

VOLCANIC AND SEDIMENTARY FACIES OF PART OF THE
BORROWDALE VOLCANIC GROUP, CUMBRIA

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PLATES.

PLATES

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PLATE 1. (folded map, in pocket)

**Geological map of the Brown Knotts area,
Borrowdale. Based on enlarged aerial
photographs. A - B marks the line of the
cross-section of Figure 3.3b**

GEOLOGICAL MAP OF THE BROWN KNOTTS AREA, BORROWDALE

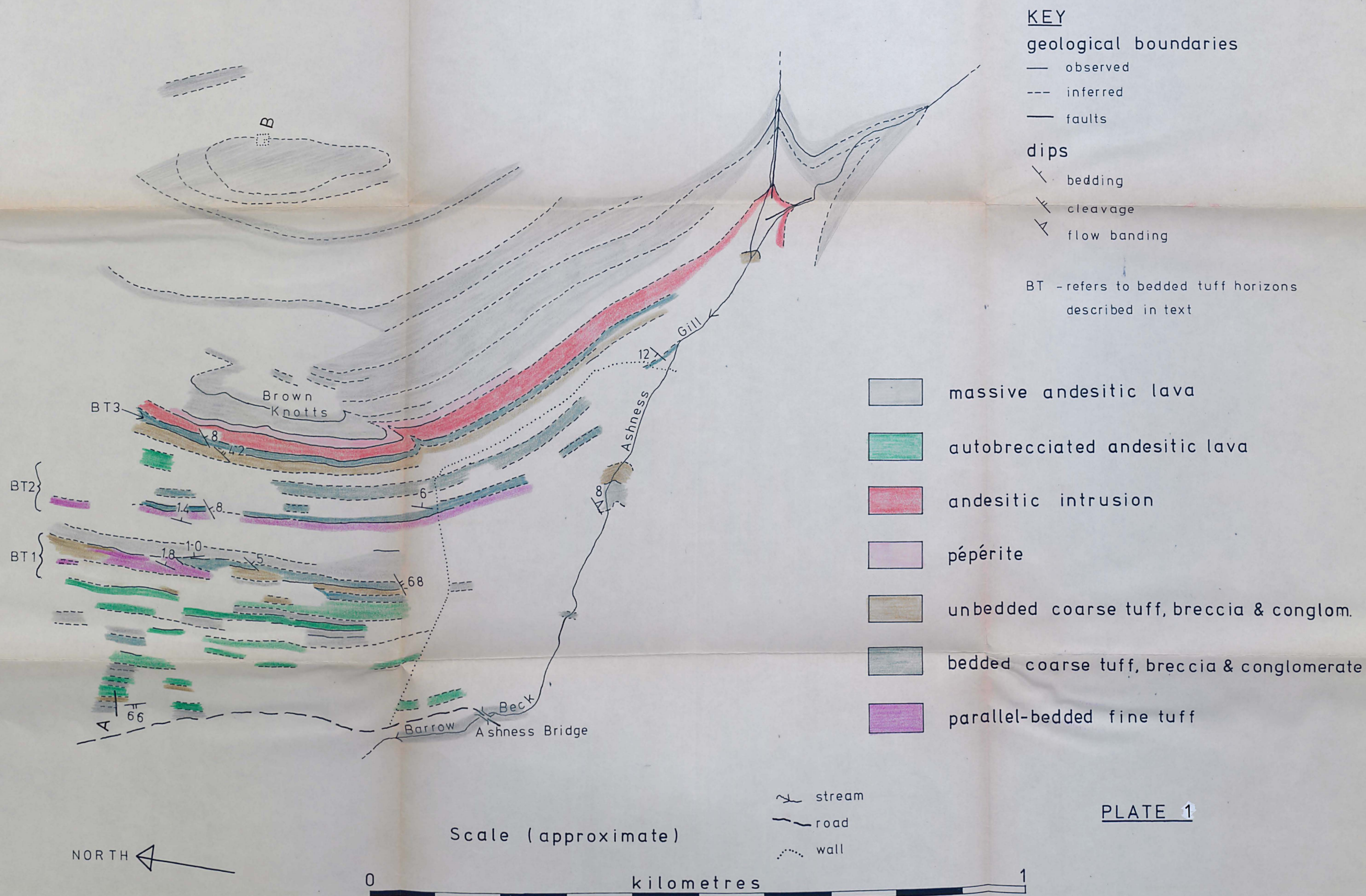


PLATE 1

PLATE 2

**Aerial photograph of the Brown Knotts -
Falcon Crag area, Borrowdale. The
features formed by the gently dipping
rocks of Brown Knotts are clearly seen
in the lower part of the photograph.
To the north, massive andesitic lavas
are exposed in the precipitous faces
of Falcon Crag (in shadow). North is
towards the top of the photograph.
Scale approximately 1:10,250.**

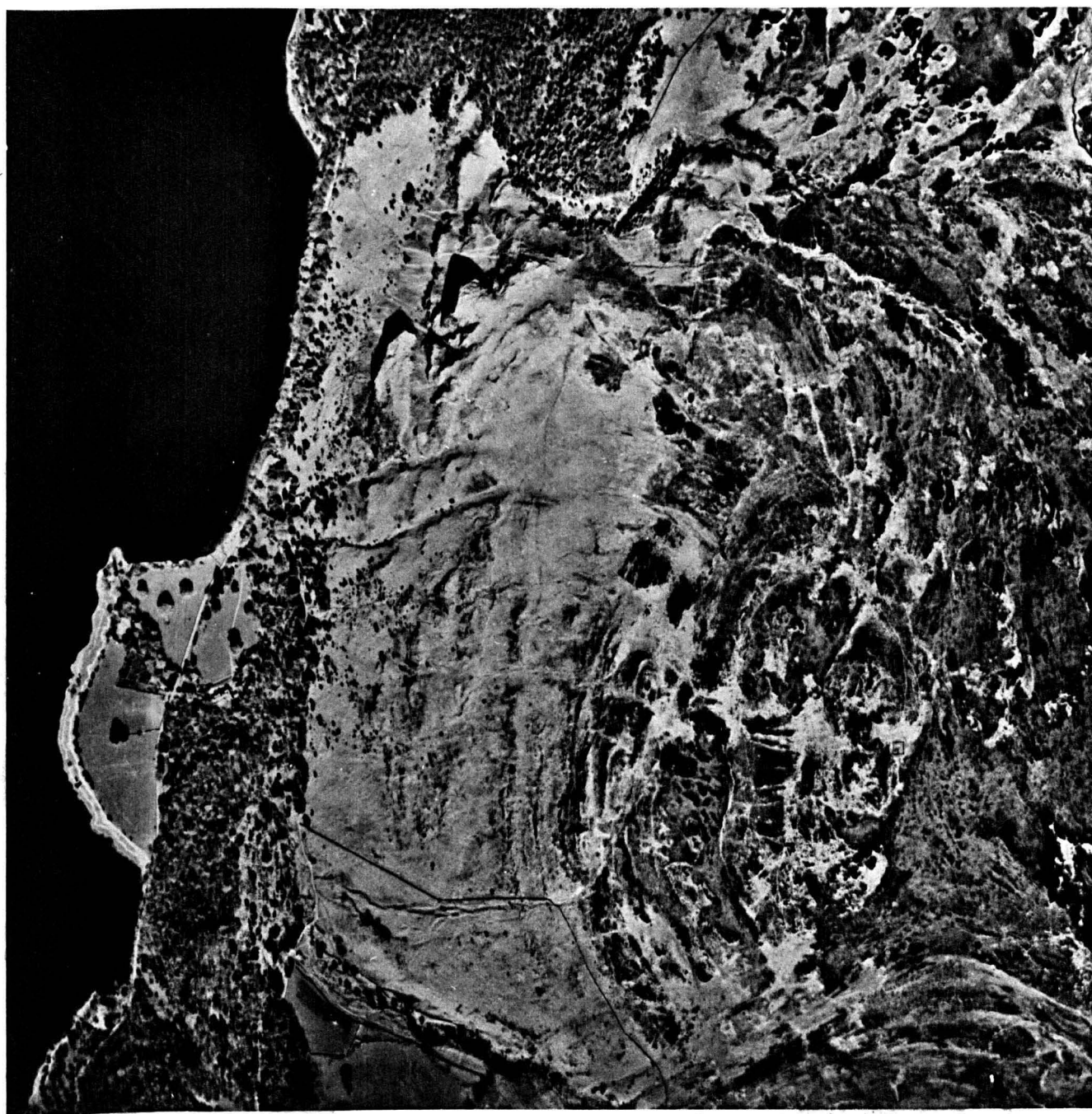


PLATE 3

**Panorama of the area east of Derwentwater, taken
from a boat on the lake.**

w - Walla Crag

f - Falcon Crag

bk - Brown Knotts

b - Bleaberry Fell

a - Ashness Gill

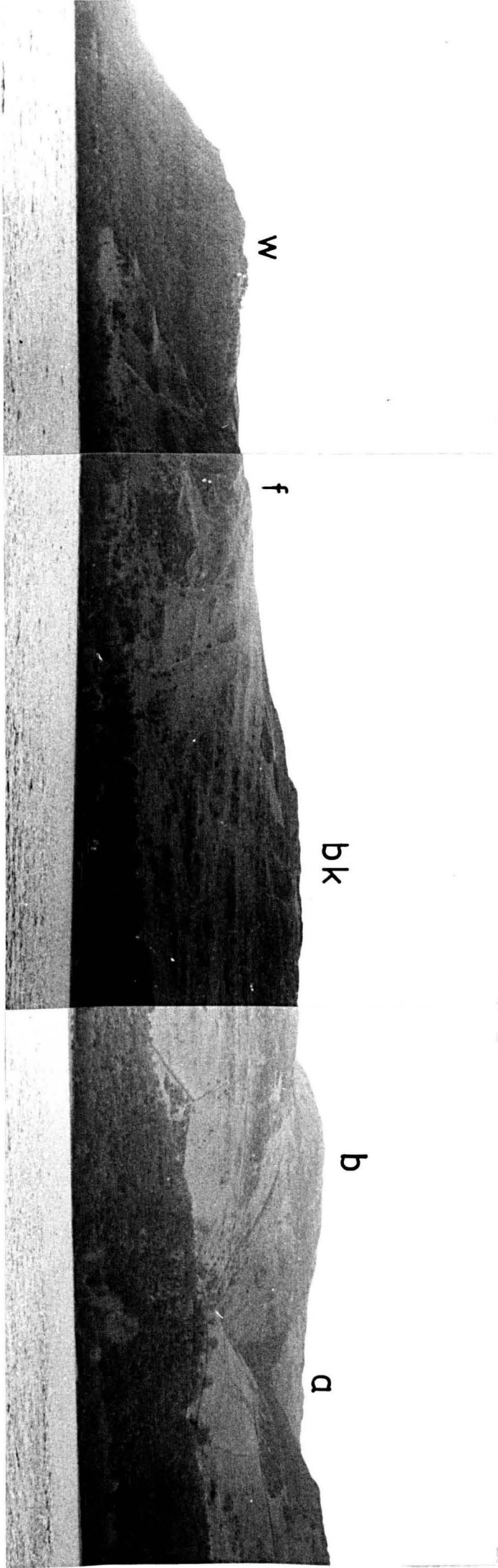


PLATE 4

View of Falcon Crag from a boat on Derwentwater.

Prominent crags are formed by gently dipping

massive andesitic lavas. The crag is bounded

on the left by the wooded ravine of Cat Gill.



PLATE 5

A. Flow banding on the weathered surface of an andesitic lava flow, seen in cross-section. Brown Knotts, locality 5. (H 1)

B. Autobrecciated basal part of the same lava flow. Andesite blocks are contained in a matrix of fine grained andesitic lava, which stands out on the weathered surface. Cross-section. (N 14)

Lens cap 5 cm diameter.



PLATE 6

**A Basic inclusions in garnetiferous andesitic
lava. Brown Knotts, locality 14. Lens
cap 5 cm diameter. (J 16)**

**B Varnished slice of plagioclase- and pyroxene-
phyric andesitic lava. Note the light-coloured
weathered edge. Specimen B2.18, Brown Knotts.
(M 6).**

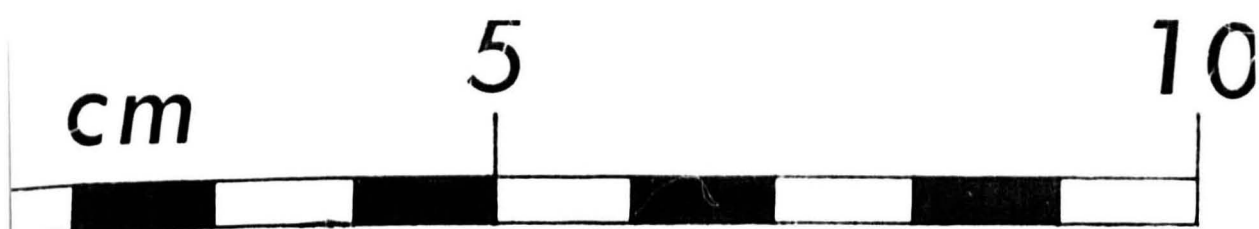


PLATE 7

A Amygdaloidal andesite. Most amygdales are of chlorite, whilst some of the larger ones have quartz in the centre. Many have very thin, white chalcedony rims. Plagioclase phenocrysts are also present. Specimen B2.30, Brown Knotts. (M 19)

B Aphyric andesite, containing approximately 40% amygdales, filled with chalcedony. Specimen B2.22, from near the base of a lava flow, Brown Knotts. Scale in cm. (M 11)



cm 5



PLATE 8

A. Peperite from above andesite sill, with blocks of andesite contained in disrupted bedded tuff. Locality 27, Brown Knotts. Lens cap 5 cm diameter. (N 26)

B Varnished slice of peperite from locality 27. Highly angular vitric andesite fragments in a matrix of fine tuff. Specimen BK13. Scale in cm. (I 21)



PLATE 9

A. Vitric tuff, containing angular equant red andesite fragments ranging in size from fine sand to lapilli, in a very fine-grained matrix.

Specimen B8.1. (M 10)

B. Vitric tuff, containing angular andesite fragments. Specimen BK9. (K 11)

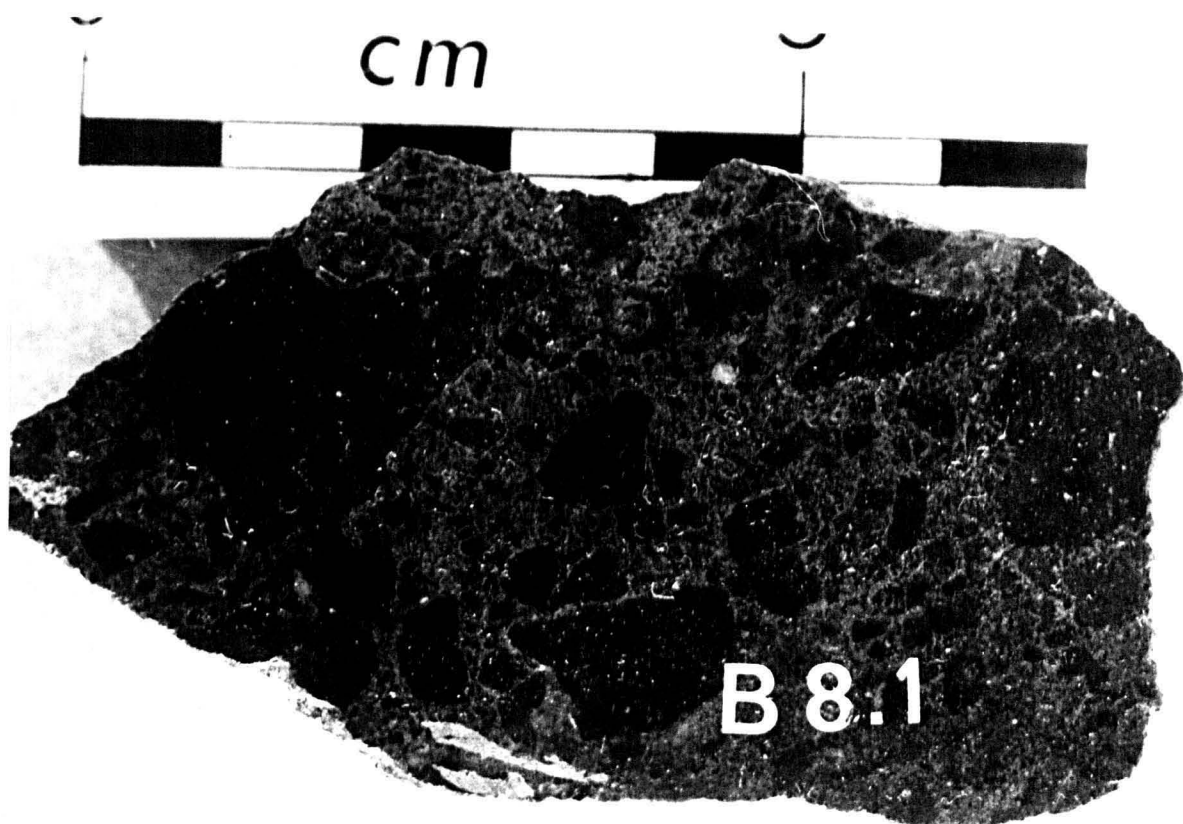


PLATE 10

Welded tuff, showing dark-coloured fiammé

(immediately below lens cap) and undeformed

lava clasts. Near locality 25, Brown Knotts.

Lens cap 5 cm diameter. (N 23)



PLATE 11

A. Parallel-bedded tuffs, with thicker sand grade beds and thinner silt-clay grade beds, which stand out on the weathered surface. Horizon BT1, locality 1. Scale in 10 cm. divisions. (F12)

B. Close-up of (a), showing soft-sediment faulting and parallel lamination. (F 13)

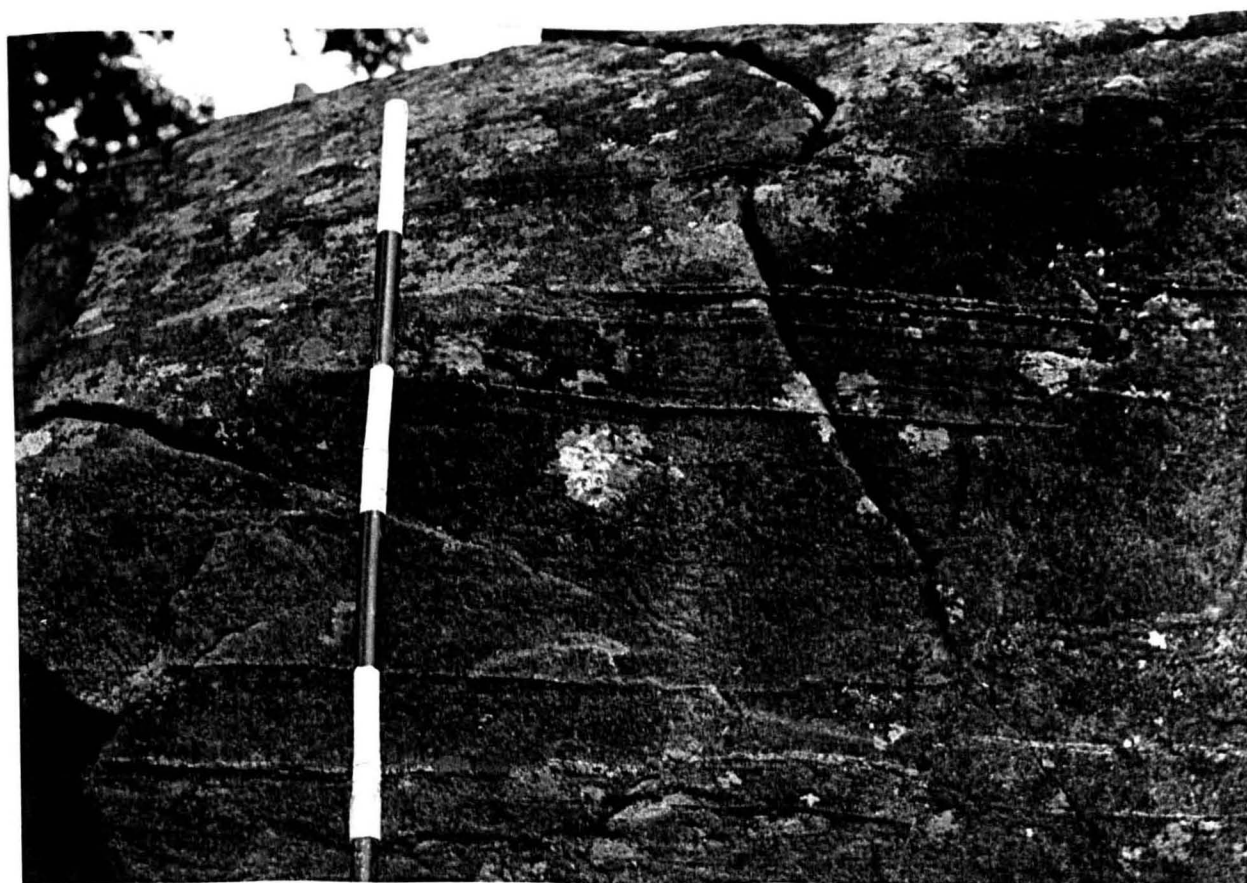


PLATE 12

- A. Parallel-bedded sand and silt-clay grade
tuffs overlain by tangentially based cross-
bedded tuffs. Horizon BT1, locality 2.
Lens cap 5 cm diameter. (F 16)**
- B. Irregular trough cross bedding, flat
bedding and soft-sediment faulting in sand grade
tuffs. Horizon BT1, locality 3. Scale
in 10cm divisions. (F 18)**

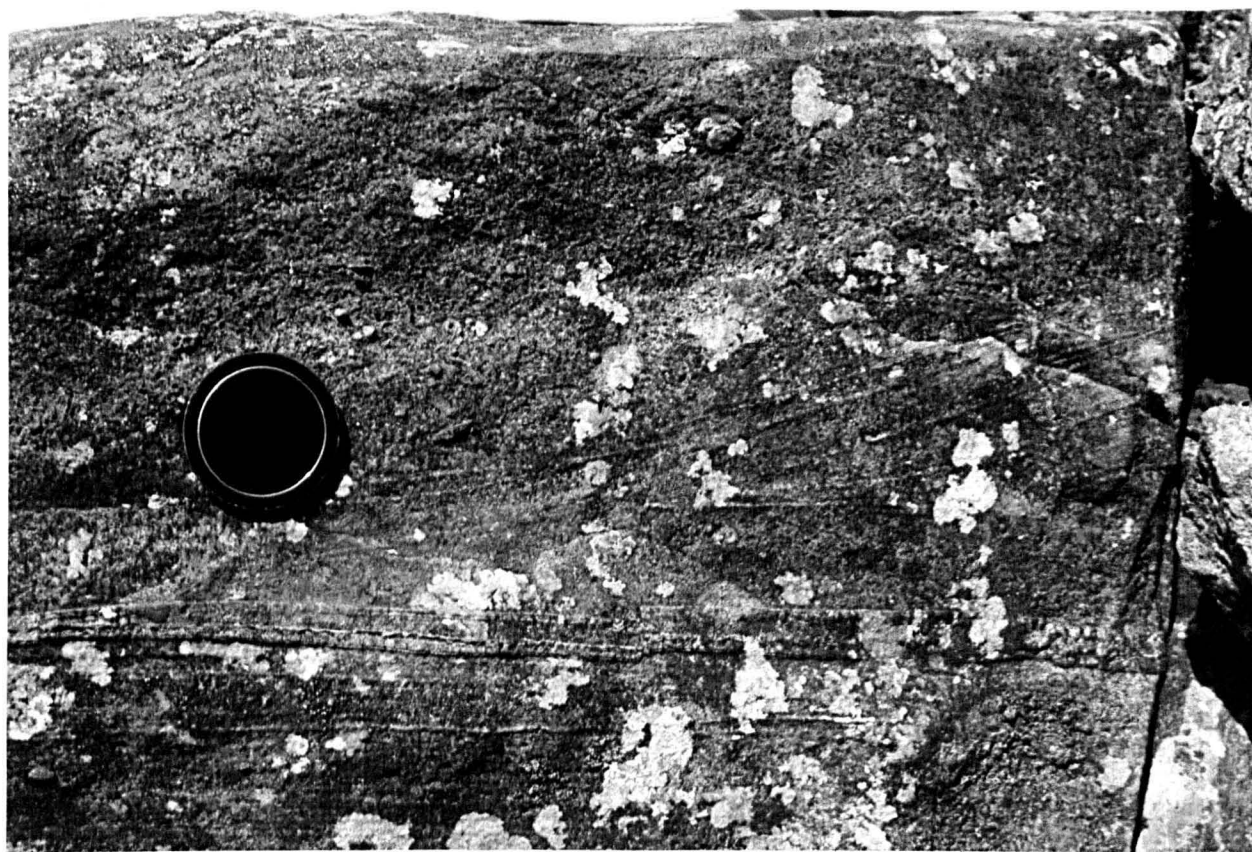


PLATE 13

**A. Poorly defined cross bedding in lapilli
tuff. Horizon BT1, locality 6. (G 7)**

**B. Poorly defined flat bedding in lapilli
tuff. Horizon BT1, locality 6. (G12)**

Scale in 10 cm divisions.

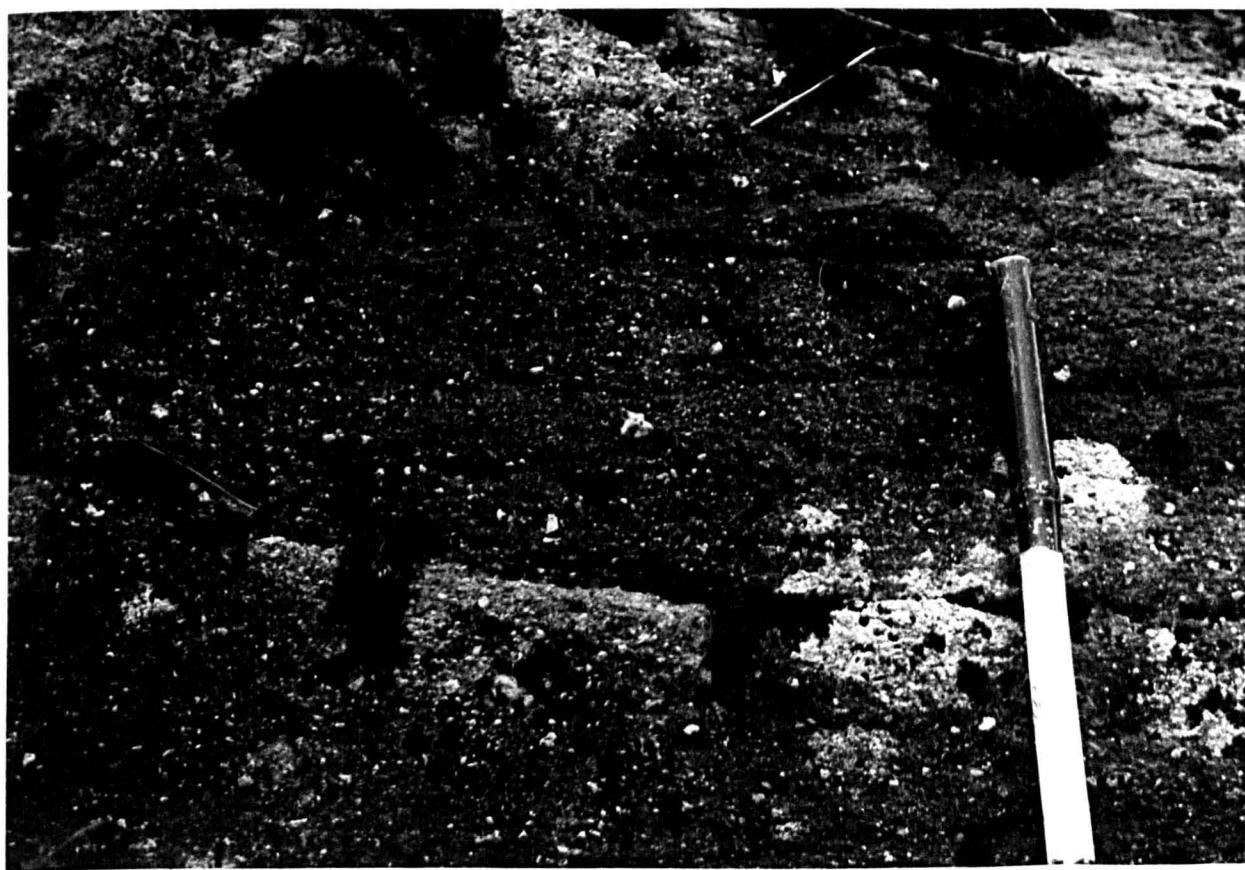
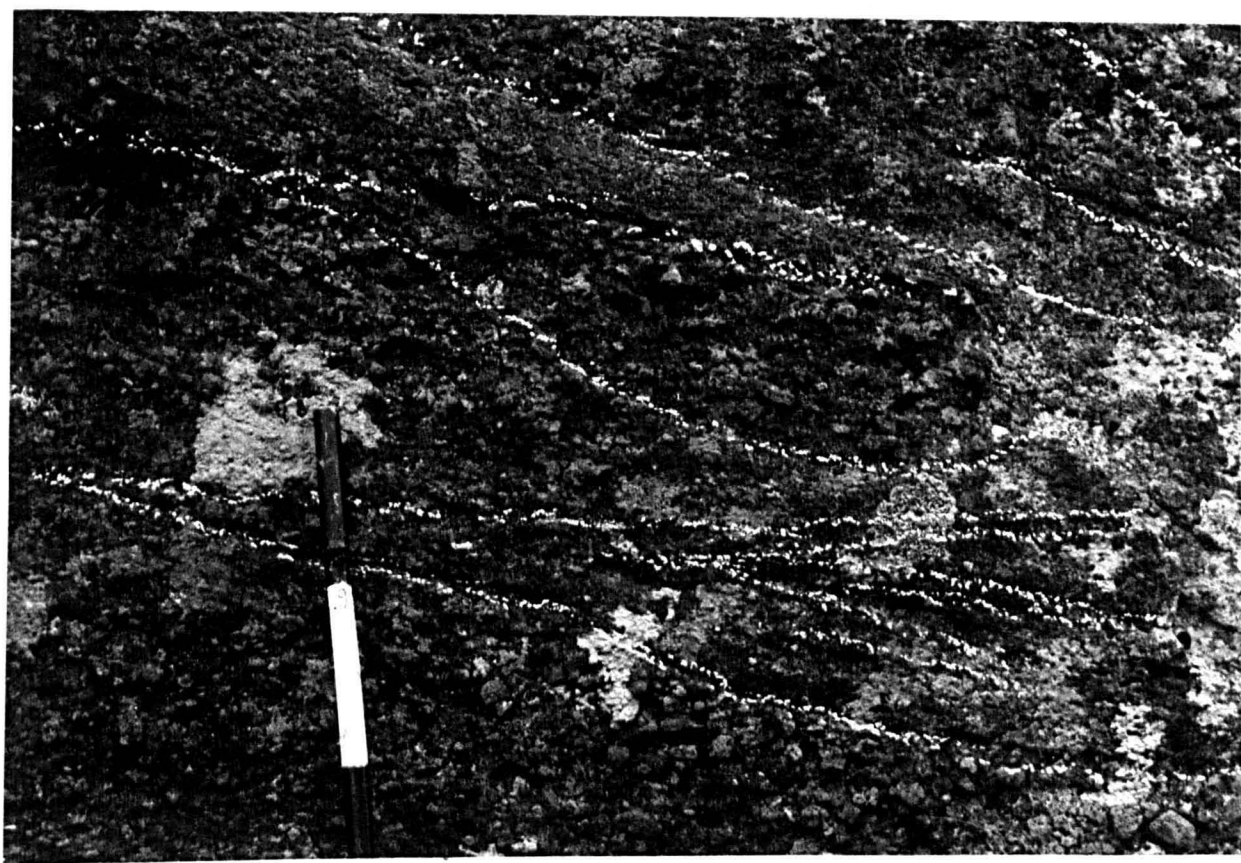


PLATE 14

A. Clast-supported conglomerate. Pebbles are mostly of andesite, many of them rectangular in shape. Lens cap 5 cm diameter. Horizon BT1, locality 5.

B. Cobble conglomerate with sand to lapilli grade matrix. Clasts are of andesitic lava, some of them showing flow banding. Scale in 10 cm divisions.



PLATE 15

Large lava block in conglomerate. Horizon

BT1, locality 6. Scale in 10 cm. divisions.

(G 4)



PLATE 16

**A. Channel with stepped cross section,
eroded into bedded tuffs and filled
with boulder conglomerate. Horizon
BT1, locality 3. (F 10)**

**B. Steep-sided channel eroded into
bedded tuffs and lapilli tuffs, and
filled with bedded tuff and conglomerate.
Horizon BT1, locality 5. Scale in
10 cm. divisions. (F 26)**

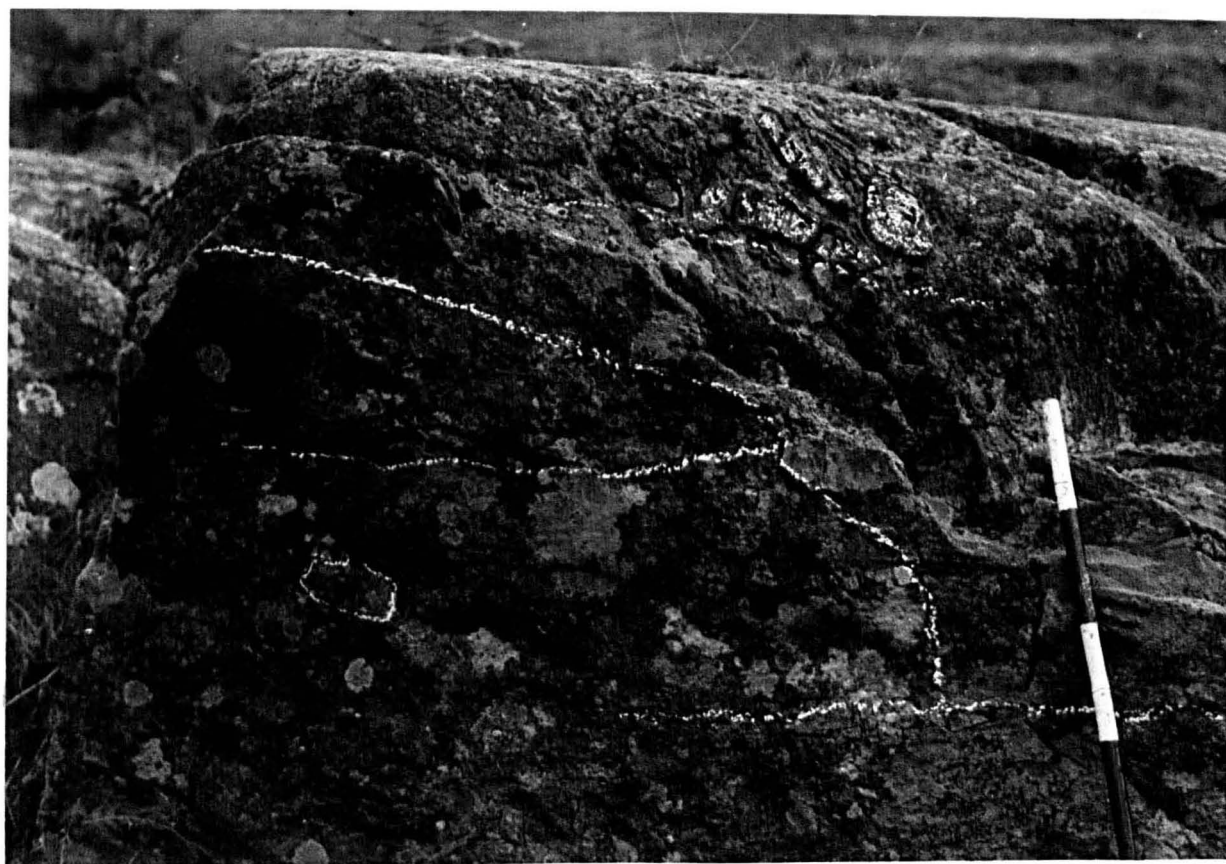


PLATE 17

Graded bedding in very fine sand to silt grade tuffs. The lower, coarser parts of the beds are darker in colour than the fine tops. Note the presence of ripple cross-lamination at the base of beds in the upper half of the photograph. Many beds are parallel-laminated. Locality A, horizon BT2. Lens cap 5 cm diameter. (tr 5)

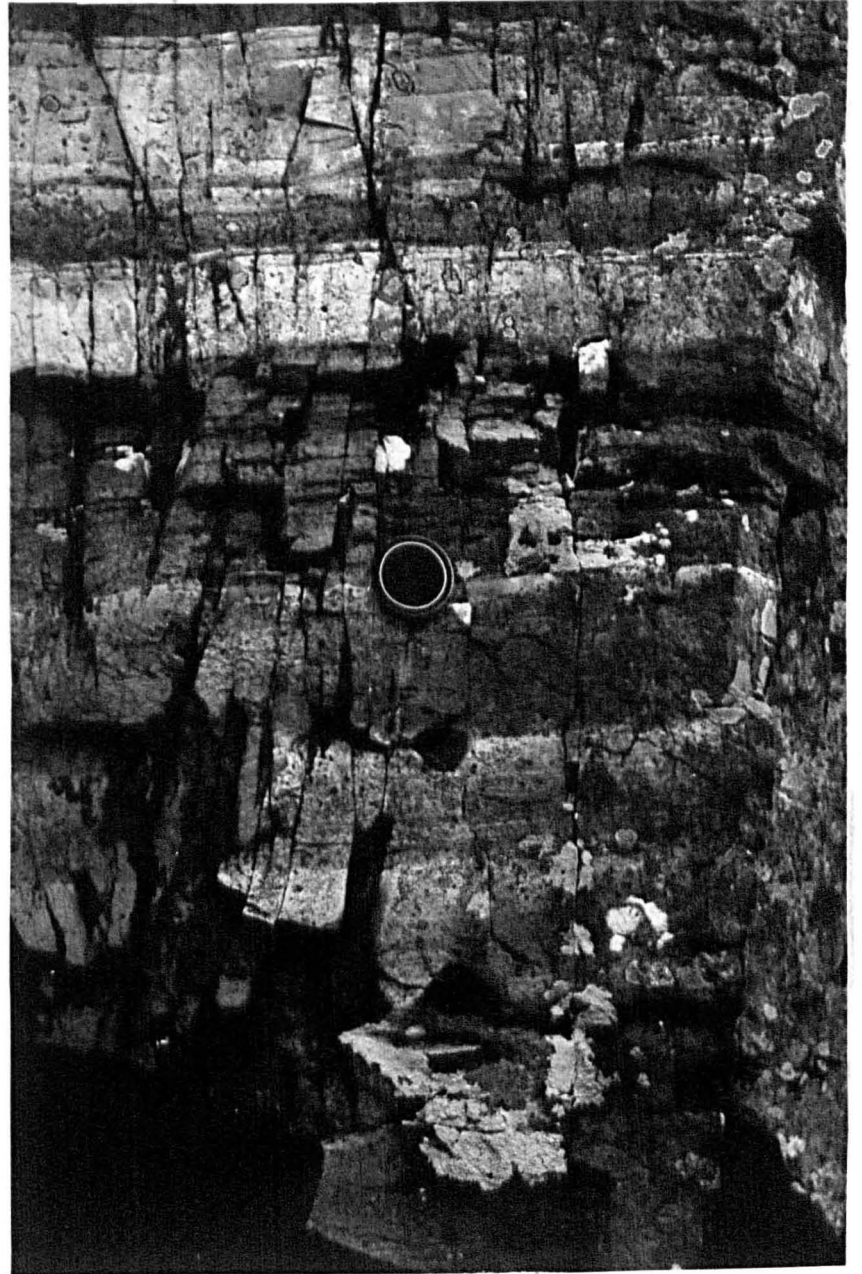


PLATE 18

A. Discontinuous intraformational conglomerate
at the base of a thin sand grade bed. The
clasts are of bedded silt-clay grade tuff,
identical to the underlying and overlying
beds, and are imbricated. Horizon BT2,
locality 23. (J 18)

B. Small channel eroded into parallel-
bedded very fine sand to clay grade tuffs.
The channel is draped by thin beds which
are truncated by the overlying flat-lying
beds. A smaller channel is seen above
and to the right of the lens cap.
Horizon BT2, locality 23. (J 19)

Lens cap 5 cm diameter.



PLATE 19

**A. Parallel-bedded silt to clay grade
tuffs overlain by an intraformational
breccia containing bedded tuff clasts
up to 50cm long. The breccia is
overlain by cross-bedded coarse tuffs.
Horizon BT2, locality A. (N 17)**

**B. Another view of the intraformational
breccia , to the right of A. (N15)**

Lens cap 5 cm diameter



PLATE 20

**Parallel-bedded very fine sand to clay grade
tuffs, showing cross-sections of symmetrical
wave ripples with bimodal cross-laminations.**

Horizon BT2, locality A. Part of pencil

shown is 4 cm long. (N 19)



PLATE 22

A. Parallel-bedded fine sand and silt-clay grade tuffs. Well developed load and flame structures at the base of the upper thick sand grade bed. Horizon BT4, locality 15. Pen top approximately 5 cm long.
(J 12)

B. Draping of rippled fine tuff over an erosion surface in parallel-bedded coarser tuffs. The fine tuff is overlain by lapilli tuffs. Horizon BT4, locality 15. Lens cap 5 cm diameter. (tr 125)



PLATE 21

**A. Trough cross-bedding in coarse tuffs.
Horizon BT3, locality 12. Lens cap
5 cm diameter (J 3)**

**B. Erosion surface (chalked in) within
cross-bedded coarse tuffs. Breccias
overlie the tuffs at the top of the
photograph. Horizon BT3, locality
12. Part of hammer handle seen is
approximately 20cm long. (J 1)**

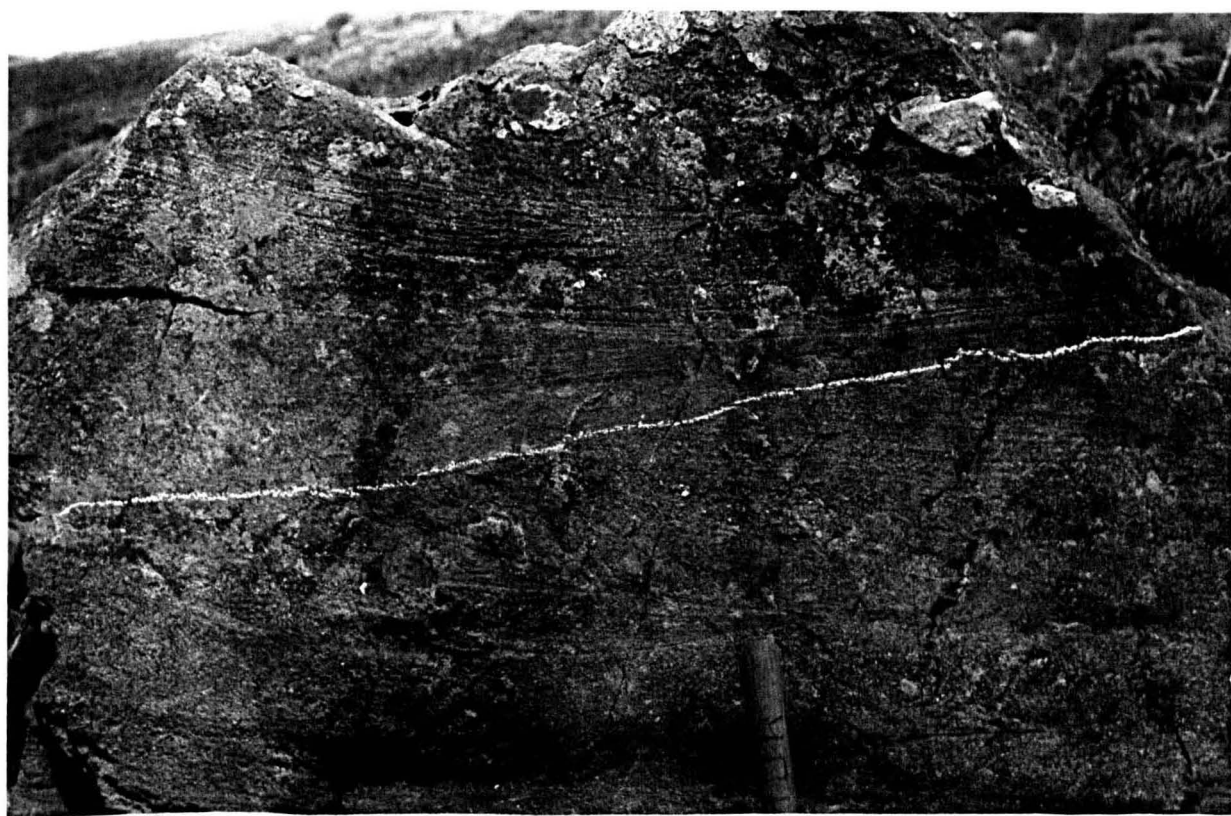


PLATE 23

A. Small scour filled with ripple cross-laminated tuff, overlain by lapilli tuff. Horizon BT4, locality 15. (J 13)

B. Irregular surface of coarse tuff draped by rippled, laminated silt grade tuff. Horizon BT4, locality 15. (J 8)

Lens cap 5 cm diameter.

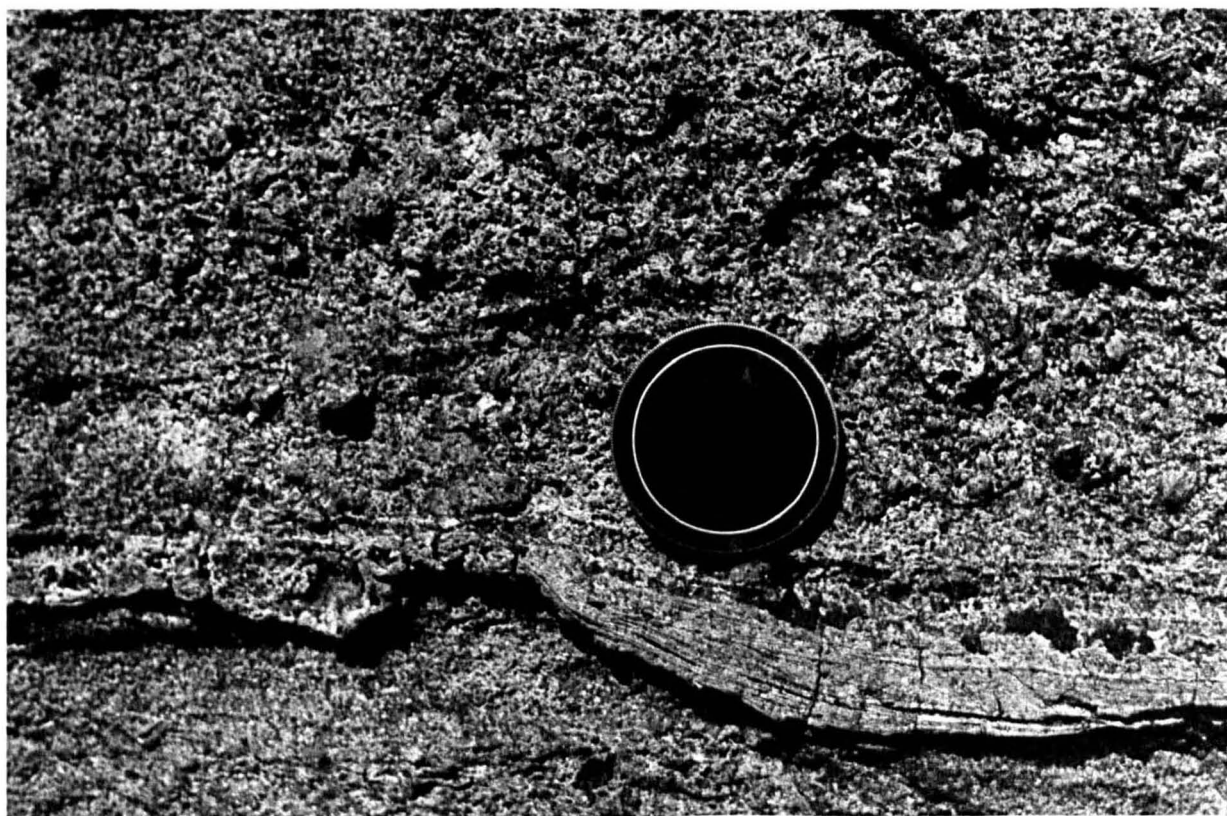


PLATE 24

A. Coarse bedded tuffs overlying parallel-bedded fine tuffs with a sharp, planar, non-erosive contact. Locality 15, horizon BT4. (tr 129)

B. Lenticular cross-bedded tuffs interbedded with massive lapilli tuffs and breccias. Locality 15, horizon BT4. (tr 109)

Hammer 30 cm long.

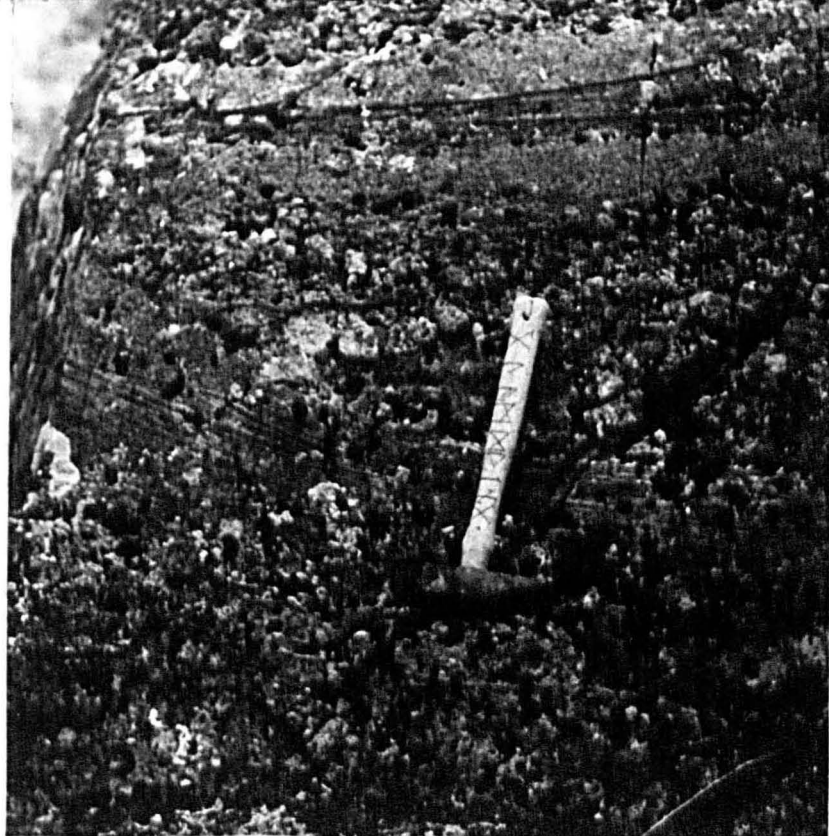
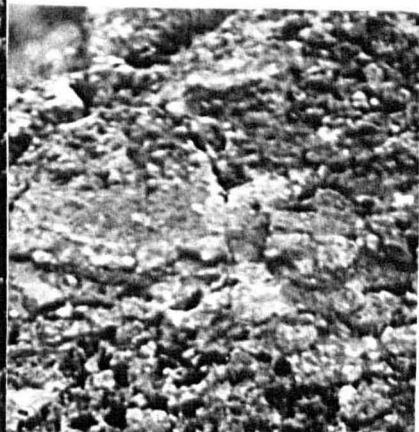


PLATE 25

A. 1m thick breccia unit, interpreted as mudflow deposit. Note fine-grained basal layer and coarse tail grading of the upper two-thirds of the bed. Horizon BT4, locality 15. (J 5)

B. Closeup of A. The large crystal tuff clast above the hammer head appears to have broken in situ. At the top of the unit, the narrow vertical features may represent sheet dewatering structures. (J 6)

Hammer head 15 cm long.



PLATE 26

- A. Channelling in bedded tuffs. At least three phases of channelling can be distinguished. A fine-grained tuff bed has collapsed into one channel, probably as a result of undermining. Horizon BT4, locality 15. (J 5)
- B. Twin channels eroded into, and filled with, bedded tuff. Note the steep to overhanging channel walls, and the thin layer of very fine-grained tuff draping the erosion surface. Horizon BT4, locality 15. (tr 117)

Lens cap 5 cm diameter



PLATE 27

A. Varnished section of parallel-bedded very fine sand to silt grade tuffs. Beds are graded, parallel-laminated in part, with sharp planar bases. Ripple cross-lamination at the base of one bed. Specimen BK12, horizon BT2, locality A. Scale in cm.
(I 20)

B. Parallel-bedded fine sand to silt grade tuffs. Thin graded beds occur in the lower fine-grained part, and a unit near the base is ripple cross-laminated. Sparse pumice fragments (dark in colour) are present. Specimen BK28, horizon BT2, locality 18.
(K 3)

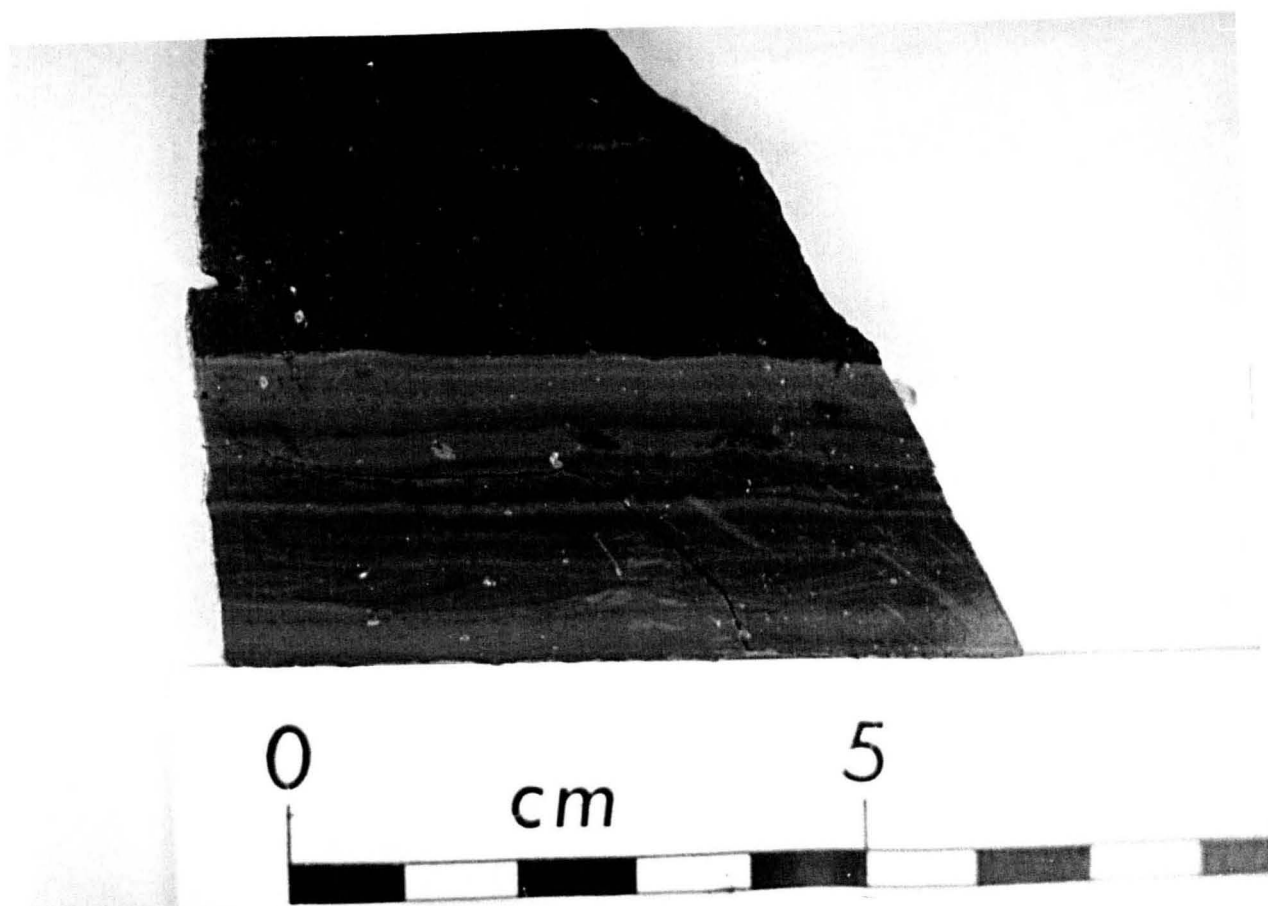
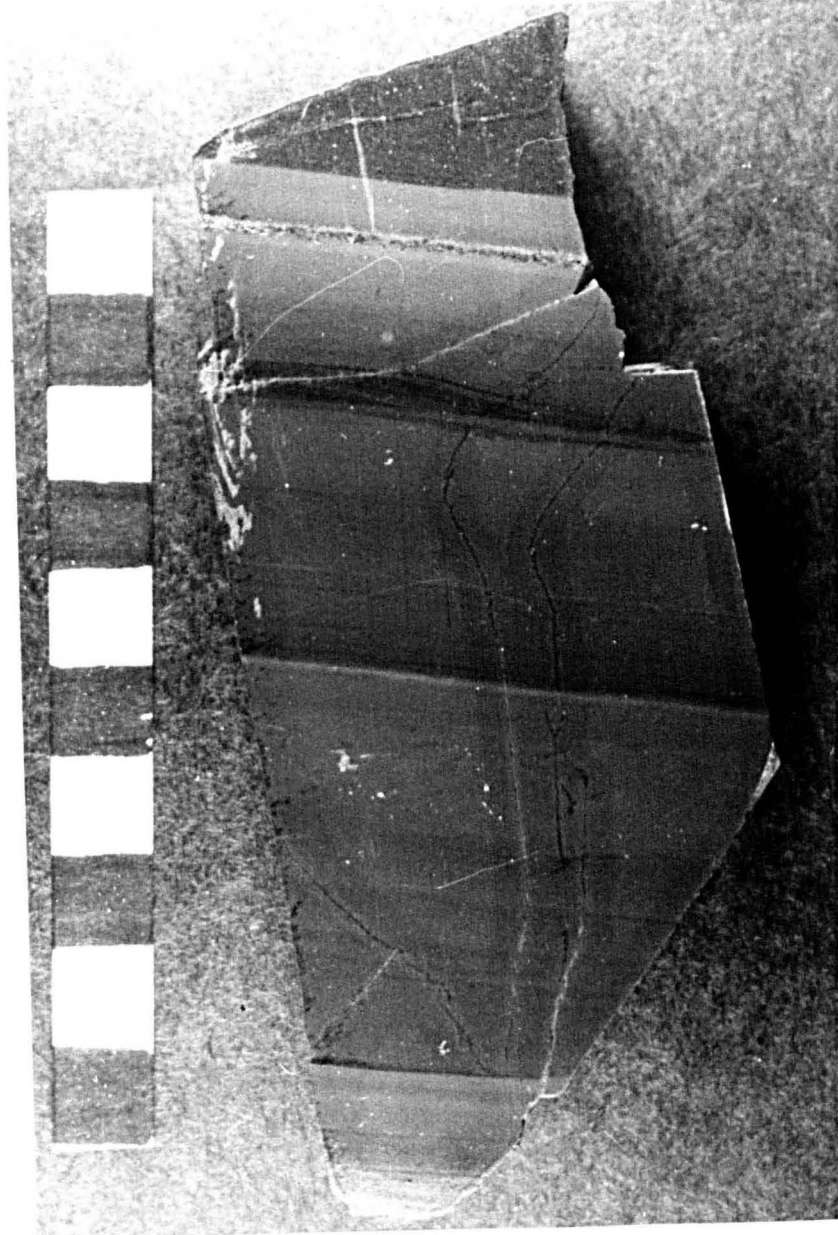


PLATE 28

**A. Parallel-bedded very fine sand to silt
grade tuffs, showing ripple cross-
lamination and soft sediment faults.
Chloritized pumice fragments are abundant.
Specimen BK33, horizon BT2, locality 22.
(K 4)**

**B. Parallel-bedded tuffs rich in feldspar
crystals. Directional load casts at
the base of the upper, coarse bed, and
ragged lava fragments in the lower unit.
Specimen BK44, horizon BT4, locality 15.
Scale in cm. (I 27)**

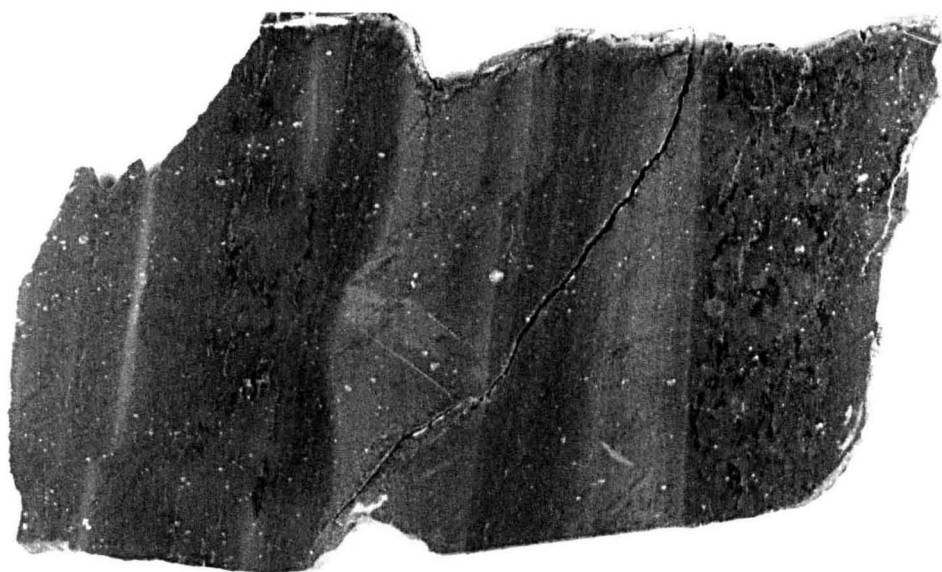
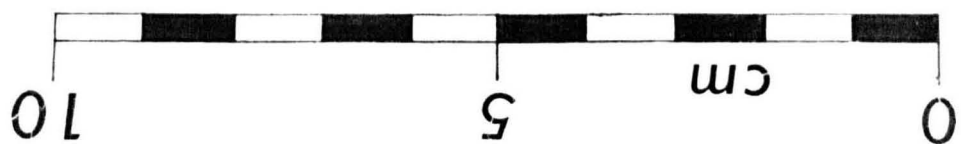


PLATE 29

**A. Fine-grained bedded tuff overlain by
lapilli tuff with various lithic fragments,
including lava and quartzose sandstone.
Specimen BK17, near locality 12. (I 23)**

**B. Well-sorted lithic tuff, consisting of
andesite grains of various types. Specimen
BK7, locality 7. (I 30)**

Scale in cm.



BK 7



PLATE 30

A. An active basaltic aa flow on the north side of Mount Etna, Sicily, on 30th April, 1975. The flow front is 2 to 3 m high, and is advancing toward the camera at a speed of several metres per minute.

Note the breccias in front of and on top of the flow. The massive molten lava showing in the centre and right of the photograph is red hot. (tr 229)

B. Bedded ashfall tuffs exposed in the crater wall of Vulcano, Aeolian Islands, Italy.

The tuffs dip away from the crater at up to 30° . The dark tephra represents a later eruption than the underlying light coloured tuffs. Note the development of gullies on the lower crater walls.

(tr 62)



PLATE 31

A. Recent parallel-bedded acid pumice tuffs of ashfall origin, Lipari, Aeolian Islands, Italy. Note the presence of low angle cross bedding and water escape structures in the lower part of the photograph. Section approximately 1 m high. (tr 86)

B. Section to the right of A., showing a channel whose stepped, overhanging walls partly follow bedding planes in the ashfall tuffs. The channel is filled with darker coloured bedded material, possibly also of ashfall origin. Section approximately 3 m high. (tr 85)

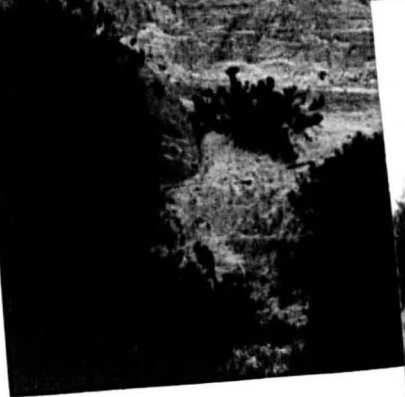


PLATE 32

A. View from the east of the main cone of Vulcano, Aeolian Islands, Italy. The highest point of the crater rim is 391m above sea level. Extensive gullying has removed much of the thin layer of light coloured tephra deposited during the 1888 - 1890 eruption of the volcano.
(tr 15)

B. Detail of a gully on the cone of Vulcano. The gully slopes downhill to the right at 25 to 30°. Note the stepped and overhanging channel walls, following bedding planes in the partly consolidated ashfall tuffs. Channel is approximately 1m deep.
(tr 67)

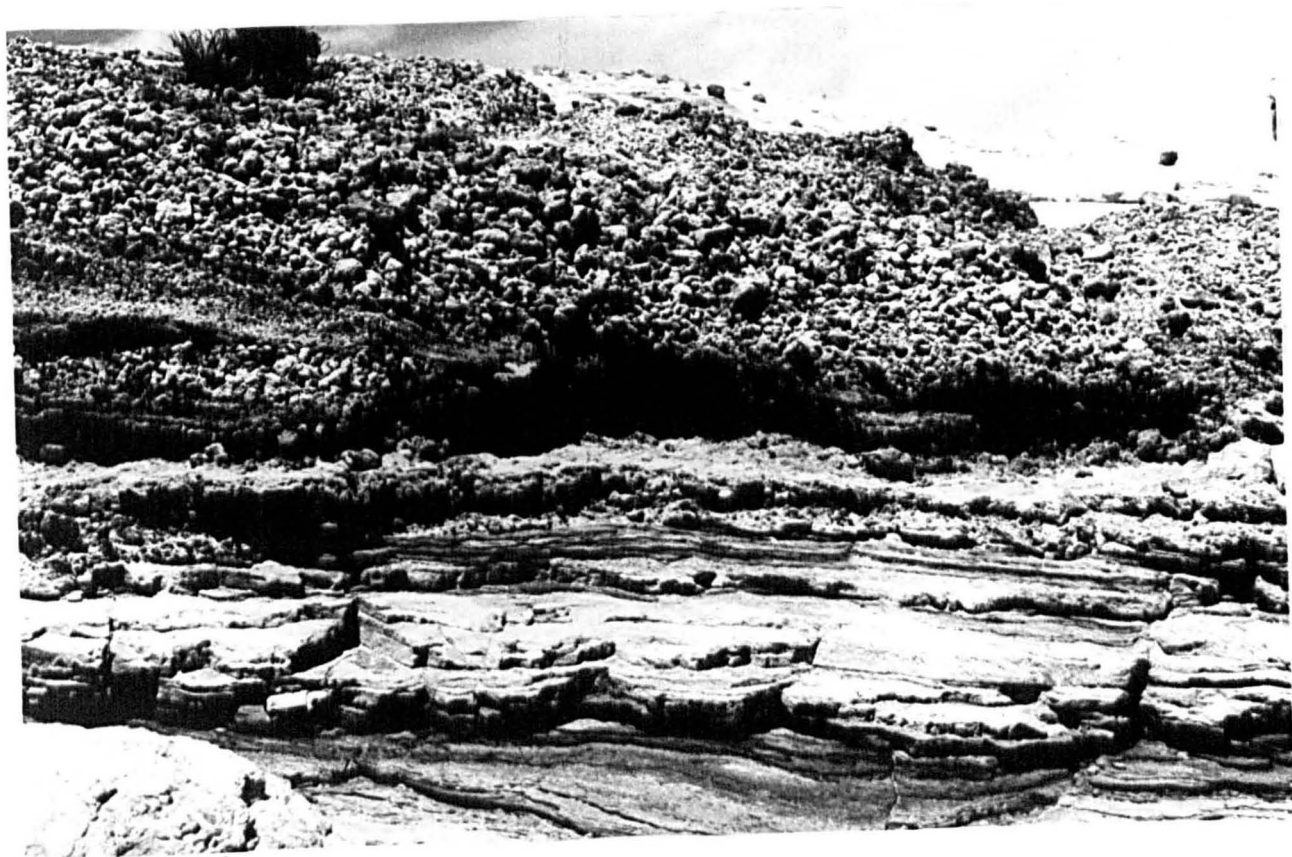


PLATE 33

**A. Flow folding in cleaved amygdaloidal
andesite, locality 18 (E 29)**

**B. Cleaved amygdaloidal andesite showing
large gas cavity, locality 18. (E 28)**

Lens cap 5 cm diameter.



PLATE 34

**A. Flow banding on weathered surface of
andesitic lava, locality 6. Top to
left. (B 27)**

**B. Flow jointing in andesitic lava,
locality 7. Exposure meter 9 cm
long. (C 10)**

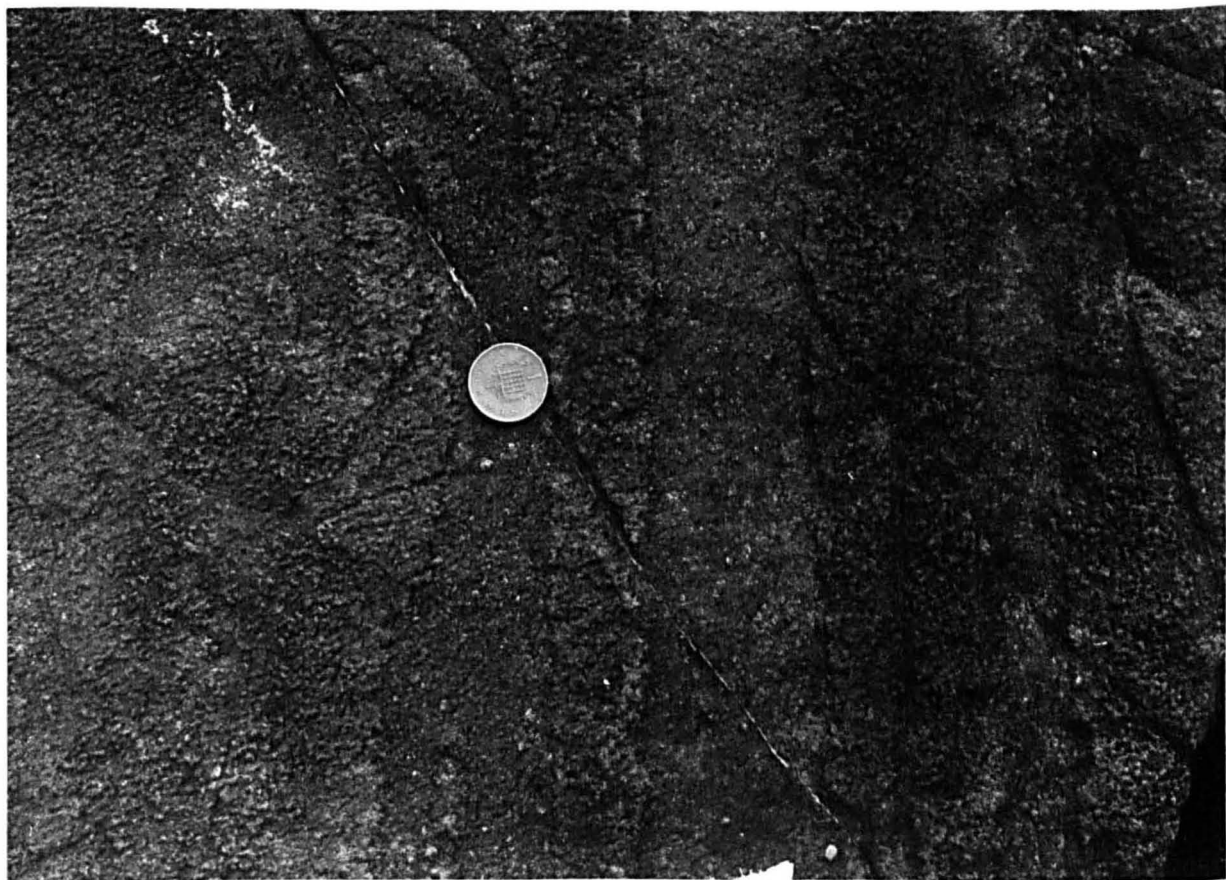


PLATE 35

**A. Autobrecciated andesitic lava,
locality 37. Hammer 30 cm long.
(K 17)**

**B. Autobrecciated andesitic lava
with fine-grained lava matrix,
standing out on the weathered
surface. Hammer 40 cm long.
(C 28)**



PLATE 36

**A. Autobrecciated andesite, loose boulder,
locality 17. Exposure meter 9 cm.
long. (C 32)**

**B. Rubbly autobrecciated andesite, Smaithwaite
road cutting. Lens cap 5 cm. diameter
(K 1)**



PLATE 37

**A. Autobrecciated andesite, with irregular
lava clasts in a tuff matrix. Locality
2. Lens cap 5 cm diameter. (A 7)**

**B. Autobrecciated flow banded andesite,
locality 18. Exposure meter 9 cm
long. (E 32)**



PLATE 38

A. Autobrecciated top of an andesitic lava flow (lighter coloured), with a hollow filled by darker coloured heterolithologic breccia. Lava flow dips towards lower right. Locality 13. Notebook 20cm long. (C 30)

B. Close-up of lower right-hand part of A, showing jigsaw-fit autobreccia, with slight movement of the uppermost lava fragments, overlain by the darker coloured breccia. Lens cap 5 cm diameter. (C 31)



PLATE 39

**A. Autobrecciated andesite with matrix
of fine-grained bedded tuff, Smaithwaite
road cutting. (H 18)**

**B. Fissure in autobrecciated andesitic
lava flow, filled with parallel-
bedded fine-grained tuff. Locality
37. (F 7)**

Lens cap 5 cm diameter



PLATE 40

Disturbed parallel-bedded fine-grained

tuff matrix from interstices of autobrecciated

lava, locality 37. Scale in cm. (M 16)



PLATE 41

**A. Pillow-like structures in andesitic
lava, locality 18. (E 27)**

**B. Irregularly shaped pillows of
andesitic lava (L) enclosed in
disrupted bedded tuff (T) at the
base of a lava flow, locality 6.
(B 23)**

Lens cap 5 cm diameter.

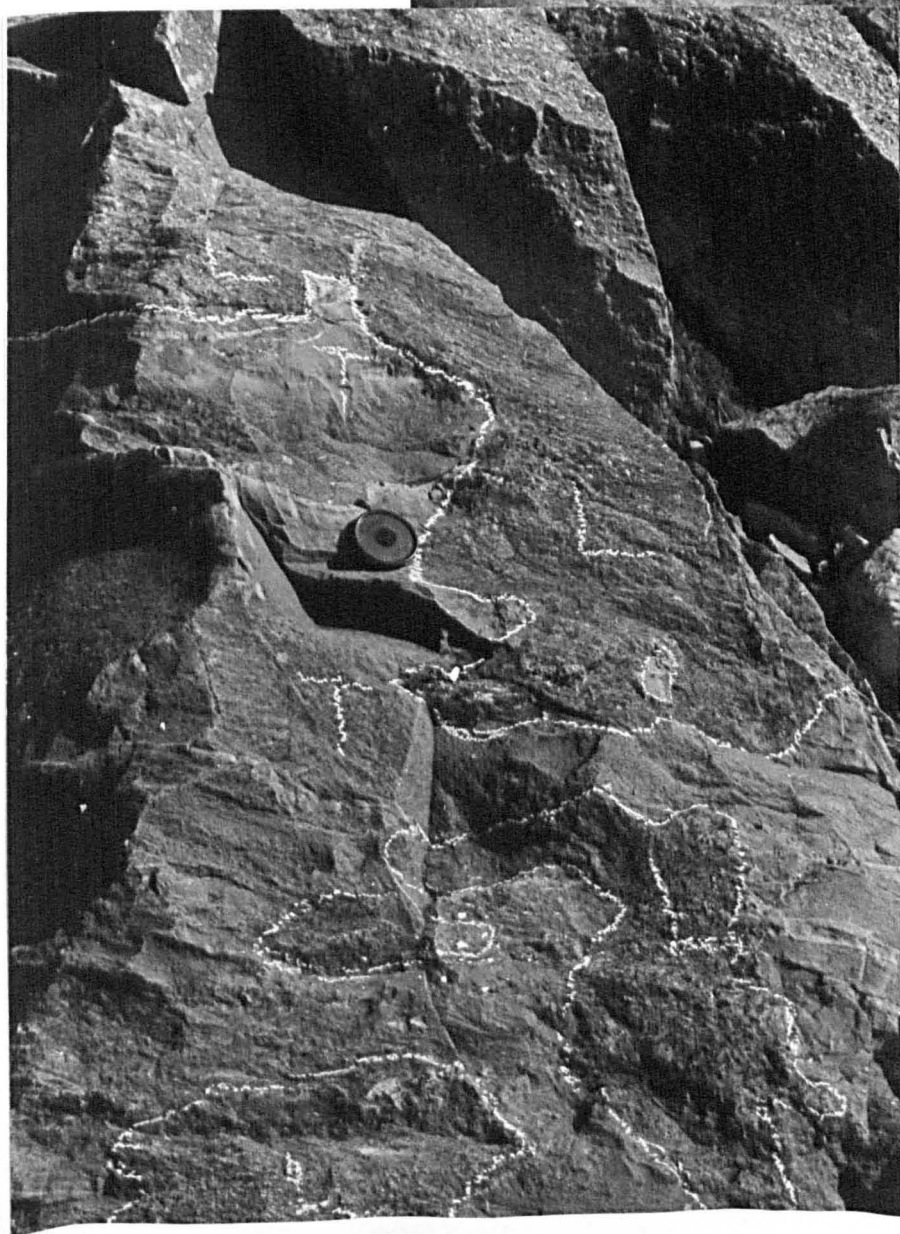


PLATE 42

**A. Cross-section of columnar jointing
in andesitic lava, locality 37
(during low lake level). Hammer
30cm long. (K 18)**

**B. Perlitic cracks in varnished
section of devitrified glassy
andesite. Alteration has
occurred along the cracks,
and small spherulites are
seen at lower right. Shoulthwaite
road cutting.**

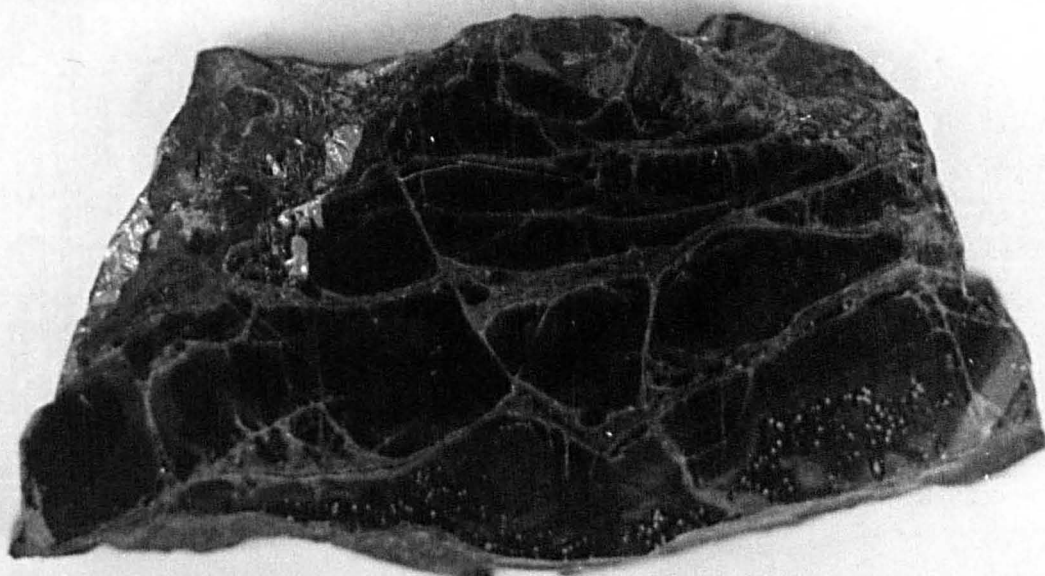
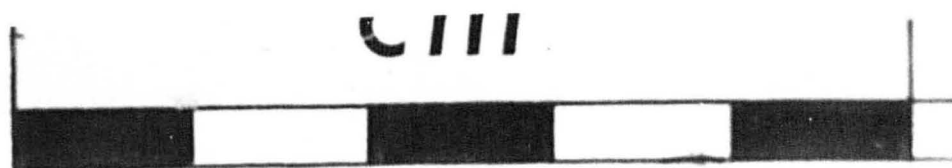


PLATE 43

A. Andesitic intrusion (smooth surface) with large inclusions of andesitic breccia (rough texture), locality 9. Scale in 10 cm divisions. (C 14)

B. Peperite, containing andesite blocks within partially disrupted bedded tuffs, locality 13. Hammer 40 cm long. (C 26)



PLATE 44

Plates 44 to 48 show various features of the andesitic sill at locality 25, Yewhow Wood. The sequence of photographs starts low in the section, and ends in the tuffs above the intrusion.

A. Autobrecciated andesite, showing blocks with chilled edges in a fragmental andesite matrix. (E 11)

B. Andesite pillows in matrix of brecciated andesite. (E 10)

Lens cap 5 cm diameter.

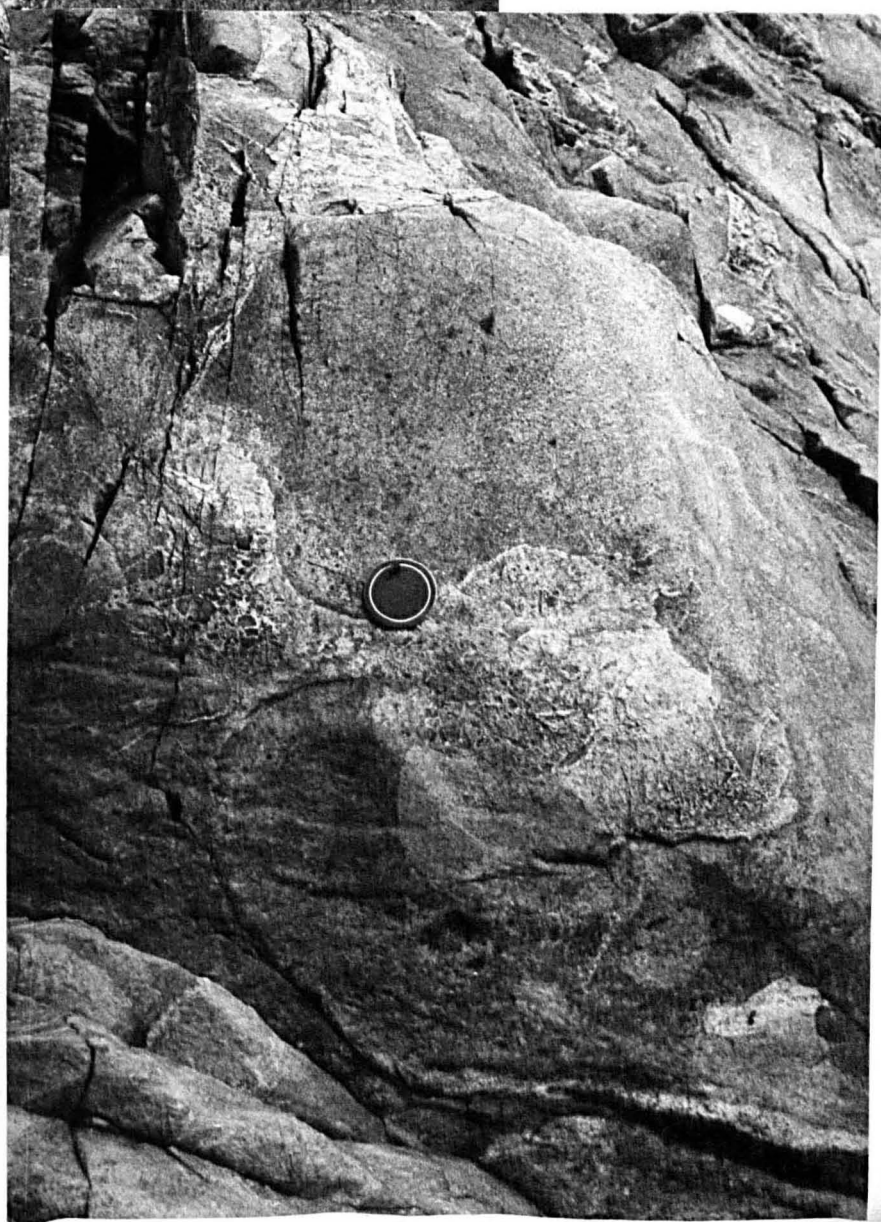
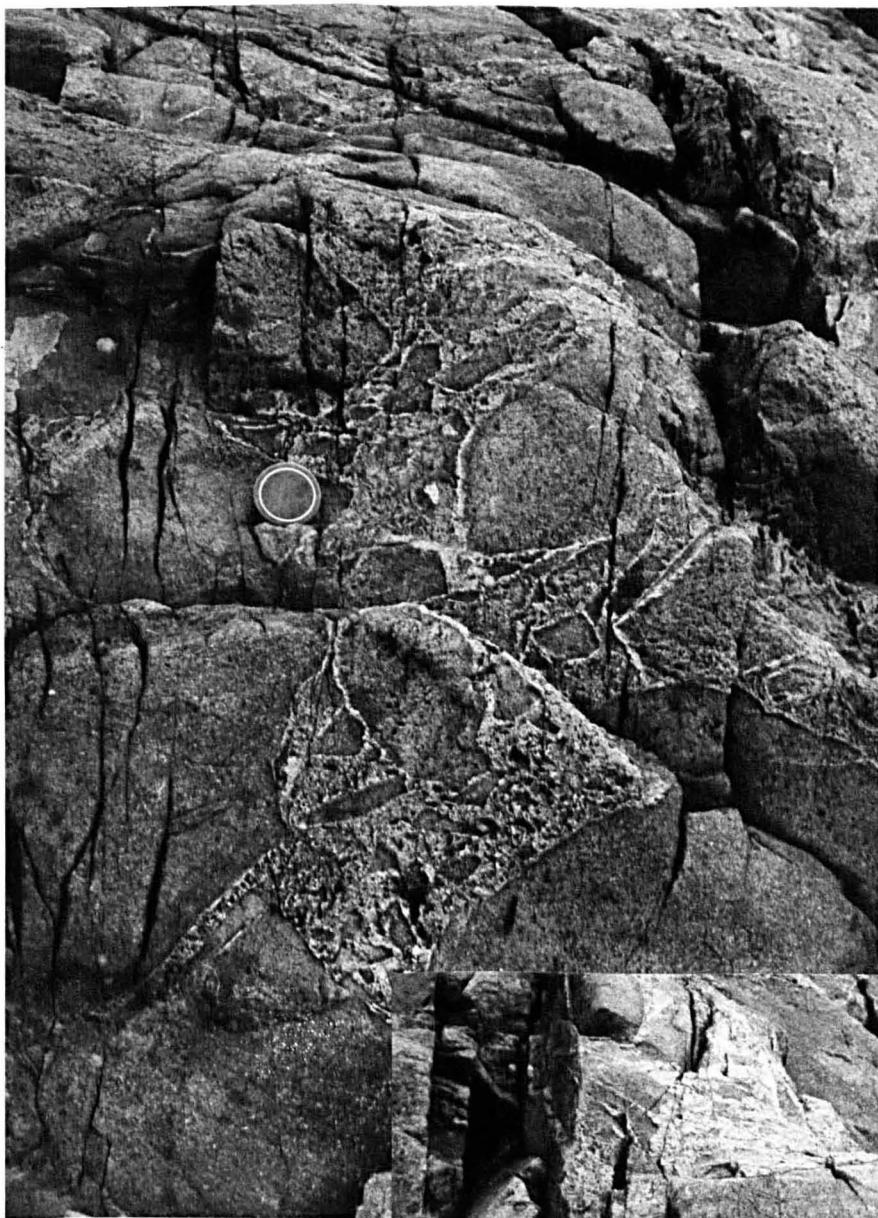


PLATE 45

**A. Andesite pillows in a matrix of red
tuff. (E 8)**

**B. Pillows and angular blocks of andesite
with chilled edges, in a matrix of
red tuff. (E 6)**

Notebook 20 cm long



PLATE 46

**A. Close-up of angular block of plagioclase-
phyric andesite showing chilled edge and
surrounded by red tuff. (E 7)**

**B. Plan view of vesicular andesite tongue
(light colour) with chilled edge,
overlying red tuff (dark). (E 4)**

Lens cap 5 cm diameter

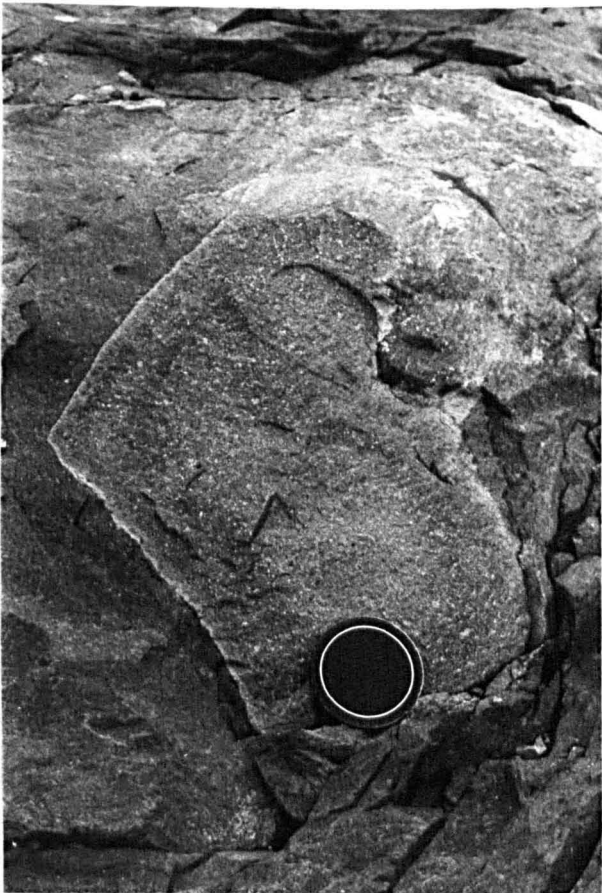


PLATE 47

A. Varnished rock slice showing irregular contact between vesicular andesite (above) and red tuff (below). Scale in cm. (M 17)

B. Isolated pocket of "jigsaw fit" autobrecciated andesite. Interstices are filled with quartz. Lens cap 5 cm diameter. (E 3)

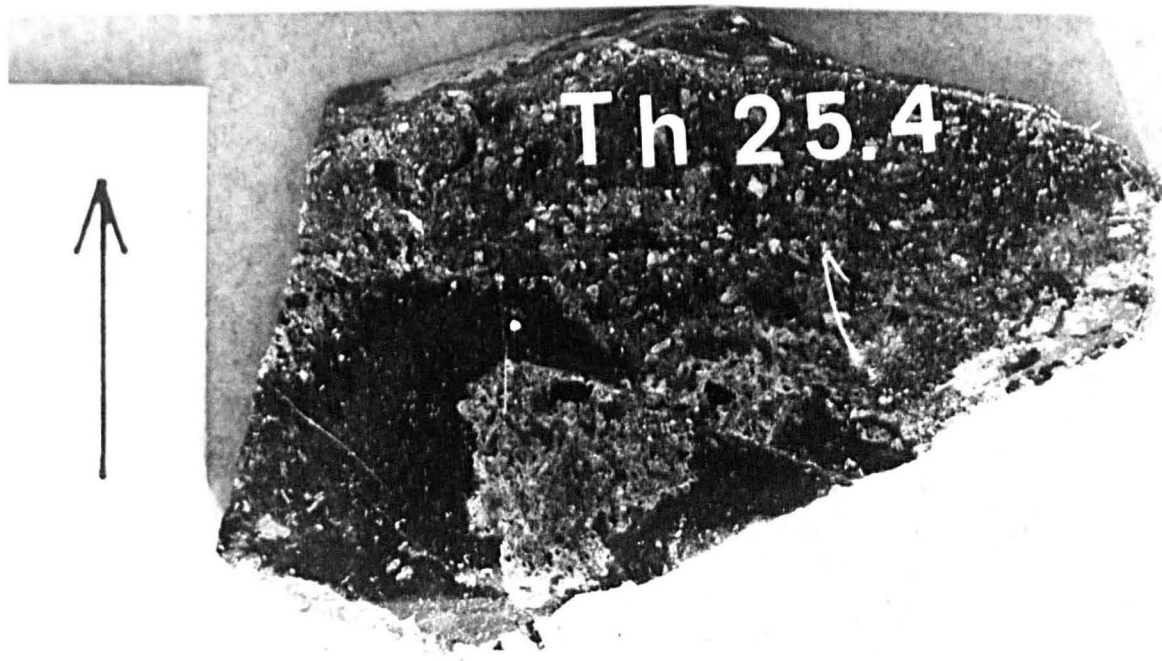
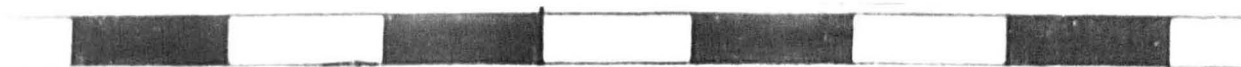


PLATE 48

Plan view of soft-sediment faults in disturbed

parallel-bedded tuffs overlying andesitic

intrusion. Lens cap 5 cm across. (H 25)



PLATE 49

**A. Disrupted bedded tuff, locality 12. Lens
cap 5 cm diameter. (C 25)**

**B. Varnished slice of lithic/crystal tuff
from A. (M 14)**

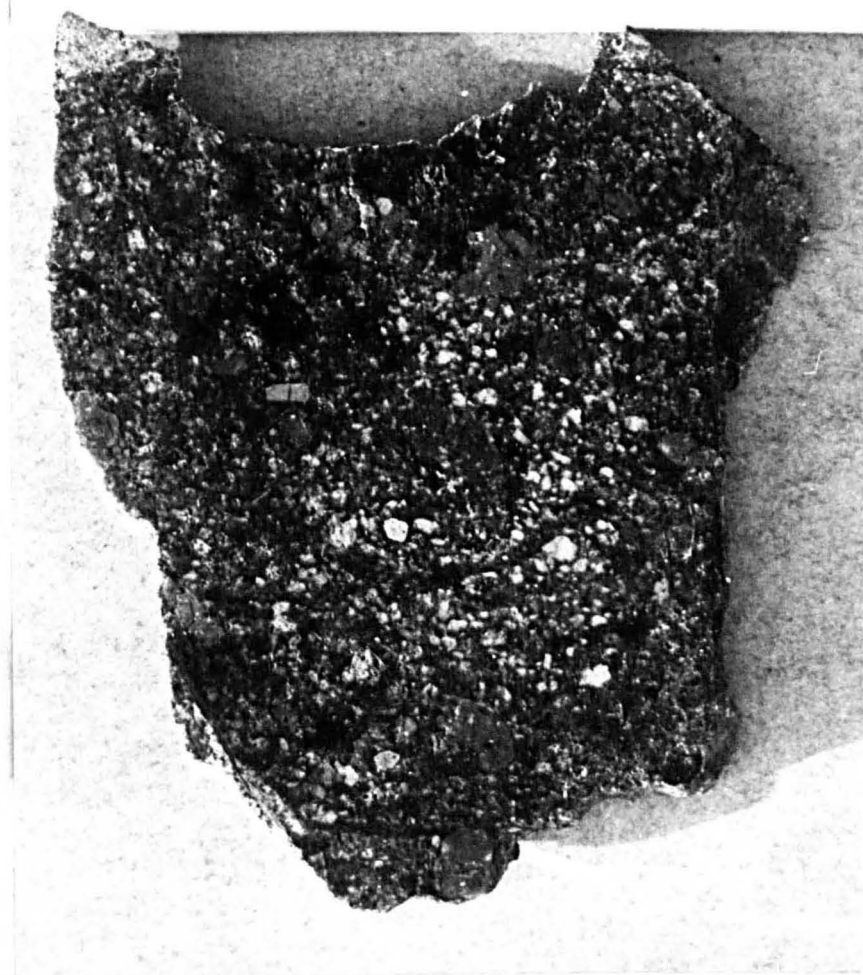
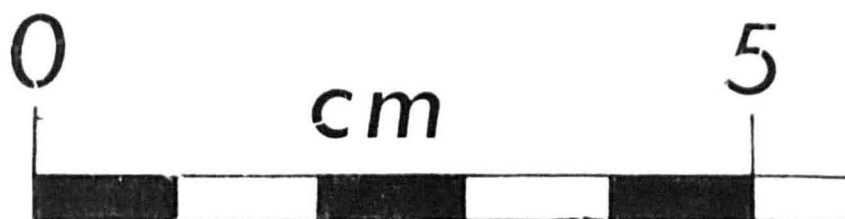


PLATE 50

**A. Dyke with irregular margins
intruding andesitic lavas,
locality 7. Exposure meter
9 cm long. (C 12)**

**B. Thin flow banded andesite dyke
cutting welded tuffs at locality
38. Notebook 20 cm long. (K 14)**

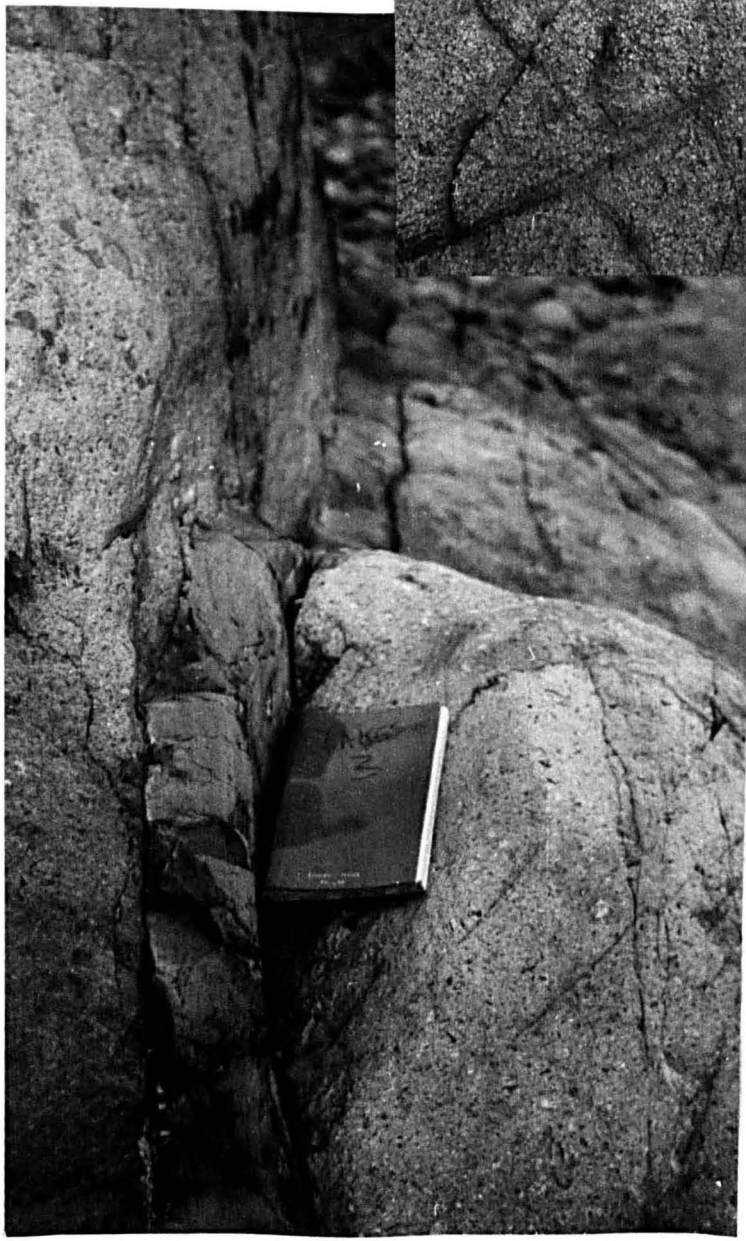


PLATE 51

A. Partially welded tuffs, showing
weathered-out fiammé and abundant
undeformed acid lava clasts,
locality 27. (E 20)

B. Plan view of welded tuff with black
fiammé, locality 28. (E 21)

Lens cap 5 cm long.

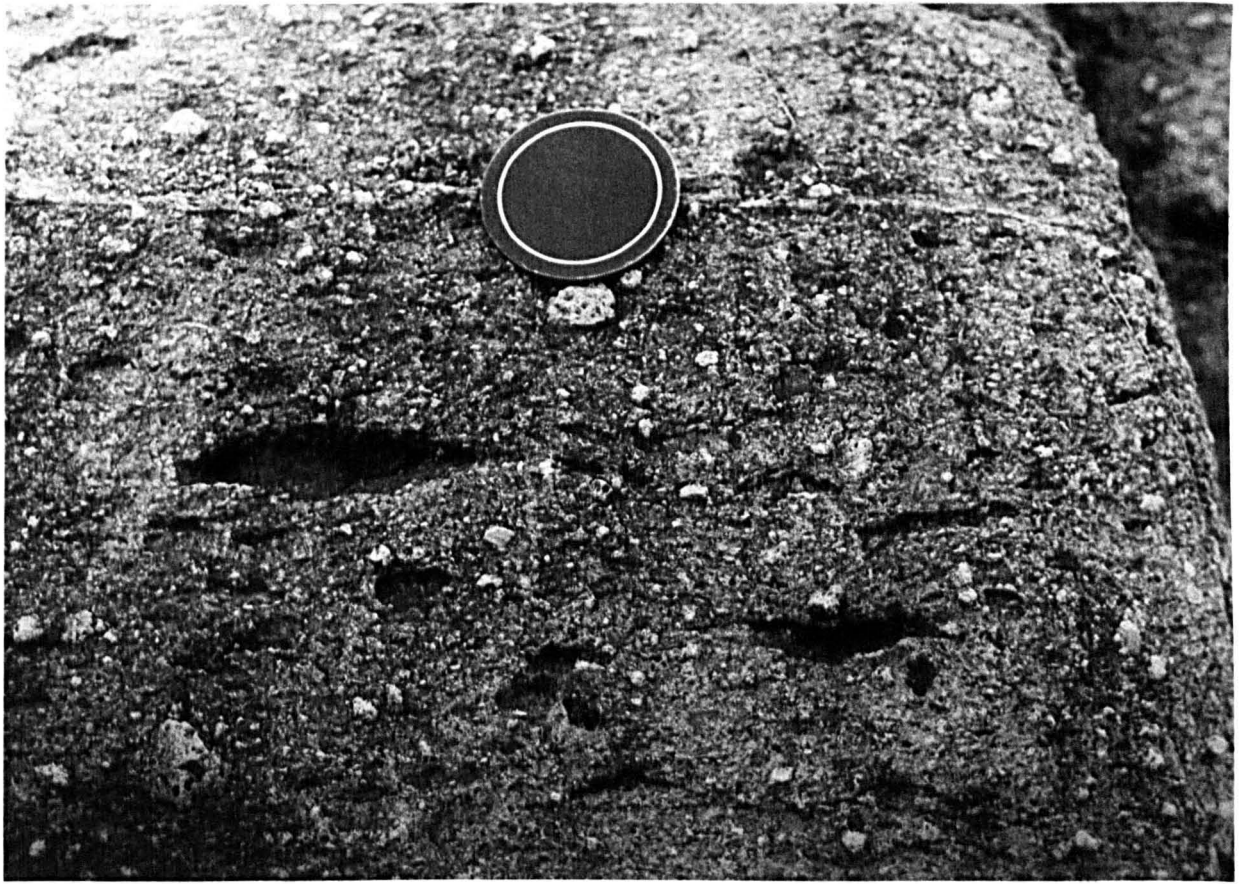


PLATE 52

A. Lowest exposed part of welded tuff-breccia, showing parallel bedding, locality 38. Hammer 40 cm long. (G 16)

B. Large welded tuff block contained in welded tuff-breccia of A. Lens cap 5 cm diameter. (K 11)

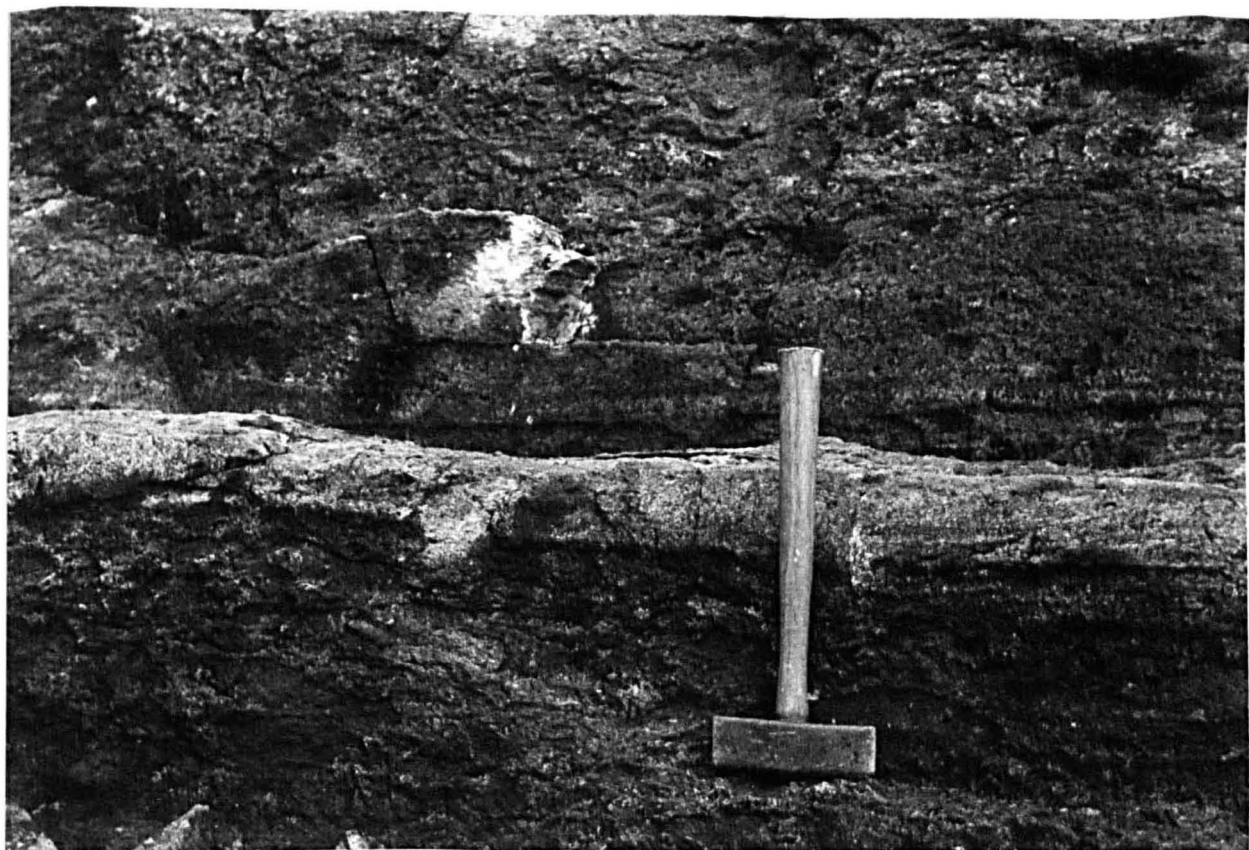


PLATE 53

**A. Plan view of welded tuff-breccia
of Plate 52, showing small lava
blocks (light) and roughly disc-
shaped fiamme (dark). (G 20)**

**B. Welded tuff with well-developed
eutaxitic texture, locality 38.
(G 22)**

Lens cap 5 cm diameter

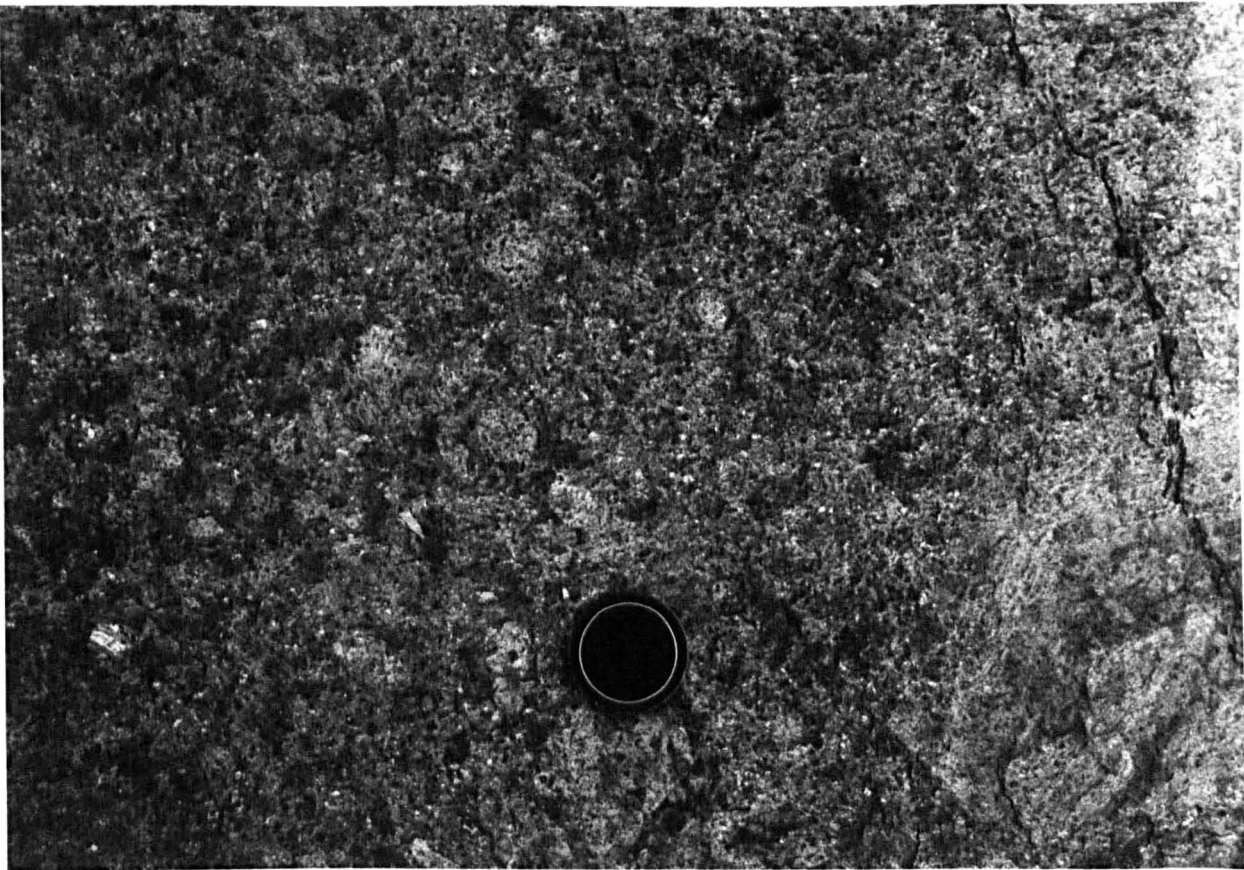


PLATE 54

A. Varnished section of welded acid tuff with chloritic *fiammé* and feldspar crystal fragments, showing good eutaxitic texture. Specimen Th38.6, from the outcrop shown in Plate 53B. Scale in cm. (M 20)

B. "Jigsaw fit" autobrecciated zone in welded tuffs, locality 29. Hammer 40 cm long. (E 24)

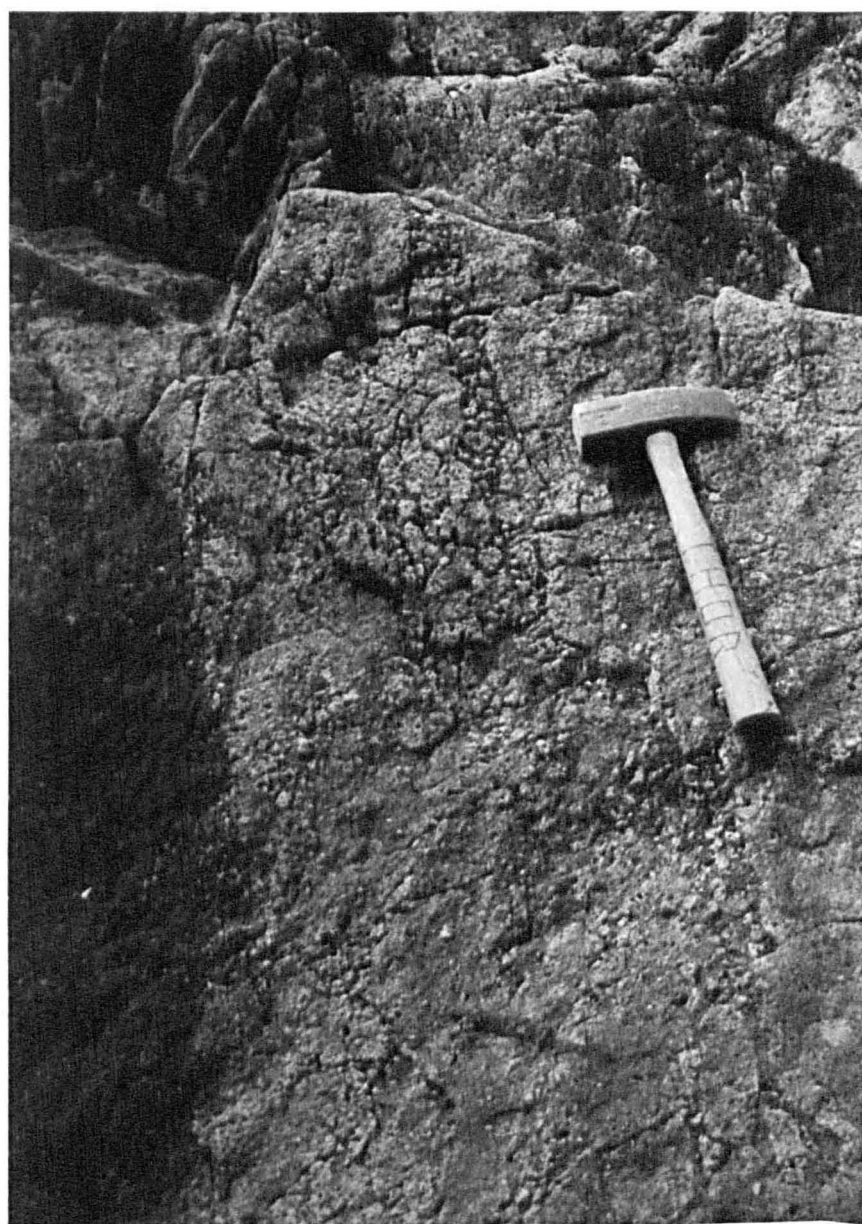
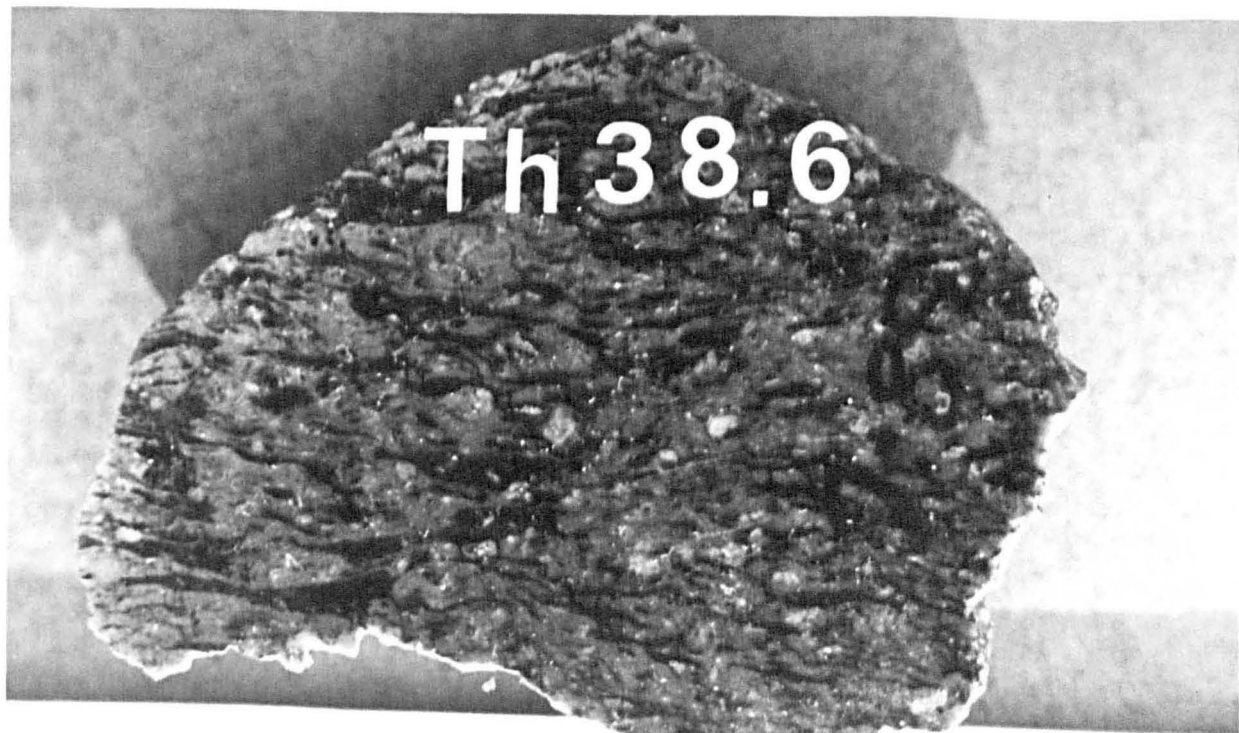


PLATE 55

**A. Clast-supported heterolithologic
breccias, locality 3. Lens cap
5 cm diameter (H 20)**

**B. Large bedded tuff clast in
heterolithologic breccias,
locality 3. Hammer 40 cm long.
(C 22)**

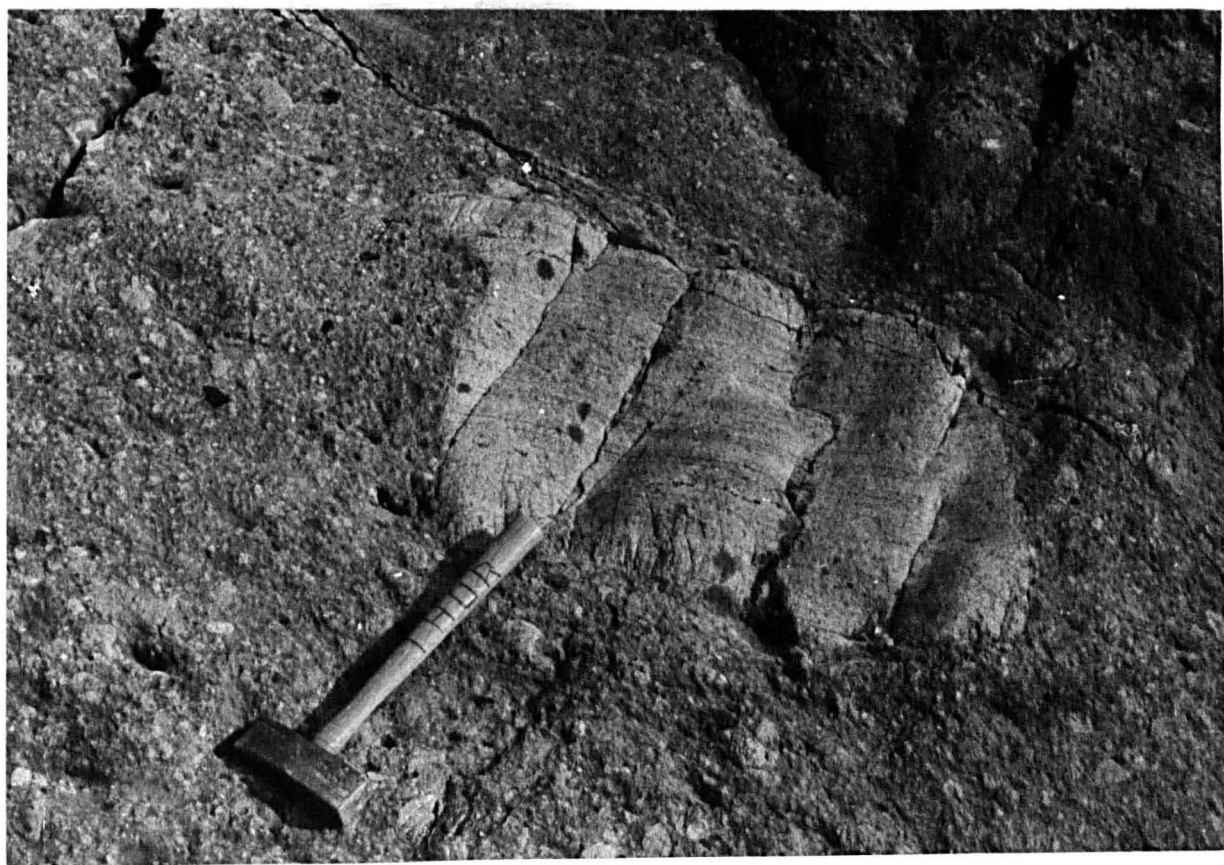
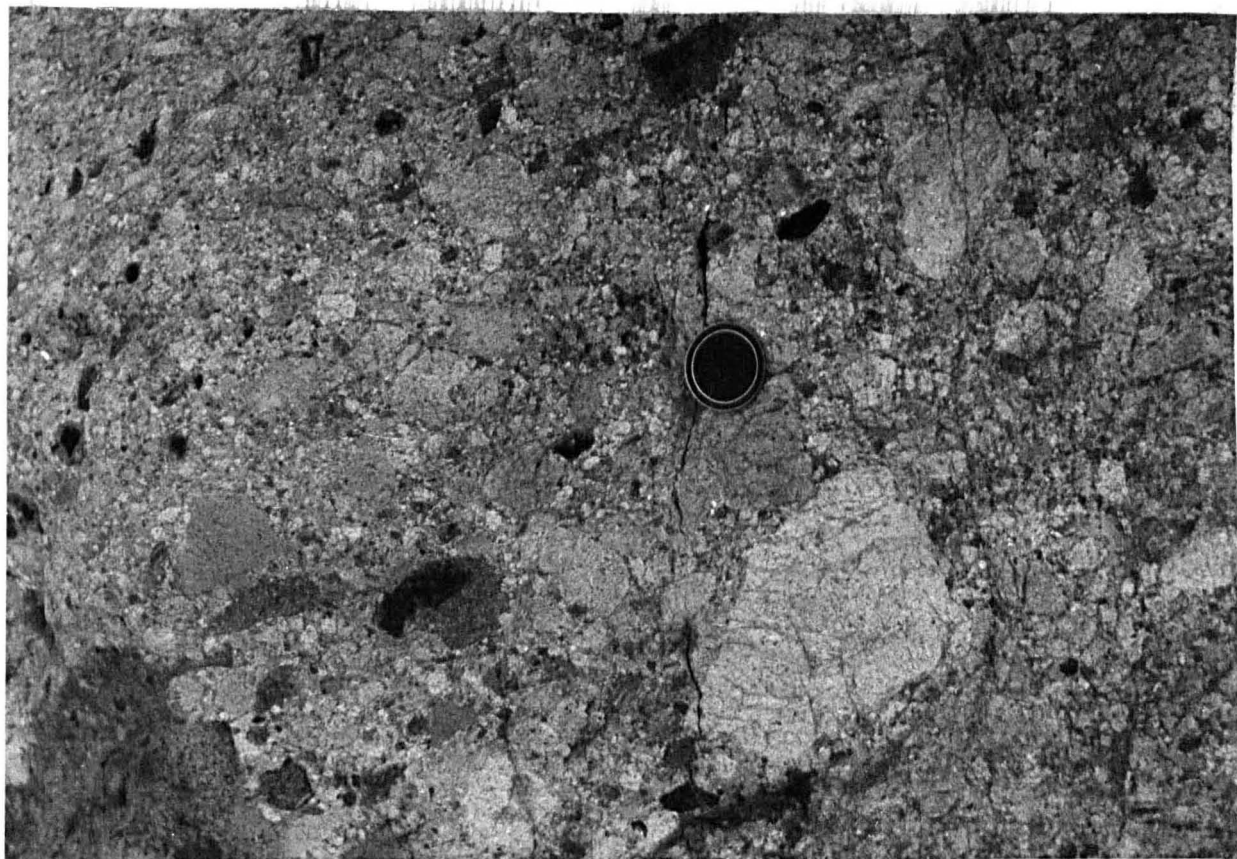


PLATE 56

**A. Deformed blocks of bedded tuff in a matrix
of coarse tuff, locality 6. Lens cap 5 cm
diameter. (A 21)**

**B. Conglomerate of partly rounded lava clasts,
locality 9. Hammer 40 cm long.**



PLATE 57

**A. General view of parallel-bedded coarse
tuffs, locality 44 (Binka Stone).
(H 29)**

**B. Parallel-bedded fine-grained tuffs,
locality 6. Notebook 20 cm long.
Younging to right. (B 18)**

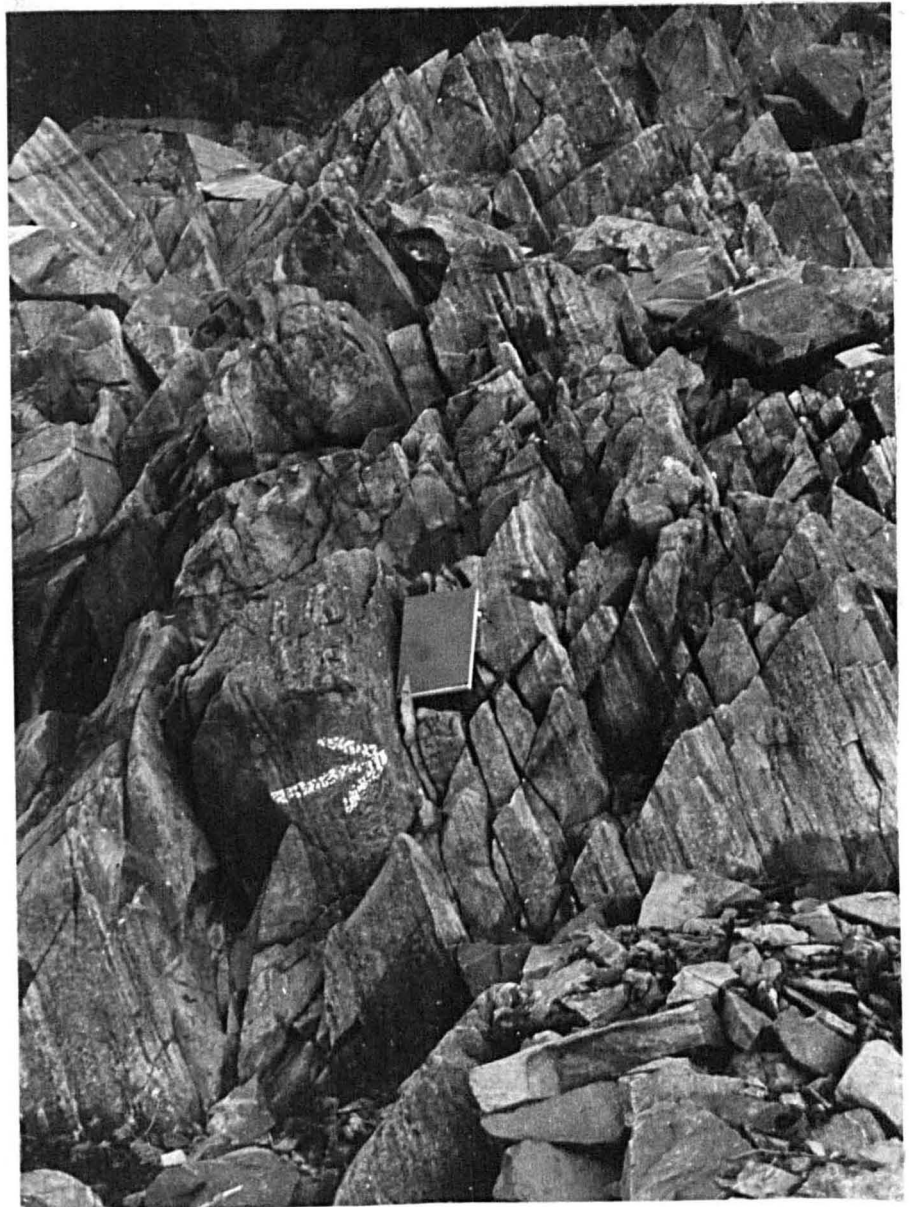


PLATE 58

A. Parallel-bedded acid tuffs of sand to clay grade. Ripple cross-lamination and graded bedding are present. Locality 37. (M 1)

B. Accretionary lapilli tuff. Note the presence of broken "rinds" of lapilli, and deformation by cleavage (running from top left to bottom right). Specimen Th. 37.25, locality 37. (M 13)

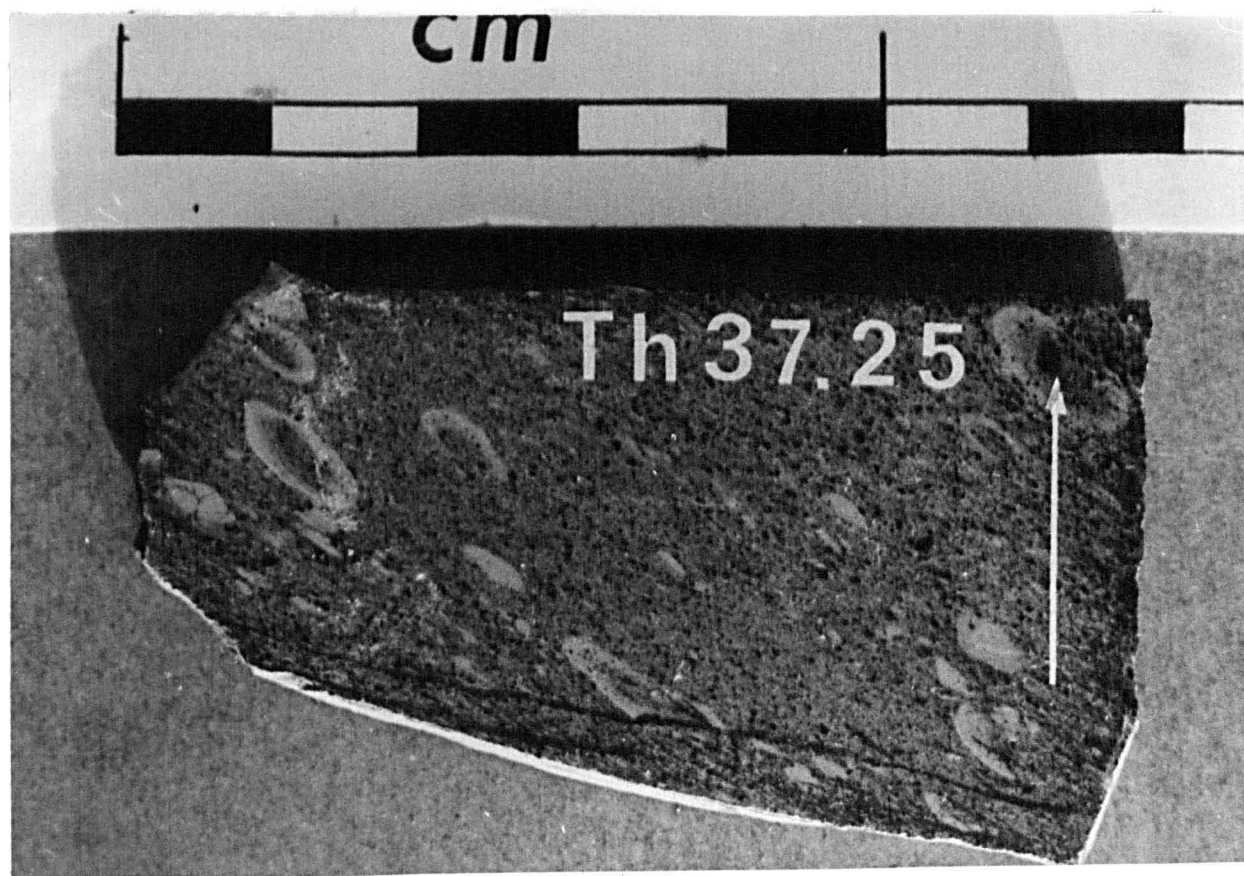
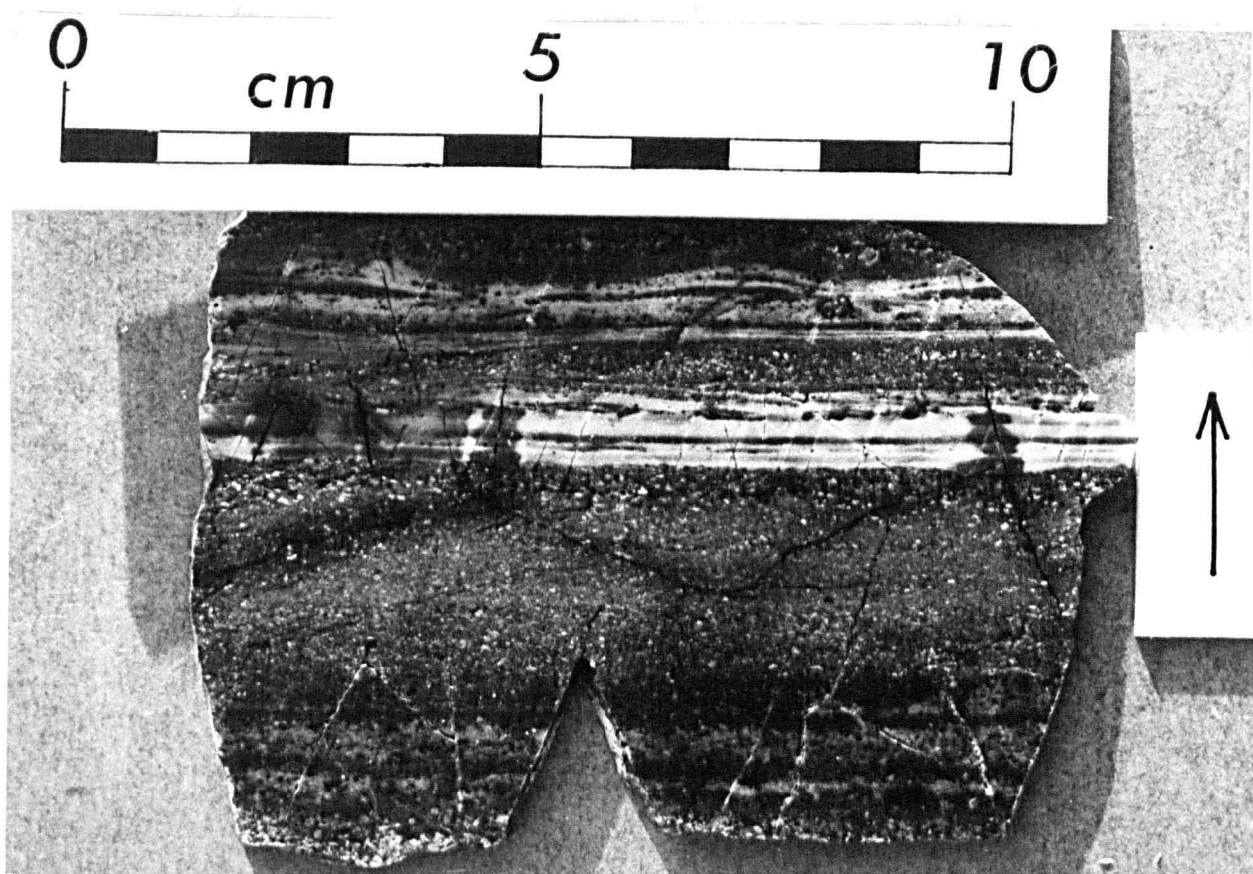


PLATE 59

**A. Autobrecciated andesite, consisting
of large andesite blocks in a matrix
of comminuted lava. 3 m below top
of upper andesite unit, top of Sour
Milk Gill (NY 228 123) (N 31)**

**B. Autobrecciated andesite, showing
"jigsaw fit" between the blocks.
Matrix of fine-grained, light
coloured tuff. Top of upper
andesite unit, Sour Milk Gill
(NY 231 122) (N 33)**

Hammer shaft 20 cm long

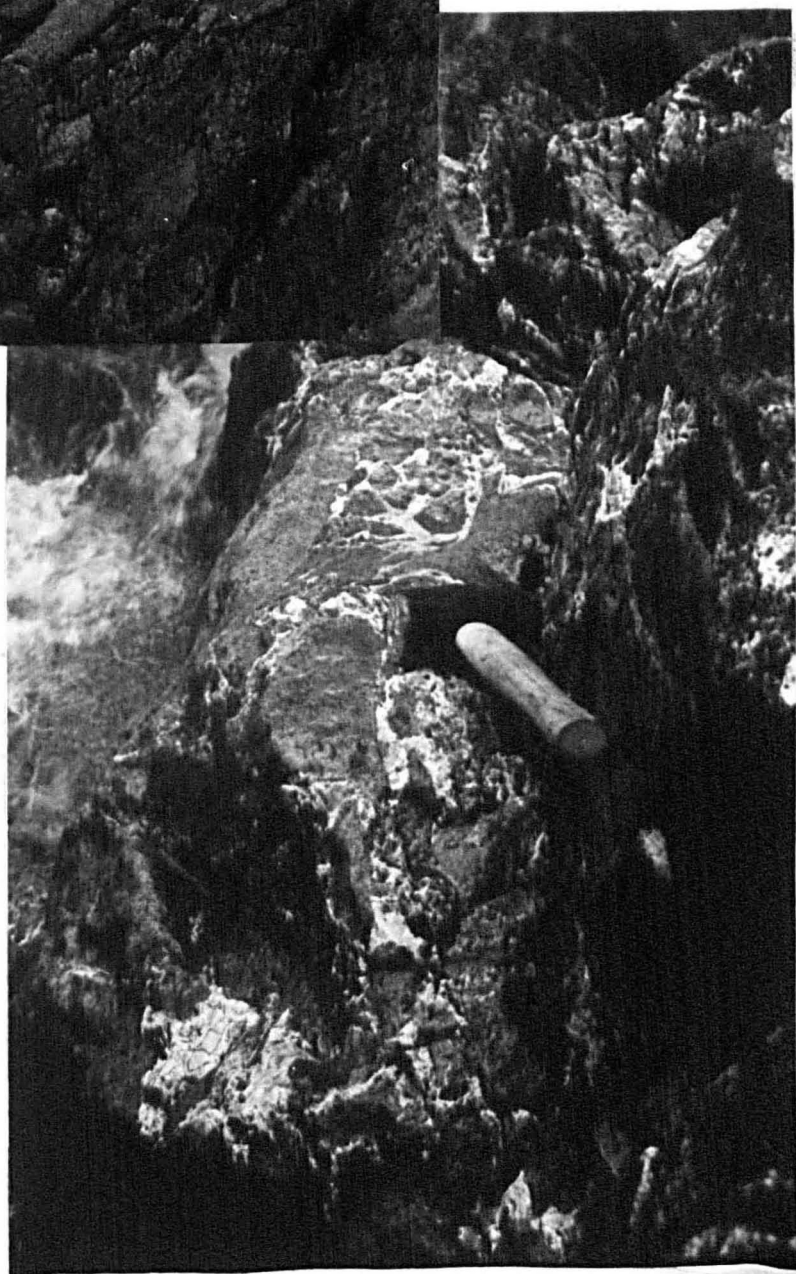


PLATE 60

- A. Thinly interbedded fine sand and silt-clay grade tuffs, showing even parallel bedding. The finer beds stand out on the weathered surface. Beds young to the right. Sour Milk Gill Tuff Member south of Sour Milk Gill (NY 227 121) Lens cap 5 cm diameter. (P 10)
- B. Silt-clay grade tuffs showing thin, even, parallel bedding, with thin fine sand grade interbeds (weathering in). The finer tuffs show parallel lamination. Lower bedded tuff unit, north of Sour Milk Gill (NY 232 124). Coin 2.8 cm diameter. (N 29)

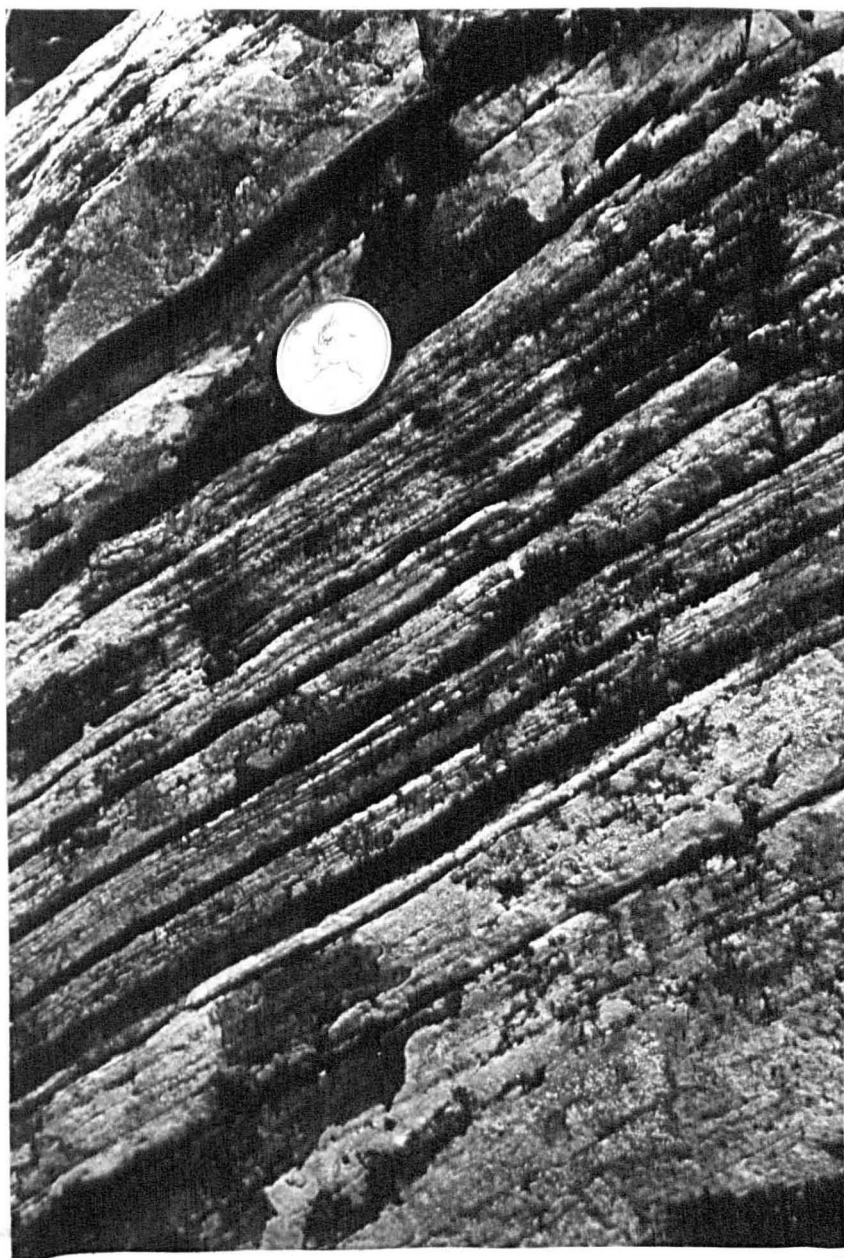
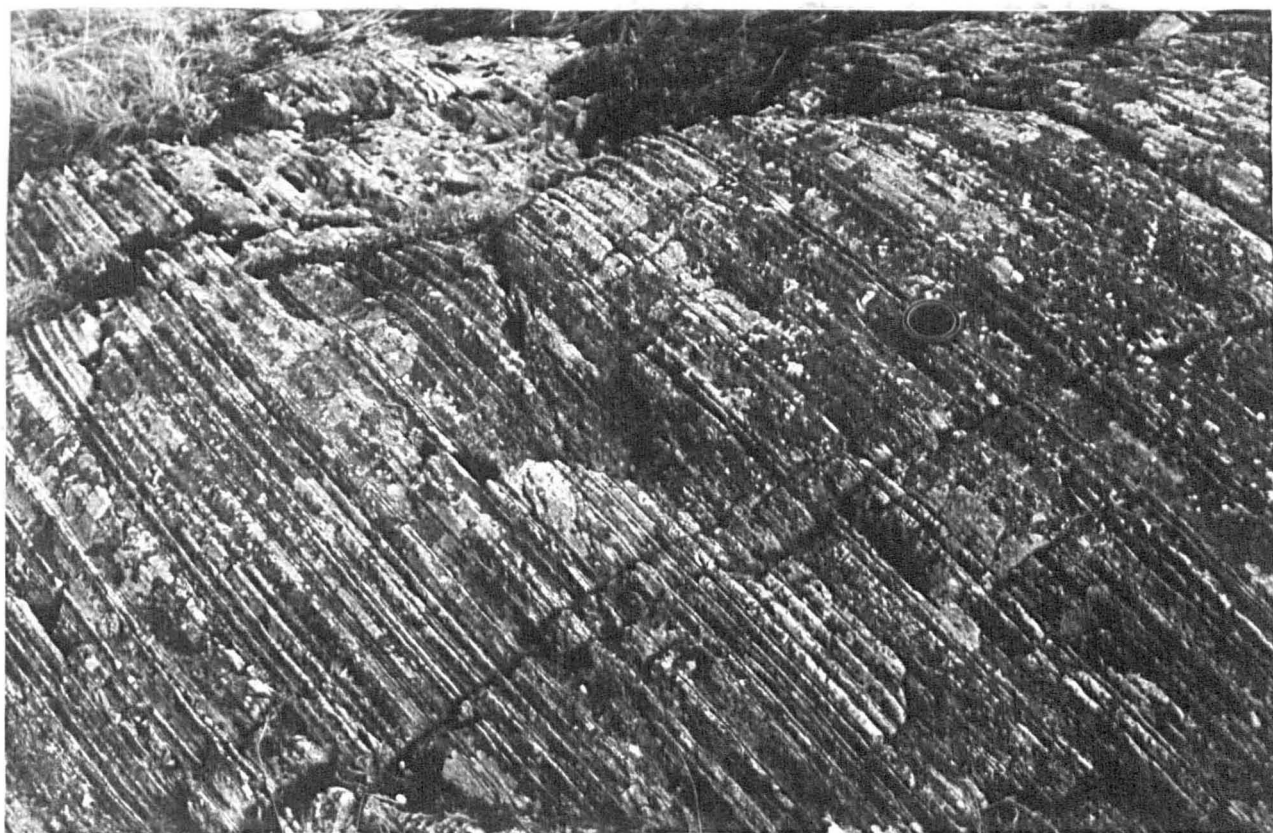


PLATE 61

Thick-bedded sand grade tuffs interbedded

with thin-bedded sand and silt grade tuffs.

Sour Milk Gill Tuff Member, south of Sour

Milk Gill (NY 227 121). Lens cap 5 cm

diameter. (P 9)

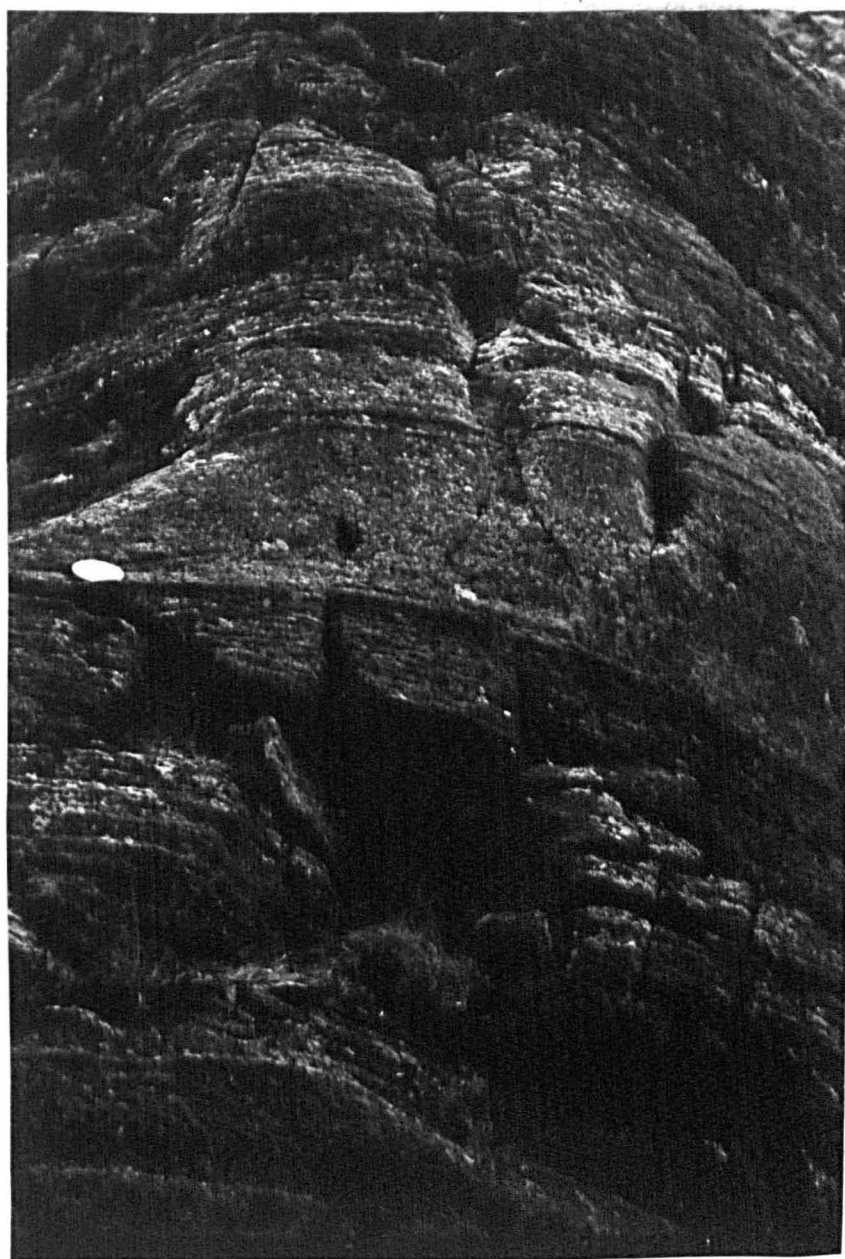


PLATE 62

- A. Current ripples with slightly sinuous
crests, draped by clay grade tuff.
Current direction up slab. Wavelength
about 10 cm. Sour Milk Gill Tuff
Member, Seathwaite Slabs (NY 233 122).
(P 32)

- B. Rippled bedding plane in bedded tuffs.
Note indistinct subordinate ripple
trend at 90° to the main trend. Loose
block, Sour Milk Gill. Notebook
20 cm long. (P 8)



PLATE 63

- A. Cross section of fine sand and silt-clay grade parallel- and wavy-bedded tuffs. Note symmetrical ripples developed in silt-clay grade tuff, and mantling of small scour by silt-clay grade material. Sour Milk Gill Tuff Member, at top of Gill (NY 227 122). Lens cap 5 cm diameter. (P 4)
- B. Bedding plane covered with probable adhesion ripples developed in silt grade tuff. Wind direction from top right or bottom left. Sour Milk Gill Tuff Member, near the Gill (NY 230 122). Coin 2 cm diameter. (P 28)

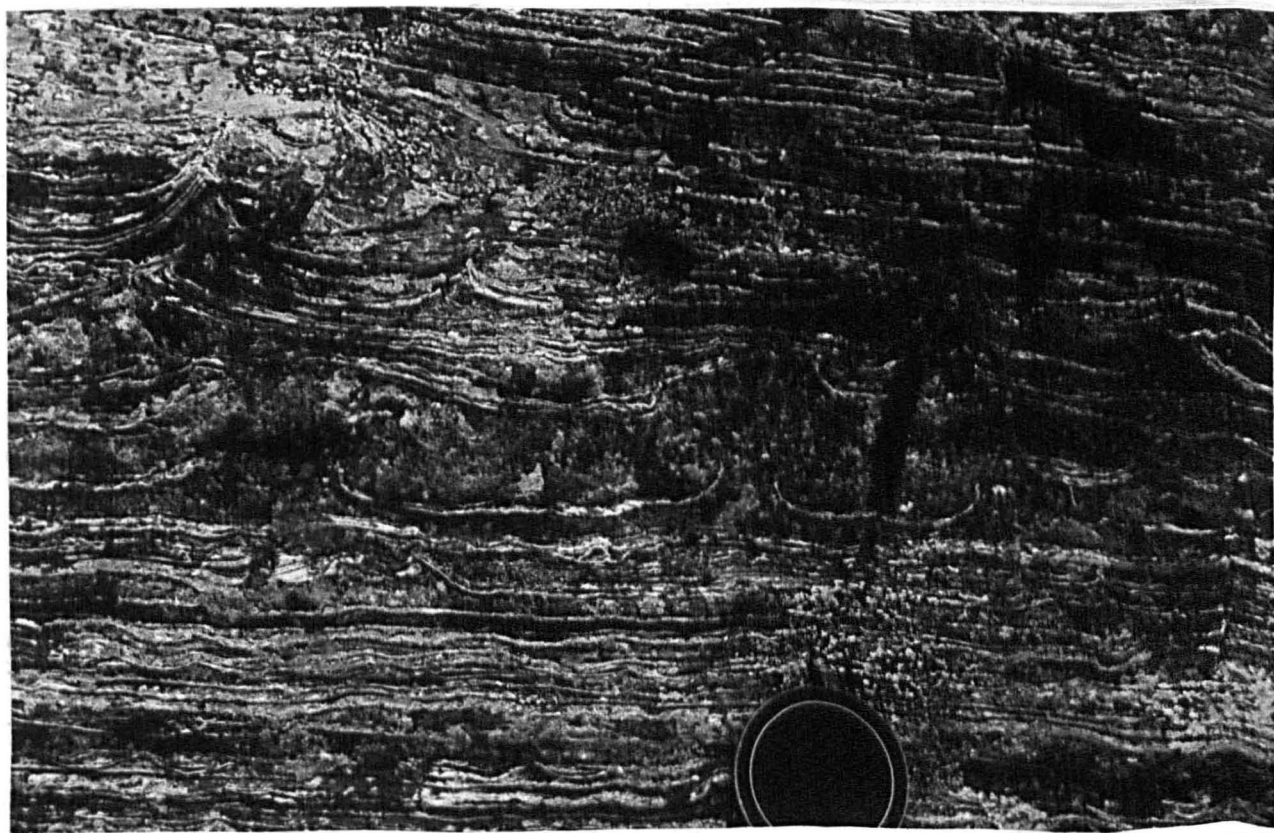


PLATE 64

- A. Bedding plane exposures, showing symmetrical, slightly sinuous crested ripples with mudcracks on a lower surface. Note also the prominent joint sets. Sour Milk Gill Tuff Member, in the bed of the Gill (NY 230 123).
Section approximately 4m high. (N 32)
- B. Cross section of in situ curled mudflakes in interbedded fine sand and silt-clay grade tuffs. Note also soft sediment faulting and folding towards top of photograph. Sour Milk Gill Tuff Member, top of Sour Milk Gill (NY 227 122) Lens cap 5 cm diameter. (P 1)

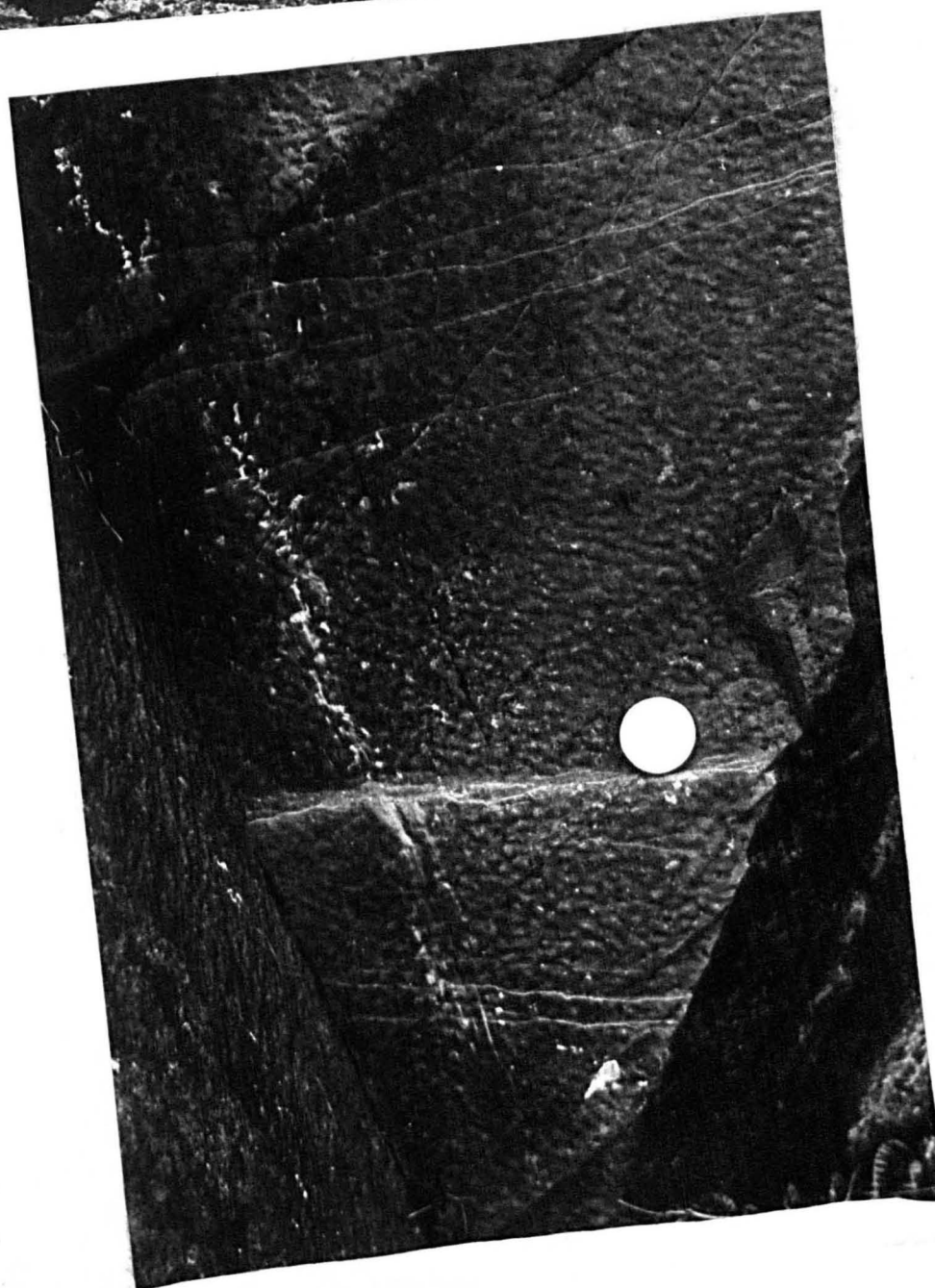
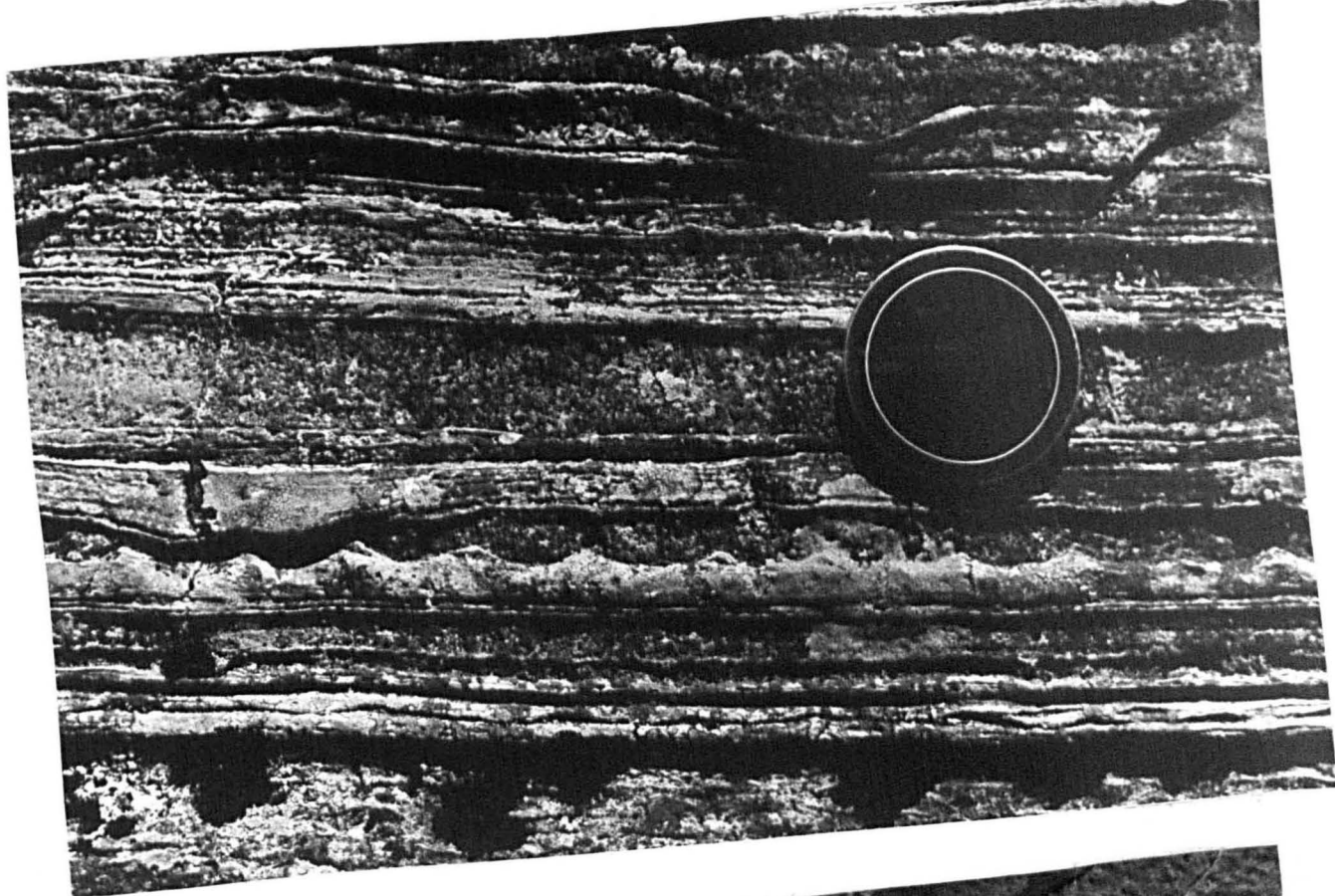


PLATE 65

A. Mudcracks on bedding plane of silt grade tuff, infilled with very fine sand grade material. Note thin mudcracks within the larger mudflakes. Lower tuff unit, north of Sour Milk Gill (NY 232 124). 10 cm divisions on tape. (N 28)

B. Desiccation cracks developed in peaty silt on the dried out bed of Thirlmere, for comparison with A. Notebook 20 cm long. (K 20)

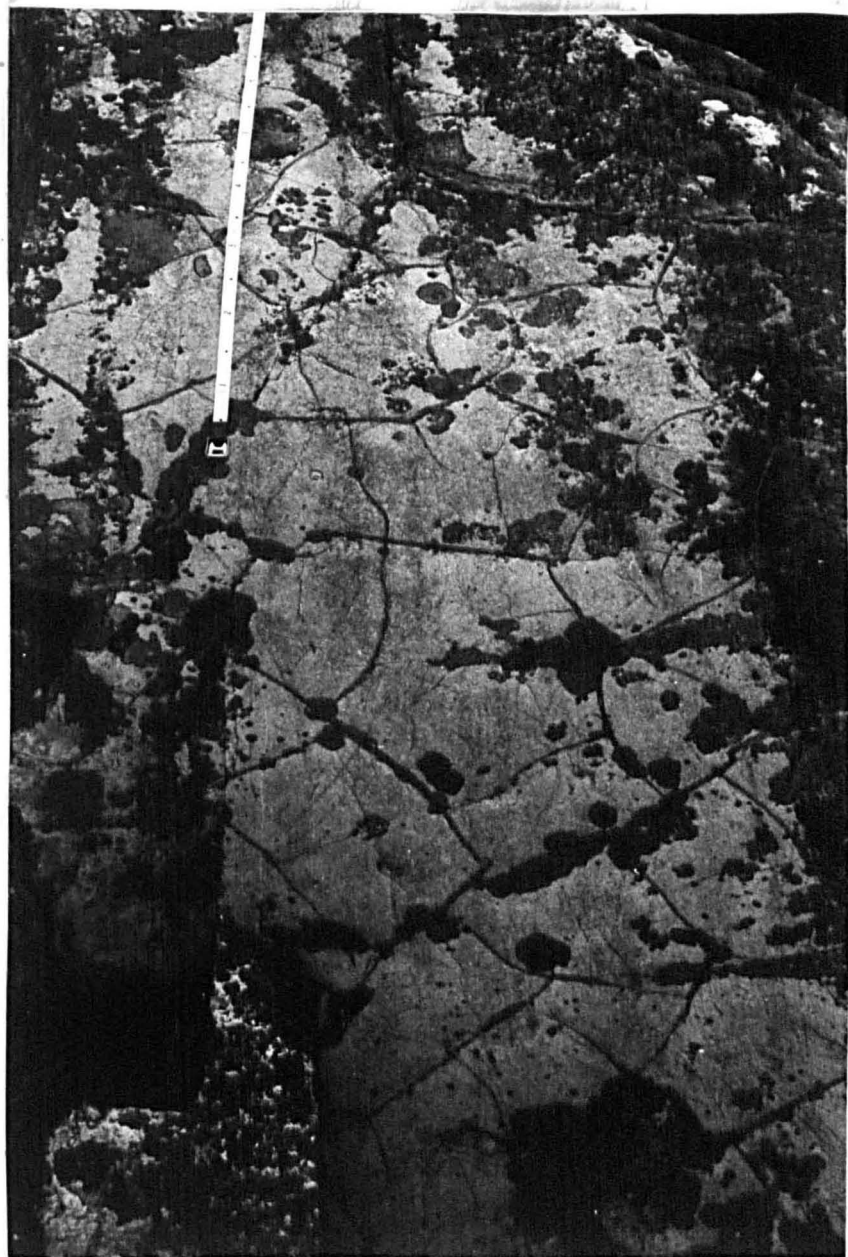


PLATE 66

A. Diapir or sand volcano of medium to coarse sand grade tuff, overlain by a thin veneer of clay grade tuff. Lower bedded tuff unit, north of Sour Milk Gill (NY 232 124). (N 27)

B. Faulting and brecciation of bedded silt-clay grade tuffs. The breccia toward the top of the photograph has a fine sand grade matrix. Sour Milk Gill Tuff Member, top of Sour Milk Gill (NY 227 122). (N 36)

Lens cap 5 cm diameter.

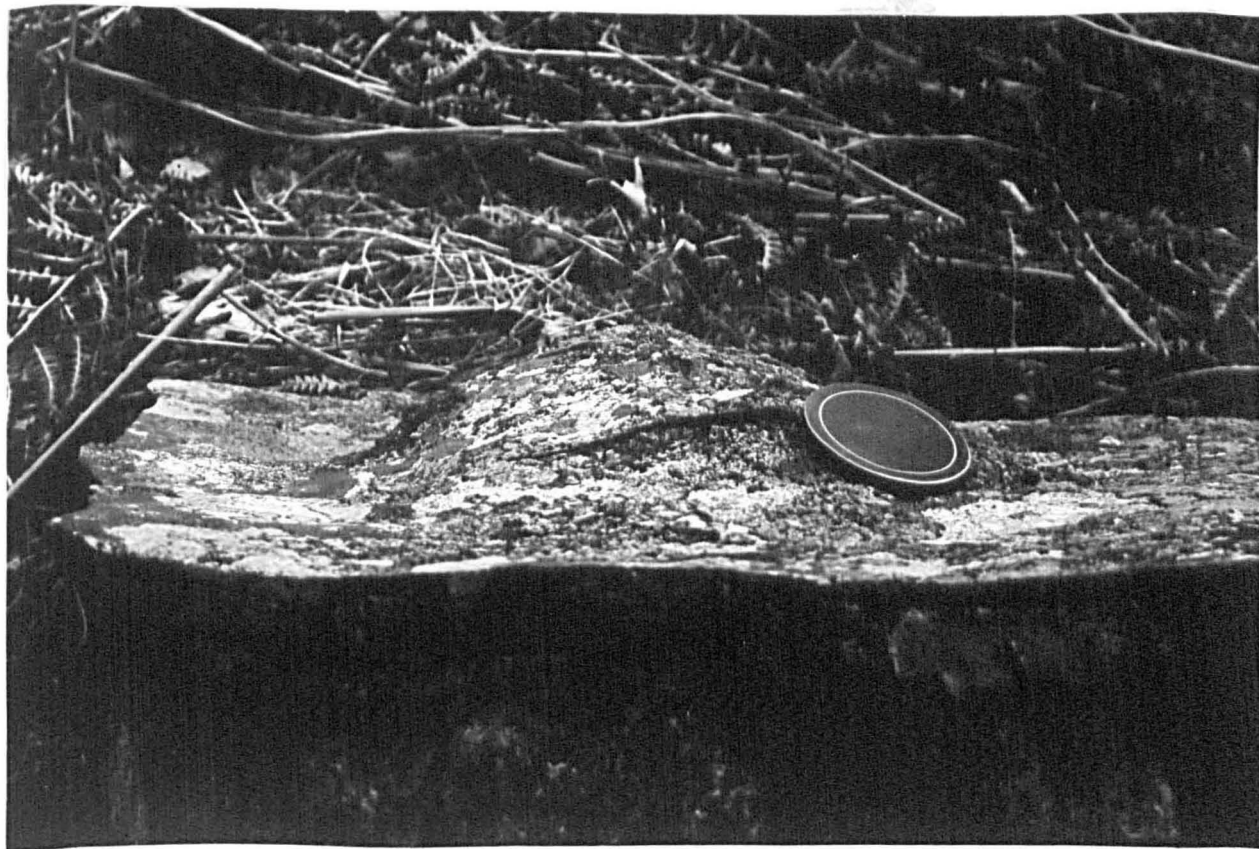


PLATE 67

A. Soft sediment faults with rather large throws, in bedded sand and silt grade tuffs. Sour Milk Gill Tuff Member, top of Sour Milk Gill (NY 227 122). Lens cap 5 cm diameter. (P 7)

B. Graded beds of breccia, younging to left. Note the very large blocks, and pronounced grading of the matrix material, particularly in the lowest bed. Breccia unit, Sour Milk Gill Tuff Member at Seathwaite Slabs (NY 233 122). Rucksack for scale. (P 34)



PLATE 68

A.. Coarse breccia underlain and overlain by bedded tuffs. Note highly disrupted underlying tuffs (below hammer). Breccia unit in Sour Milk Gill Tuff Member near the Gill (NY 230 122). Hammer shaft 20 cm long. (P 29)

B. Detail of the top of the breccia unit of A., showing the overlying bedded tuffs draped over and banked against the blocks at the top of the breccia. Lens cap 5 cm diameter (P 30)



PLATE 69

A. Cross bedded fine sand to very fine grade tuff, overlain by tuff rich in accretionary lapilli. Transport towards left. Base of Airy's Bridge Formation, Hanging Stone (NY 228 121). Coin 2.4 cm diameter. (P 13)

B. Bed rich in accretionary lapilli, base of Airy's Bridge Formation. Same locality as A. (P 14)

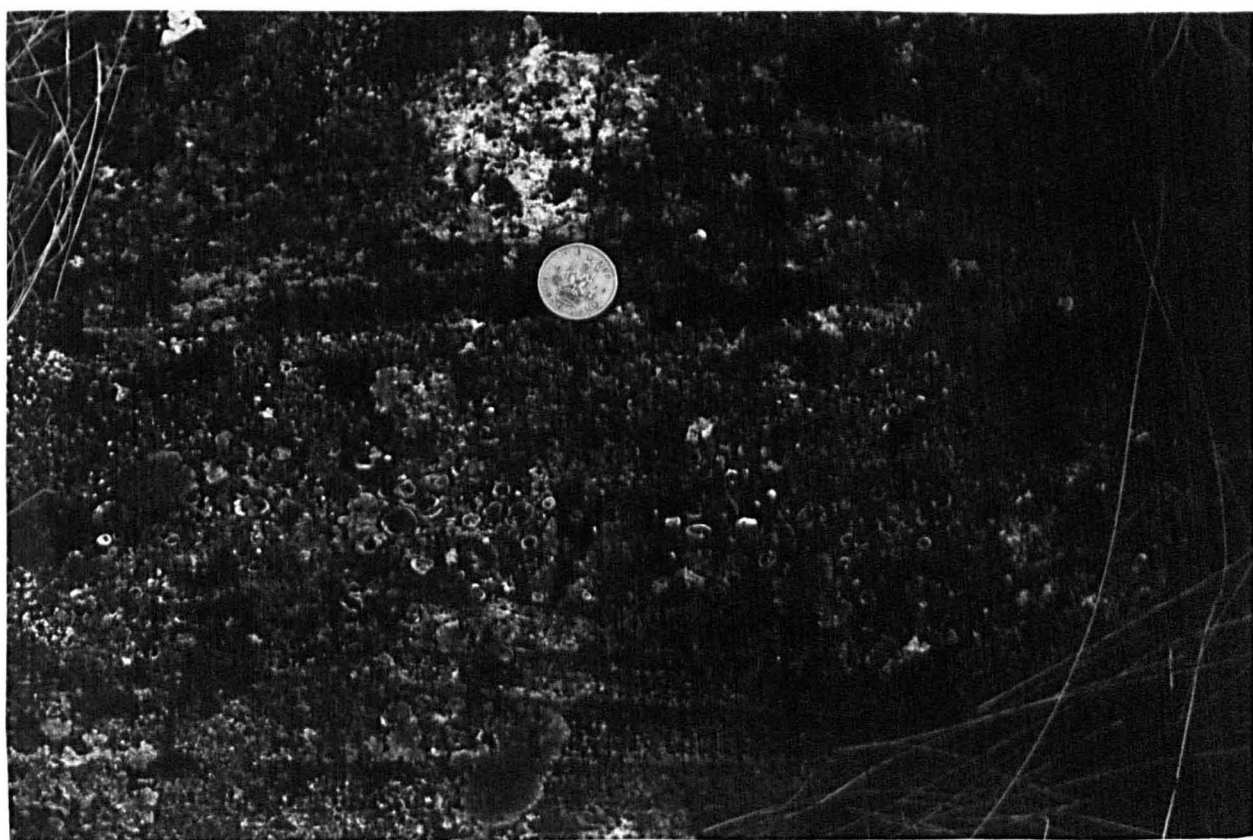


PLATE 70

**Low angle cross bedding in very fine to
fine sand grade tuff. Transport towards
left? Base of Airy's Bridge Formation,
Hanging Stone (NY 228 121). Note thinning
of layers over crest of dune. Lens cap
5 cm diameter. (P 16)**



PLATE 71

A. Welded tuff with fiammé weathering inwards.

Airy's Bridge Formation, Hanging Stone

(NY 228 121). Lens cap 5 cm diameter. (P 21)

B. Welded tuff slightly higher in section

than A. Note the large fiammé. Same

locality as A. Lens cap 5 cm diameter.

(P 25)

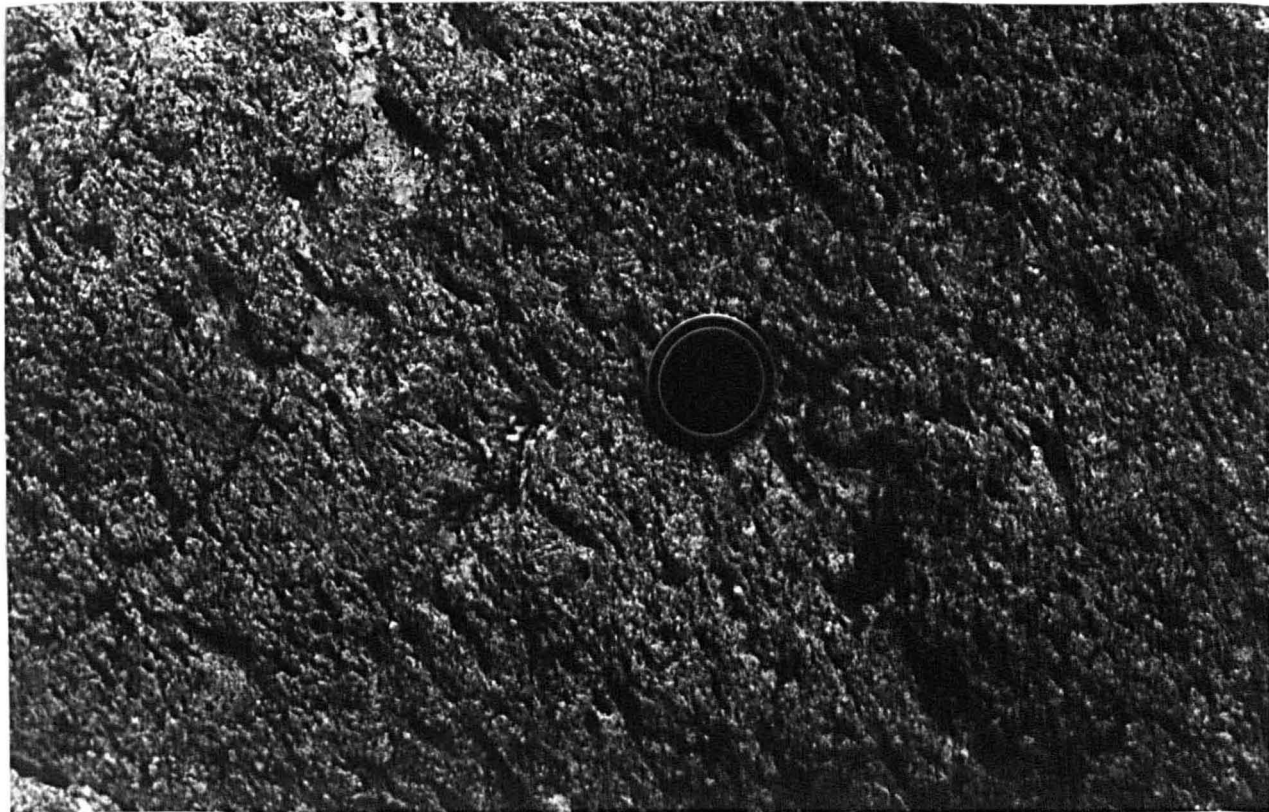


PLATE 72

**A. Coarse welded tuff with undeformed acid
lava blocks. Note flattened fiammé.**

Airy's Bridge Formation, Hanging Stone

(NY 228 121). Hammer shaft 20 cm

long. (P 23)

**B. Thick beds of welded tuff interbedded
with thinner silt-clay grade beds.**

Same locality as A. Lens cap 5 cm

diameter. (P 20)

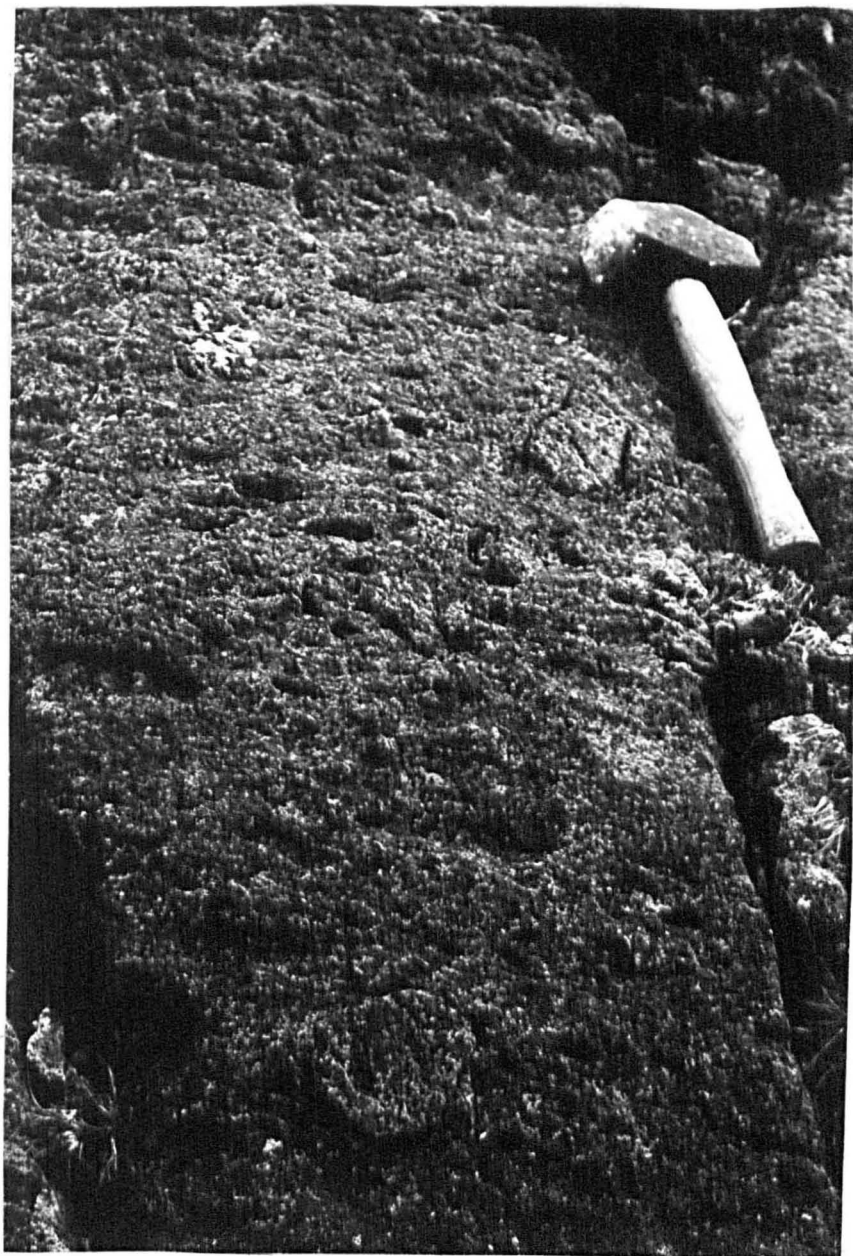


PLATE 73

**A. View of the Thrang Quarry area from
Banks Quarry (NY 316 044), Langdale.
The prominent crags halfway up the
hillside are in the Wrengill Andesite
Formation. (N 1)**

**B. View south to Lingmoor from above
Robinson Place (NY 312 063), Langdale.
The prominent crags are formed by
lavas of the Wrengill Andesite Formation,
and the Langdale Tuffs are exposed
below them. (N 9)**



PLATE 74

A. Varnished section of altered plagioclase-
phyricandesite from thin lava flow within
the Langdale Tuff Formation. Specimen
CS6, locality 17. (K 12)

B. Autobrecciated andesitic lava, Wrengill
Andesite Formation, west of Robin Gill
(NY 314 065). Hammer 25 cm long. (N 10)

cm

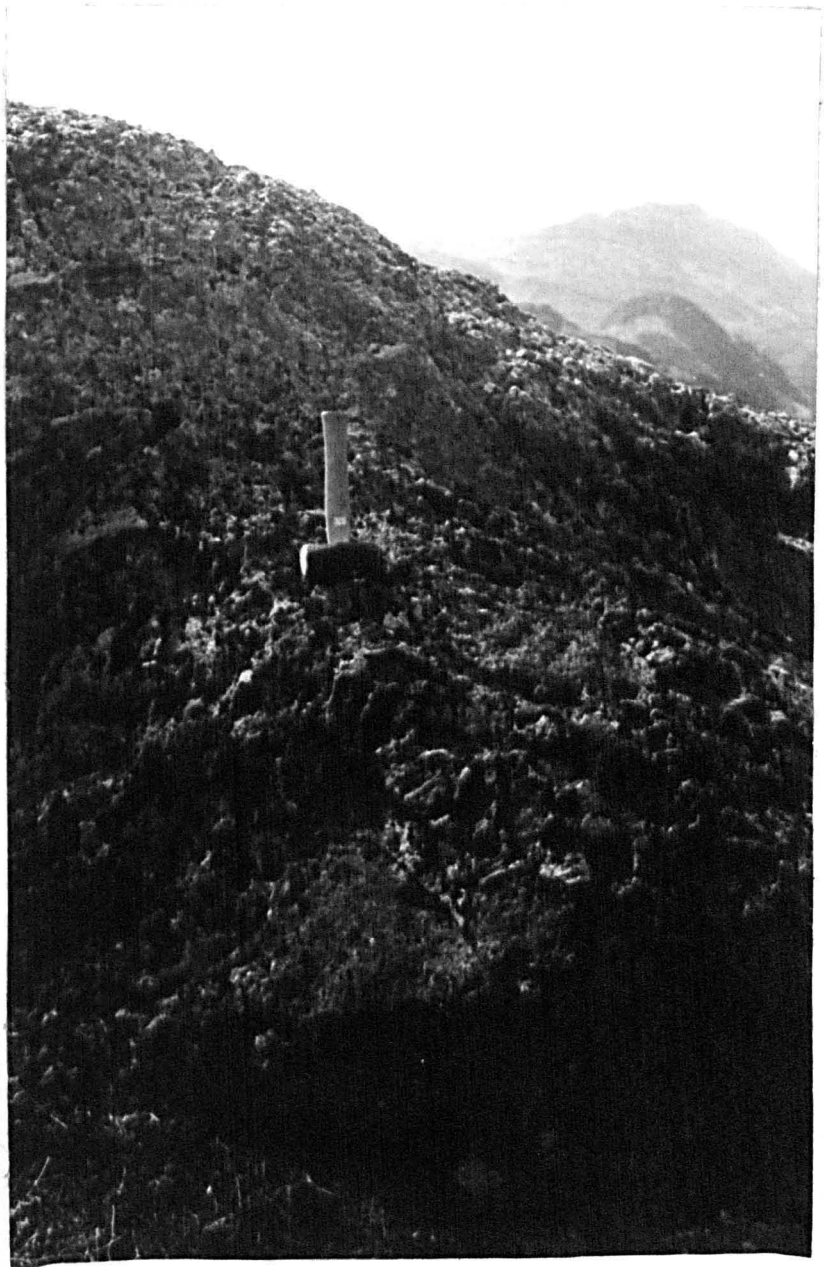
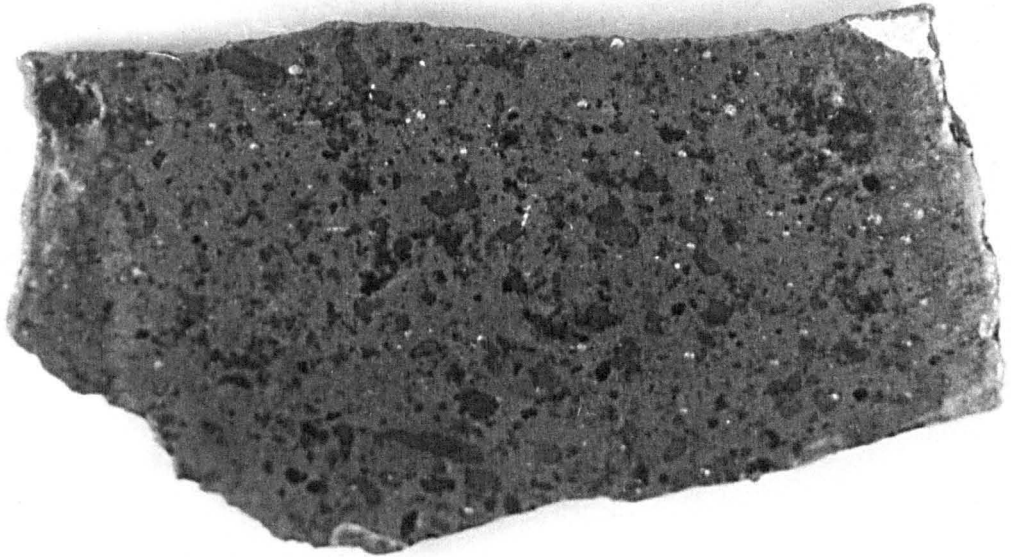


PLATE 75

A. Parallel-bedded tuffs showing graded bedding and abundant pumice fragments. Loose block, Thrang Quarry. (M 26)

B. Thick, structureless graded bed, with pumice clasts concentrated towards the top, and sparse calcitic concretions. Section 5, Thrang Quarry. Scale in 10 cm divisions. (J 35)

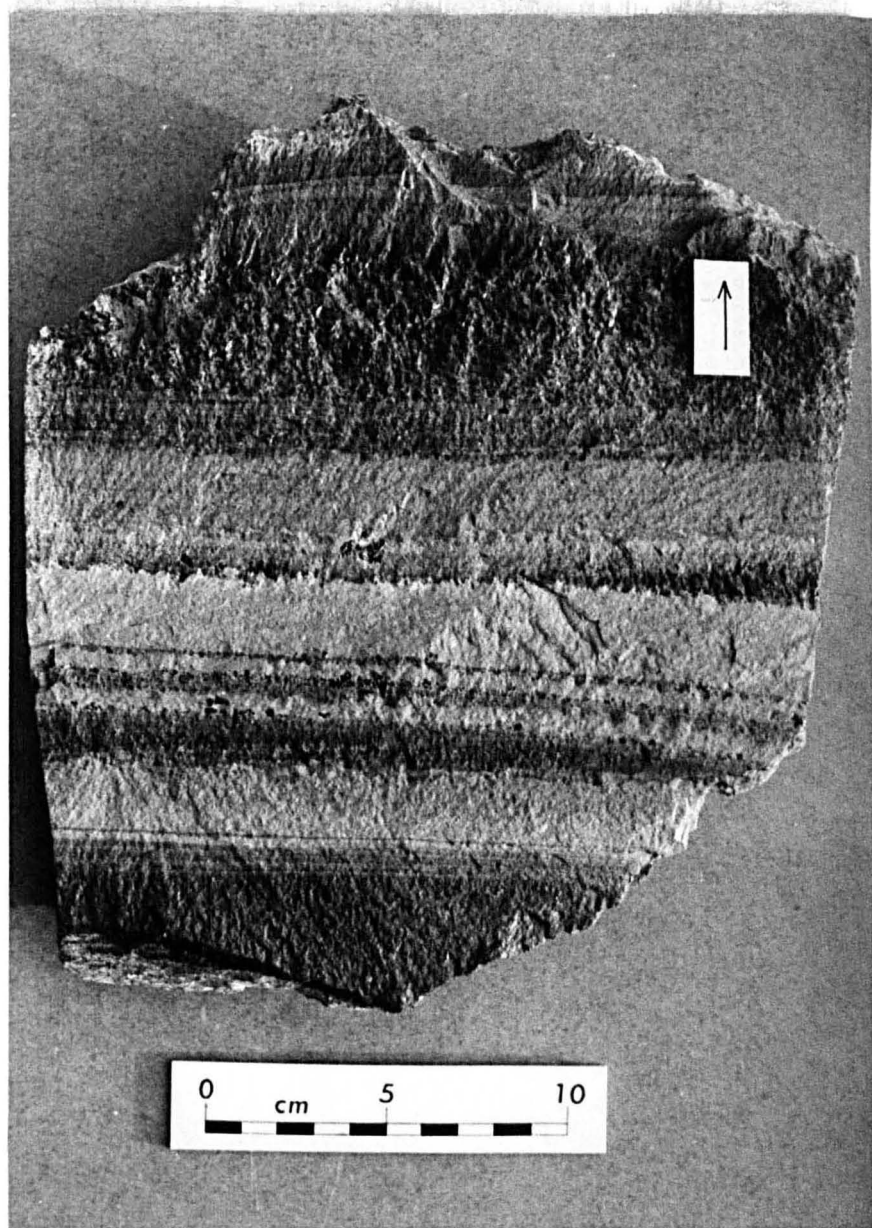


PLATE 76

- A. Parallel-bedded and parallel-laminated
silt grade tuffs with thin disturbed
bed, overlain by thicker very fine
sand grade bed with pumice fragments.
Banks Quarry (NY 316 044) (N 5)**

- B. Coarse tuff with small scale cross
bedding, sharply overlain by thick,
massive unit with pumice blocks.
Beds dip steeply to right. South-
east of Raw Pike (NY 311 069). (N 11)**

Lens cap 5 cm diameter.

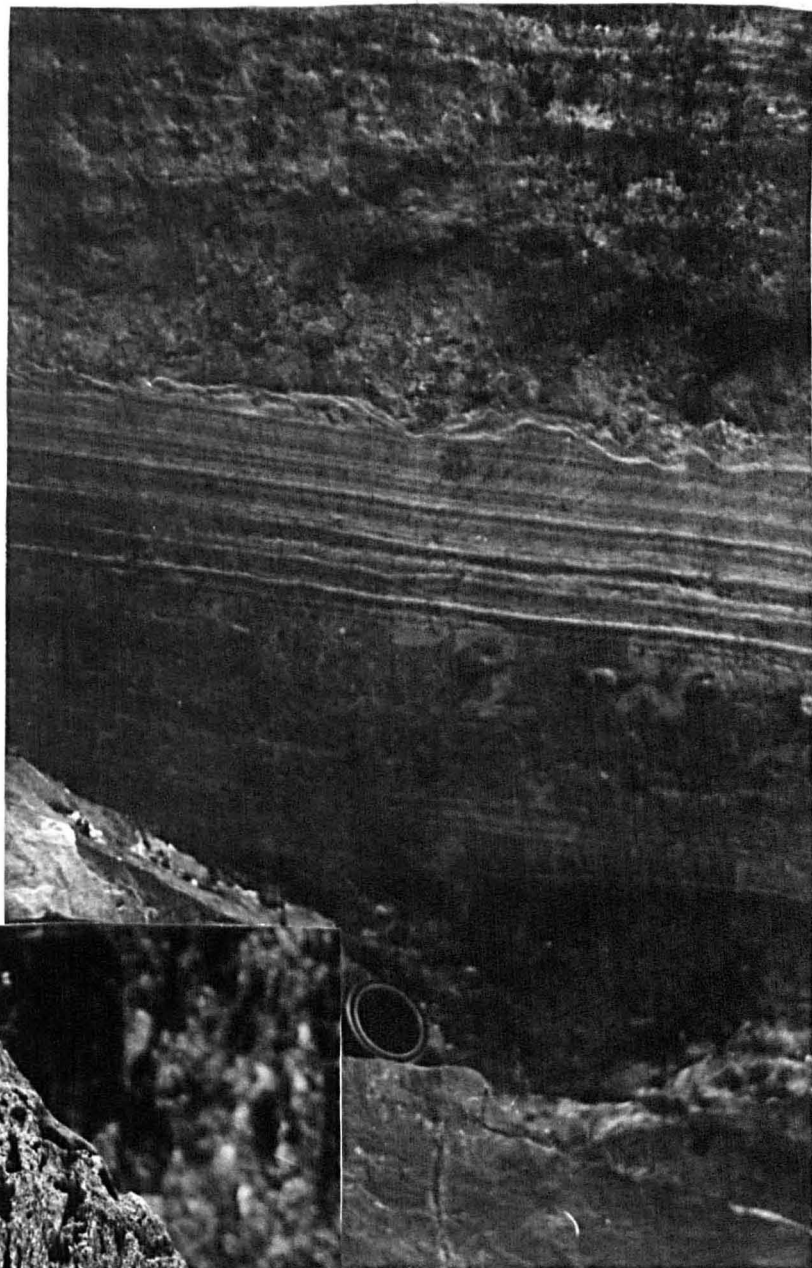


PLATE 77

**A. Parallel-bedded tuff with layer
of pumice clasts. Loose block,
Banks Quarry (NY 316 044) (M 28)**

**B. Highly irregular pumice clasts
in silt grade tuff. Loose block,
small quarry (NY 325 044) south-
west of Elterwater. (M 25)**

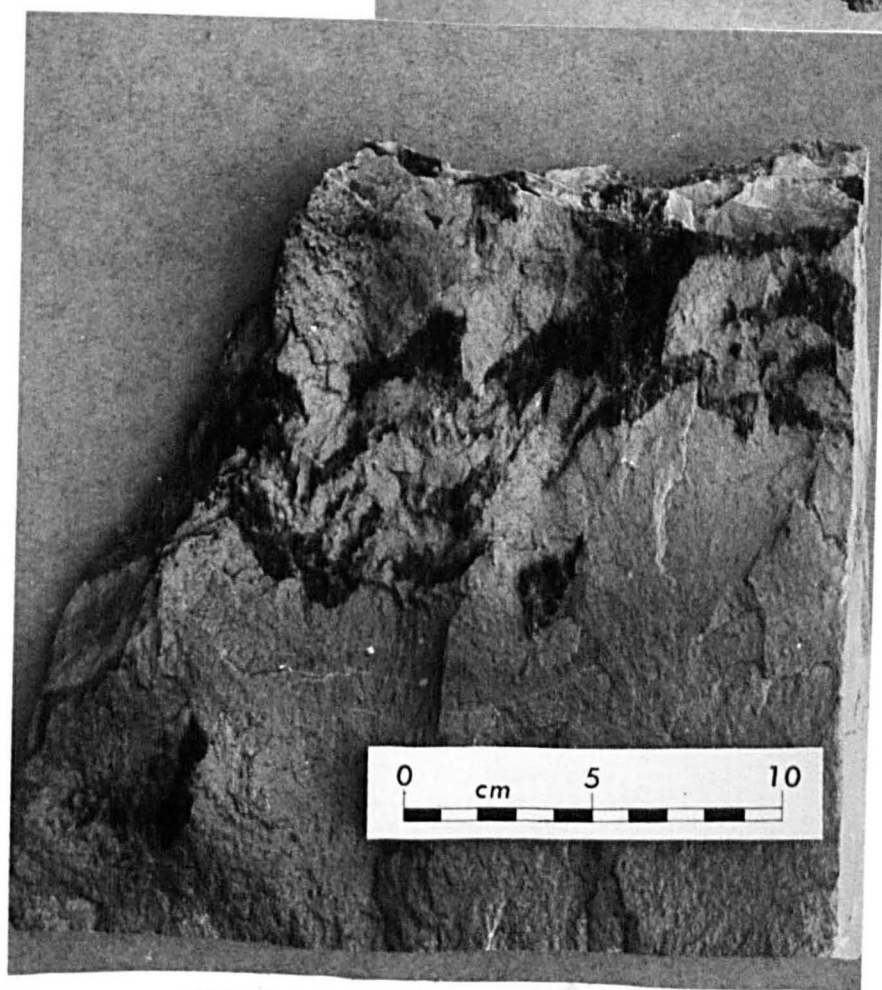
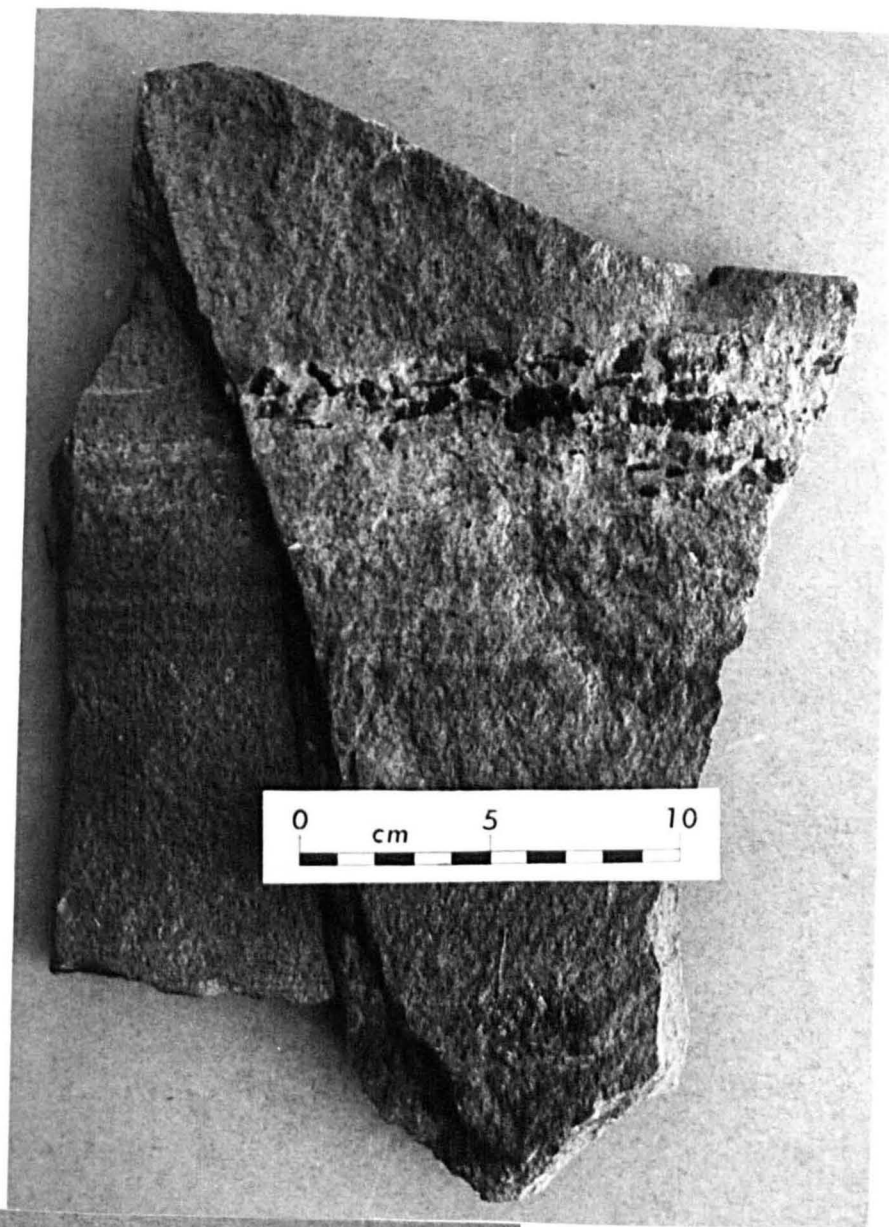


PLATE 78

**A. Several thick graded beds in cleaved
tuffs. Section 4, Thrang Quarry. (J 29)**

**B. Graded beds. Note the thinning of bed
5, and the lateral passage from undisturbed
parallel bedding to convolute bedding in
a higher unit. Soft sediment faulting is
also present. Section 2, Thrang Quarry.
(J 25)**

Scale in 10 cm divisions



PLATE 79

A. Graded beds interpreted as turbidites.

Note the presence of partial Bouma sequences, including parallel-lamination and ripple cross-lamination. Loose block, Thrang Quarry. (L 2)

- B. Thin parallel-laminated silt grade tuffs (light coloured) overlain by a graded bed showing an upward passage from parallel-lamination to climbing ripple lamination and back to parallel lamination. This is interpreted as a turbidite showing divisions b,c,d,e, of the Bouma sequence. It is overlain by another graded bed with a loaded base. Loose block, Thrang Quarry. Lens cap 5 cm diameter. (J 32)

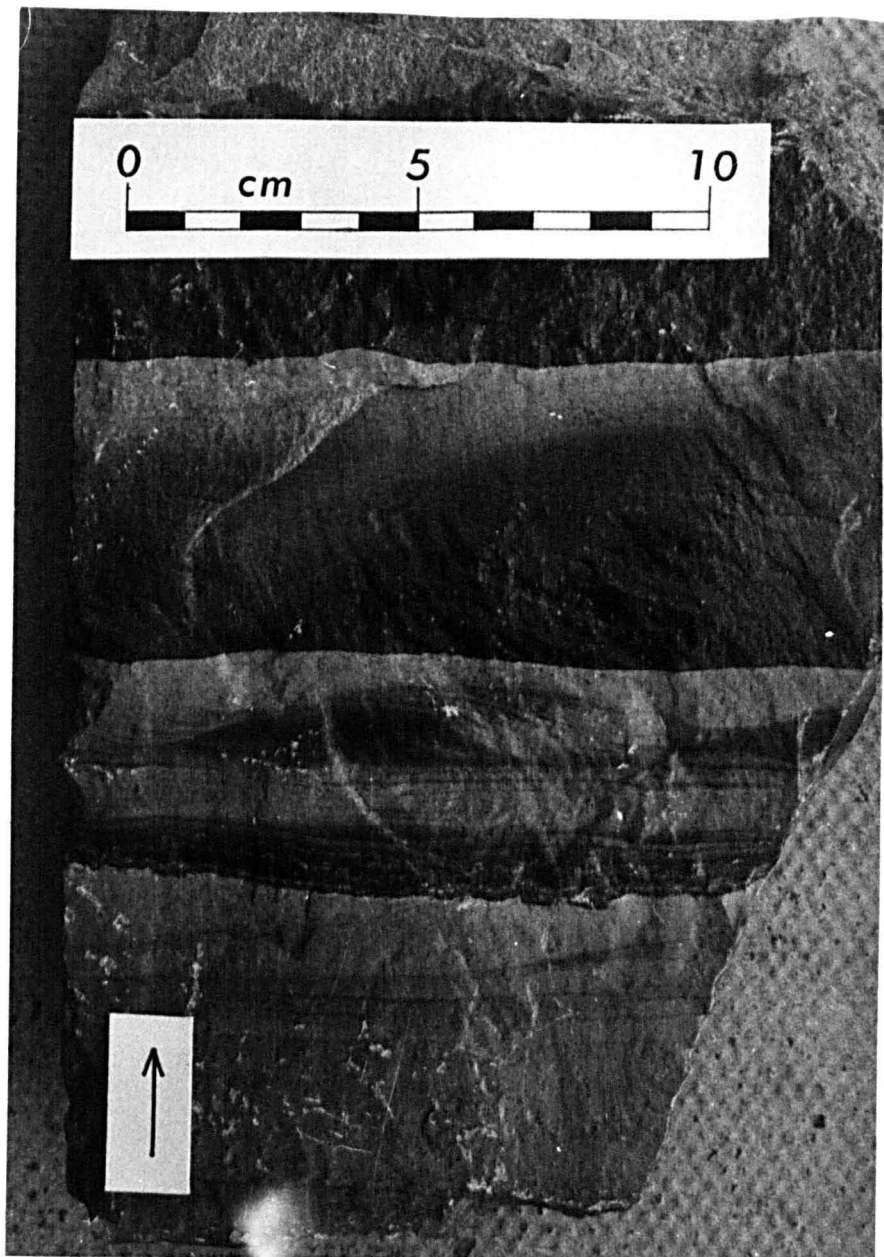


PLATE 80

- A. Graded bed interpreted as a turbidite, showing parallel lamination and ripple cross lamination. The base is erosive, and the structures seen may represent cross-sections of flute or groove casts. Section 2, Thrang Quarry. Lens cap 5 cm diameter. (H 35)**
- B. Large load and flame structures at the contact of a graded bed with the underlying finer-grained bed. Loose block, Thrang Quarry. (L 11)**

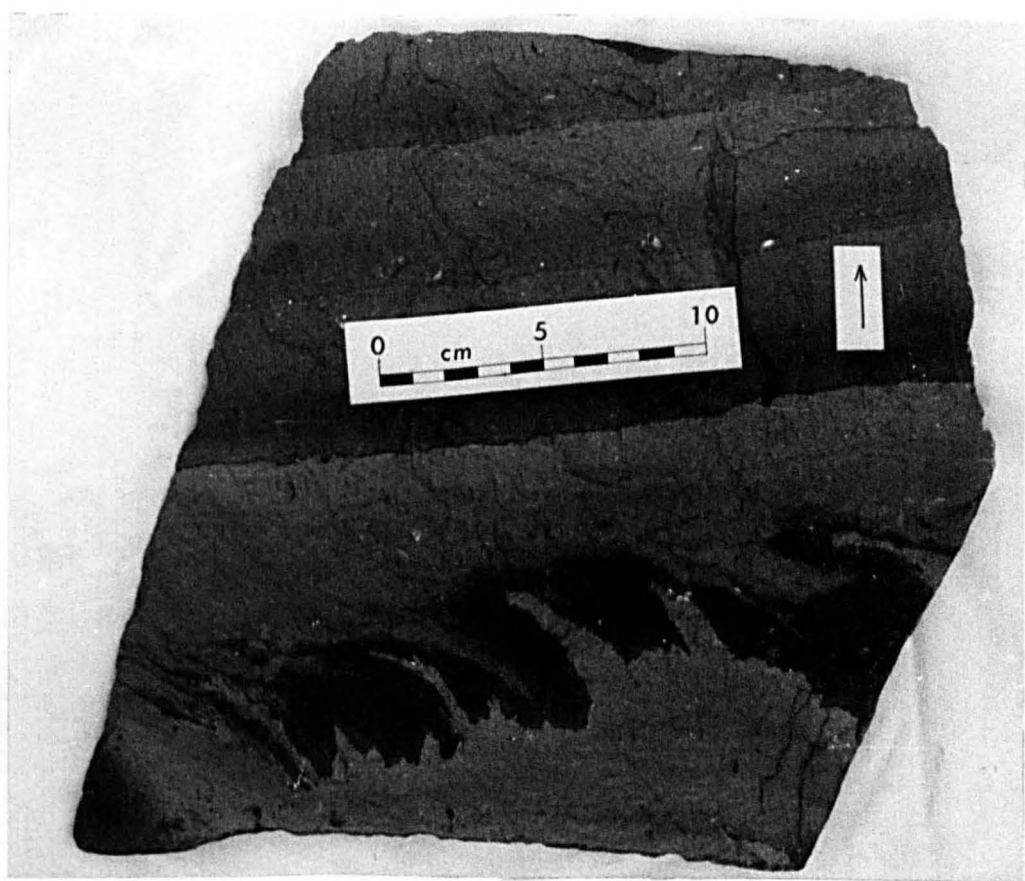


PLATE 81

**A. Flame structures at the top of a sharp-based
silt bed. Locality (13). Lens cap 5 cm
diameter. (H 30)**

**B. Directional load structures at the base
of a very fine sand grade bed overlying
silt grade tuff. Section 2, Thrang
Quarry. Ruler 3.2 cm wide. (J 20)**

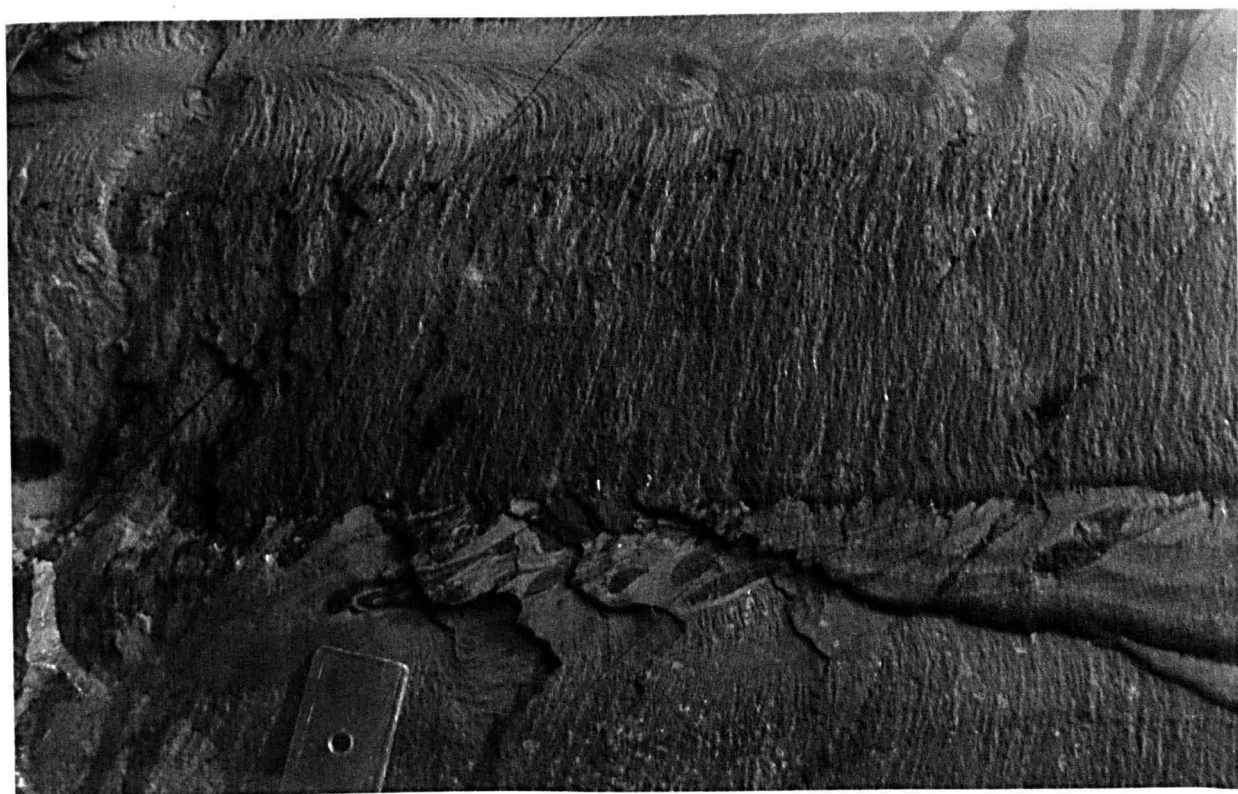
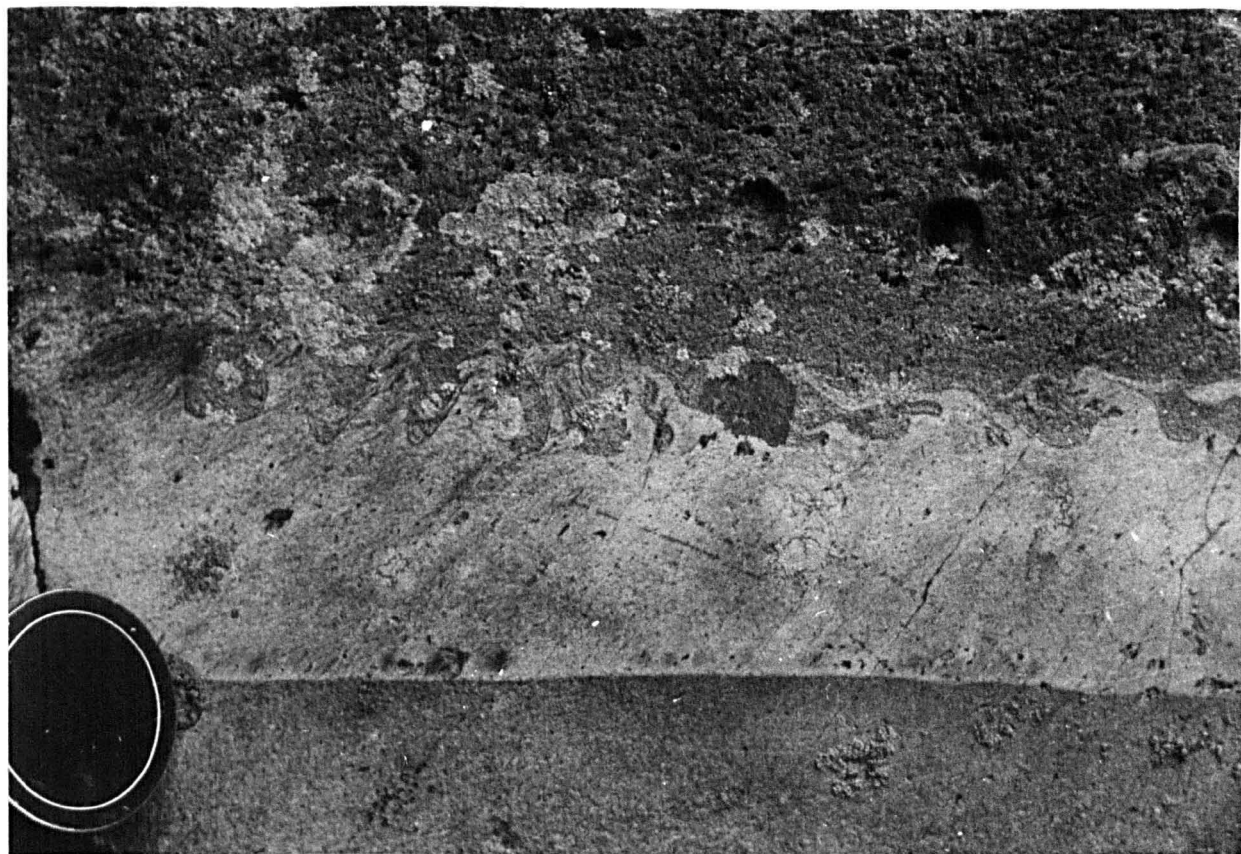


PLATE 82

**A. Load casts at the contact of sand grade
tuff with the underlying silt grade bed.
Loose block, Thrang Quarry. (L 3)**

**B. Load cast attached to the overlying sand
grade tuff from which it originated by
a narrow neck. This structure is markedly
similar to ball-and-pillow structures
produced experimentally by Kuenen (1965).
It is flattened in the plane of the
cleavage. Loose block, Thrang Quarry.
Scale in cm. (L 5)**

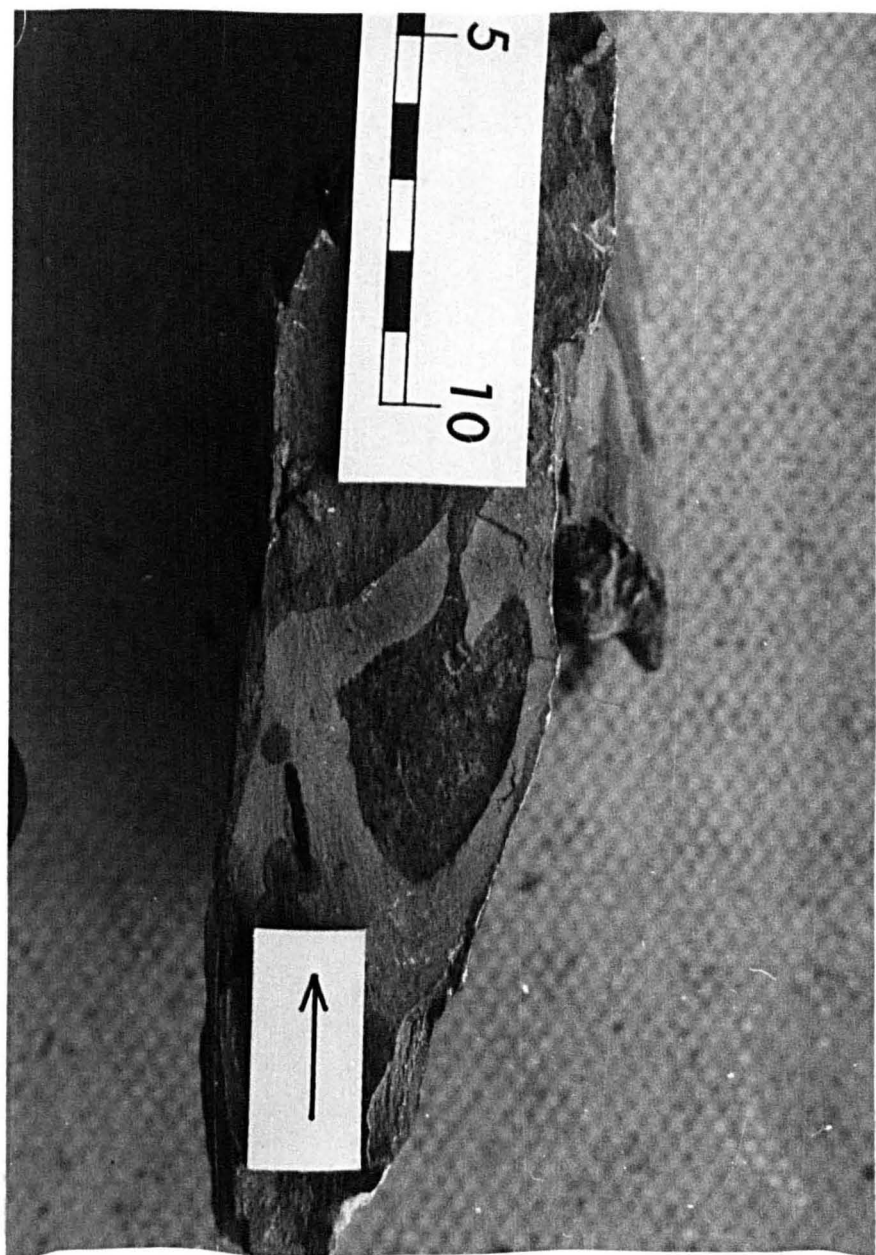
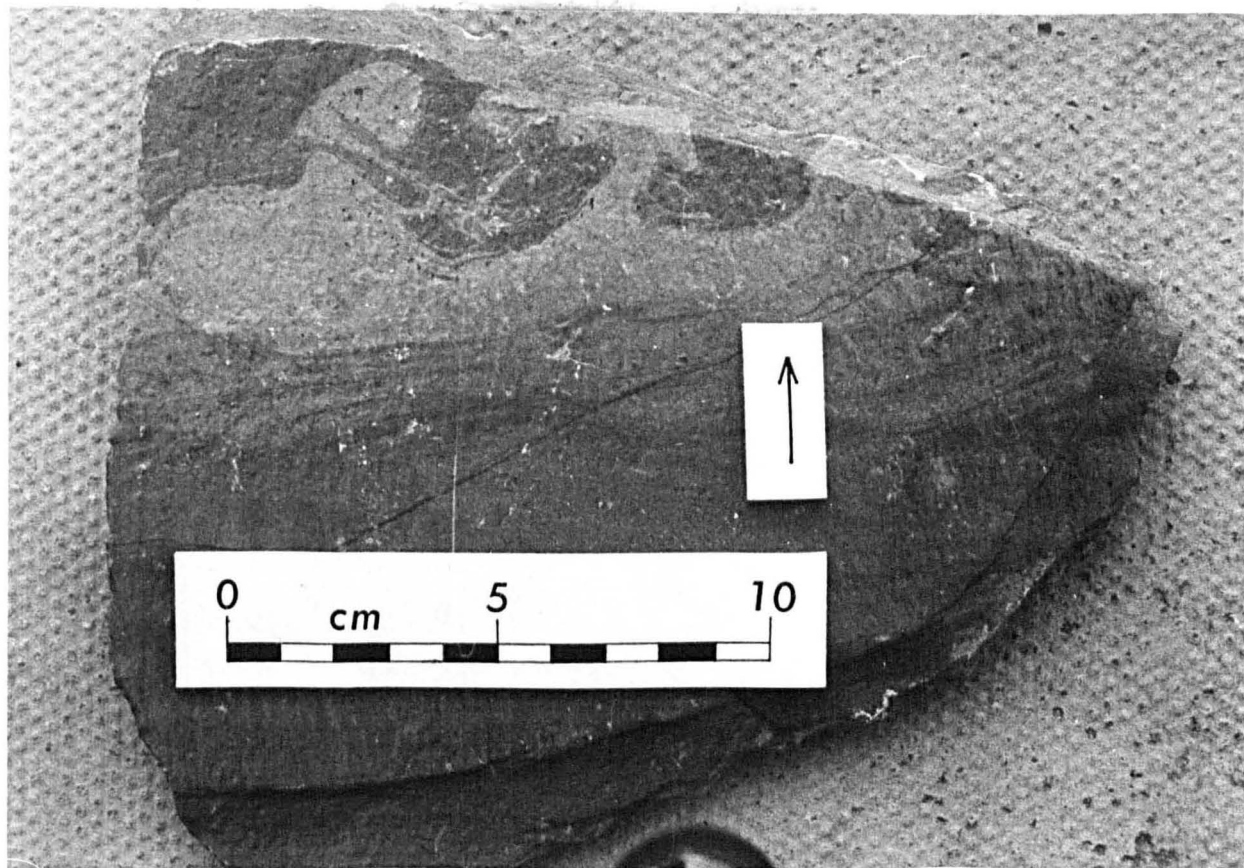


PLATE 83

**A. Plastically folded, disrupted horizon,
including several graded beds. Section
3, Thrang Quarry. (J 27)**

**B. Brecciated silt grade tuff along an
angular disconformity in bedded tuffs,
probably representing a rotational
slump scar. Loose block, Thrang Quarry.
(H 41)**

Lens cap 5 cm diameter.

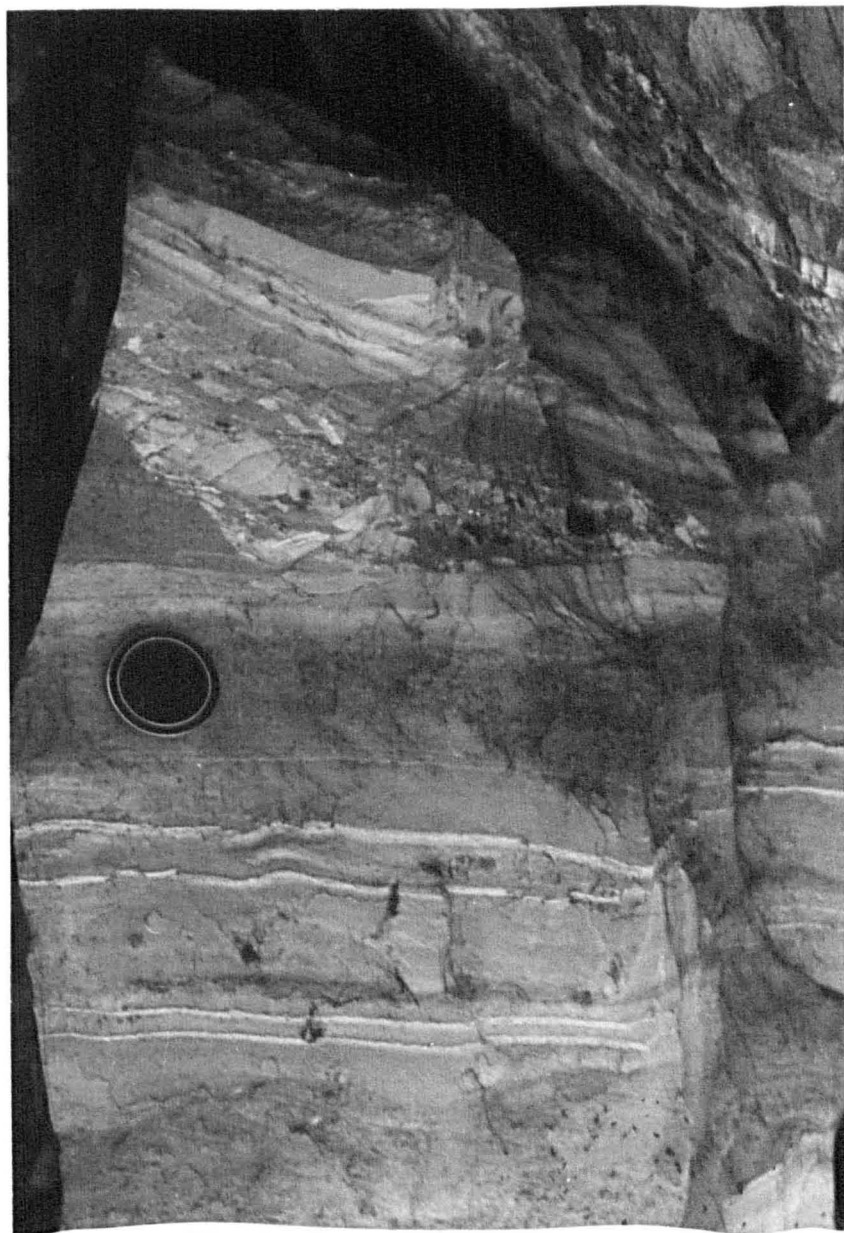
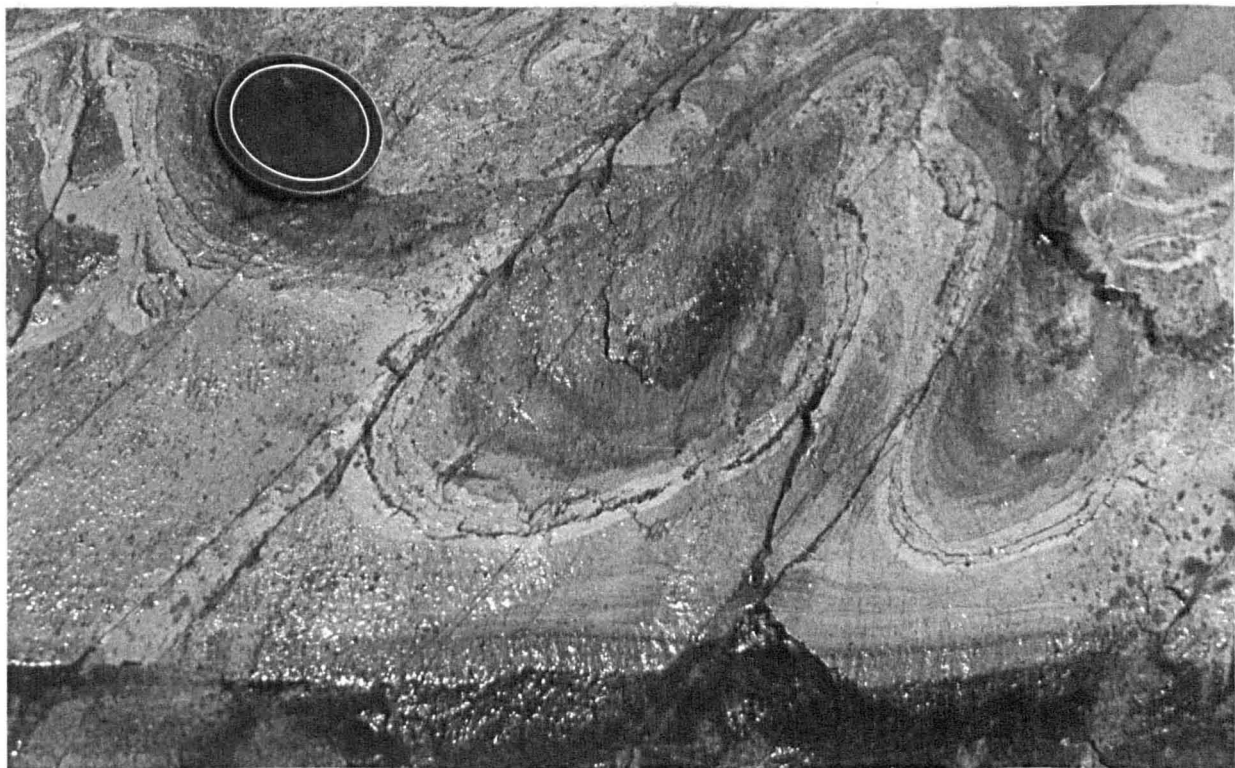


PLATE 84

**A. Breccia of silt grade tuff clasts in
fine sand grade matrix. Loose block,
Thrang Quarry. (M 24)**

**B. Disrupted bedding in parallel-bedded tuffs,
section 10, Thrang Quarry. (tr 12)**

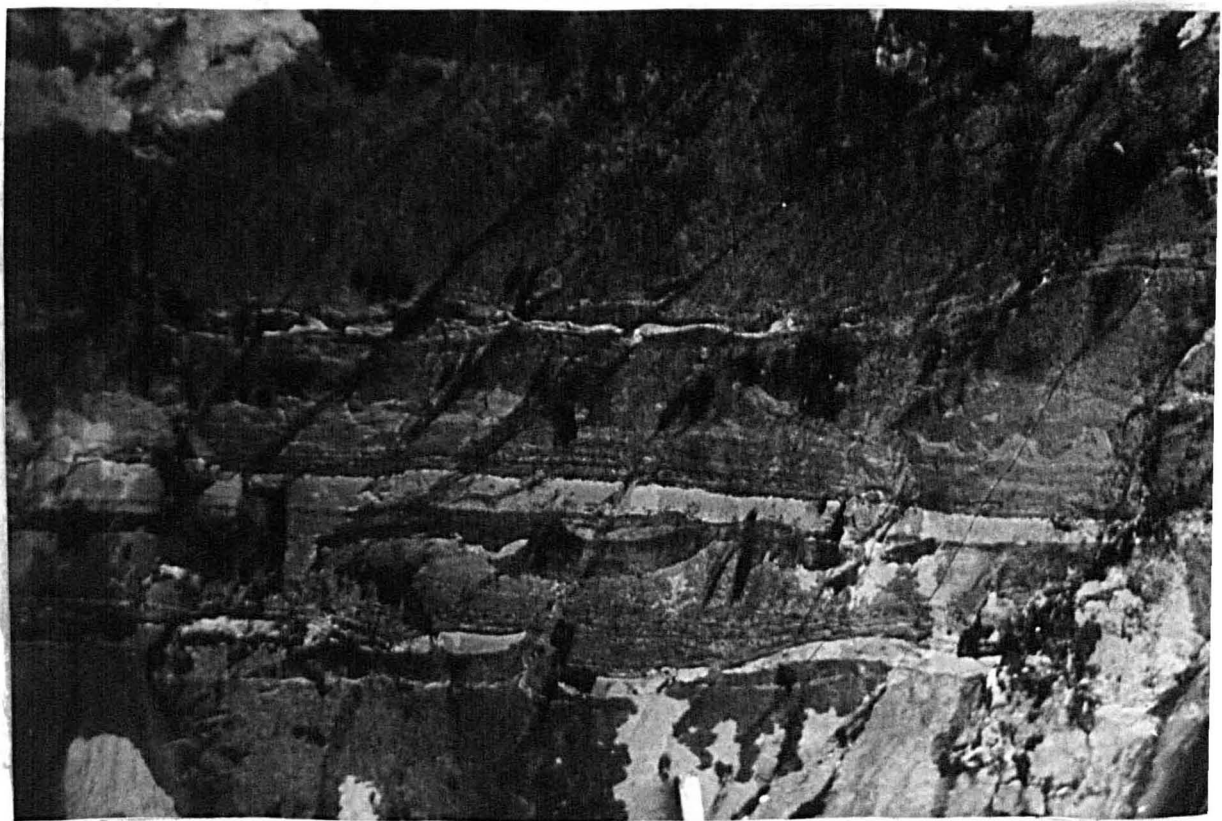


PLATE 85

A. Fine-grained bedded tuffs showing weathered-out calcareous concretions. Concretions occur both along bedding planes and at random within beds. Road cutting west of Thrang Quarry. (N 12)

B. Accretionary lapilli in silt-clay grade tuff, near top of Langdale Tuff Formation. Lens cap 5 cm diameter. (N 7)

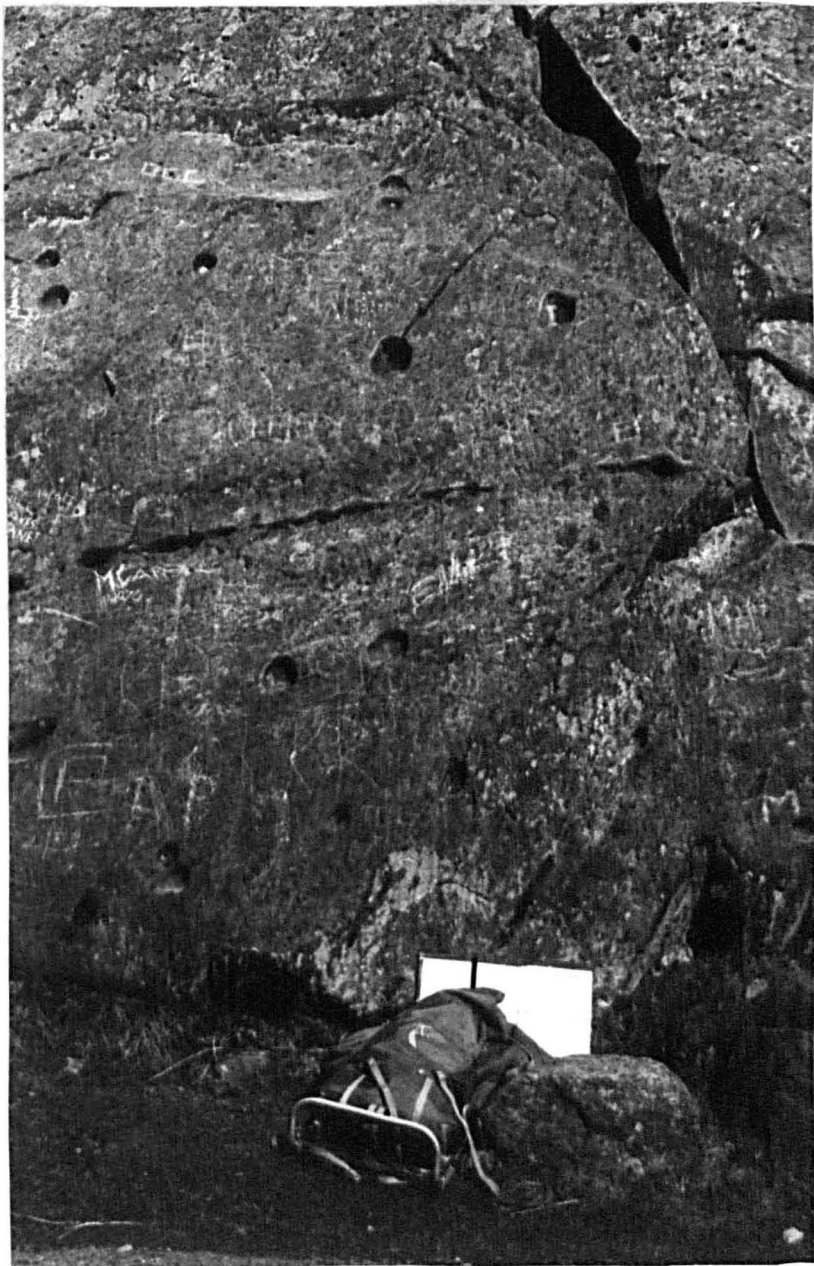


PLATE 86

**A. Flat-bedding and trough cross-bedding in
sand grade tuffs, locality 13. Hammer
head 12 cm long. (K 5)**

**B. Water escape structures in flat-bedded
sand grade tuffs. Lens cap 5 cm diameter.
(H 32)**



PLATE 87

A. Channel eroded into flat-bedded sand grade tuffs and filled with sand grade tuff which is cross-bedded at its base. Locality 13. Numbered divisions on tape are 10 cm apart. (K 3)

B. Channel eroded into sand grade tuff, and filled with cross-bedded conglomeratic tuff with very steep foresets. Locality 13. Lens cap 5 cm diameter. (H 33)

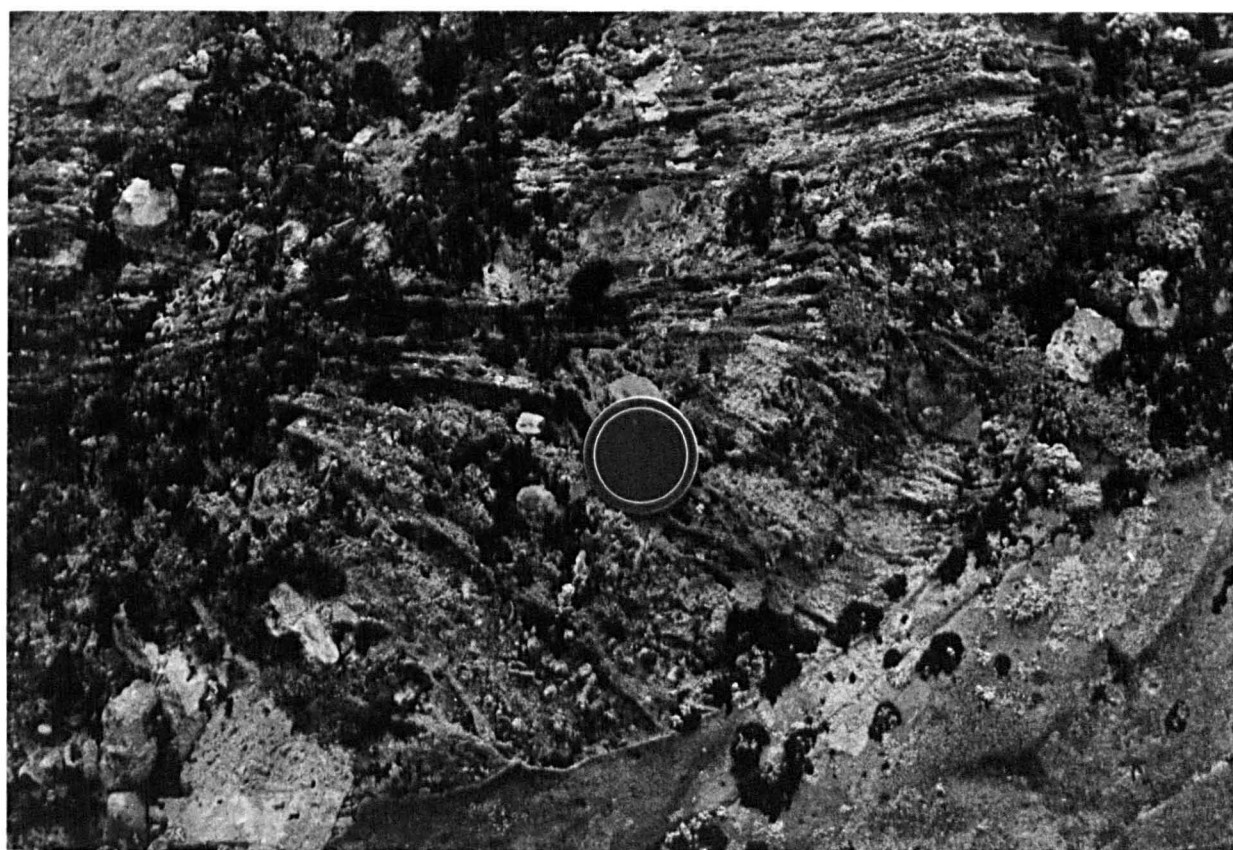
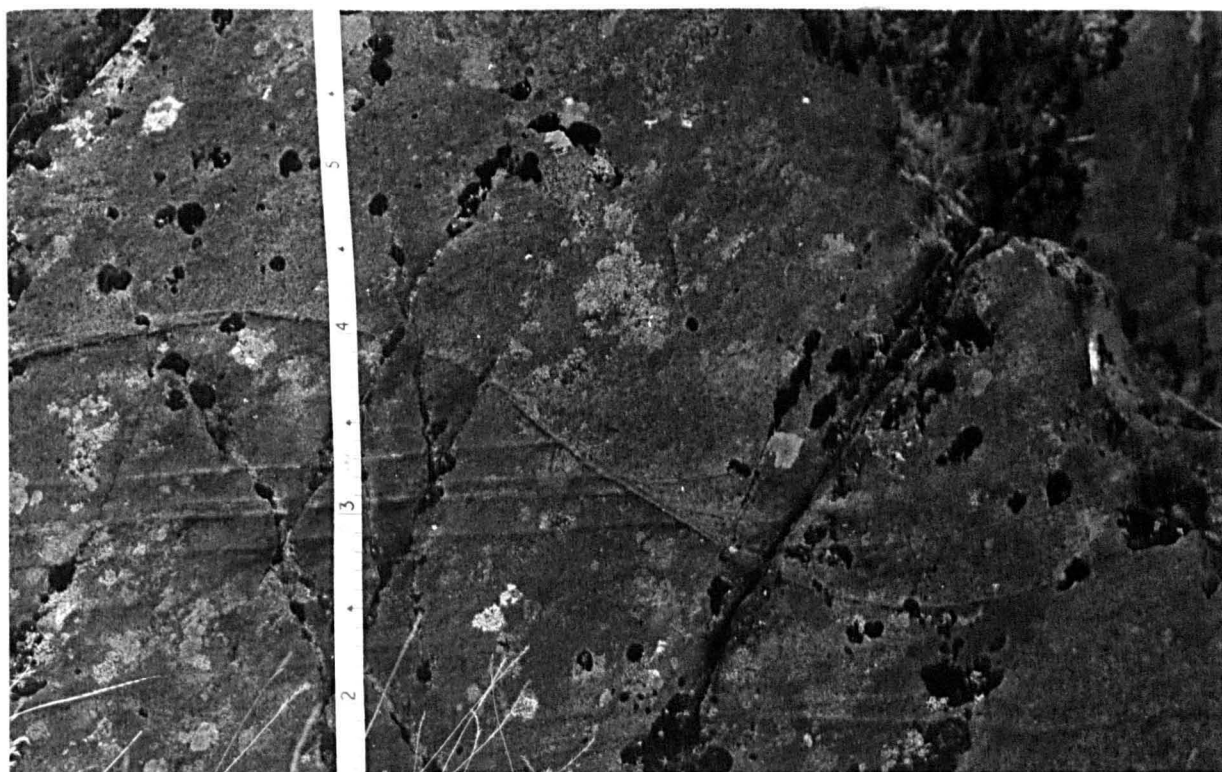


PLATE 88

**Varnished section of coarse sand to granule
grade lithic/crystal tuff with abundant acid
lava fragments. Specimen CS 7, locality 19.**

Scale in cm. (I 29)

