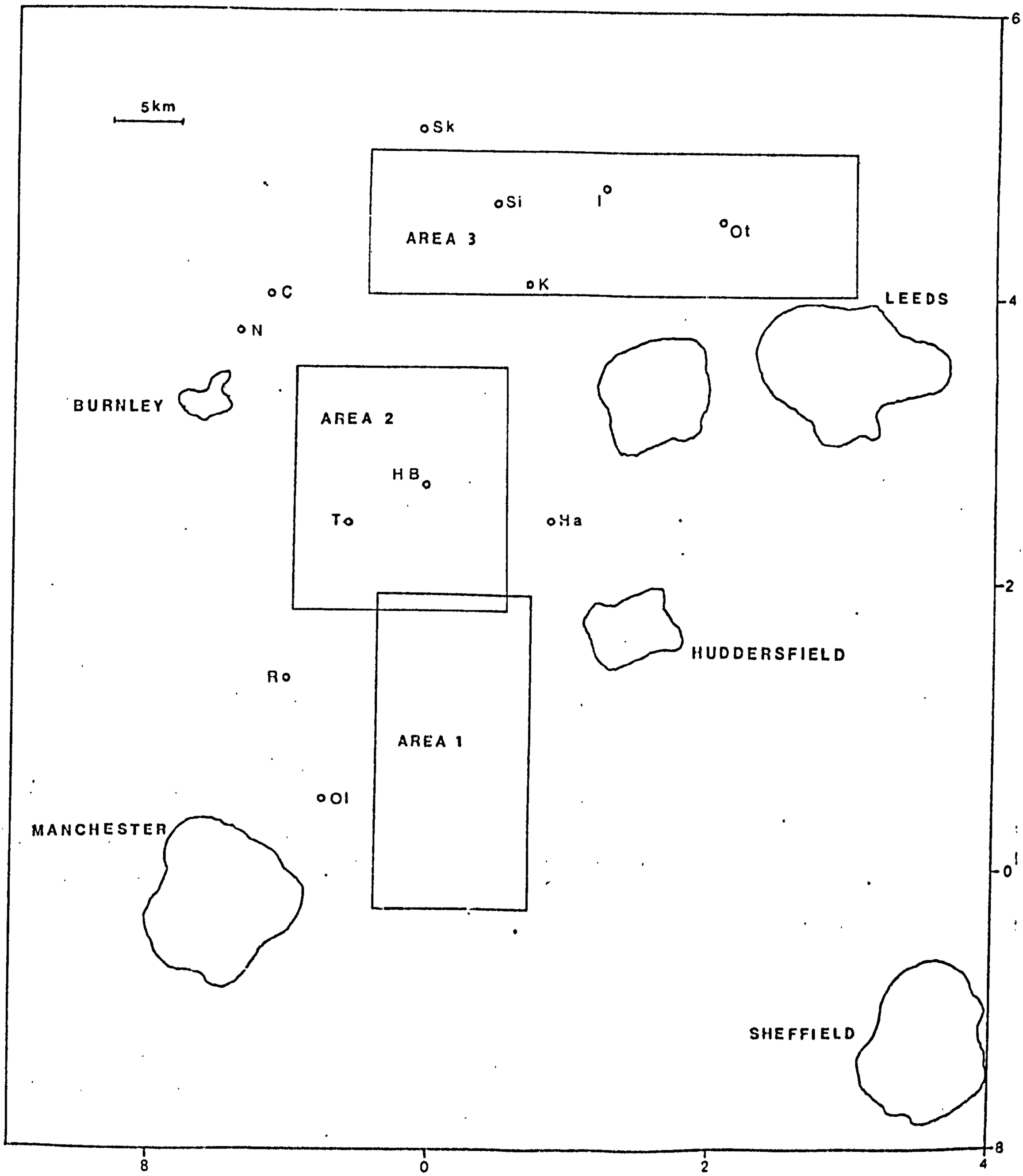

A
B
C
1
2
3

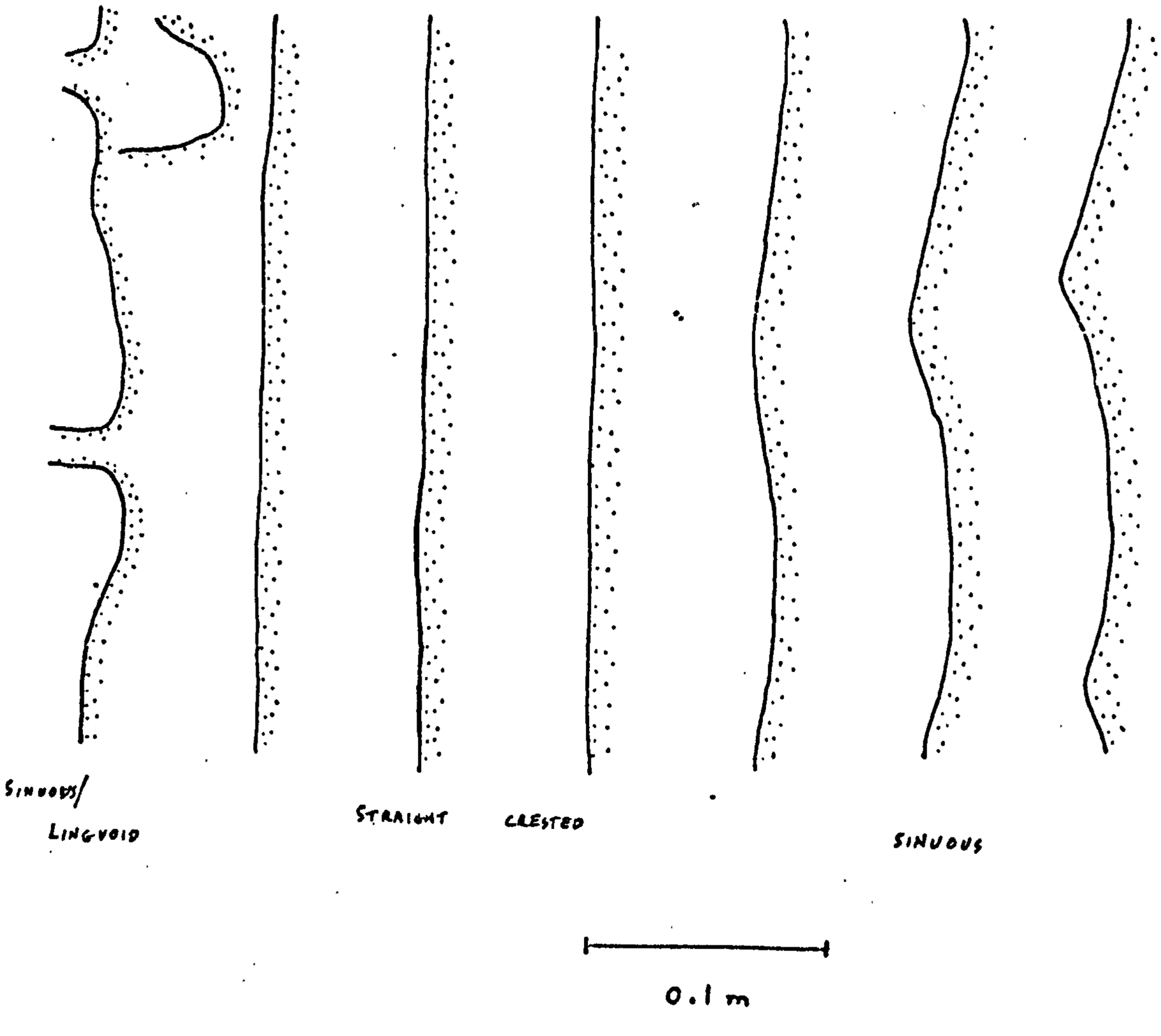


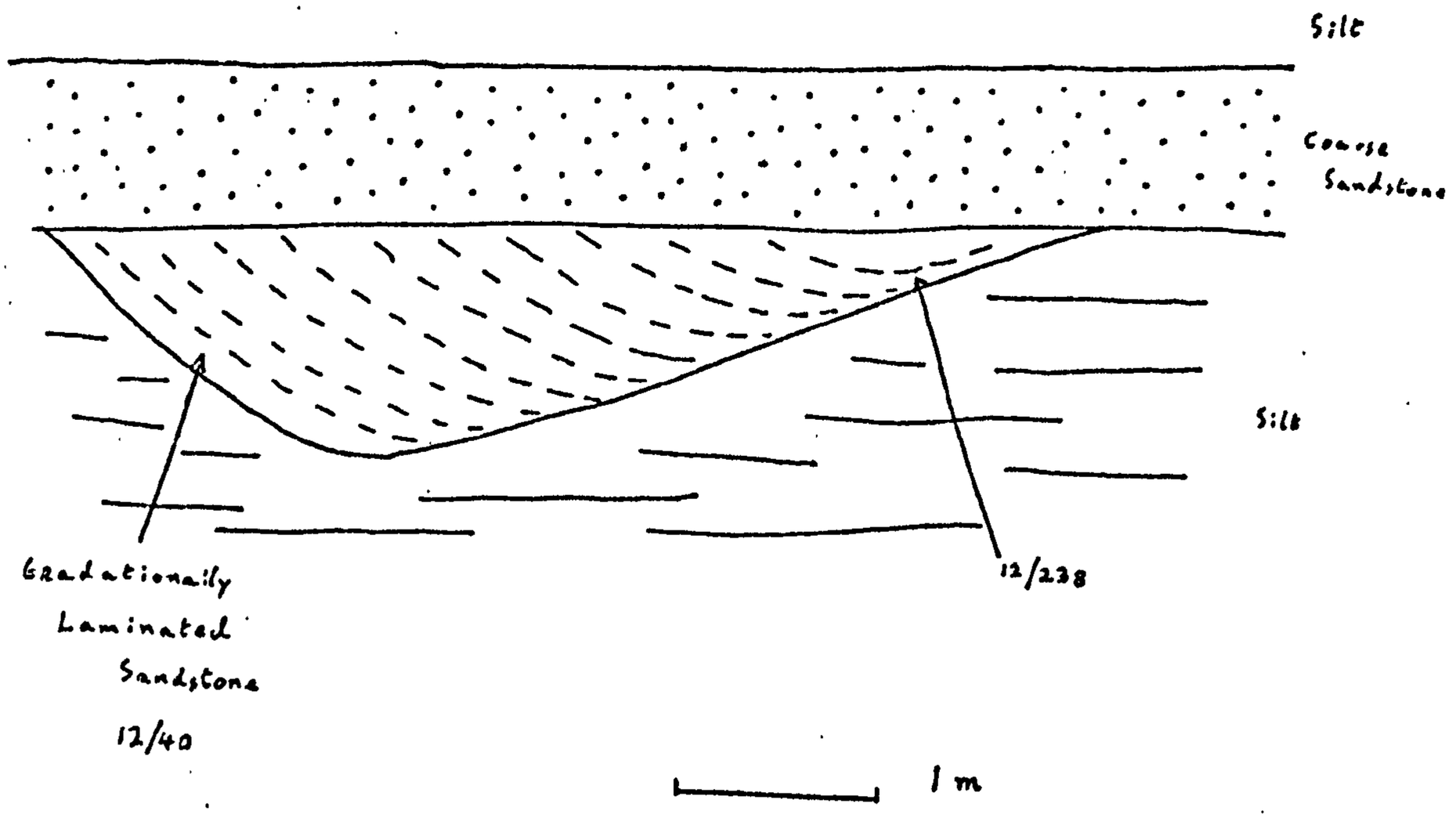
x1

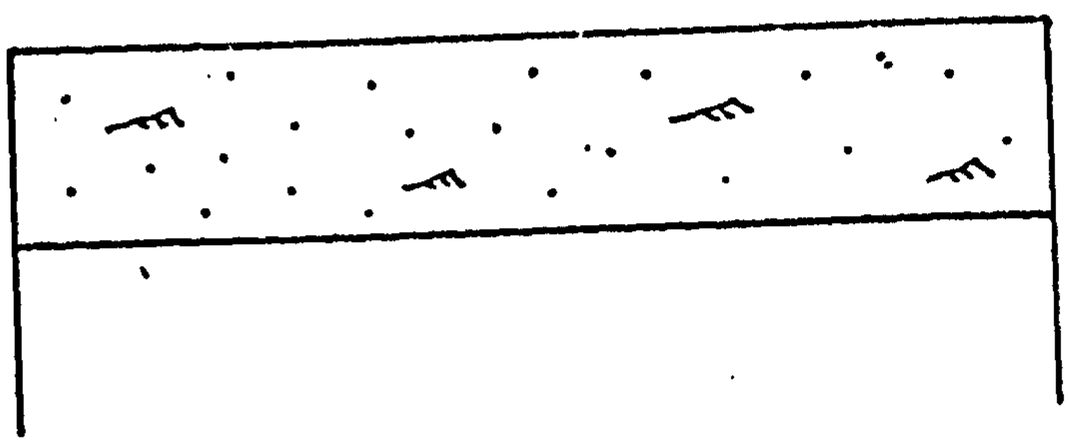
= Quartz

= Feldspar


5km
oSk
oSi
I o
AREA 3
oOt
oK
oC
oN
LEEDS
BURNLEY
AREA 2
HB o
To
oHa
HUDDERSFIELD
Ro
AREA 1
oOl
MANCHESTER
SHEFFIELD
6
4
2
0
8
8
0
2
4

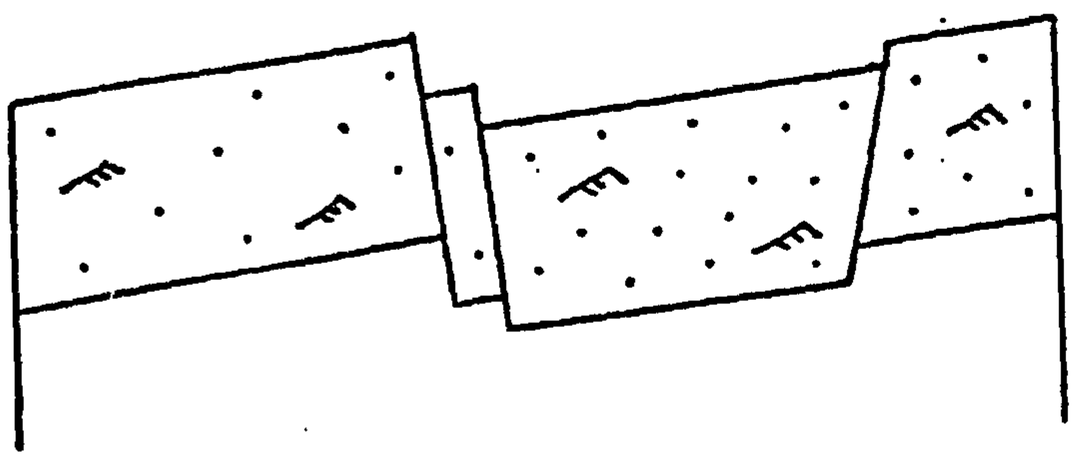

SINUOUS/
LINGVOID
STRAIGHT
CRESTED
SINUOUS
0.1 m

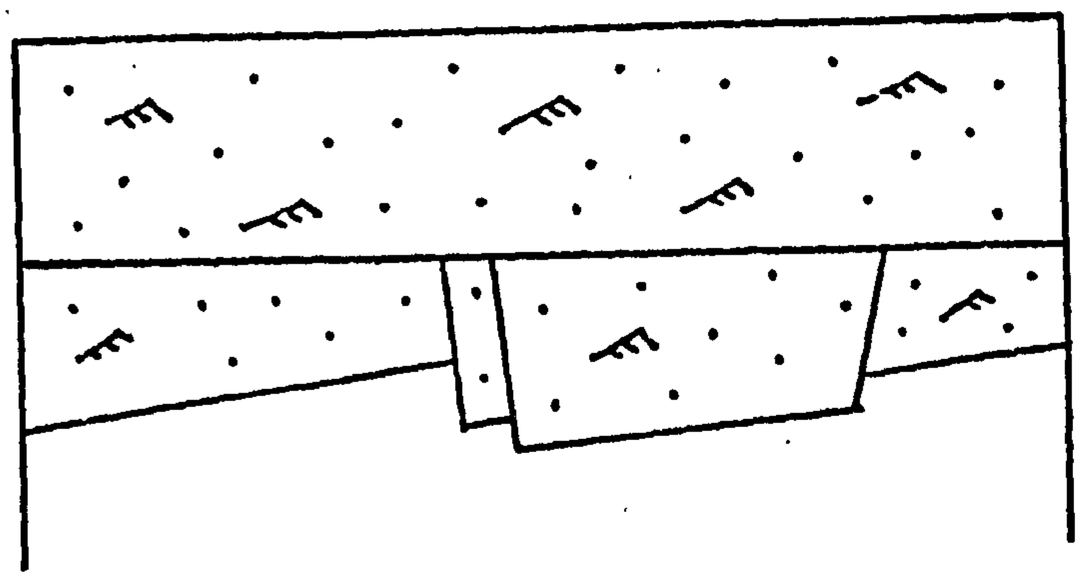

Silt
Coarse
Sandstone
Silt
Gradationally
Laminated
Sandstone
12/40
12/238
1 m

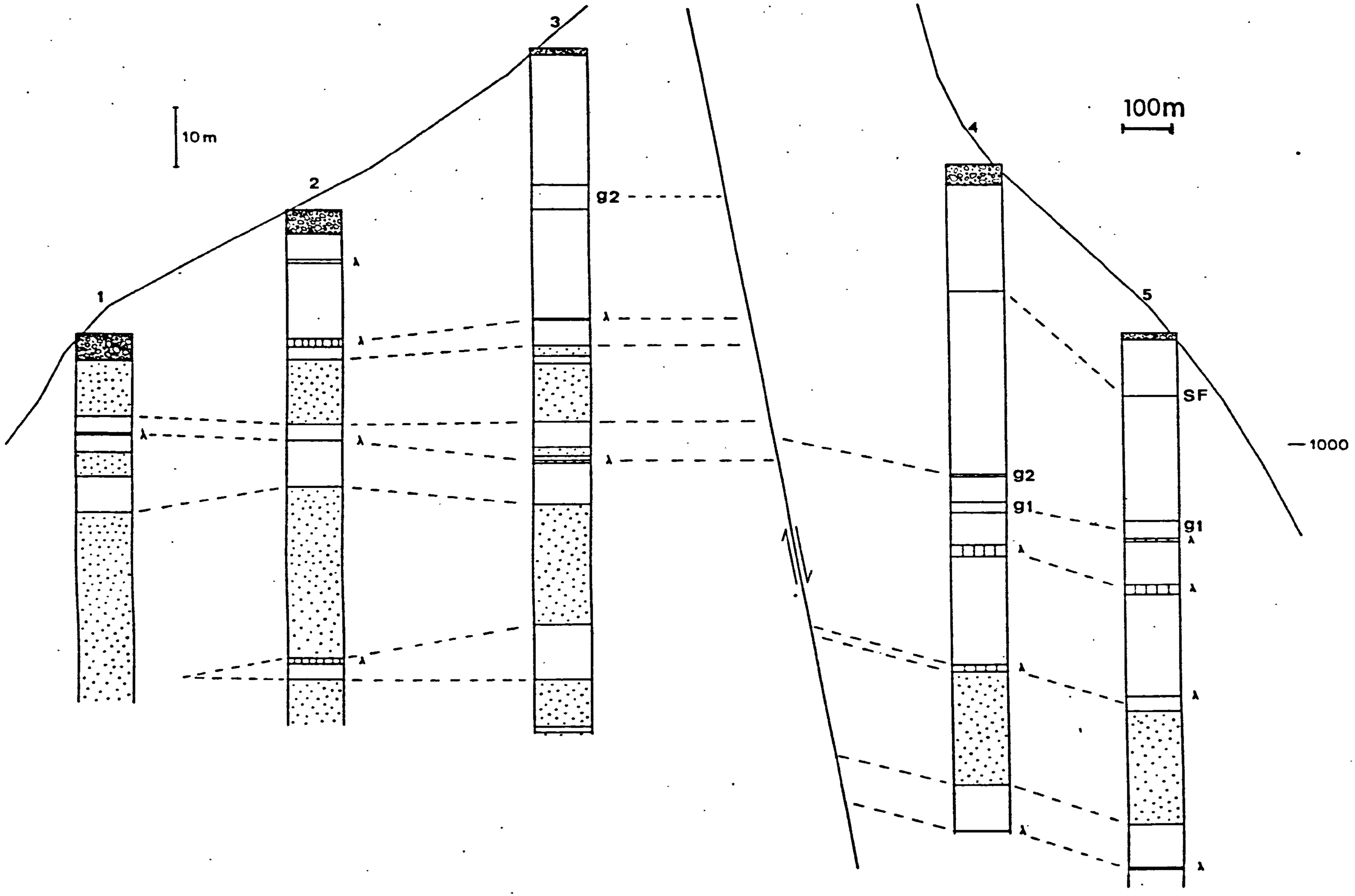


RIPPLED FINE SST.

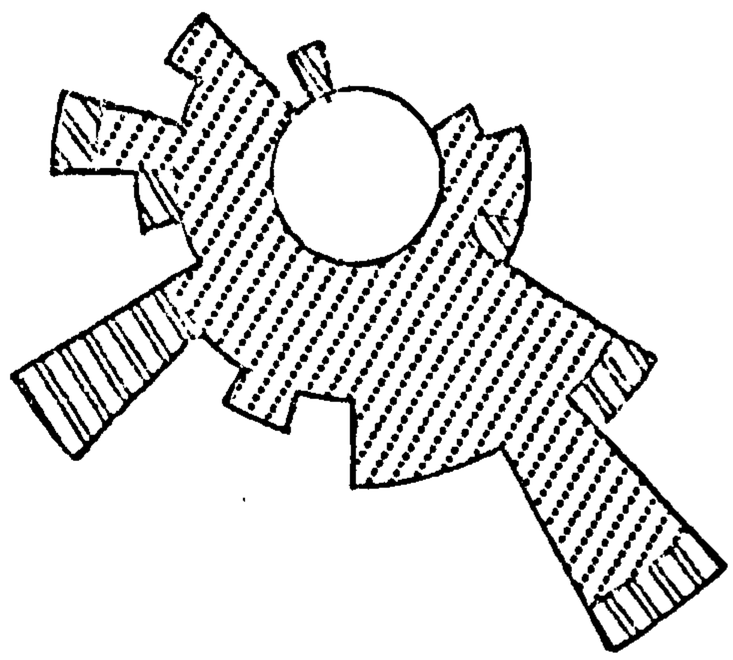
HOMOGENOUS MUDROCK






10 m
100m
1
2
3
4
5
g2
g1
SF
λ
1000

A



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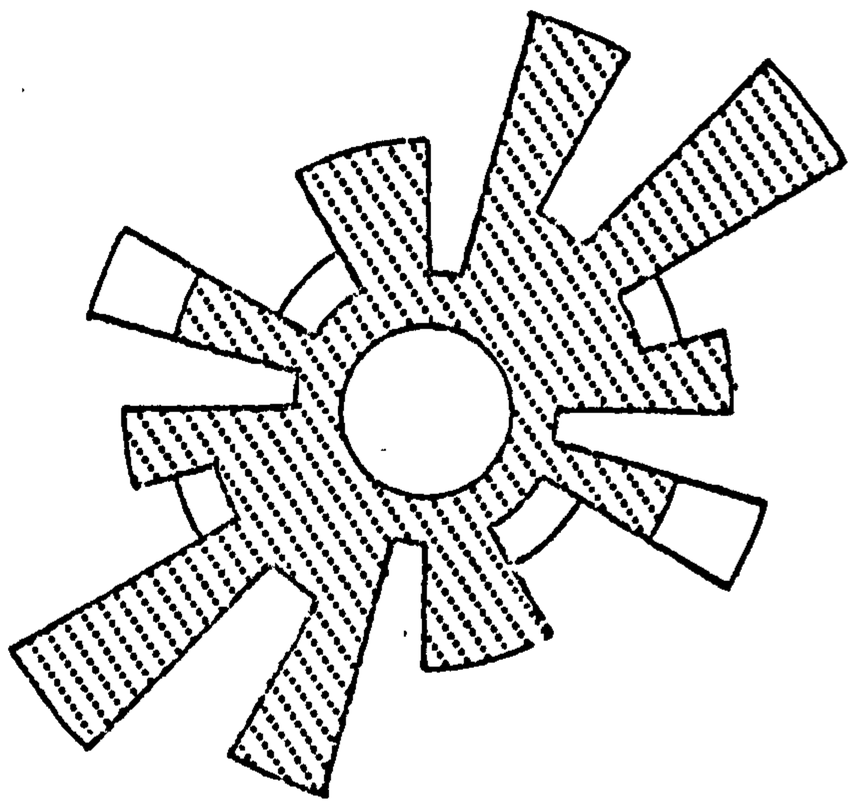
B



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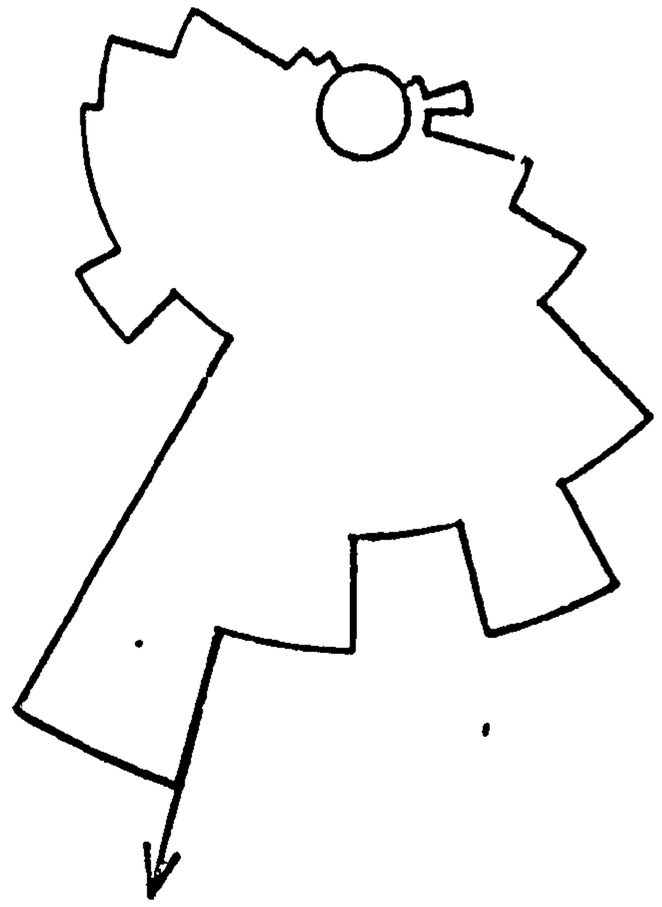
C



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D

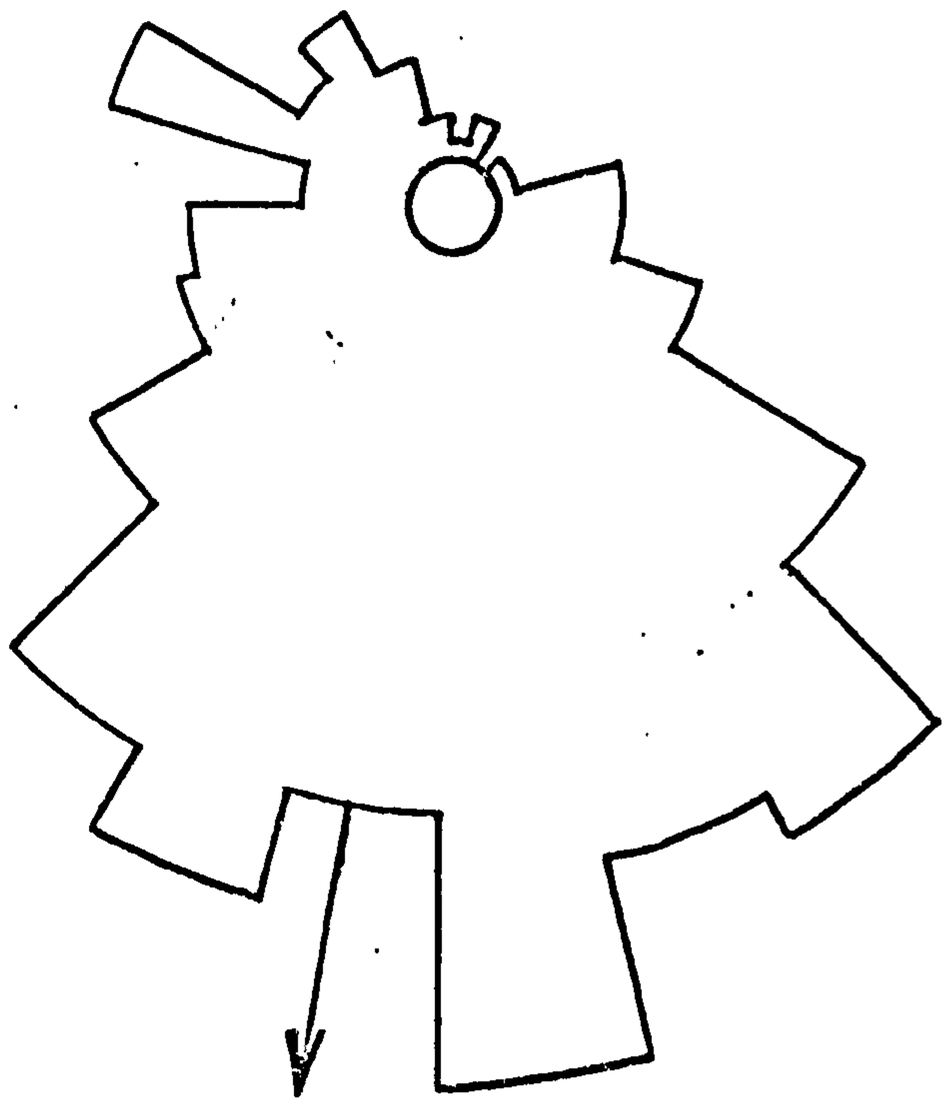

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Fig. 25

Palaeocurrent histogram for south, Area 1 (S, right hand column); centre, Area 2 (C, middle column); and north, Area 3 (N, left hand column).

Top row - Facies 20, large-scale cross-beds.

Middle row - Facies 13, medium-scale cross-beds.

Bottom row - Facies 3, turbidites; black - sense and direction known, white - direction only known.

Arrows indicate vector mean.

N

19

C

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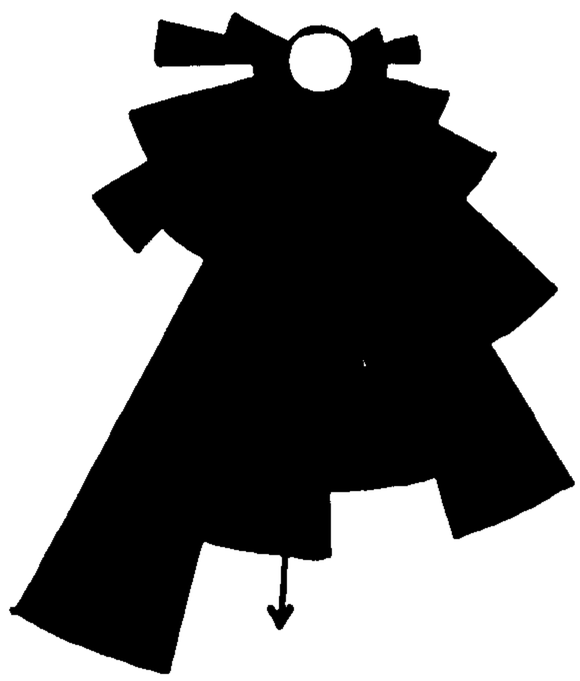
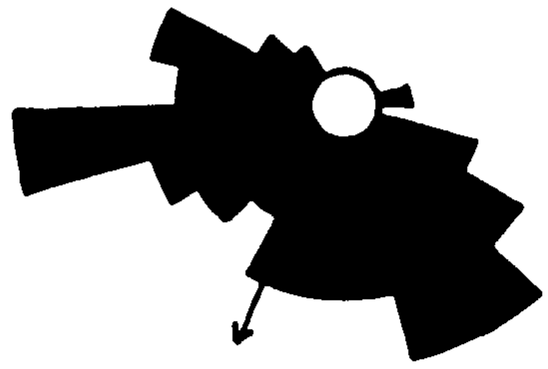


S

70



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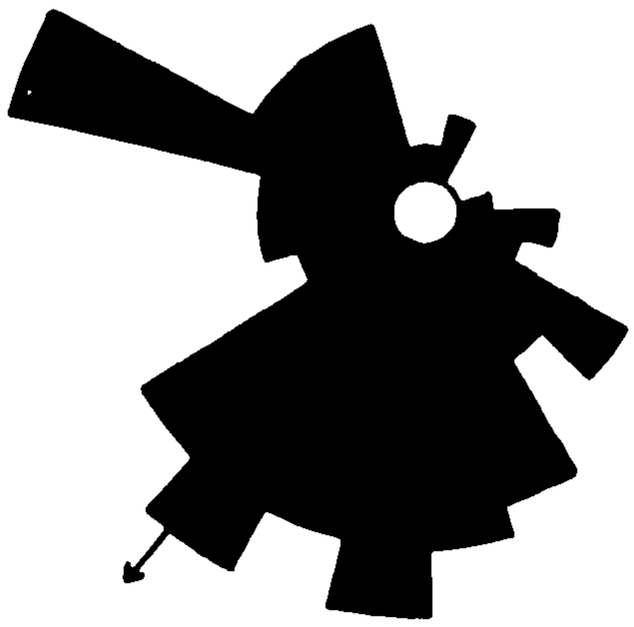
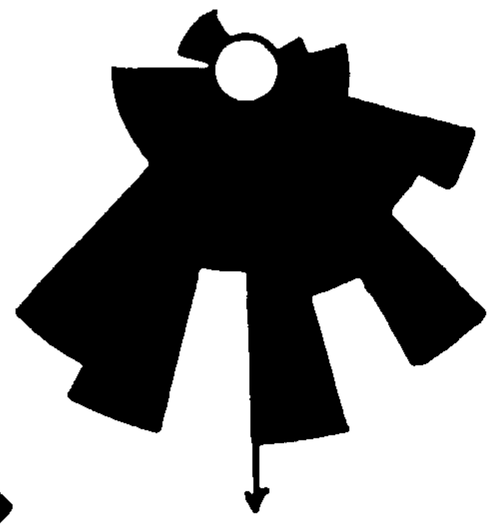


109

77



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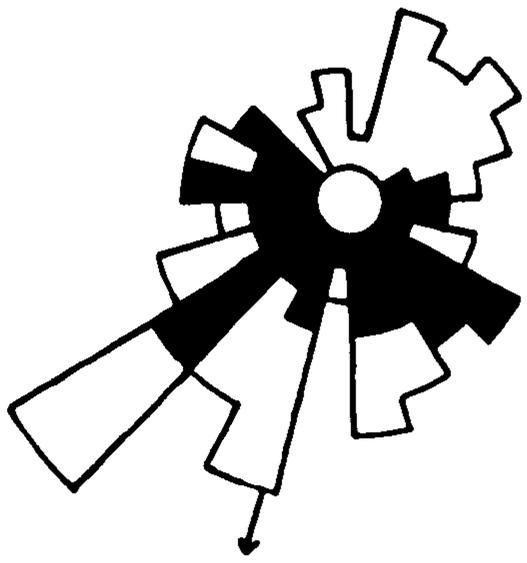
72



32

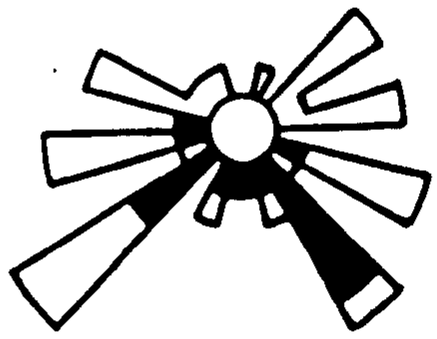


Plate 1

Oblique aerial photograph of Dove Stone Rocks, near Greenfield (SE023038); Grindslow Shale and Kinderscout Grit Formations. 75m of Facies 4, unlaminated sandstone at the top of Assemblage B. Facies 20, large-scale cross-beds, of Assemblage C crops out in the rocks at the top left.

Plate 2

Upper reaches of Chew Brook, near Greenfield (SE030016). Showing marked break in slope between Grindslow Shale Formation (Assemblage B) and overlying Kinderscout Grit Formation (Assemblage C). Facies 20, large-scale cross-bedding, and Facies 13, medium-scale cross-bedding, form the prominent "grit edge".

Plate 3

Earl Crag, looking towards Wainman's Pinnacle, near Cowling (SD984429). Break in slope between Silsden Shale and Sandstone Formation (Assemblage B) and overlying Kinderscout Grit (Assemblage C). Note slumping of the Silsden Formation.

Plate 4

Otley Sandstone Formation near the junction with Ilkley Shale Unit, Storris House railway cutting (SE179447), Otley. Thin turbidite beds, Facies 3, in mudrock, Facies I with a discordance along the line YZ. Hammer 0.3m long.

Plate 5

Sandstone dyke in Otley Formation near junction with Ilkley Shale Unit. Storris House railway cutting (SE179447).


Y
Z

Plate 6

Carbonate concretion in mudrock, Facies 1, showing burrow and laminae free of carbonaceous material. Pyrite preferentially infills burrows. Specimen from Samlesbury Bottoms (SD618291).

Plate 7

Prod and brush marks at base of turbidite sandstone, Facies 3. Specimen from Shale Grit Formation, Dovestones Reservoir cutting (SE016035) near Greenfield.


MM
1
2
3
4

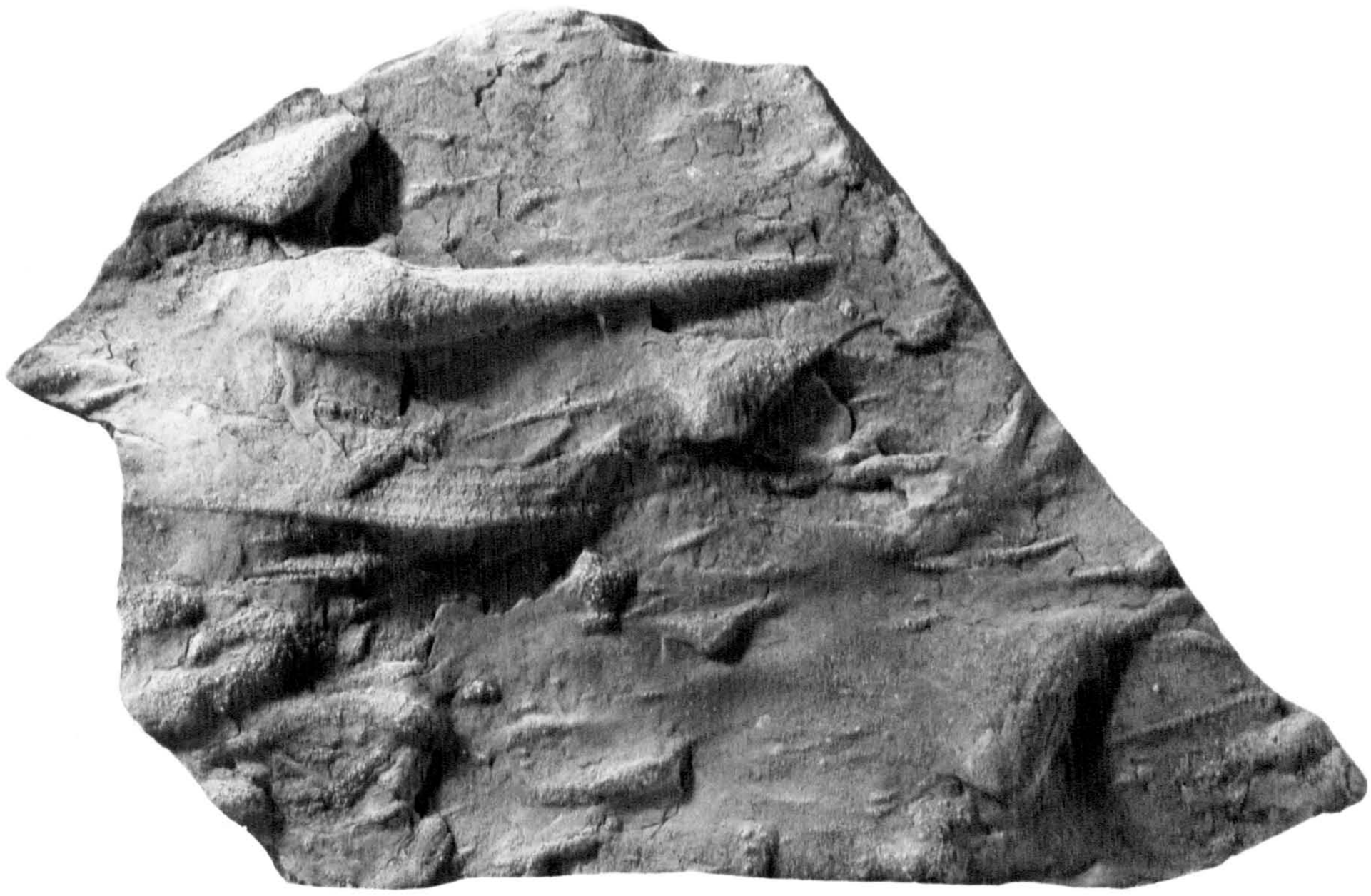

MM
1
2
3
4

Plate 8

Furrow marks on base of Facies 3, turbidites. Loose block from Otley Sandstone Formation; Cow Close Gill, Ilkley (SE125469).

Plate 9

Load casts on base of Facies 3, turbidites. Locality as in Plate 8.

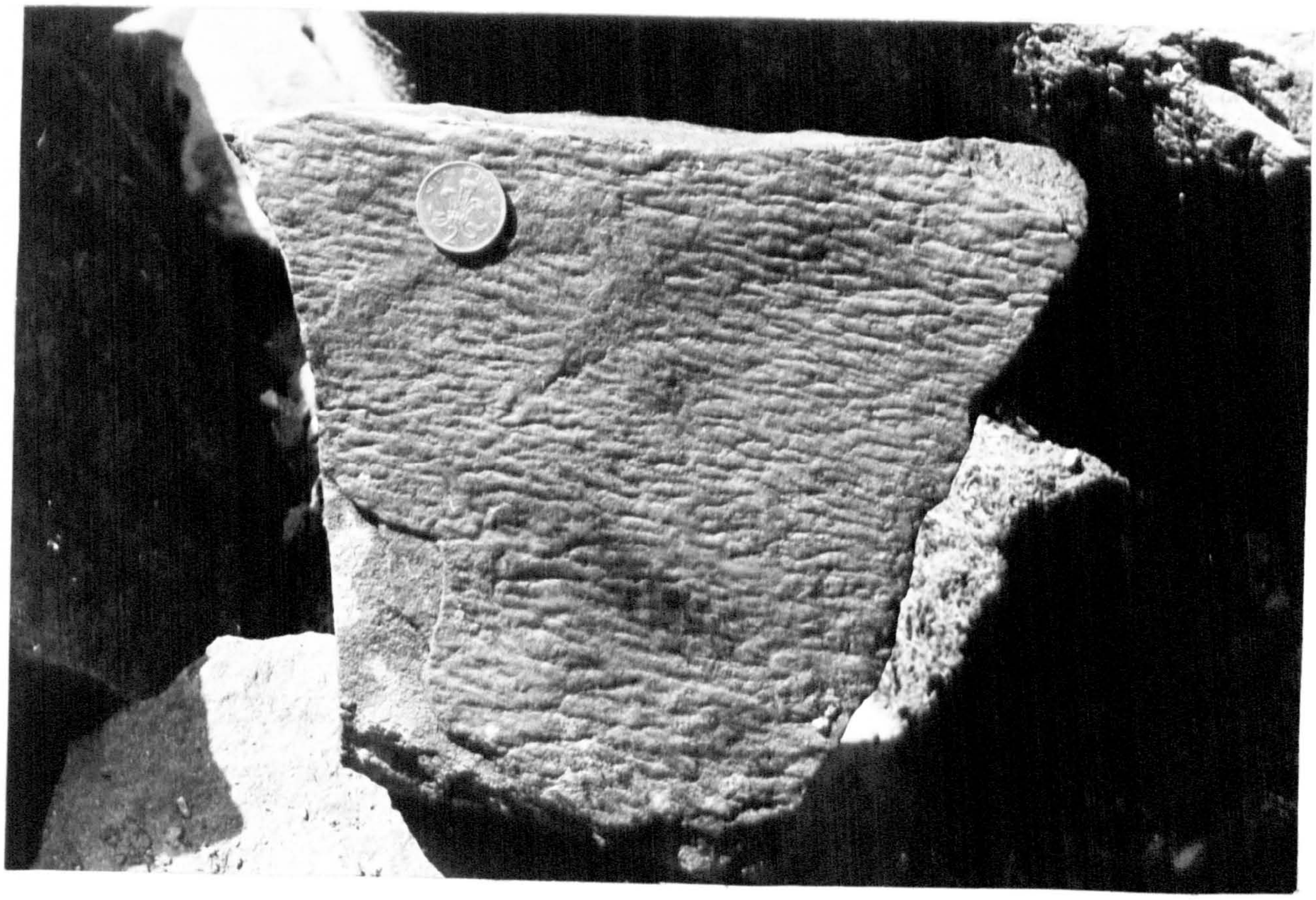
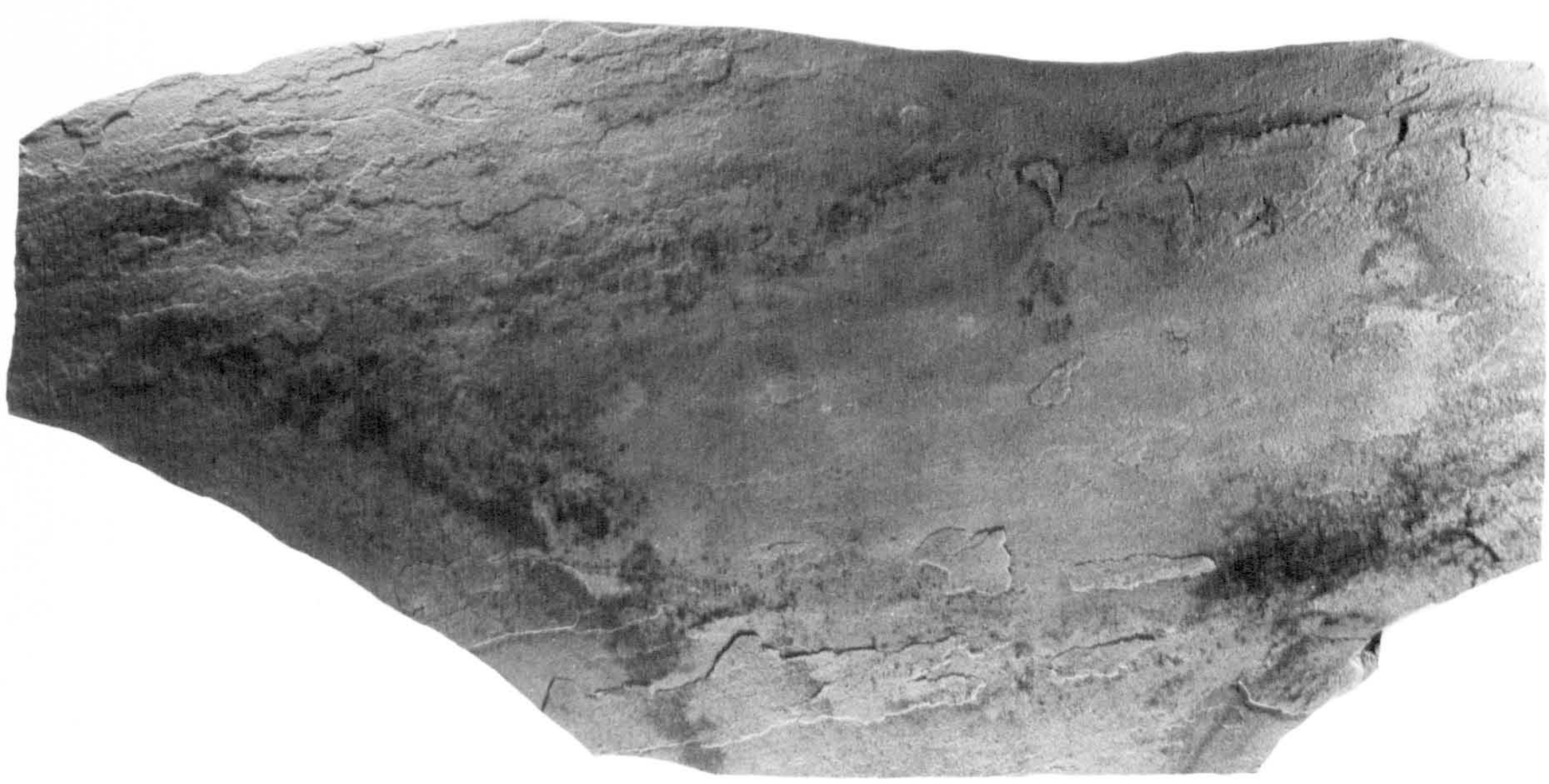


Plate 10

Facies 3, turbidite, showing parting lineation (top) and linguoid ripples (bottom) indicating identical current direction. The plate shows one specimen photographed from both sides, with negative of parting lineation printed in reverse. N.B. scale in inches. Specimen from Todmorden Sandstone Formation; Lumbutts Clough (SD953234), near Todmorden.



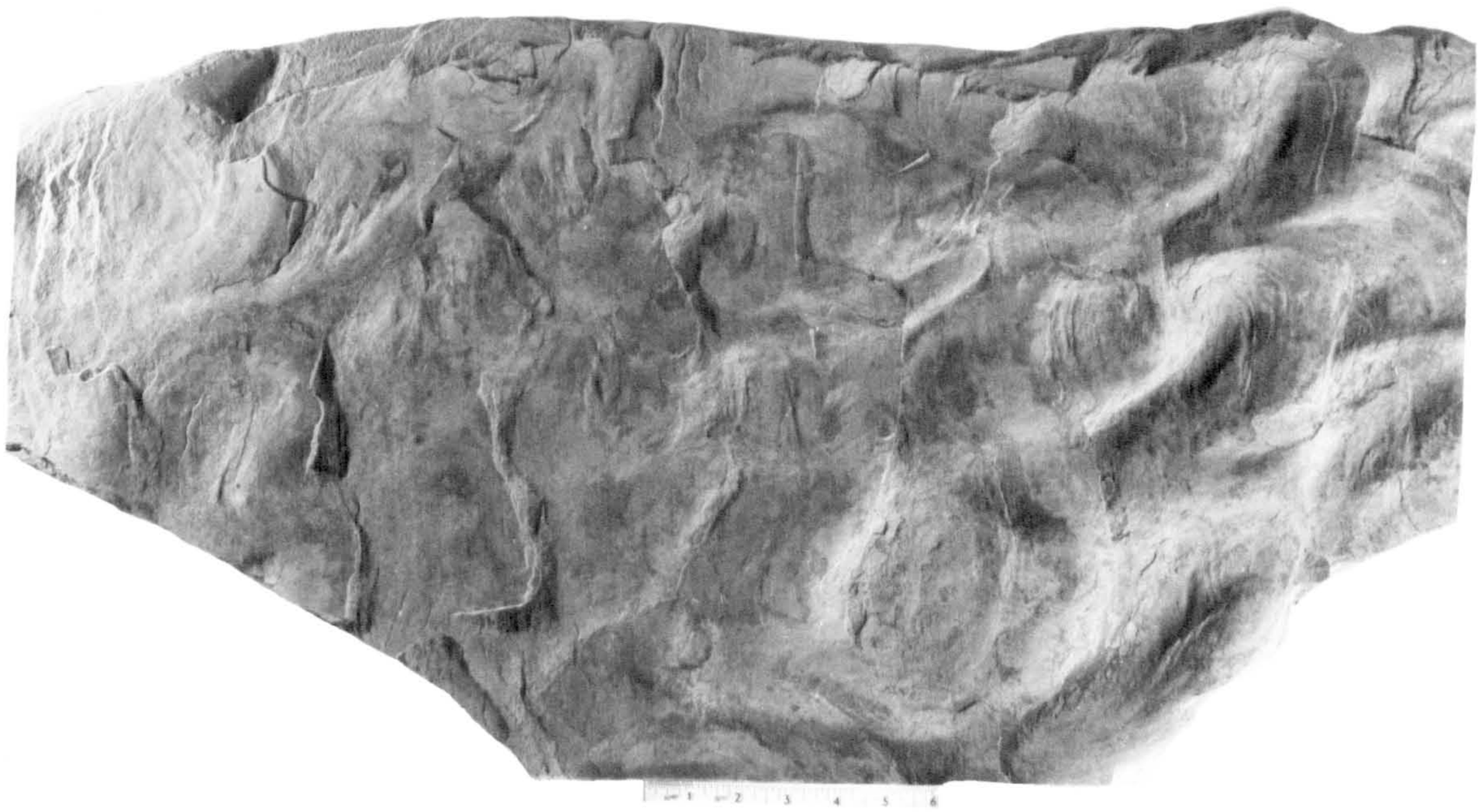


Plate 11

Straight crested ripples at top of Facies 3, turbidites. Specimen from Shale Grit Formation Dovestones Reservoir cutting (SE016035) near Greenfield.

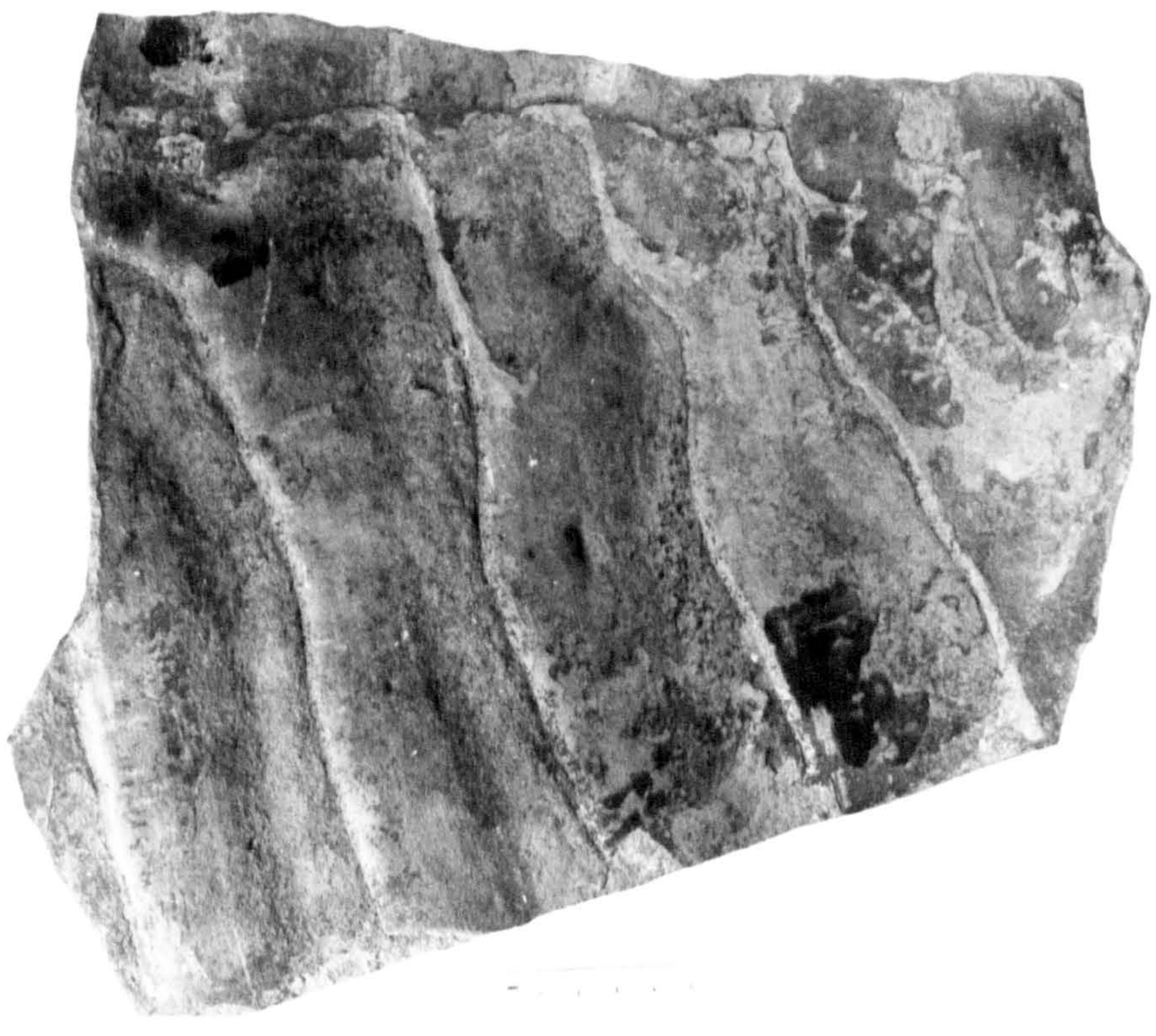


Plate 12

Gradationally laminated sandstone, Facies 8, showing laminae rich in carbonaceous material alternating with laminae, of coarser grain size, poor in carbonaceous material. Photograph of thin section. x3.

Plate 13

As above with early carbonate cement. Note the considerably greater lamina thickness although the grain size is similar. x $2\frac{1}{2}$.

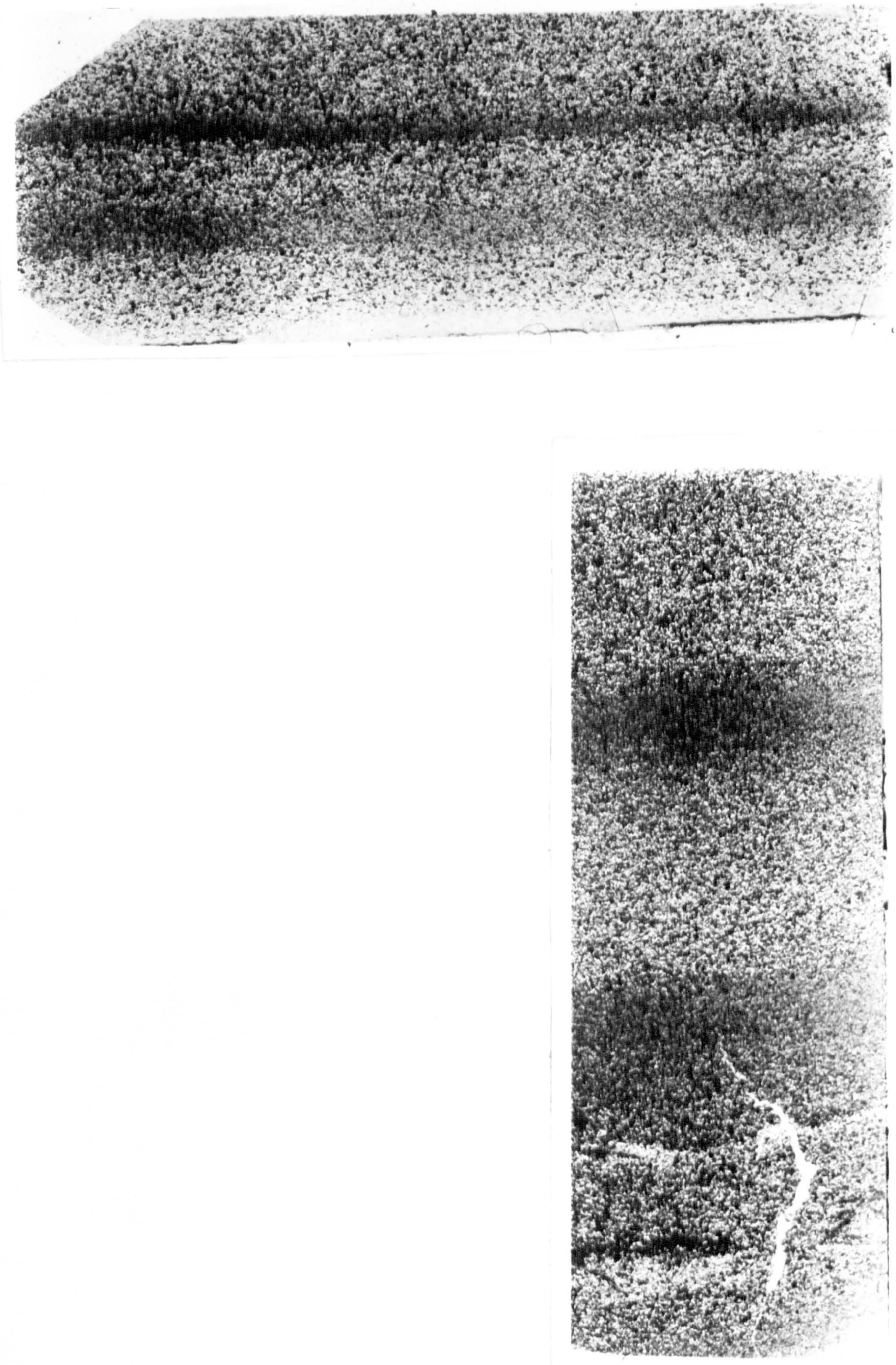
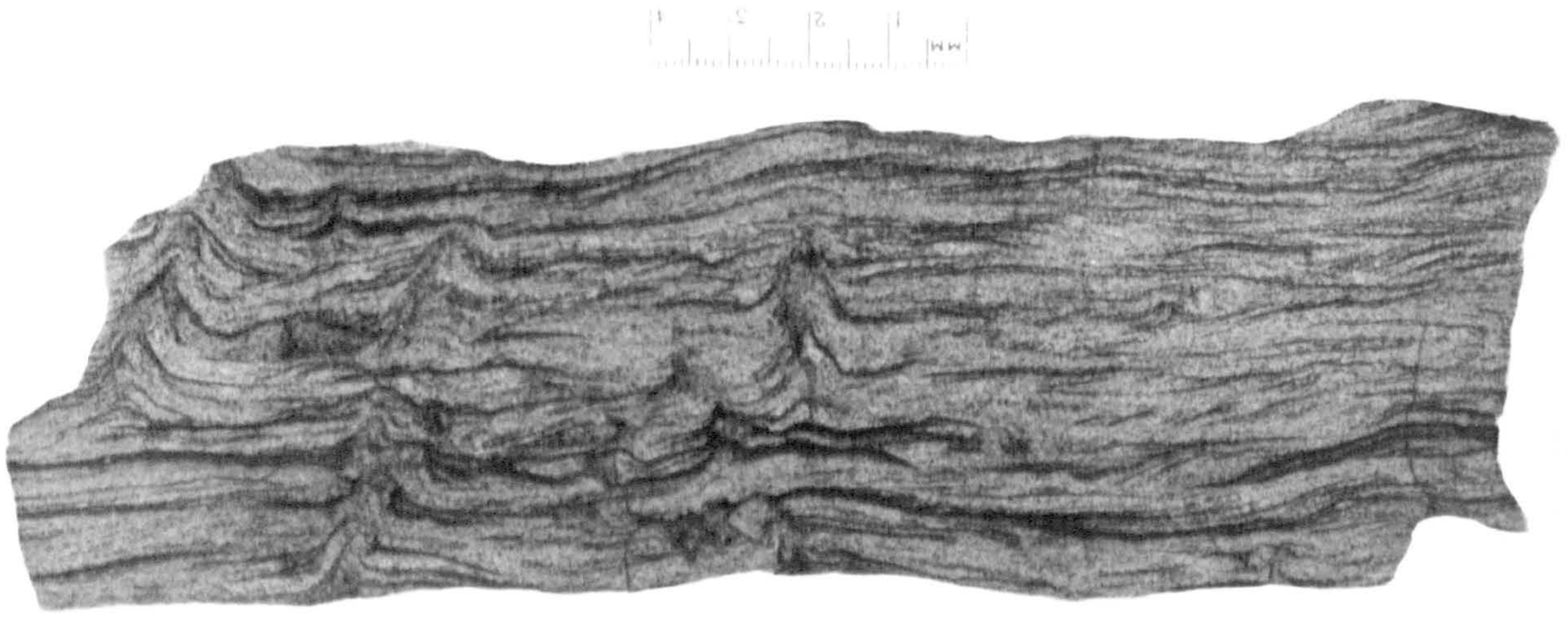


Plate 14

Facies 11, ripple laminated sandstone with coarse sandstone. Note the carbonaceous nature of the fine grained ripple laminated sandstone and the unlaminated nature of the coarse sandstone. There is little evidence of erosion at the base of the coarse sandstone. Specimen from Silsden Shale and Sandstone Formation; Eastburn Quarry (SE020440) near Sutton-in-Craven.

Plate 15

Facies 10, ripple laminated sandstone. This cross-section shows good examples of Pelecypodichnus V - shaped traces. Specimen from Silsden Formation; quarry at southern end of Brunthwaite Crag (SE060461) near Silsden.


4 3 2 1 mm

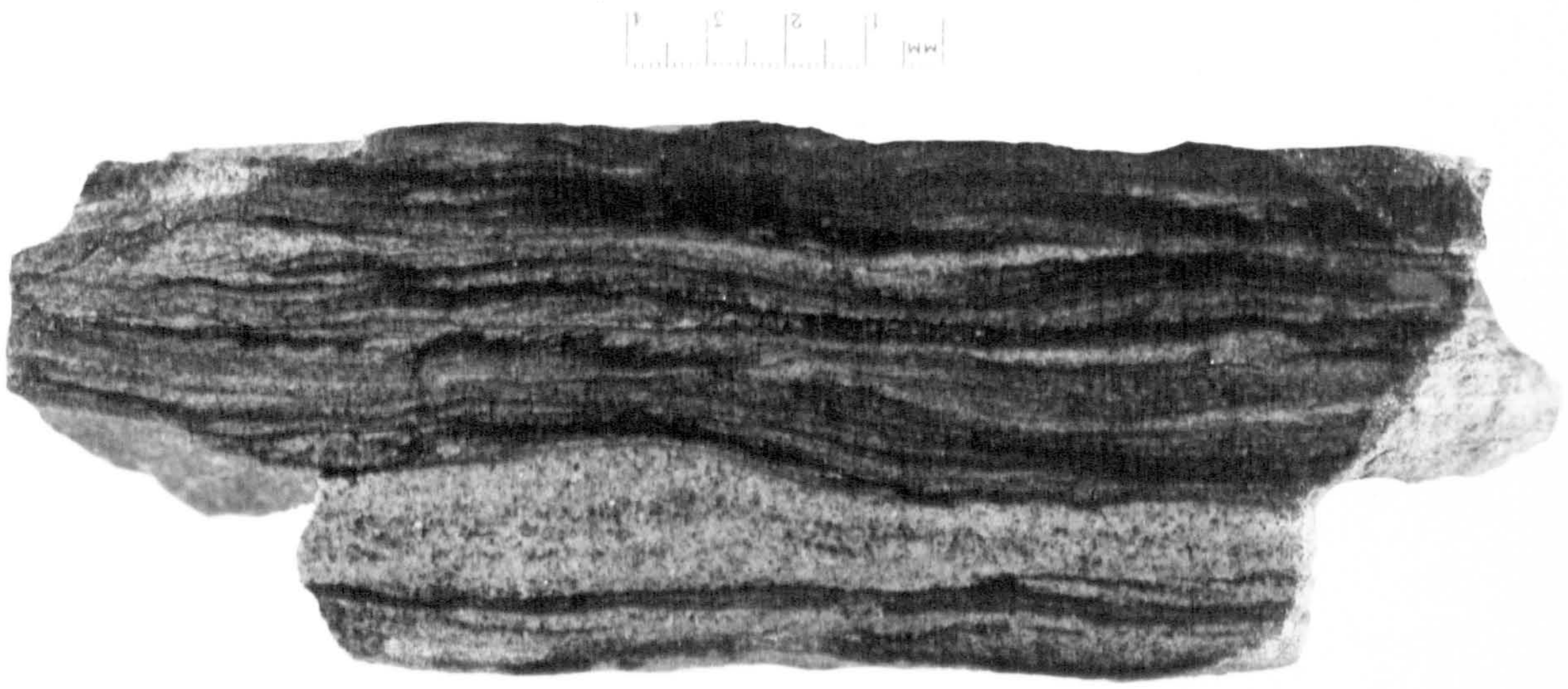

4 3 2 1 mm

Plate 16

Two units of Association B_2. Note the heterogenous nature of the association. The lower unit is virtually horizontal whilst the upper unit, overlying the truncation surface W X is orientated $8^{o}/275$. Outcrop approximately 10m high. Hebden B ridge Shale and Sandstone Formation; Hebden Dale (SD971302).

Plate 17

Typical stream section in Association B_2, inclined units. Photograph shows two units with markedly different orientations. The major facies is 8, gradationally laminated sandstones. Note the rucksack and compass, at upper right centre, for scale. Hebden Bridge Formation, Dale Clough (SD972266) near Hebden Bridge.

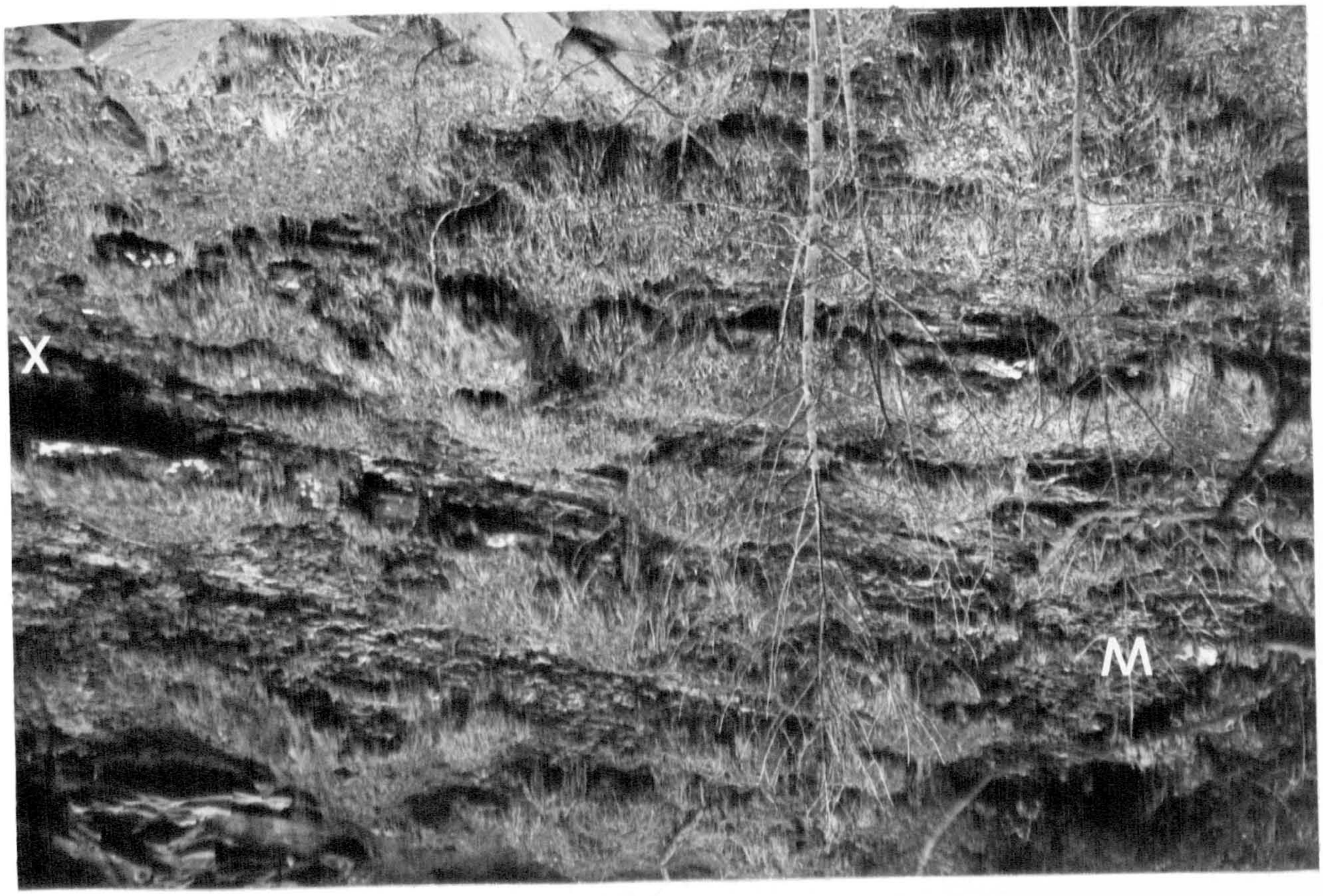

X
M

Plate 18

Truncation surface (V - V) in Association B_2, Hebden Bridge Formation. Note how the overlying beds, mainly Facies 8, gradationally laminated sandstones, drape over the surface. Rochdale Canal near Hebden Bridge (SD974265).

Plate 19

Penecontemporaneous faulting at base of an Association B_2 unit. Faults occur at Q, R, S and T. Hebden Bridge Formation, Hebden Dale (SD972306).


V
V

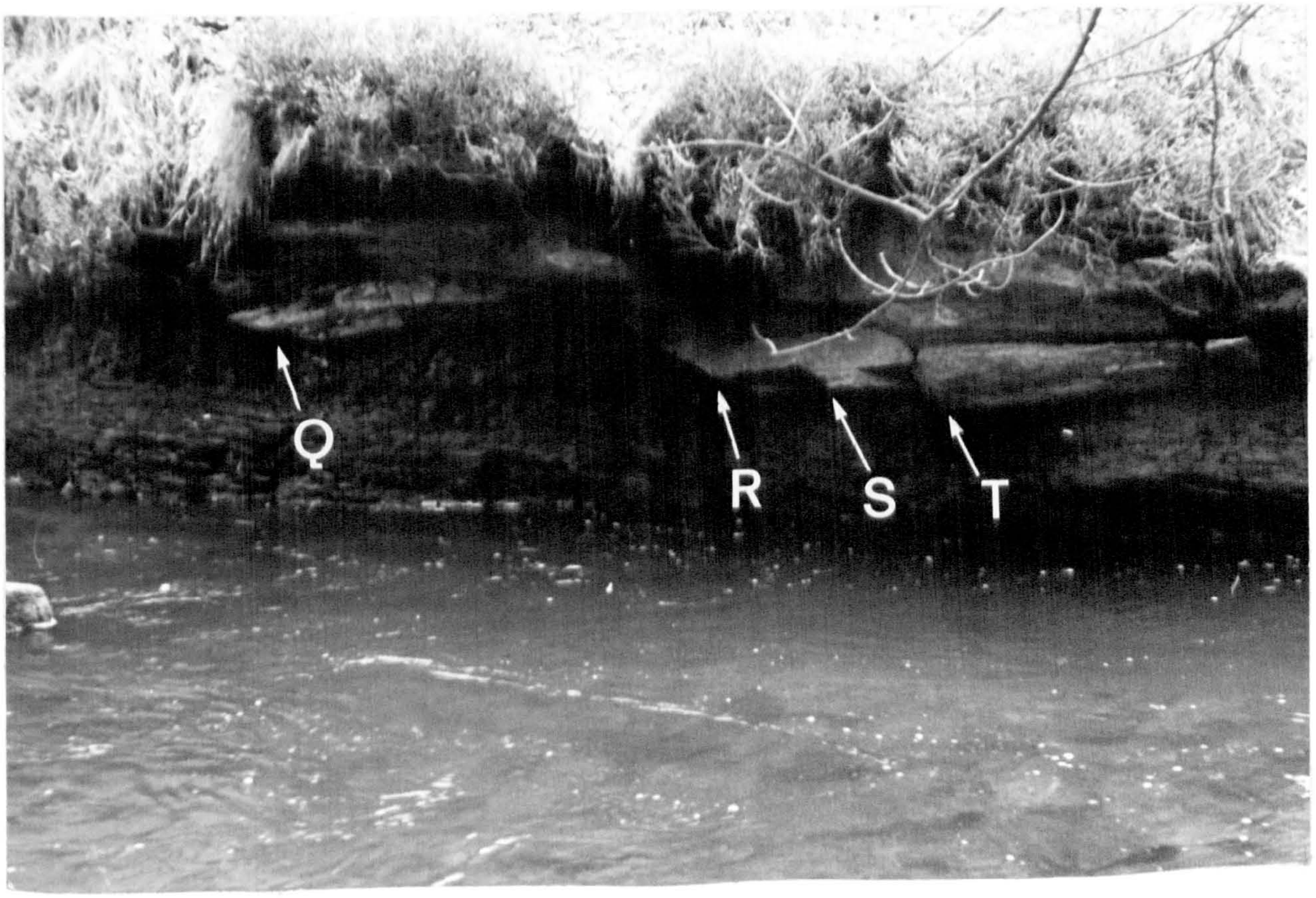

Q
R
S
T

Plate 20

Flute at base of sharp based sandstone, Facies 12.

Specimen from Hebden Bridge Shale and Sandstone Formation, High Greenwood Wood, Hebden Dale (SD970311). x0.5.

Plate 21

Goniatite faunal bed (Facies 2) of Assemblage B with early carbonate cement. Uncrushed goniatites at bottom right occur near the centre of the concretion whilst the remainder, forming the outer part of the concretion, consists of semi-crushed adult goniatites with uncrushed goniatite spat. Shales lateral to the concretion contain flattened goniatites of adult and spat form. T he concretion appears to have grown, therefore, during compaction. The white specks are quartz grains which are unusually large for a goniatite bearing bed. Specimen from Crimsworth Dean (SD989307). Photograph of thin section, x 3.6.

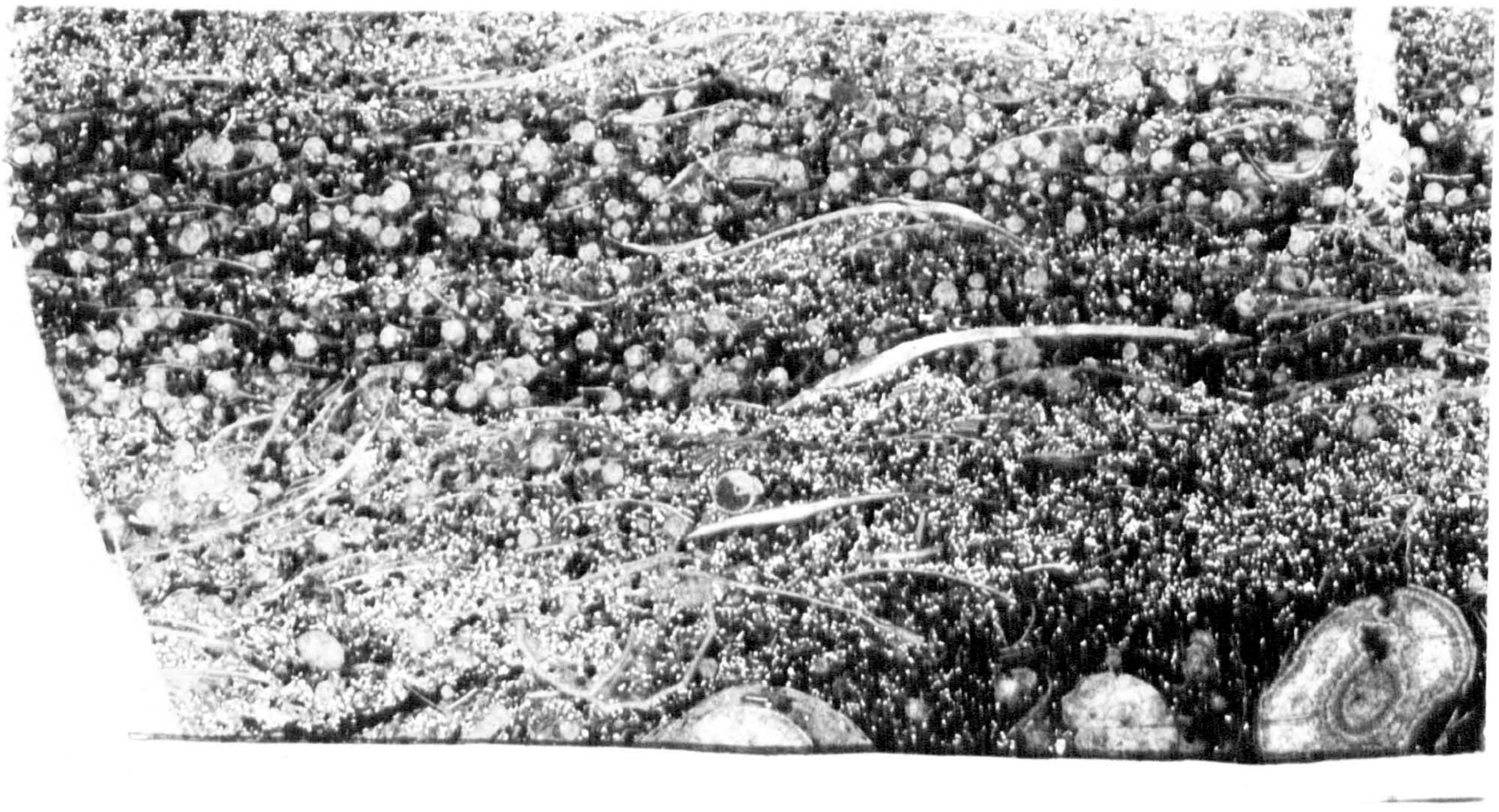


Plate 22

Flutes on base of loose blockof Facies 12, sharp based sandstone. Hebden Bridge Formation, Hebden Dale (SD972305). 10p for scale.

Plate 23

Contorted beds showing recumbent folding and boudinaging of Facies 12 sharp based sandstone. The 4m of disturbed beds are erosionally overlain by undisturbed Facies 12 beds and is interpreted as a slump deposit. Hebden Bridge Formation, Colden Clough (SD972281), near Hebden Bridge.

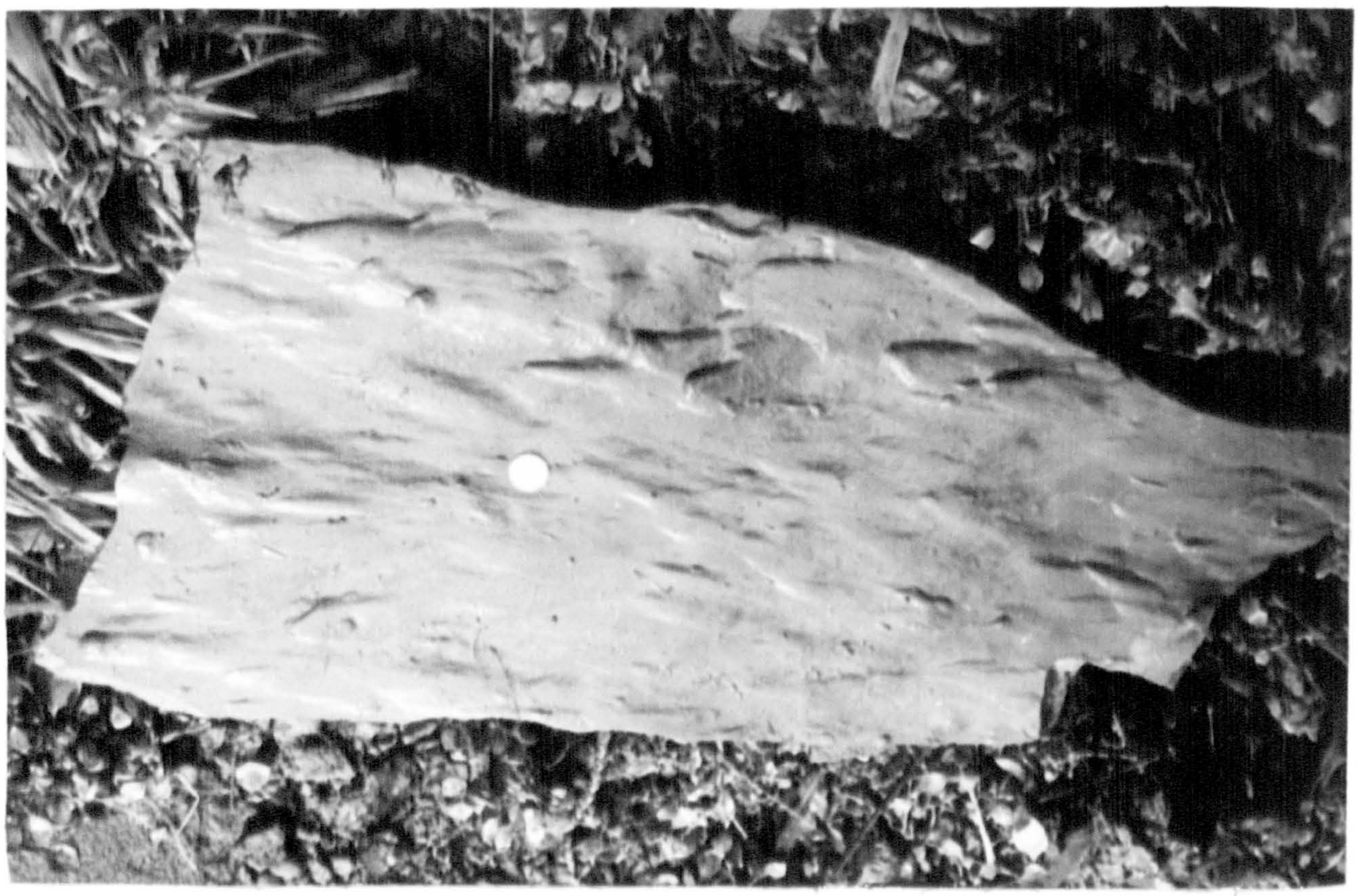


Plate 24

Facies 14, Zeta cross-stratification. Note the stratification parallel to the two channel sides. Thickness of upper channel, just to the right of waterfall - 0.8m. Hebden Bridge Formation; Dale Clough (SD972267) near Hebden Bridge.

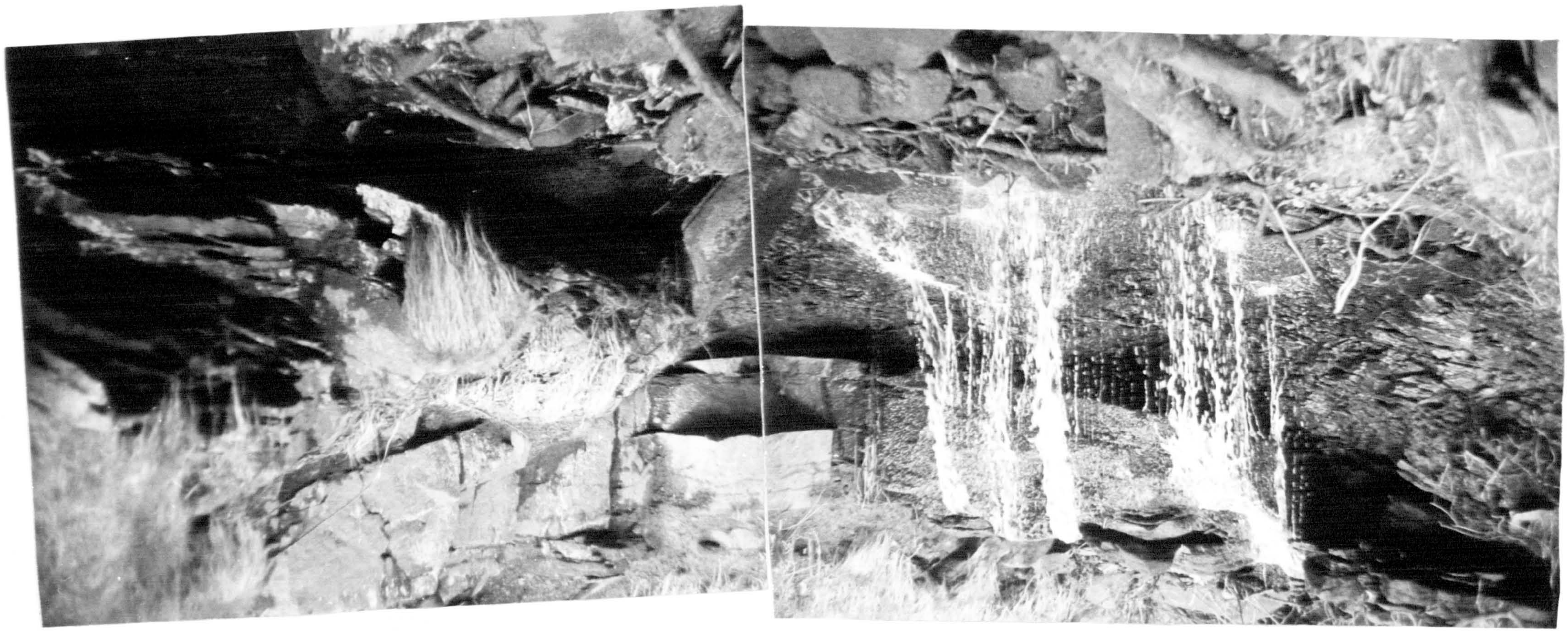


Plate 25

Channel of Assemblage B_3 showing erosive base and infill of Facies 4, unlaminated sandstone and 15, horizontally laminated coarse sandstone. Channel cut into Facies 8, gradationally laminated and 10, ripple laminated sandstone. Hebden Bridge Formation; Hebden Dale (SD971306).

Plate 26

Junction of Facies 4 and 15 in channel of Plate 25. Showing carbonate concretion, or "mare's ball", approximately 0.6m in diameter.

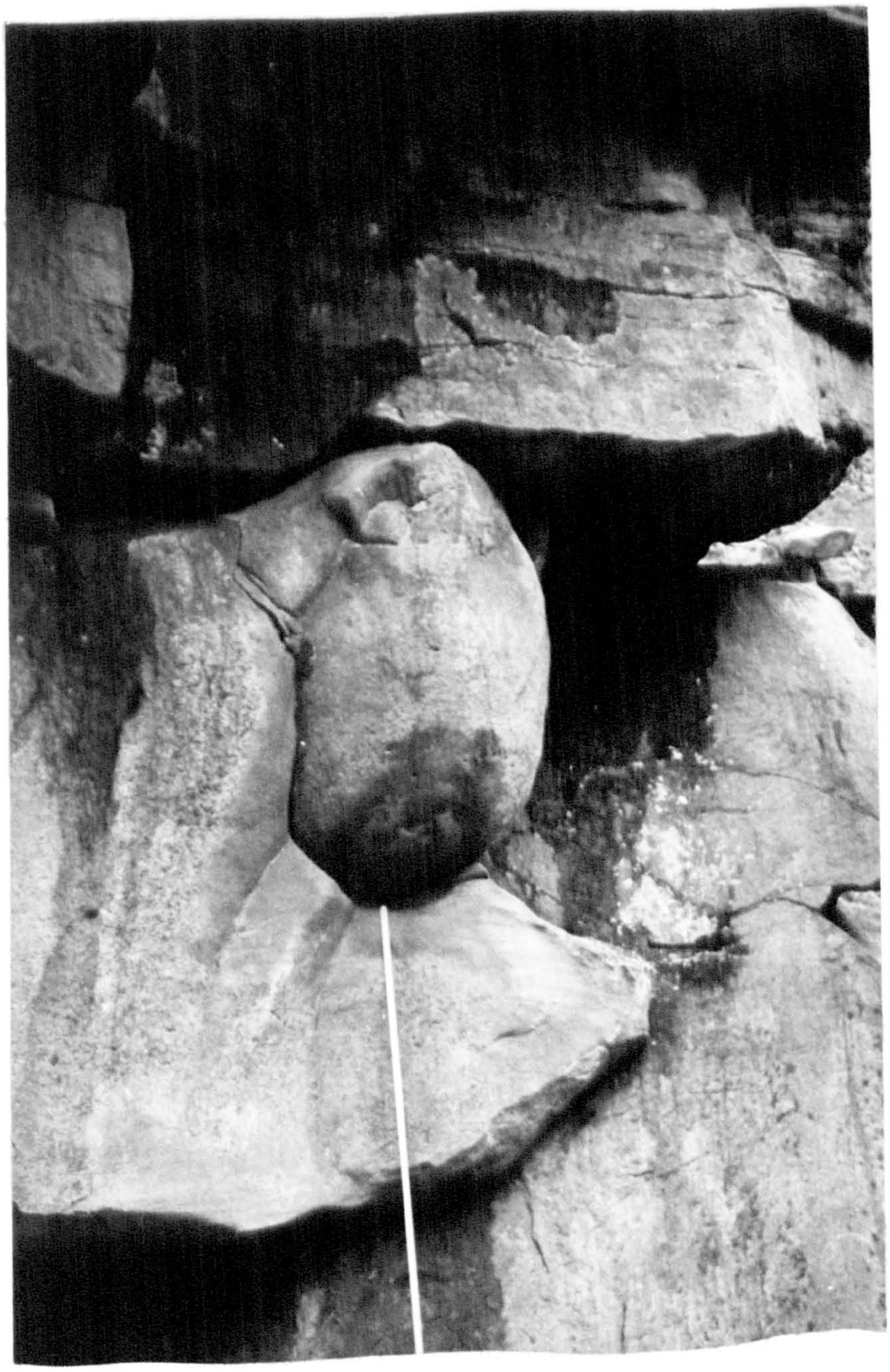


Plate 27

Erosive base, O - P, of a complex of B_3 channels. Channel cuts into Association B_1, Fine grained sediments, by over 3m. Grindslow Shale Formation; junction of Great Gruff with Chew B rook (SE028016), near Greenfield (SE028016).

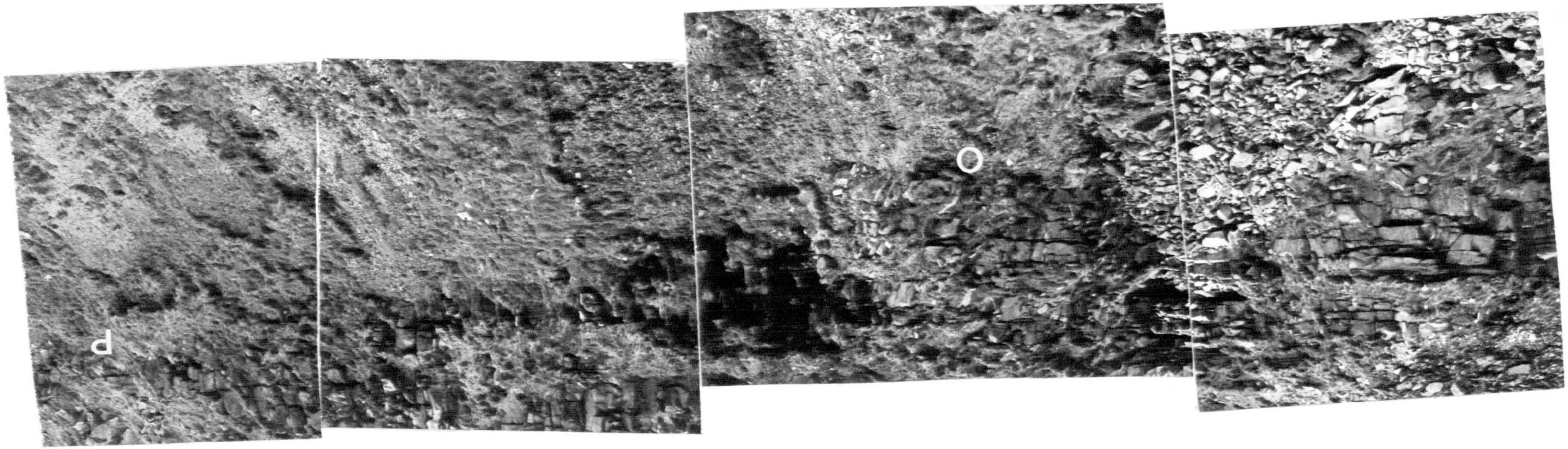

d

Plate 28

Bergaueria and groove structures on base of Facies 12, sharp based sandstone. Specimen from Hebden Bridge Formation; Colden Clough (SD972281) near Hebden Bridge.

Plate 29

Sinusites on base of Facies 12 sandstone. Grindslow Shale Formation; Rams Clough (SE018026) near Greenfield.


MM
1
2
3
4

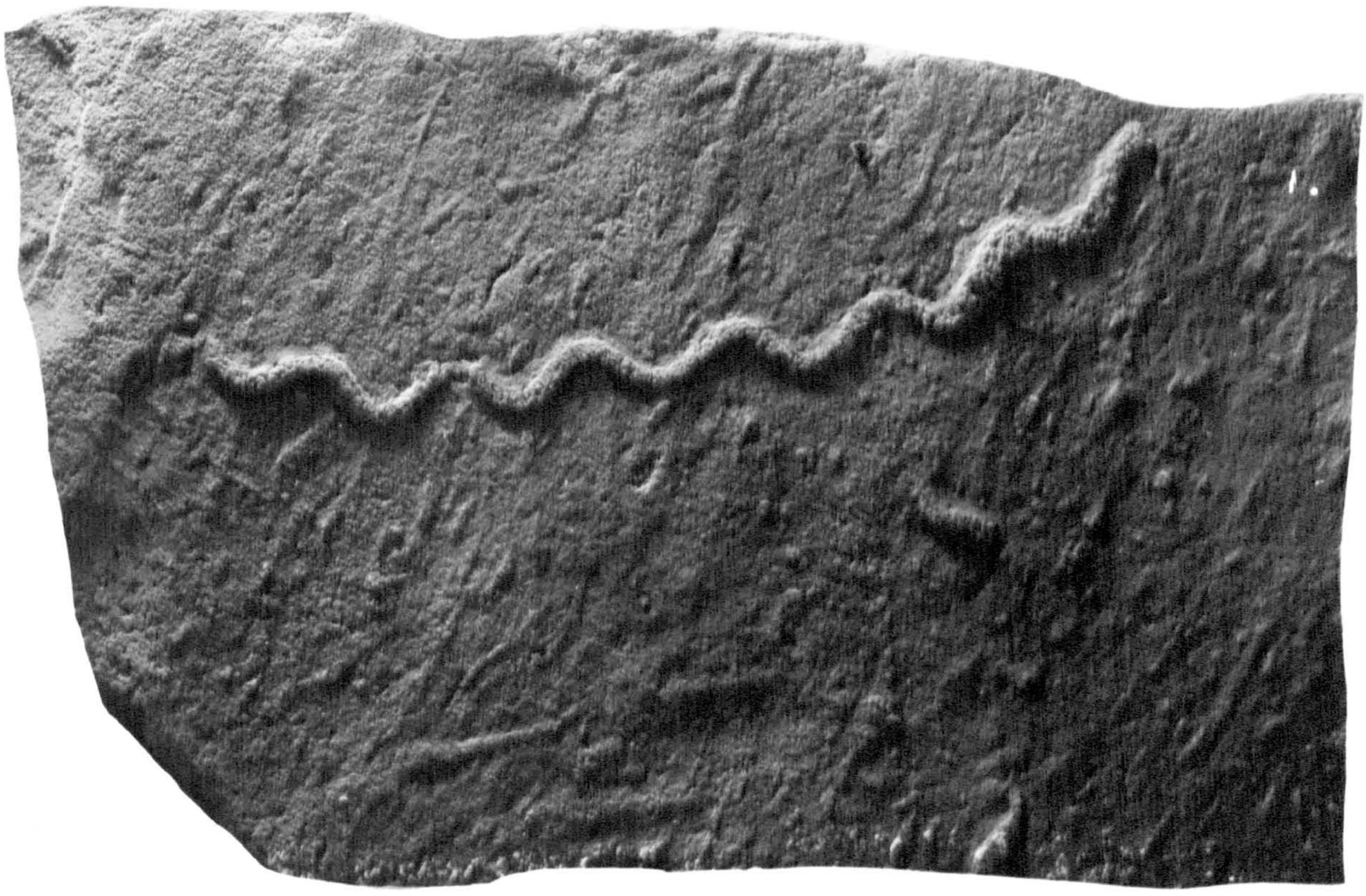

MM
1
2
3

Plate 30

Almond shaped convex hyporelief of Pelecypodichnus showing the seperation of the two valves on the right. Base of Facies 12, sharp based sandstone. Specimen from Grindslow Formation; Great Gruff (SE028016) near Greenfield.

Plate 31

Impression of two articulated valves of Anthraconaiad bivalve. Within parallel laminated part of Facies 12. Silsden Shale and Sandstone Formation; Spicey Gill (SE109467), Ilkley.


MM
1
2
3
4


MM
1
2
3

Plate 32

Pelecypodichnus convex hyporelief on underside of parting in Facies 8, gradationally laminated sandstone. Silsden Formation; Holden B eck (SE064456), near Silsden.

Plate 33

Horizontal burrows of Planolites on parting of Facies 8. Grindslow Shale Formation, Rams Clough (SE018026), near Greenfield.

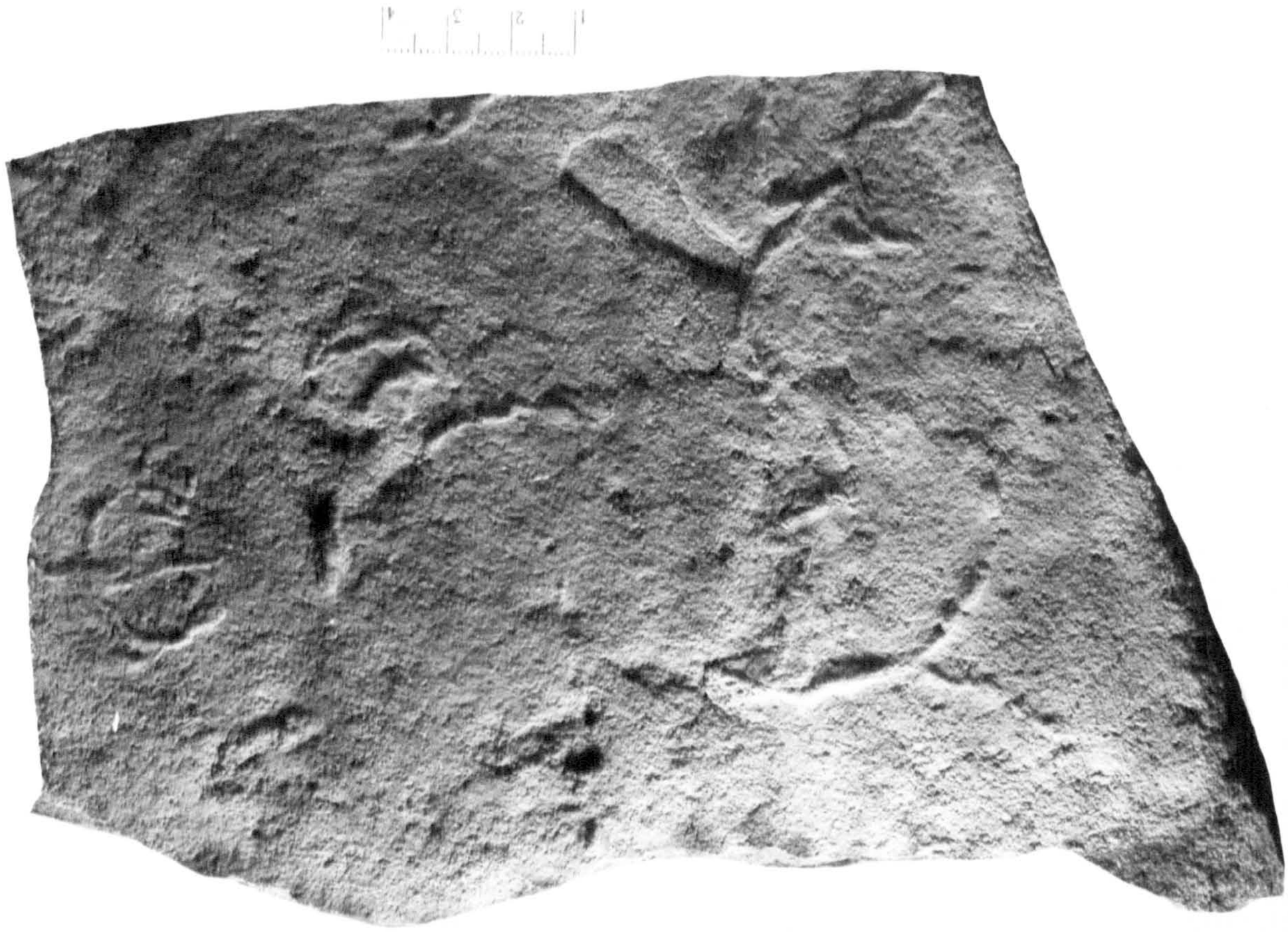


Plate 34

<u>Scolicia</u> in Facies 16, striped silts and sandstones of Assemblage C. Kinderscout Grit Formation, Rags Clough (SE016337) near Oxenhope.

Plate 35

<u>Scolicia</u> on parting of Facies 8, gradationally laminated sandstone. Note the three-dimensional form of the burrow, in the bottom right, where the burrow has been removed showing a concave mould.

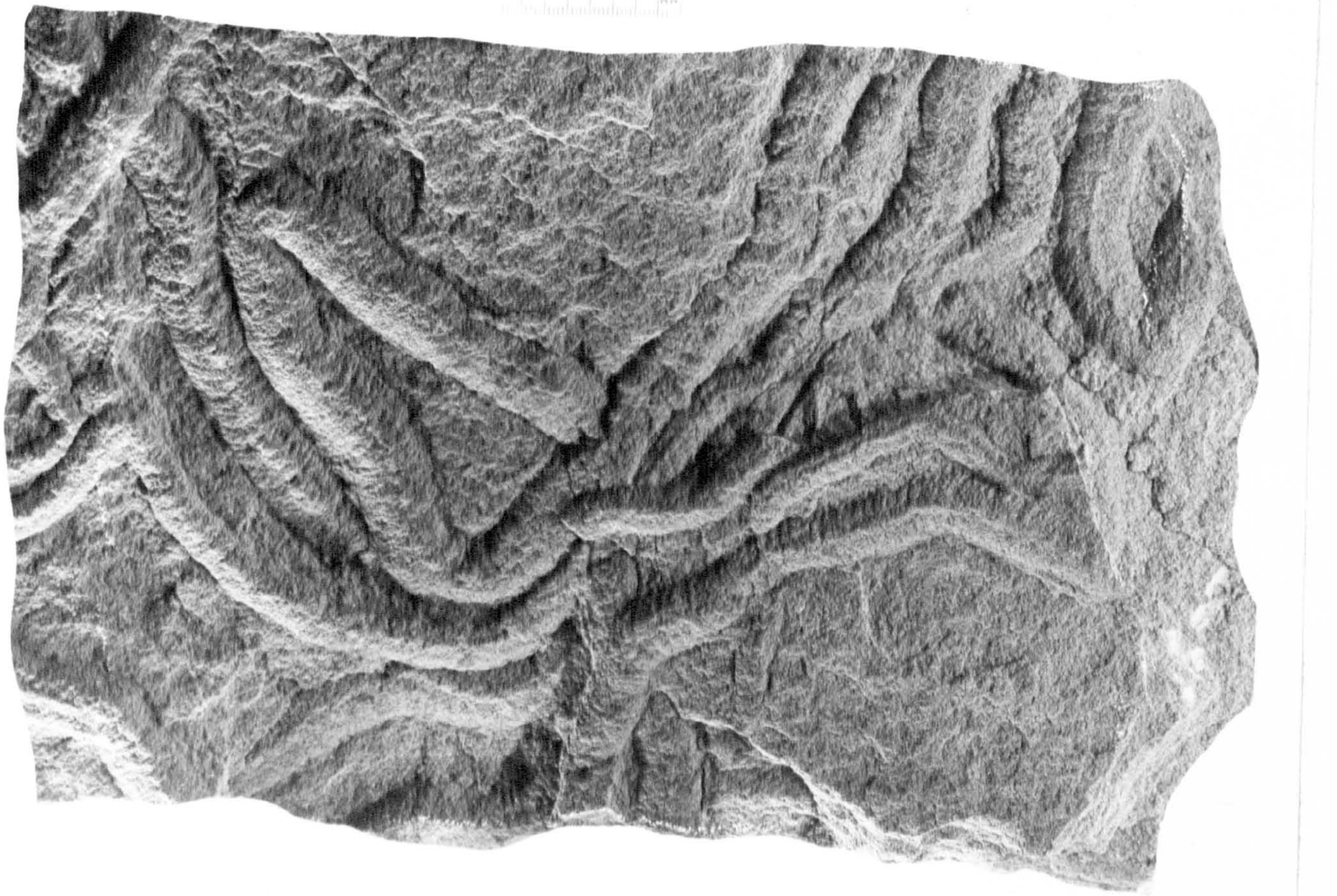
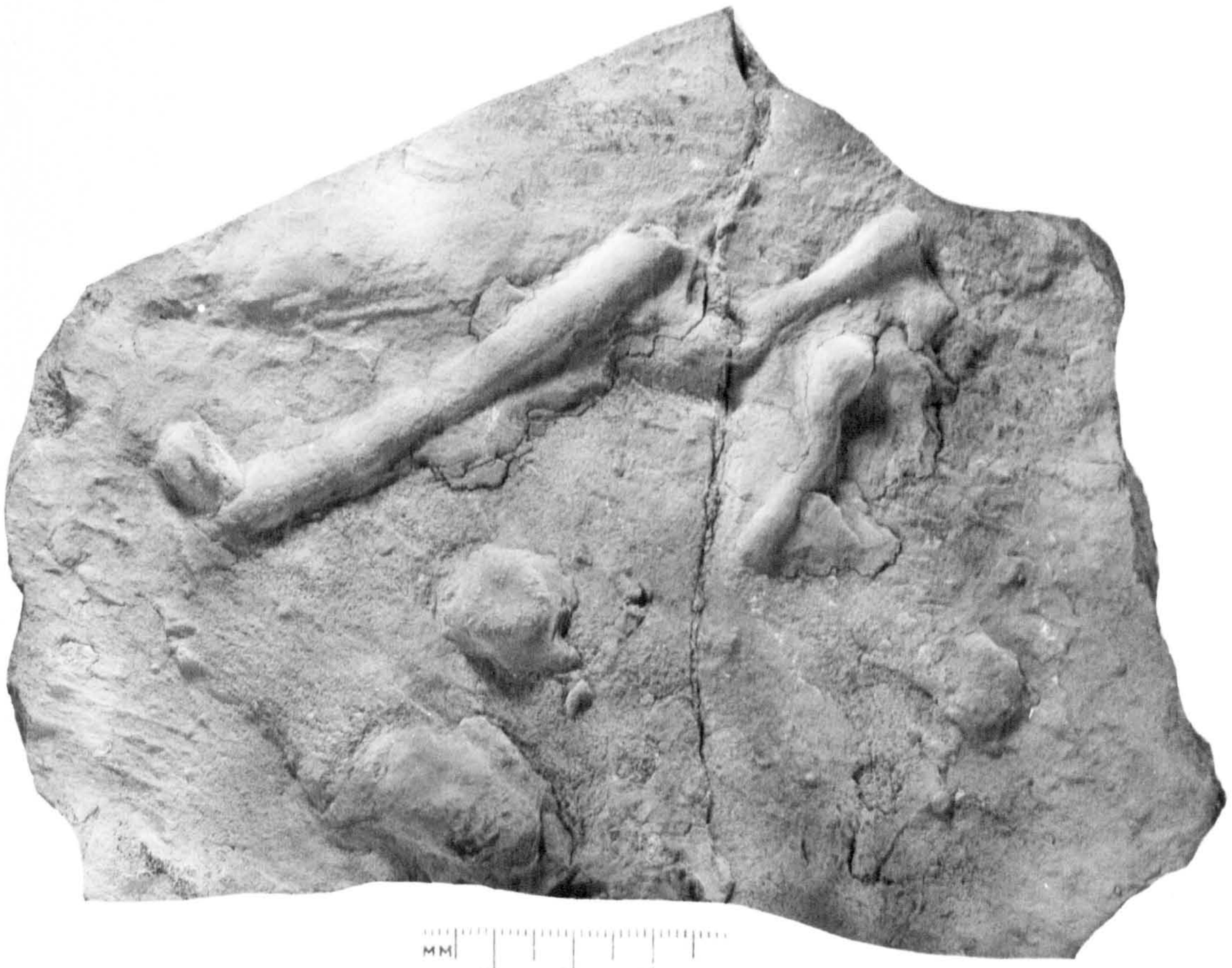


Plate 36

Knob-ended burrows (upper part of photograph) with *Bergaueria* (in the lower part) on base of Facies 12, sharp based sandstone. Hebden Bridge Formation; Colden Clough (SD972281) near Hebden Bridge.

Plate 37

A "bulbous" burrow and "surface trails" occuring as positive hyporelief on the base of a Facies 12 sandstone. Hebden Bridge Formation, Hebden Dale (SD972305).


MM
1
2
3
4

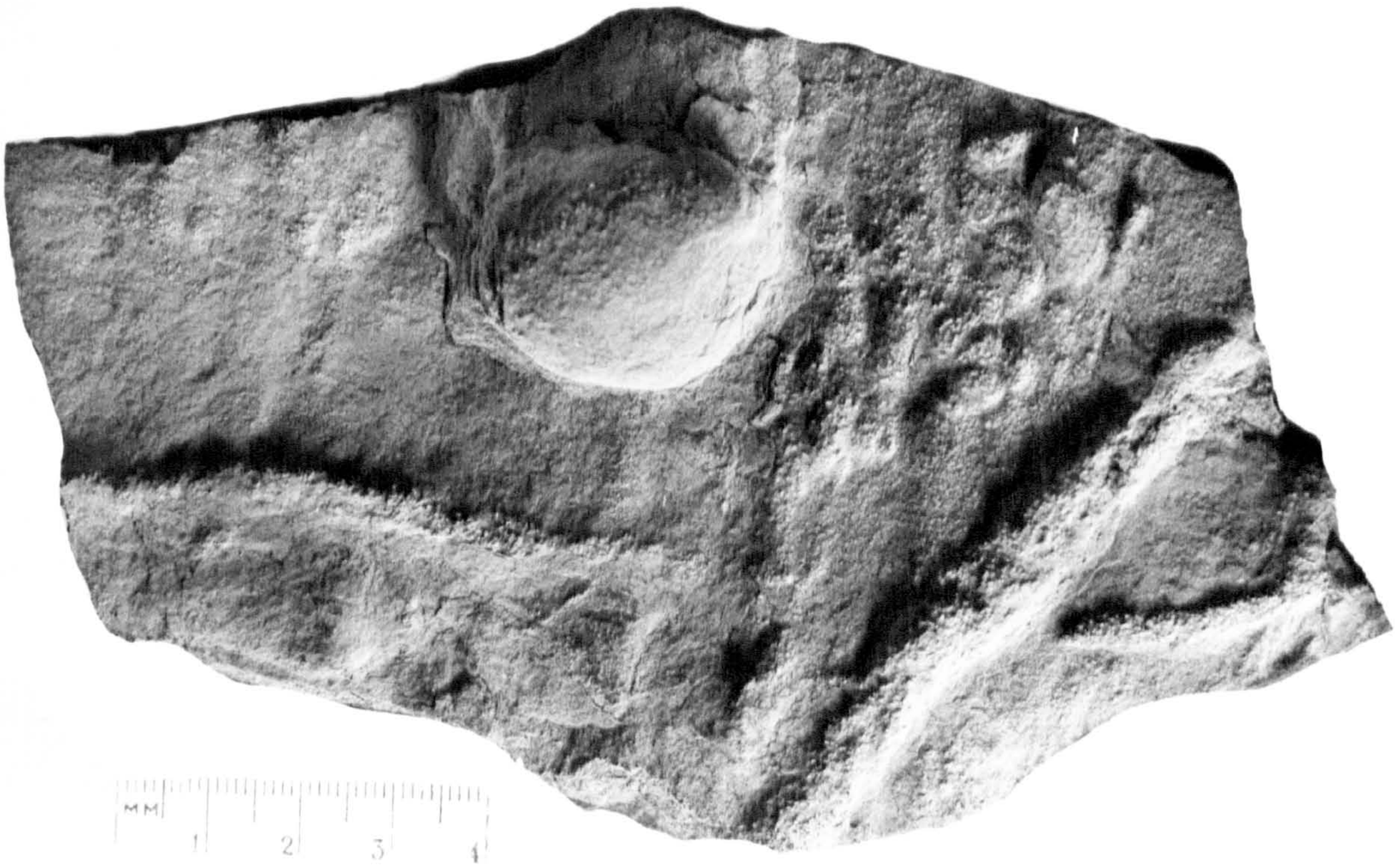
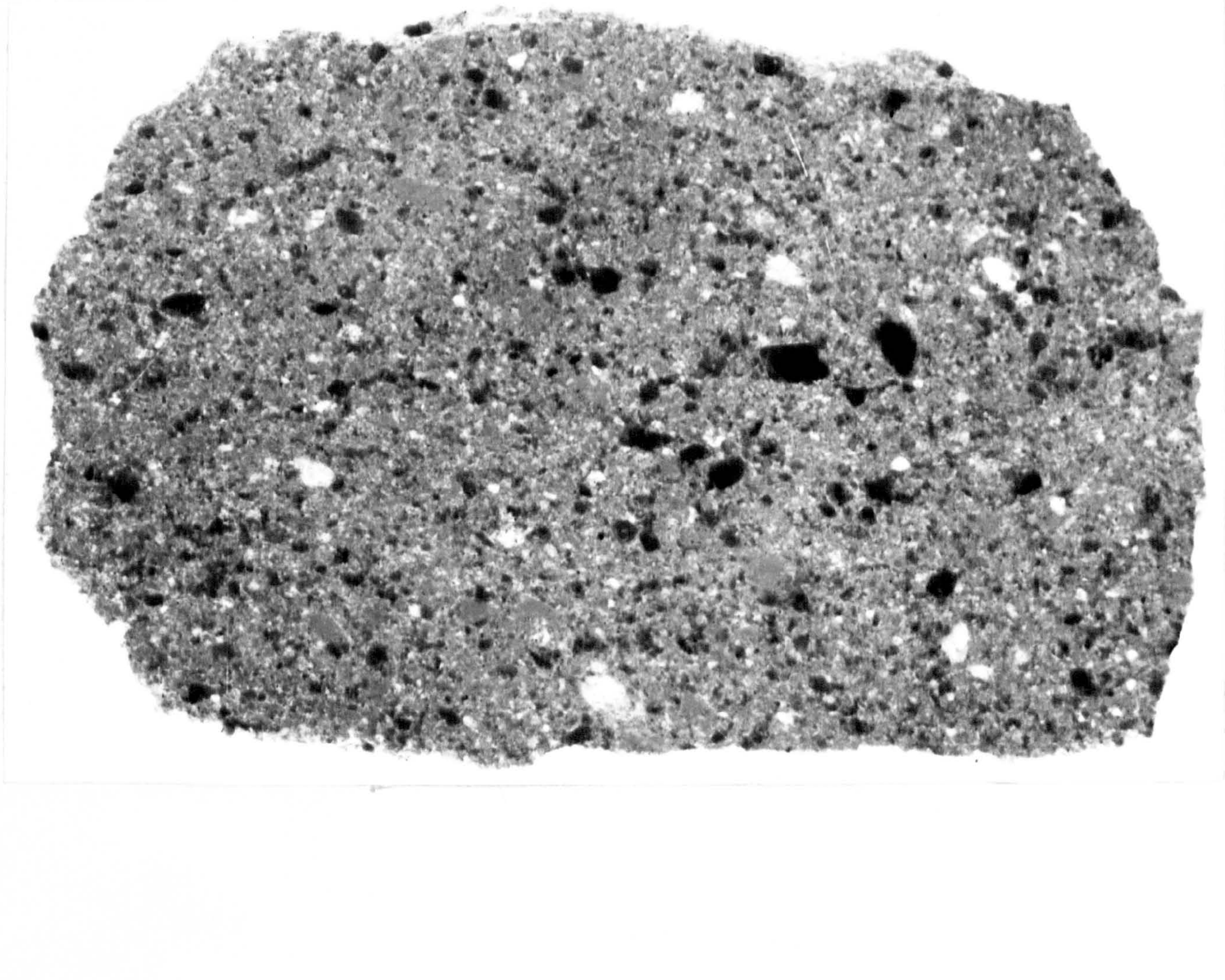

MM
1
2
3
4

Plate 38

X-ray radiograph of 4 mm thick slice of Facies 4, unlaminated sandstone of Assemblage B, cut in a vertical plane. North is towards the right hand side. Specimen from Grindslow Formation, Dove Stone Rocks (SE025038) near Greenfield. (x 1).

Plate 39

X-ray radiograph of a slice, from the same specimen as in Plate 38, cut in a horizontal plane. North is towards the upper right. Note the lack of any grain organization, cf. Plate 41. (x 1).



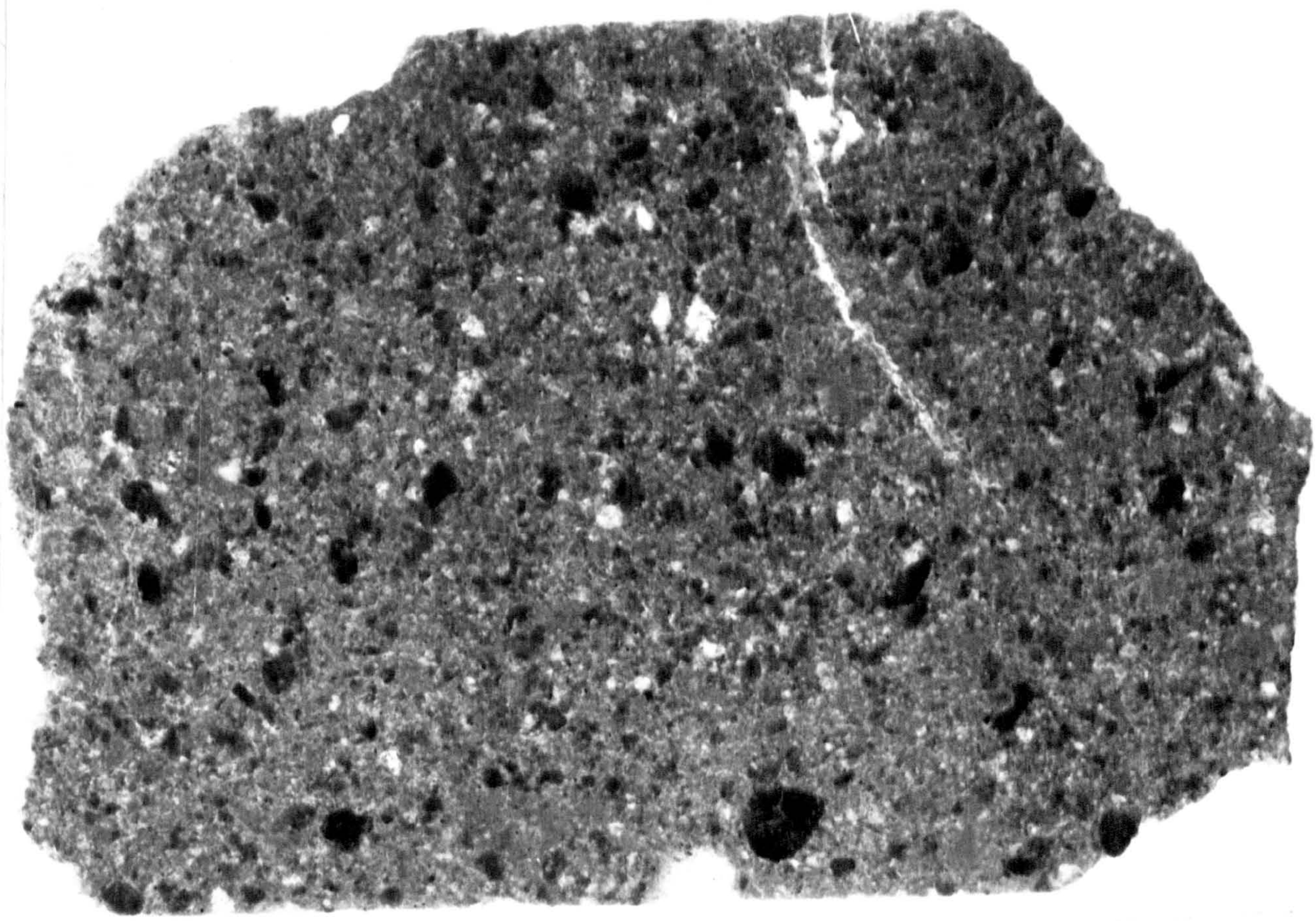


Plate 40

Bed showing single set of cross-lamination within Facies 4, unlaminated sandstone, of Assemblage C. Kinderscout Grit Formation; Buckton Quarry (SD991015), near Mossley.

Plate 41

X-ray radiograph of a 4mm thick slice of Facies 4 sandstone, of Assemblage C, cut in a vertical plane. Note the concentration of certain grain sizes along planes, cf. Plates 38 and 39. Specimen from Buckton Quarry (SD991015). (x1).

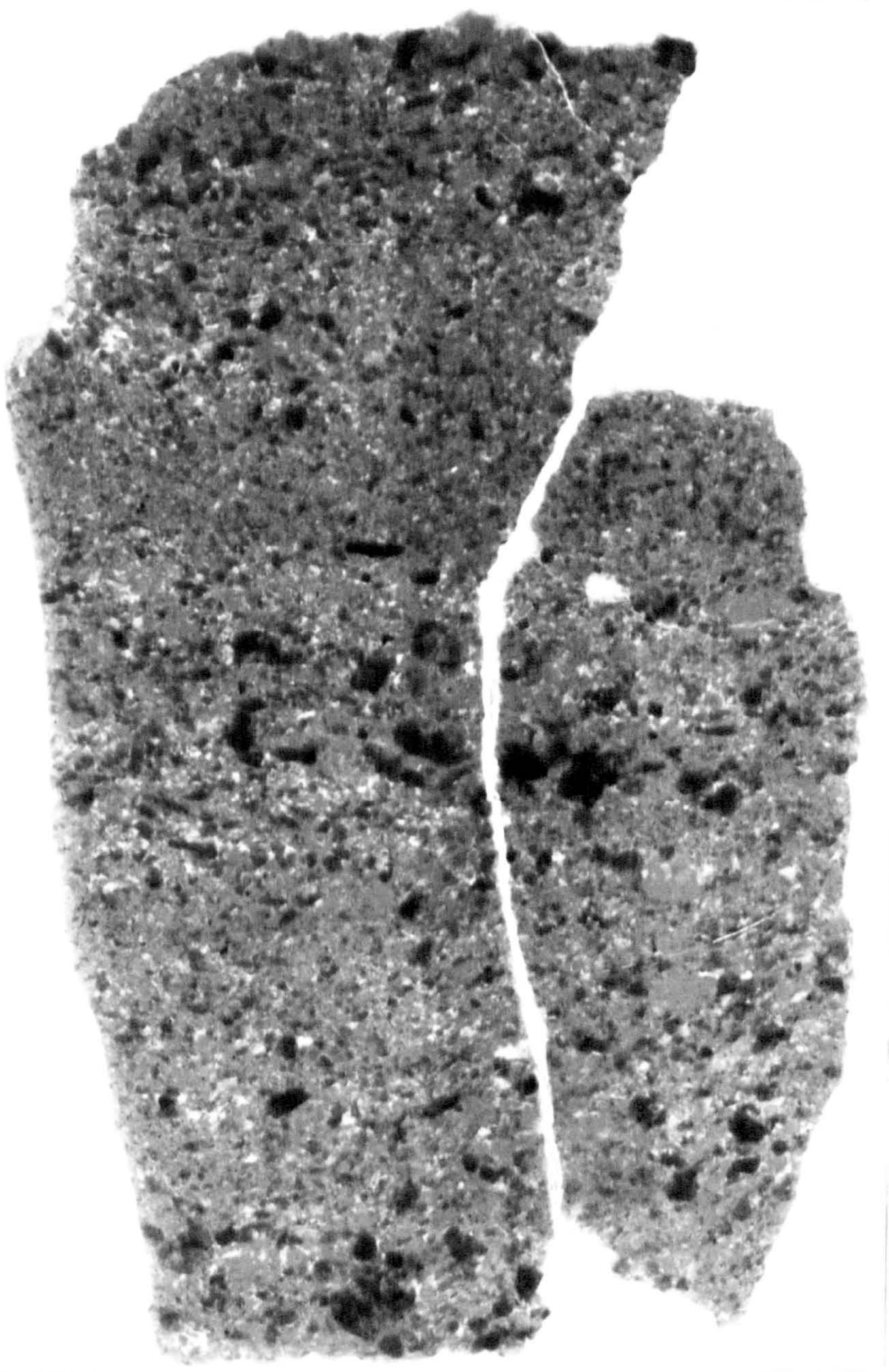
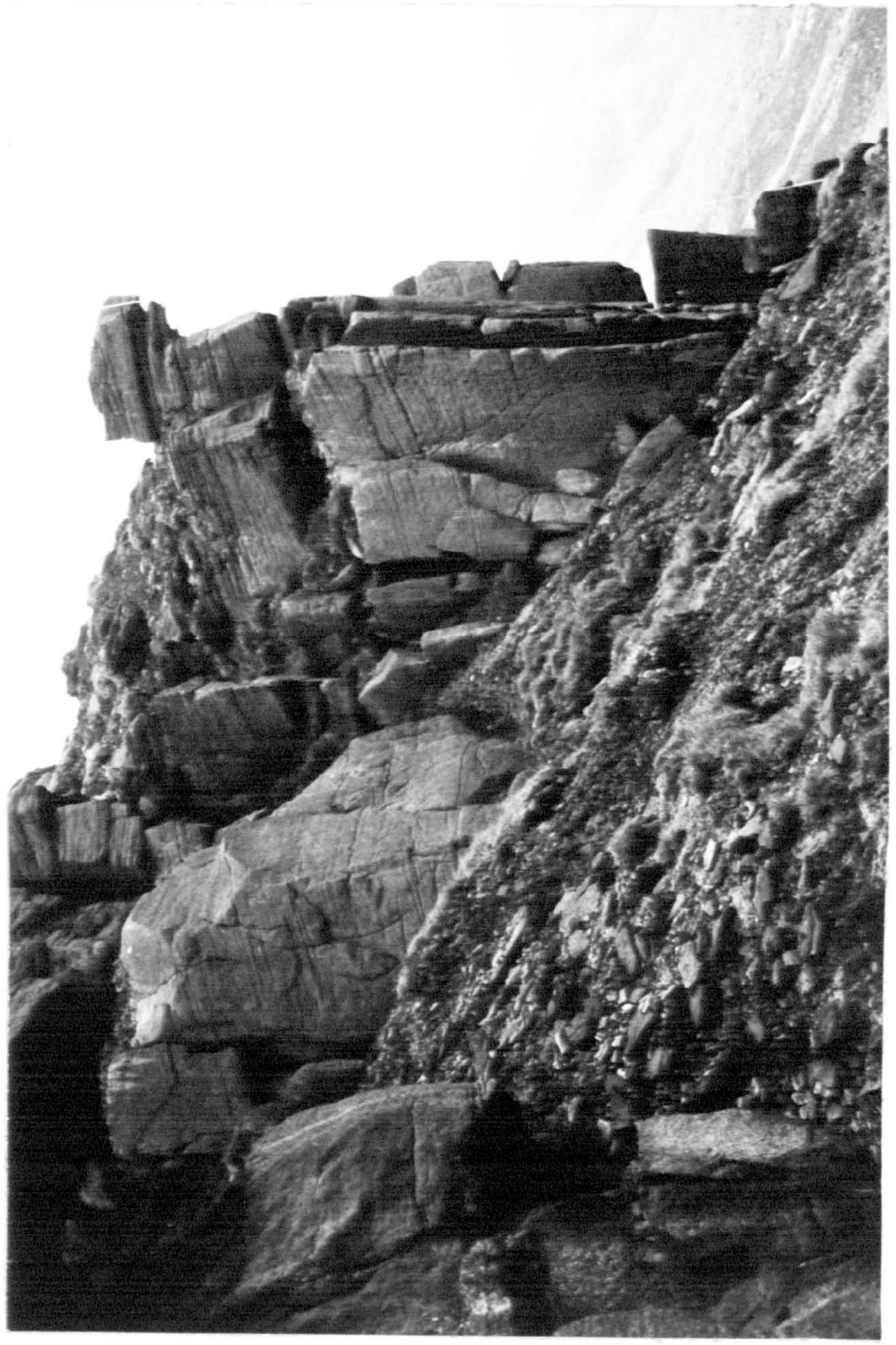


Plate 42

Facies 20, large-scale cross-bedding, showing topset beds overlain by medium-scale cross-beds. Large cross-bed set is 12m thick. Kinderscout Grit Formation; Chew Hurdles (SE028015), near Greenfield.

Plate 43

Junction of virtually horizontal toesets of large-scale cross-beds with underlying unlaminated sandstones. Kinderscout Grit Formation; Wimberry Stones (SE015024).



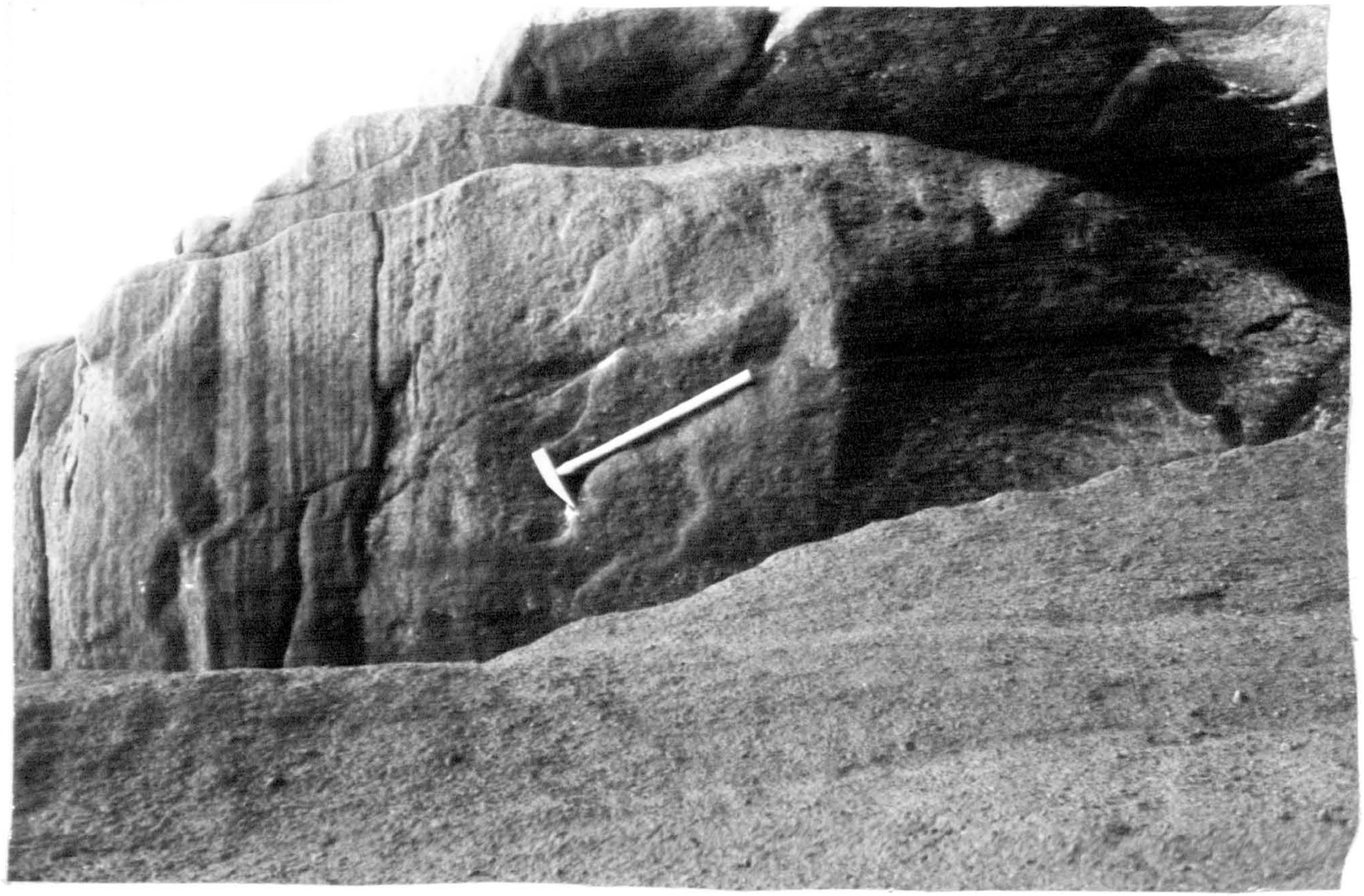


Plate 44

Facies 20, large-scale cross-bedding overlain erosionally by Facies 13, medium-scale cross-beds (indistinct). Note the concave upward foresets, the internal erosion surface L - M and the concentration of spherical carbonate concretions along certain beds. Kinderscout Grit Formation; Hell Hole, Heptonstall (SD986277).

Plate 45

The same quarry as in Plate 44 showing the truncation of low angled foresets by the internal erosion surface. The beds, overlying the erosion surface, are parallel to it in the upper part of the set but a 4m thick massive bed overlies the erosion surface near the base.

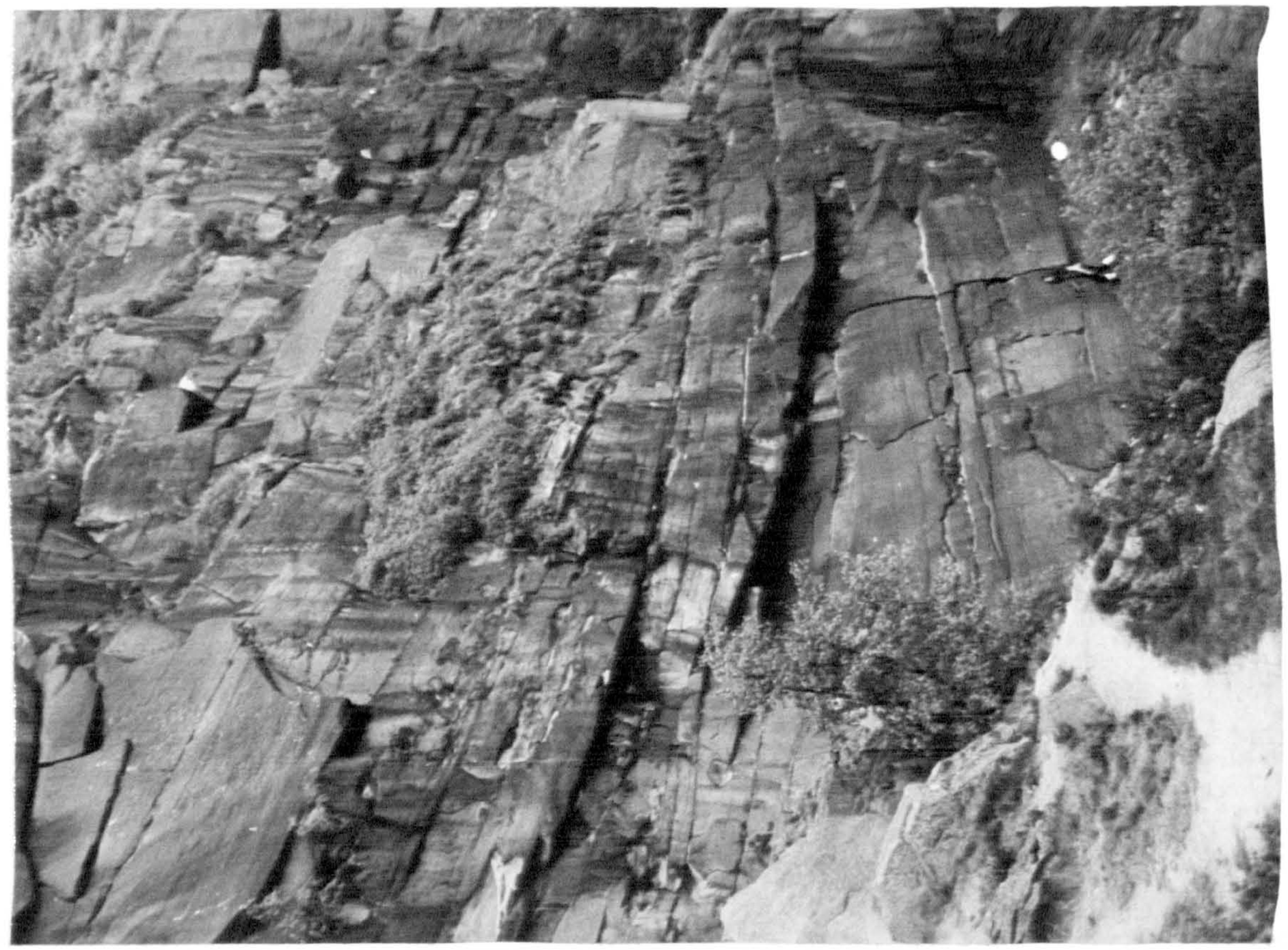


Plate 46

Large-scale cross-beds of Facies 20 with internal erosion surface (N) draped by 1m of Facies 9, micaceous silty sandstone. The large-scale cross-beds are overlain erosionally by medium-scale cross-beds but the 1m thick set seen in the far quarry face continues as large-scale cross-bedding after the internal erosion surface. Kinderscout Grit Formation; Hangingstone Quarry (SD992431) with Lund's Tower in the background, near Cowling.

Plate 47

Down dipping intrasets of Facies 20, large-scale cross-bedding. The tape measure sits on a normal, low angled foreset upon which the more steeply inclined small sets are superimposed. Kinderscout Formation, Stony Edge (SD956214) near Littleborough.


N

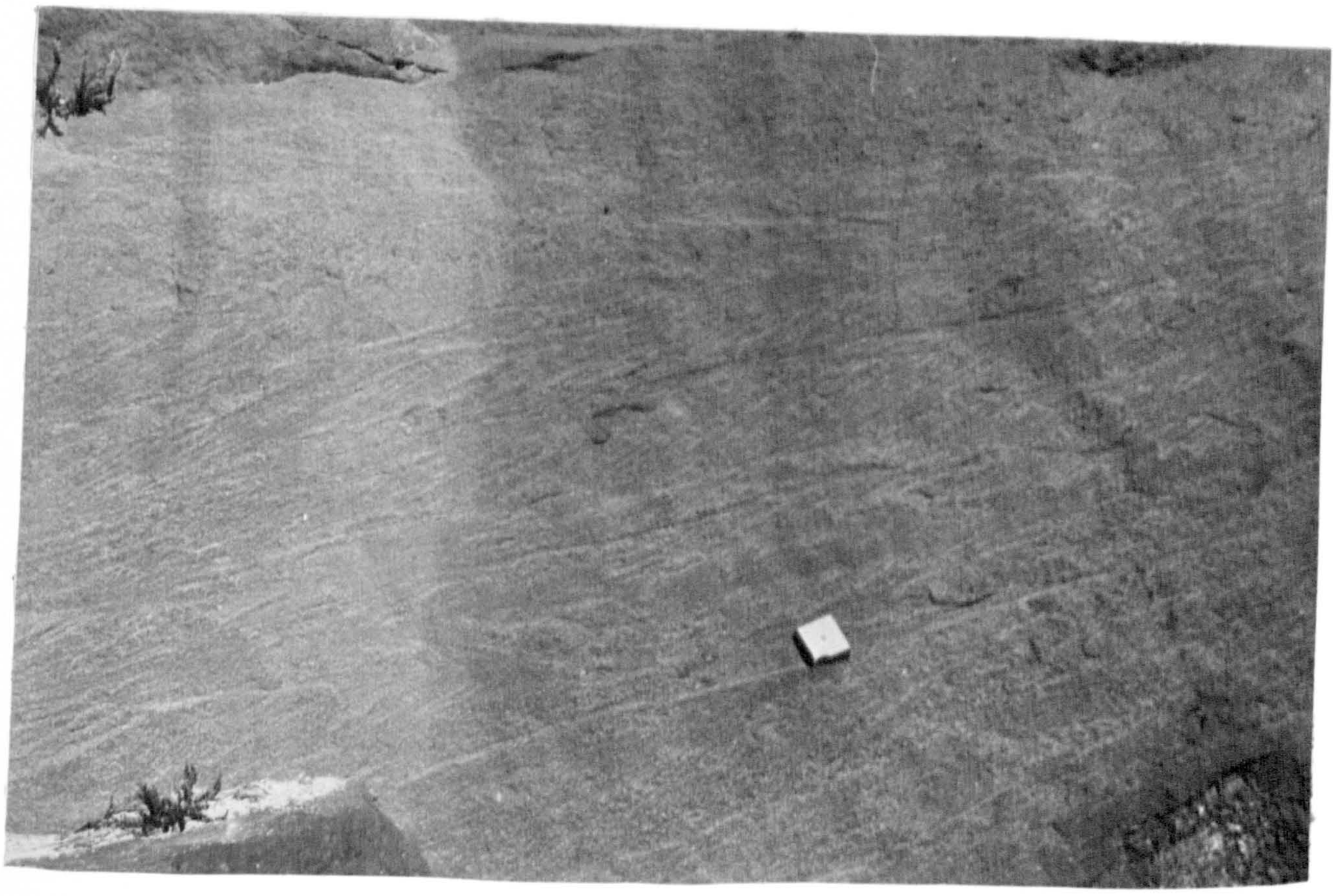


Plate 48

Large-scale cross-beds, Facies 20, (H) overlying unlaminated sandstone, Facies 4 (J) sharply at the left hand side of the quarry. On the right the foresets pass down into the apparently massive beds without a sharp break. The whole complex is cut into by a channel (K) infilled with Facies 4. Kinderscout Formation; Ladcastle Quarries (SD994059), Saddleworth.

Plate 49

Facies 20, large-scale cross-bedding, overlying Facies 4, unlaminated sandstone. Note the irregular base to the massive sandstone, the sharp, flat base of the cross beds and the internal erosion surface within the cross beds. Kinderscout Formation, Ladcastle Quarries (SD994061), Saddleworth.


H
K
J

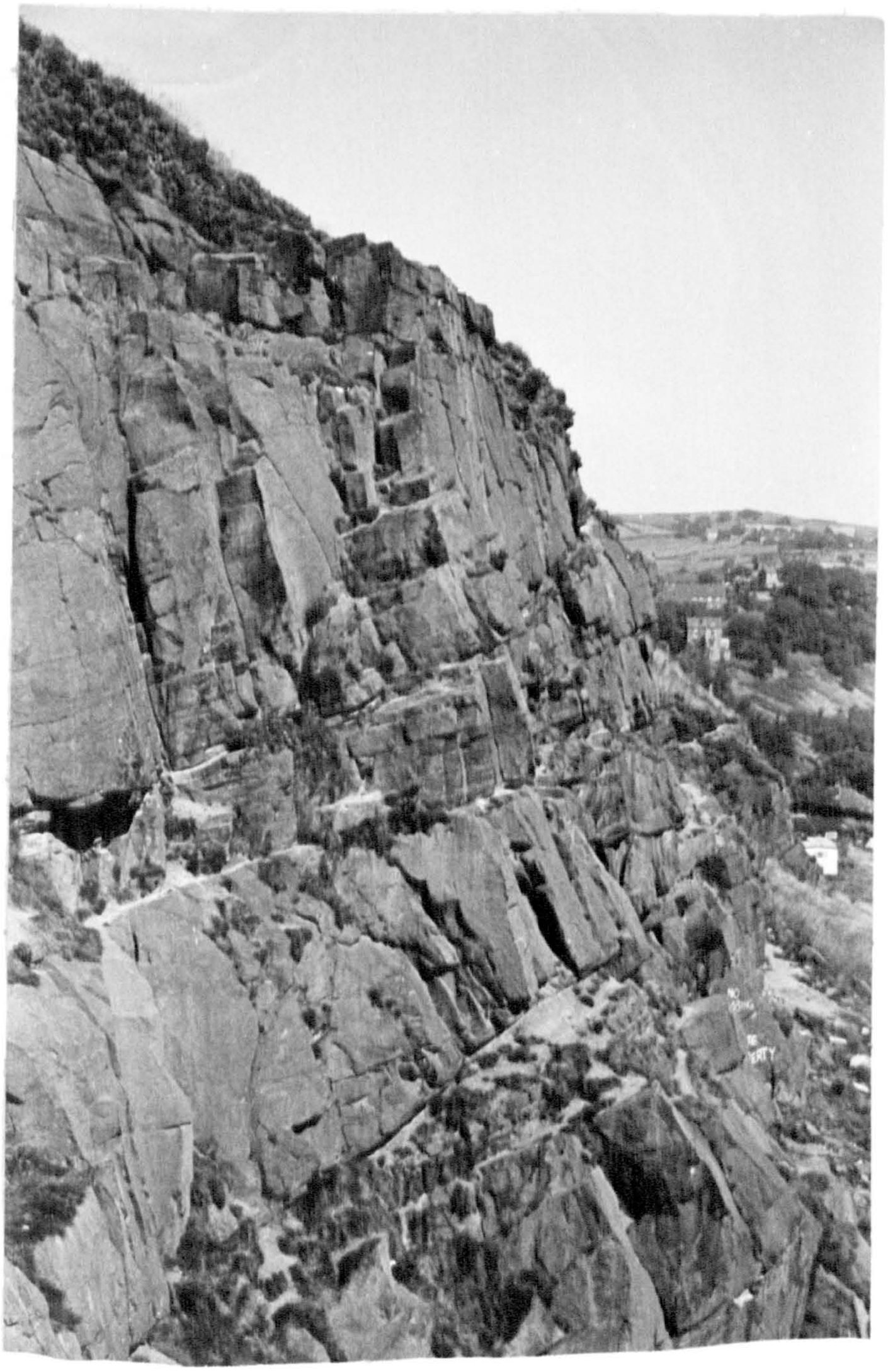


Plate 50

Facies 20, large-scale cross-bedding overlain by shales and sandstones of Association C_3 at the extreme left. Both are cut into by a large channel infilled with Facies 4, unlaminated sandstone. The cross-bed set is the same as that seen in Plate 49.

Plate 51

Large-scale cross-bed set, with flat top, cut into by small channel on the right. The channel is infilled with one set of cross-beds. The large cross-bed set, which is continuous with that seen in Plates 49 and 50 is overlain by shales and sandstones of Association C_3. The latter is cut into by an Association C_1 complex seen at the top left, which is the quarry in Plate 48.

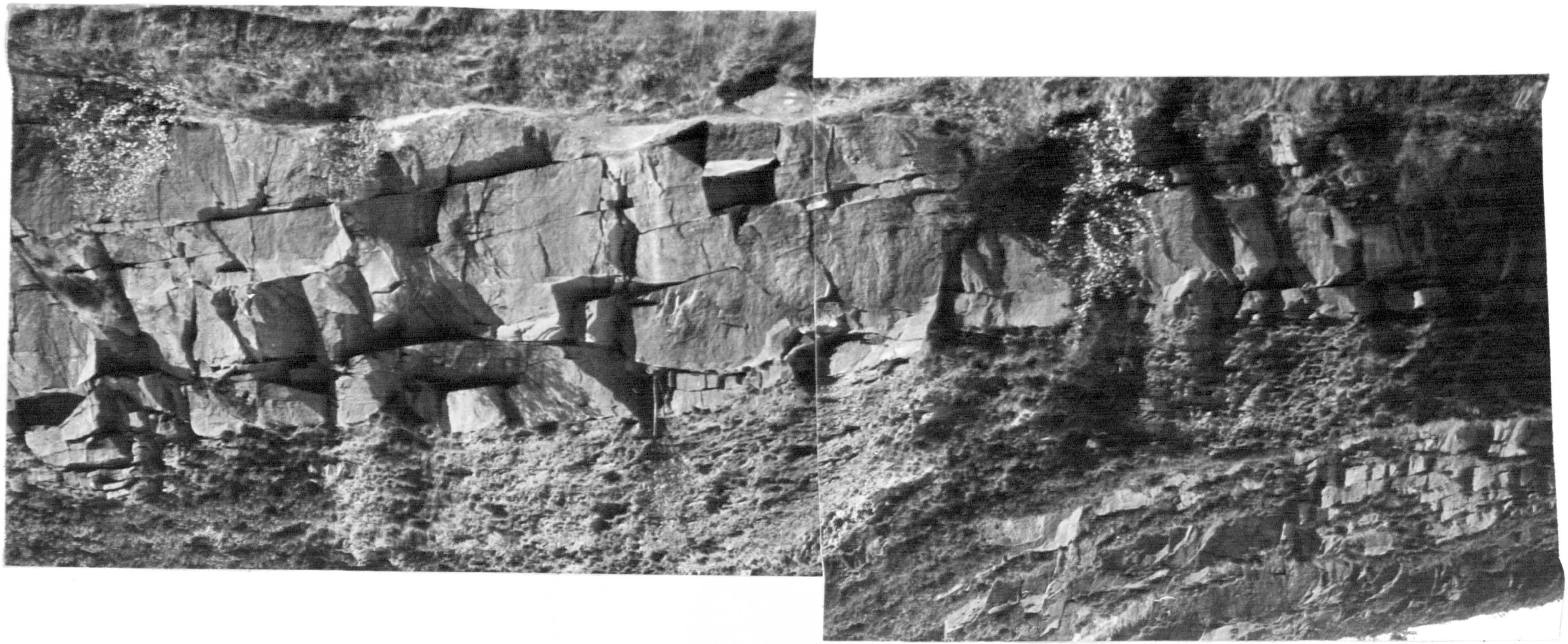


Plate 52

West side of Colden Clough (SD980277) from Heptonstall. Here two sets of Facies 20, large-scale cross-beds occur. In the quarry at F 11m of one set are seen. At the crags at G the top of the set is overlain by 4m of Facies 13, medium-scale cross-beds which, in turn, are overlain by the second, 10m set of large-scale cross-beds, seen in the top of the crags.


F
G

Plate 53

Large channel, 9m deep, cut into an Association C_1 complex of Facies 4, unlaminated sandstone at the nearside of the quarry and large-scale cross-beds at the far side. The channel is infilled with a single set of cross-bedding which appears to have infilled the channel at a high angle to the channel axis. The whole channelized complex is overlain by Facies 13, medium-scale cross-bedding on the upper level quarry face. Kinderscout Formation; Buckton Quarry (SD991015) near Mossley.

Plate 54

The same channel as in Plate 53 viewed from the other side of the quarry. The channel has a silty drape at the base. Note the more concave foresets in the nearer part of the channel as the depth ratio of base to water surface increases. The sandstone in the foreground consists of large-scale cross-bedding with foreset dip toward the camera. A channel base with Facies 21, undulatory sandstones, occurs at E.


E

Plate 55

Facies 21, undulatory bedded sandstone with internal erosion surfaces B and C. The facies is seperated from Facies 20, large-scale cross-beds at the upper left by a further erosion surface; D. Height of quarry face; 10m. Kinderscout Formation; Derby Delph (SE017160) near Ripponden.

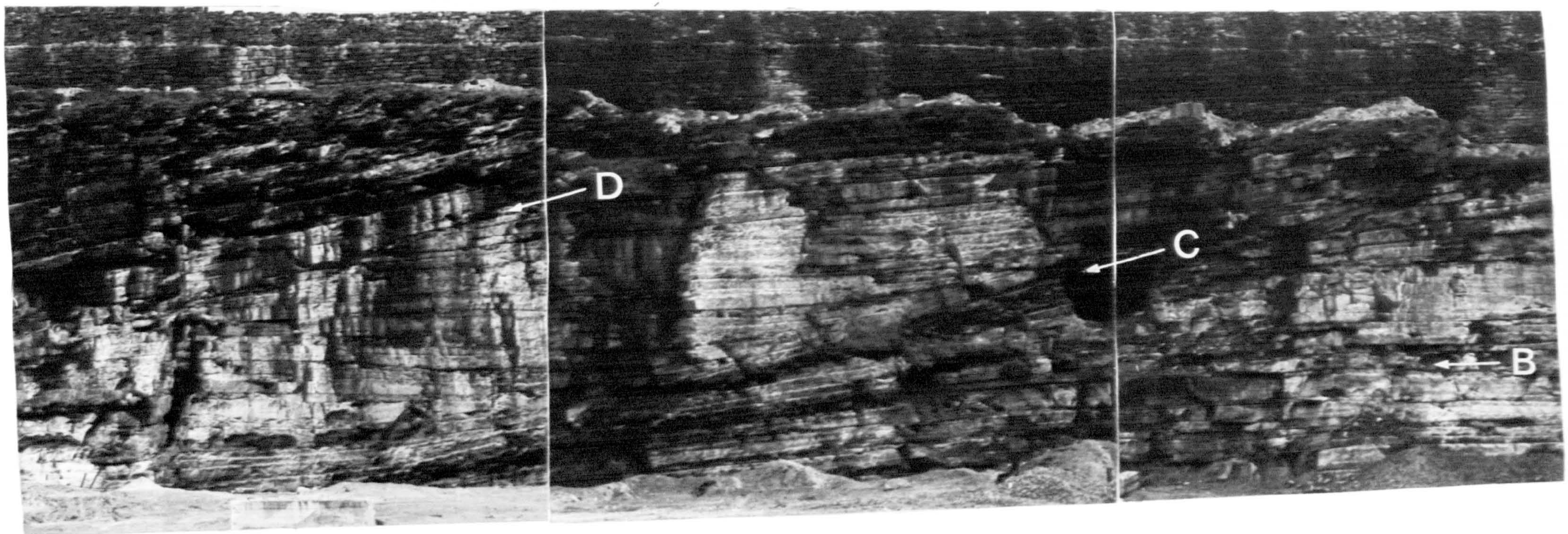

D
C
B

Plate 56

Facies 21, undulatory bedded sandstone. Internal erosion surface indicated (A). Note the spherical, carbonate concretions and the migration of the trough at I towards the right. Height of quarry face 4m. Derby Delph (SE017160) near Ripponden.


A

Plate 57

Small scale cross-stratification within Facies 21, undulatory bedded sandstone. These beds occur on the left hand side of the crest at the extreme right of Plate 56 and indicate crestward currents.

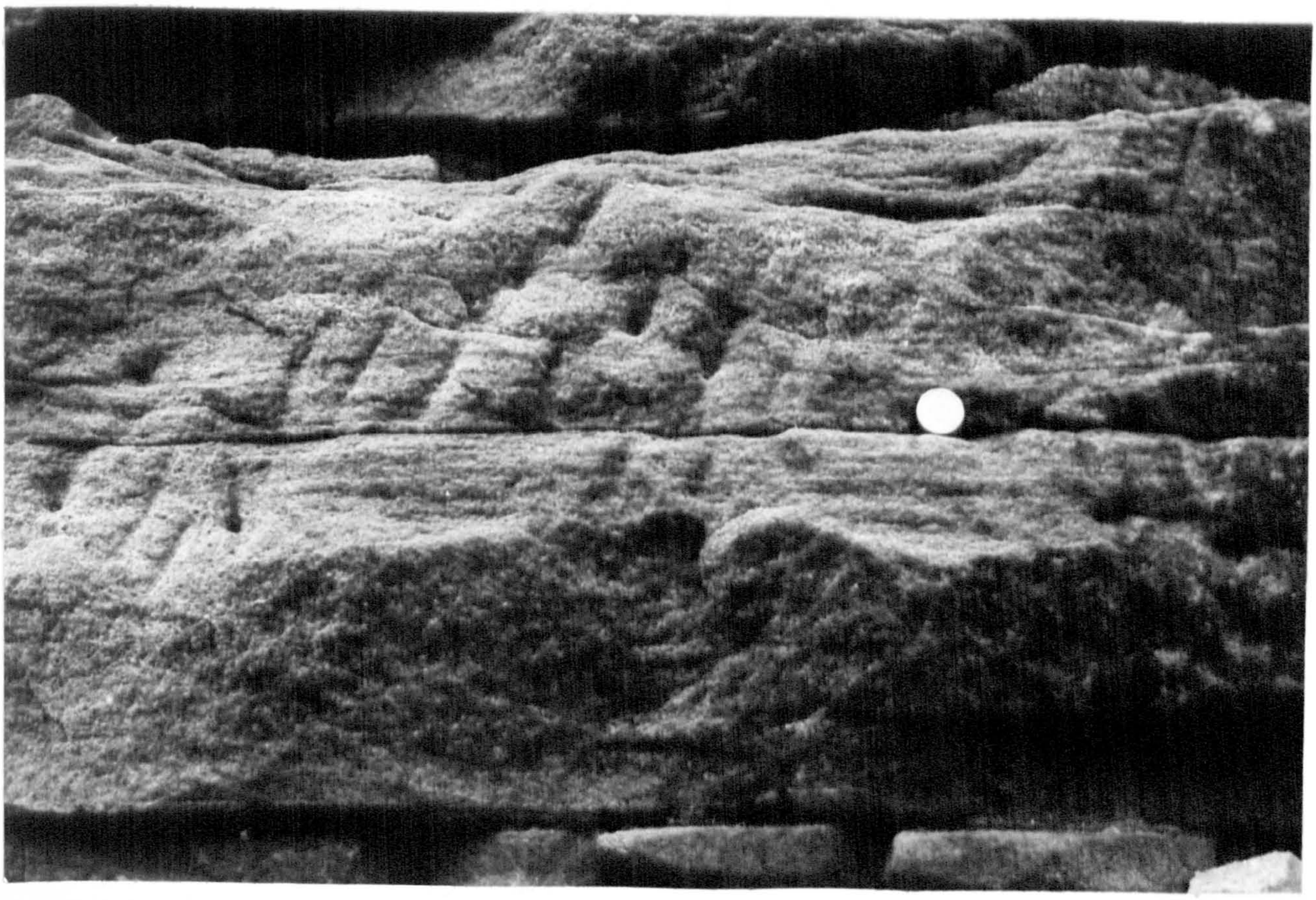


Plate 58

Coset of medium-scale cross-bedding (Facies 13).
Kinderscout Grit Formation; Chew Hurdles (SE028015)
near Greenfield.

Plate 59

Top view of trough cross-bedding of Facies 13.
Kinderscout Formation; Blackstone Edge (SD972163).

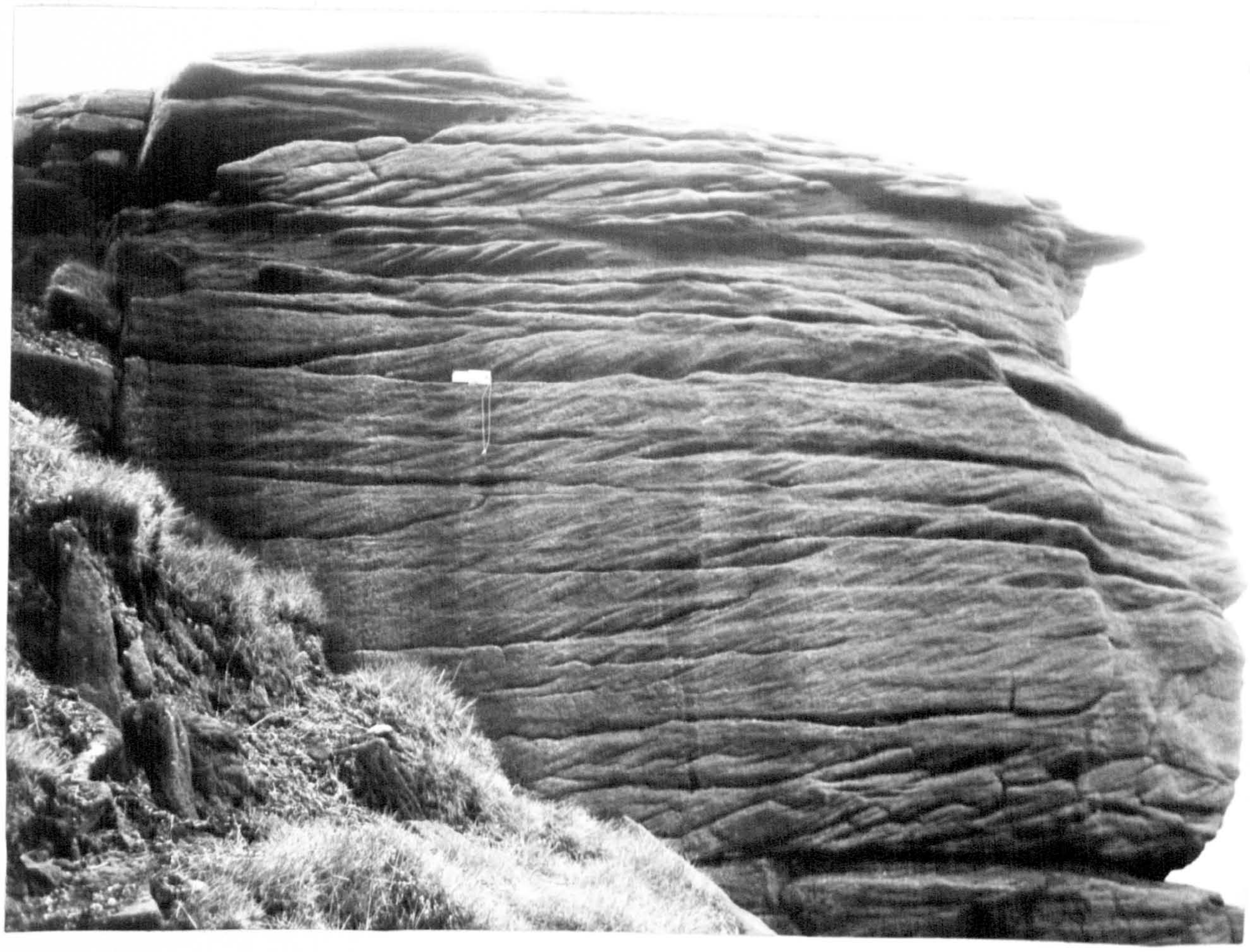


Plate 60

Facies 13, medium-scale cross-bedding shows post-depositional deformation with increasing intensity upwards. Kinderscout Formation, Cow and Calf Rocks (SE130467) near Ilkley.

Plate 61

Facies 13 showing post-depositional deformation with destruction of lamination and a massive "neck" in the area around the hammer. Cow and Calf Rocks (SE130467).

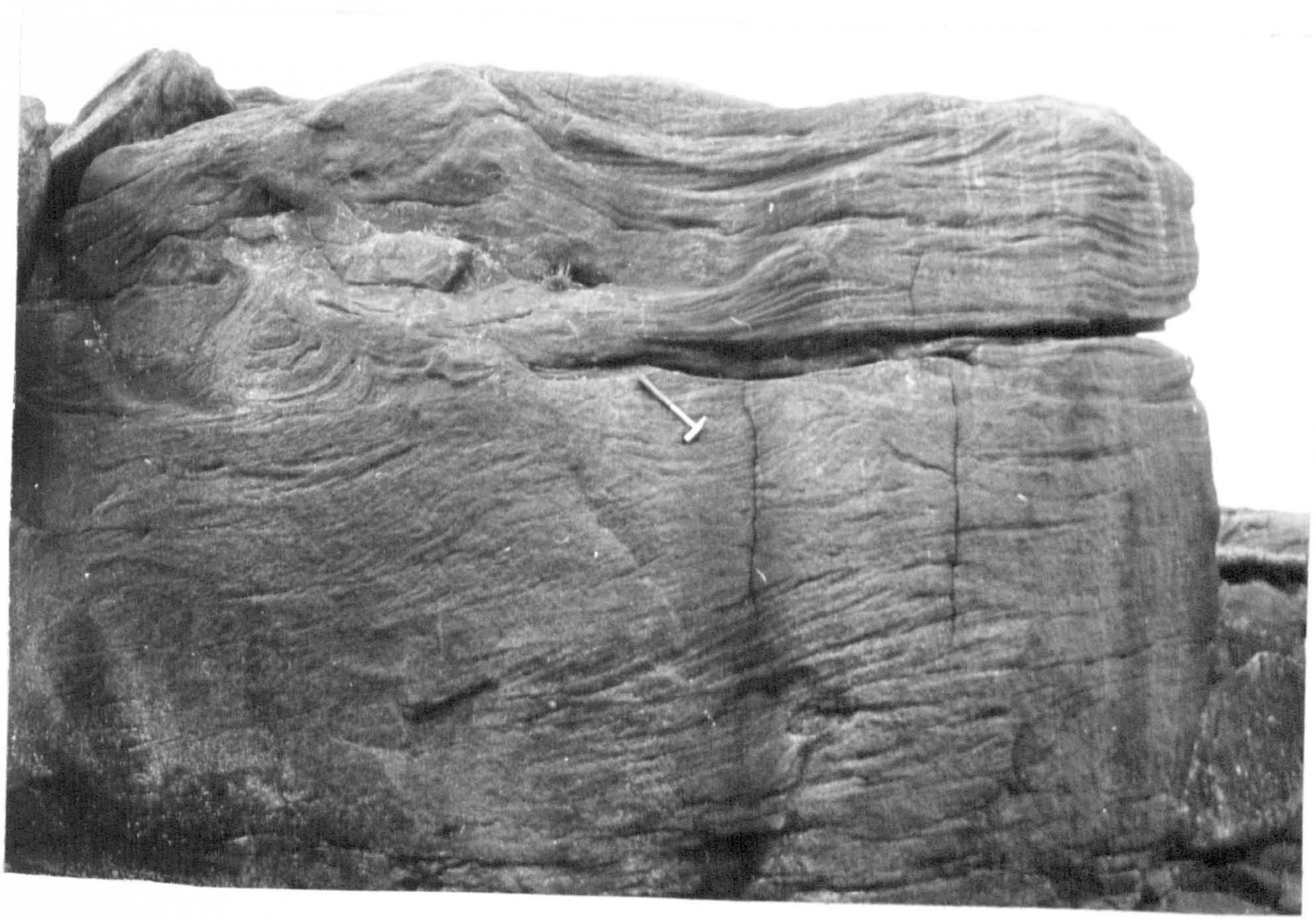
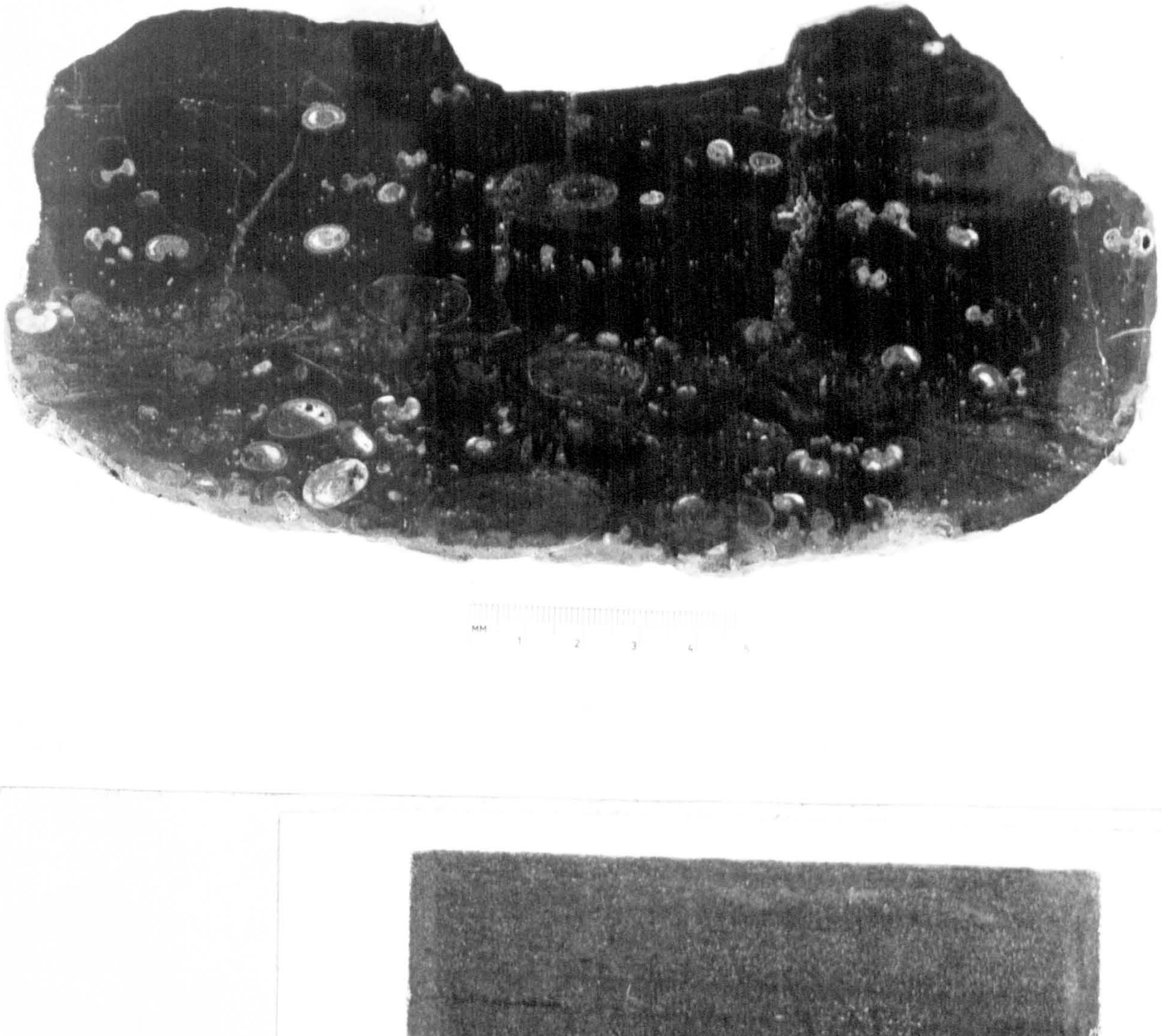


Plate 62

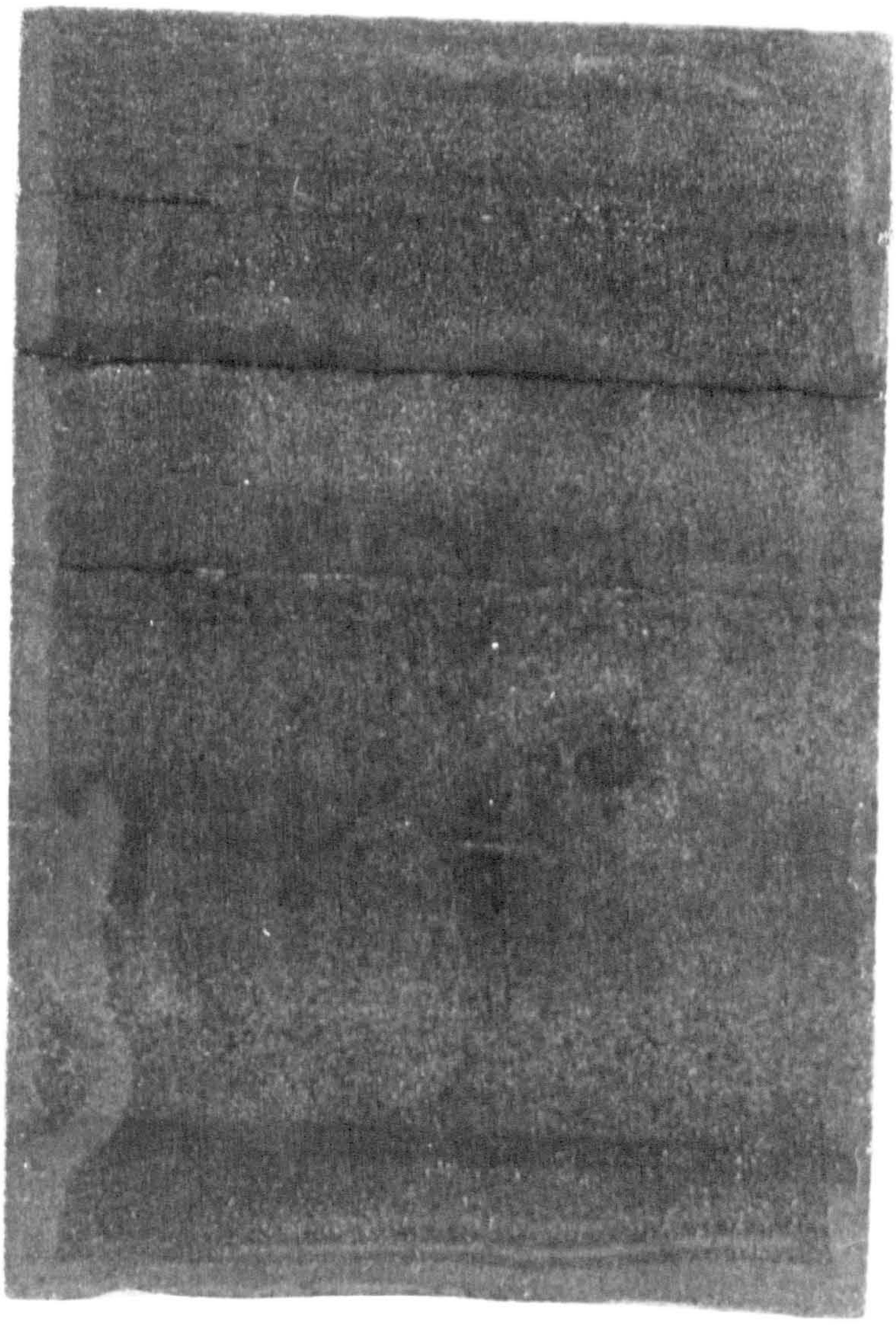
Carbonate concretion from goniatite faunal bed, Facies 2. The geopetal like infillings suggest some rotation of the goniatites giving inclined infillings. The goniatites occur in allforms between spat and adult types. R. gracile bed, Windy Hill motorway cutting (SD980147).

Plate 63

Striped fine to very fine sandstone of Facies 16. There are several sharp breaks within the sequence and the sandstone laminae show normal and reverse grading. Specimen from the Manshead (SD998198) boreholes.



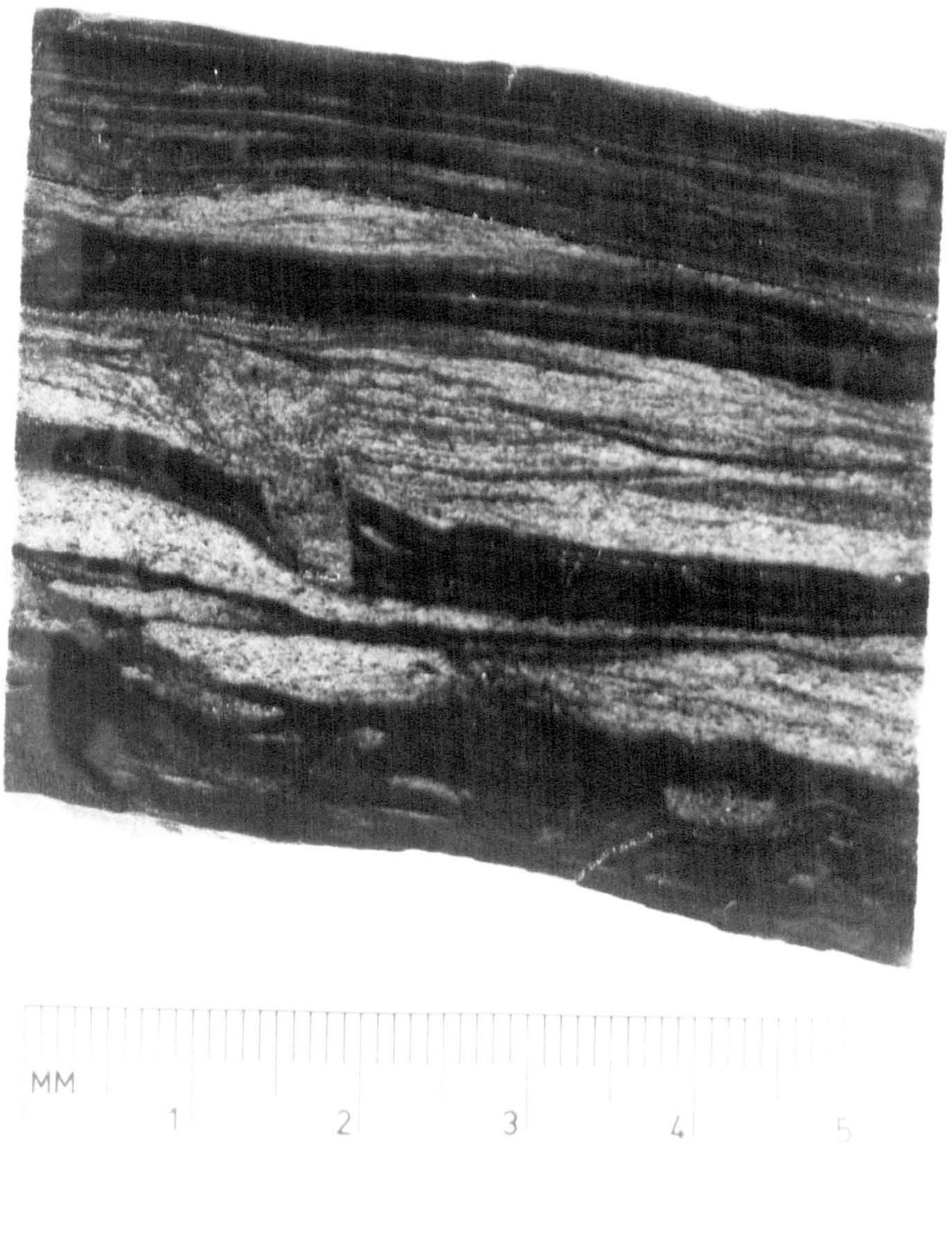
MM
1 2 3 4 5



MM
1 2 3 4 5

Plate 64

Wavy bedded sandstone and mudrock (Facies 17). Specimen


MM
1
2
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5

Plate 65

Wavy bedded sandstone with thin mudrock laminae, Facies 17.
Cf. Plate 64. Specimen from the Manshead (SD998198) boreholes.

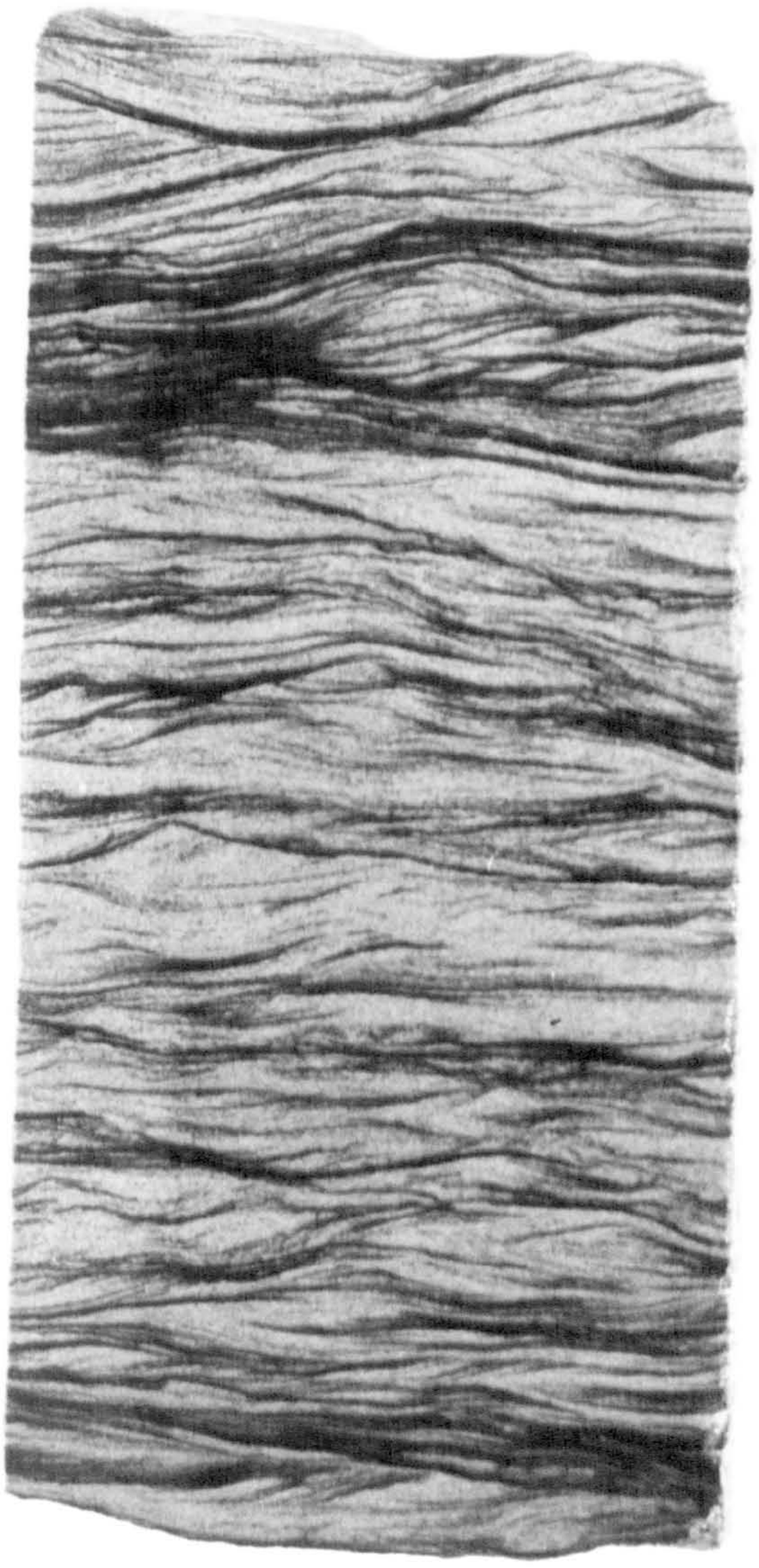
MM
1
2
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Plate 66

Ripple laminated sandstone (Facies 10) with mudrock flasers. The upper part of the specimen shows bioturbation. Specimen from Manshead (SD998198) boreholes.

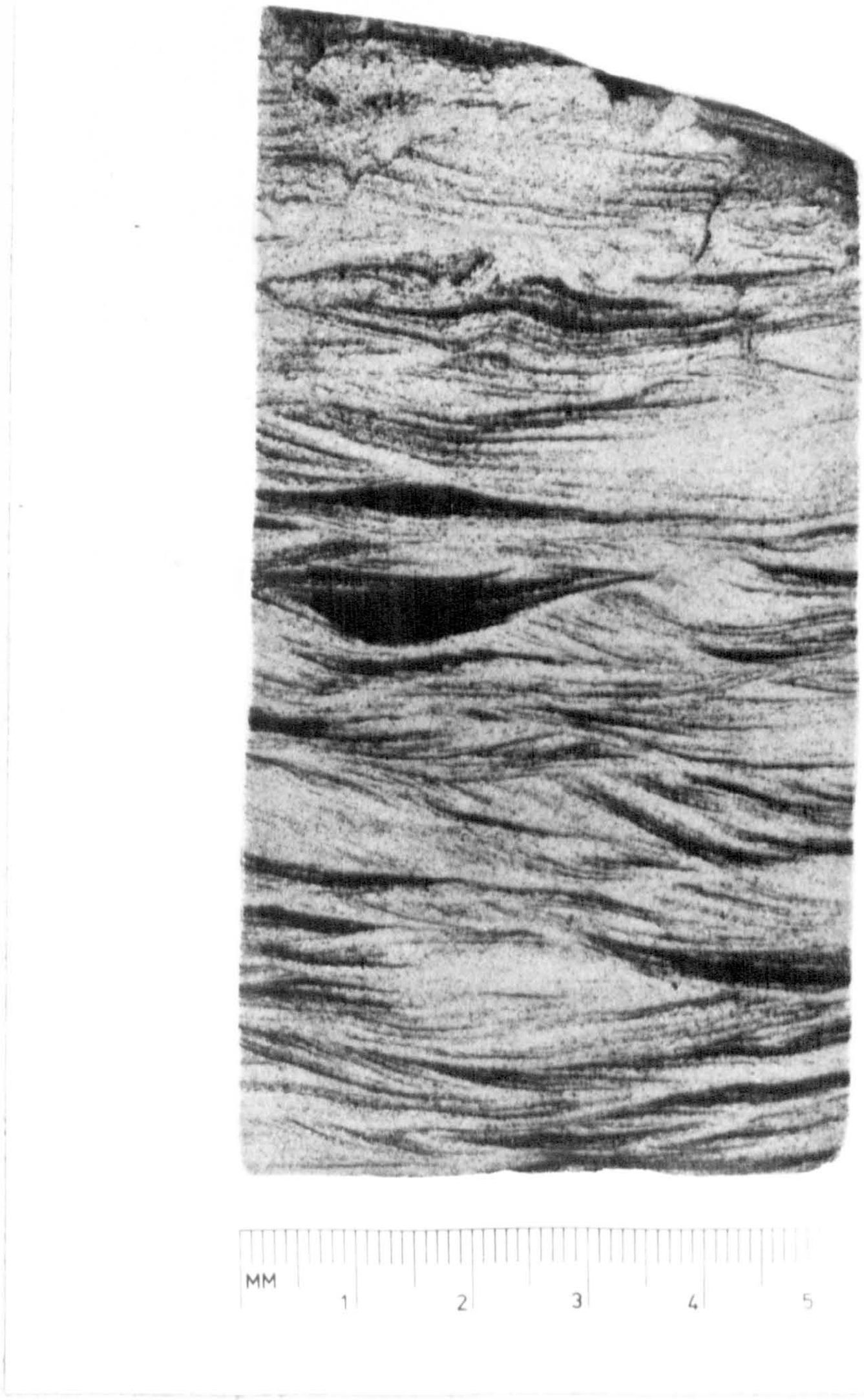
MM
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Plate 67

Parallel laminated fine sandstone (Facies 18) interbedded with mudrock laminae. A good example of an escape trace occurs in the lower half. Specimen from the Manshead (SD998189) boreholes.

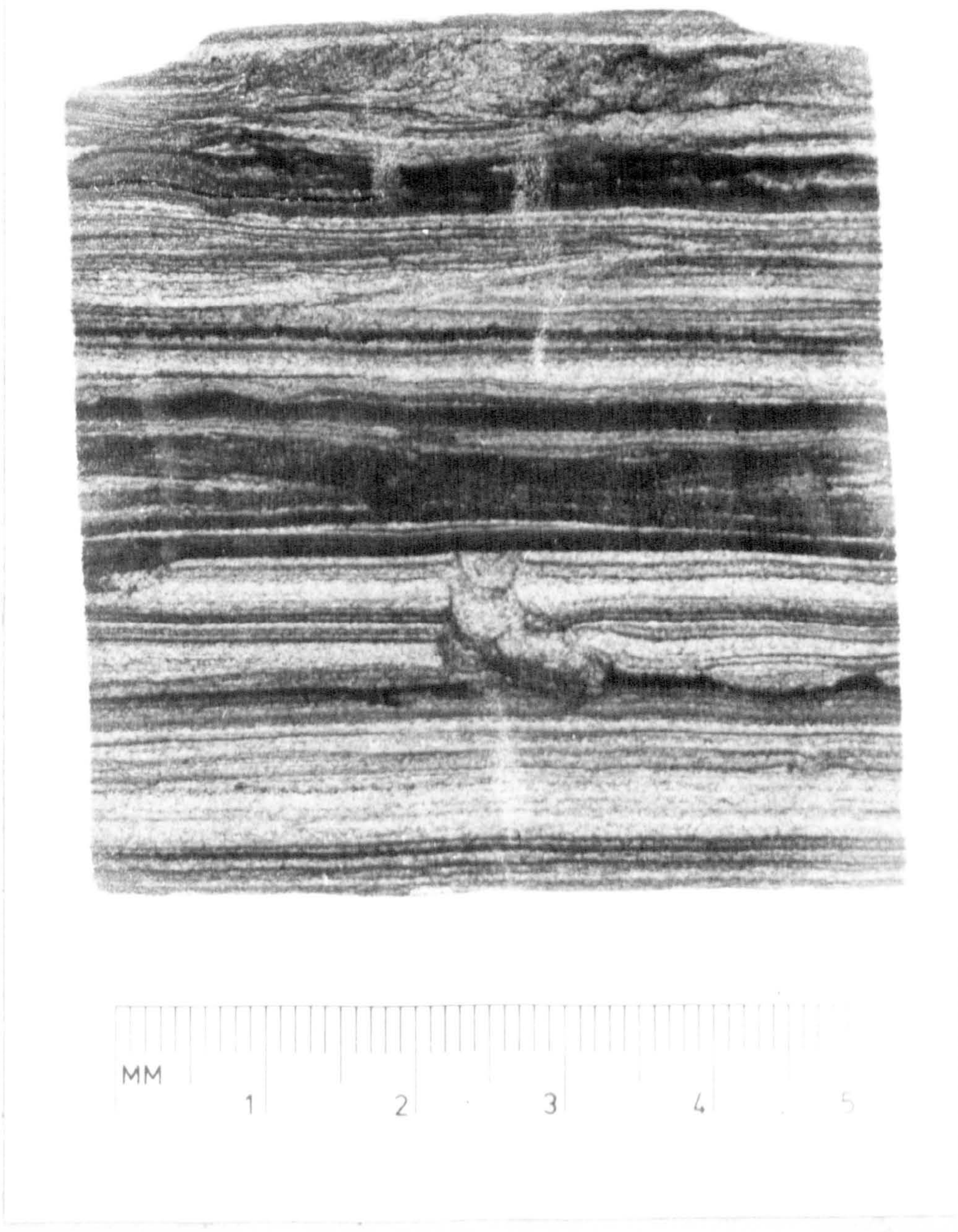
MM
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Plate 68

Parallel laminated fine to very fine sand (Facies 18). The convolute lamination in the upper half truncates the laminae to the right and is itself truncated by the overlying parallel laminated sandstone. Specimen from the Manshead (SD998189) boreholes.


MM
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2
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4
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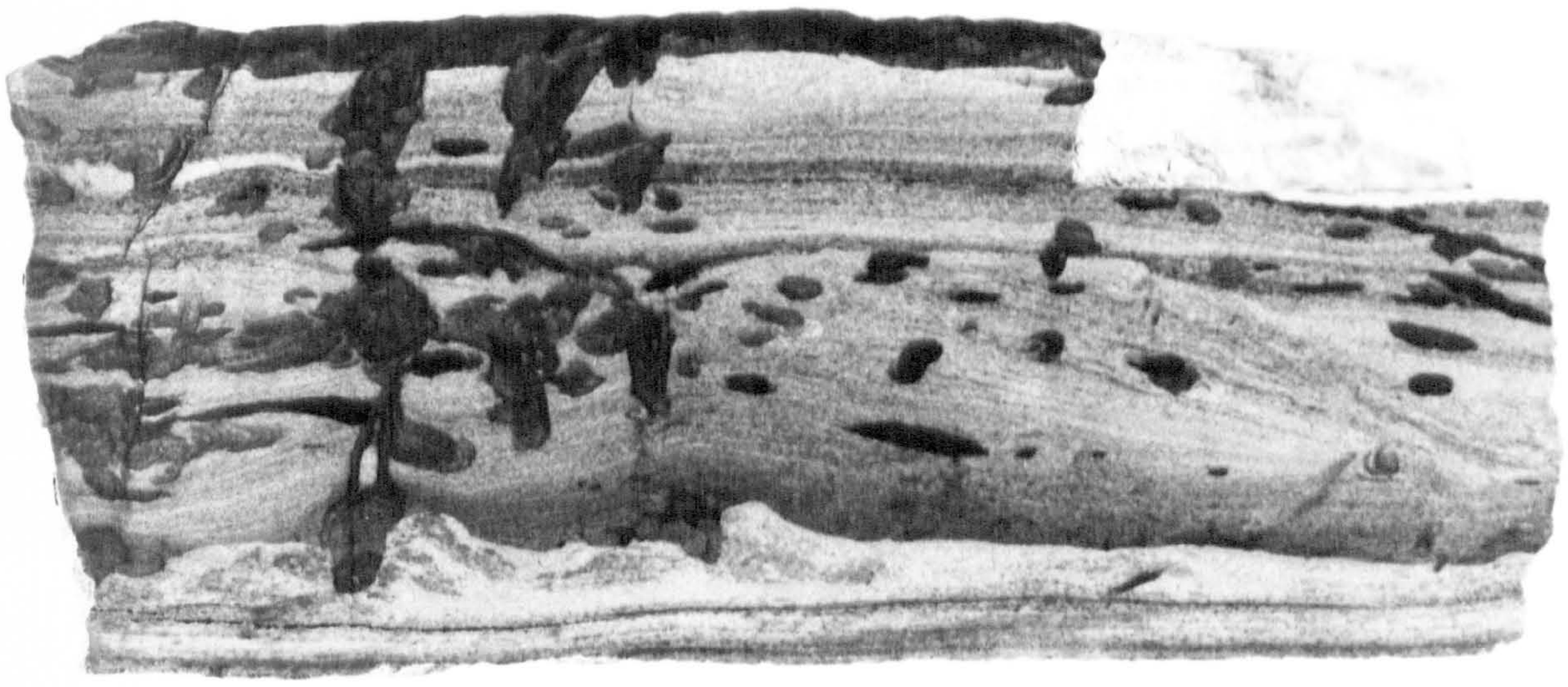
Plate 69

Facies 19, thin sandstone showing mud-filled endichnial burrows. Note the small-scale cross-stratification in the lower half of the specimen and the horizontal lamination in the upper part. Specimen from Little Snowden (SE037436) near Steeton - exposed on excavation for gas pipeline.

Plate 70

Thin sandstone (Facies 19) shows small-scale cross-stratification. Note the flat base and the undulating top surface. The latter may represent the original ripple topography. The top of the sandstone and the surrounding mudrock is extensively bioturbated. Mud-filled endichnial and sand-filled exichnial burrows occur. Locality as in Plate 69.


MM
1
2
3
4
5


MM
1
2
3
4
5

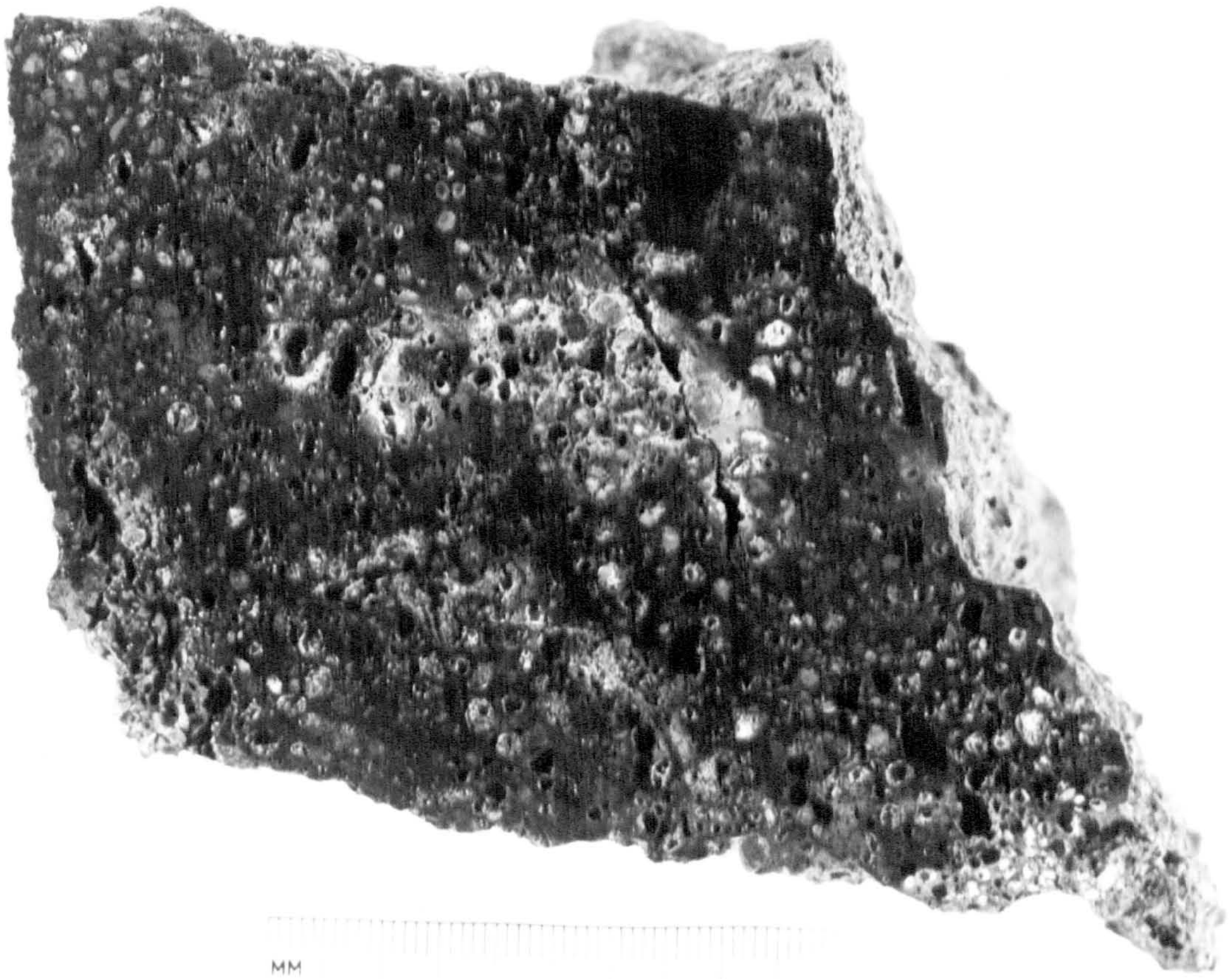
Plate 71

Base of thin sandstone (Facies 19) showing structures interpreted as casts of subaqueous shrinkage cracks. Specimen from Windy Hill motorway cutting (SD980147).

Plate 72

Sphaerosiderite from sideritic concretion within gannister, Facies 22. Specimen from Kinderscout Formation, Stoodley Pike (SD973243).


MM
1
2
3
4
5


MM
1
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5