The Bailgill Mining District, N.E. Leadhills, Lanarkshire, Scotland.

Thesis presented for the Degree of

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at the

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Department of Applied Geology.

by

THOMAS EWART VAUGHAN.
M.Sc (MNG)
F.I.C.E
F.I.Struct.E.
F.Am.Soc.C.E.
F.G.S.

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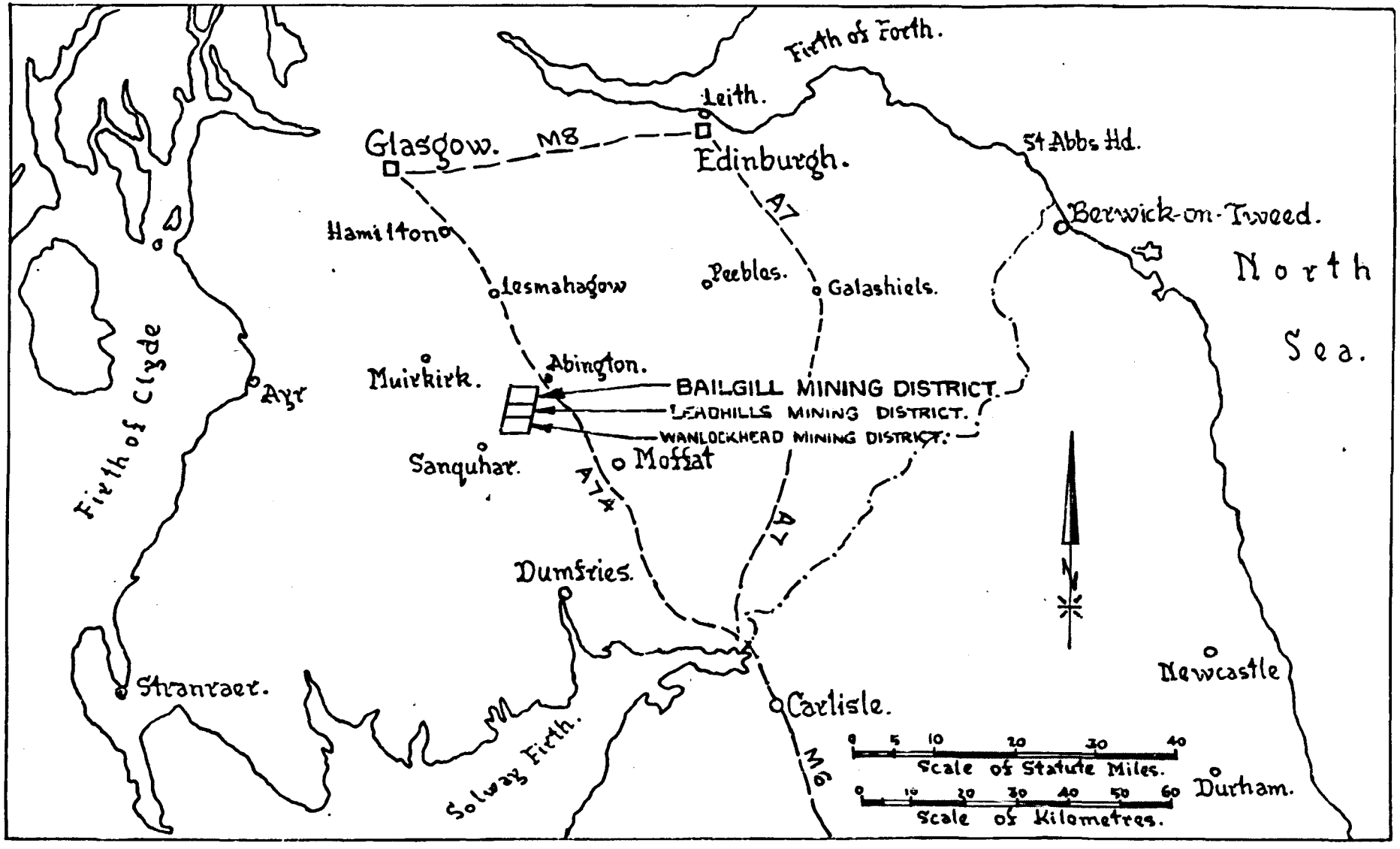

Location of Bailgill Mining District.

Acknowledgements.

The Author expresses his sincere thanks,

To Professor A. Kerr. Pringle B.Sc., FGS. FRSE. FRGS for his direction, help & encouragement.

To Kenneth Wilson, Local Agent & Head Gamekeeper to the Marquess of Linlithgow for the freedom of the moors at Leadhills

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To Mr T.R. Crosbie for the preparation of thin rock sections.

"Sir Bulmer built this Bower
who levelled both hills & moor
who got great riches & great honour
in Shortcleuch Water & Glengonner."

Sir Bevis Bulmer.
– 1613

Alleged site of Sir Bevis Bulmer's Mansion
which he built about 1580. A.D.

PHOTOGRAPH TAKEN FROM SQUARE D.4.

The Bailgill Mining District.
N.E. Leadhills.

Contents:-(Volumes I & II).

THE BAILGILL MINING DISTRICT, NE. LEADHILLS

Synopsis

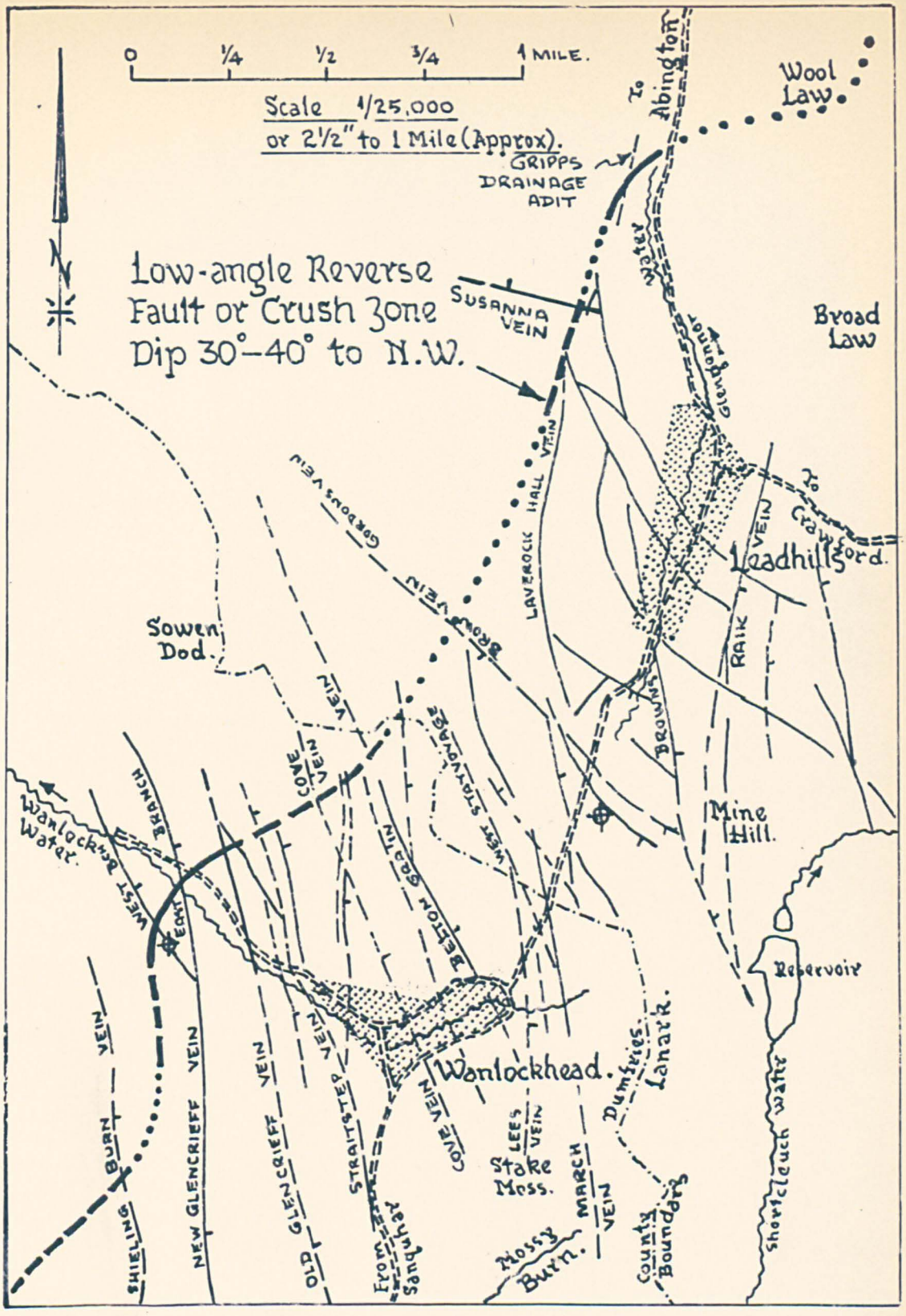
In 1958, Dr RA Mackay gave a paper entitled 'The Leadhills Wanlock-head Mining District'.[1]

One of the main points of his paper was that the major ore control of the District is a rather complex zone of dislocation dipping to the North-West. Dr Mackay traced the outcrop of this thrust plane mostly by subsurface geological exposures between the Glencrieff Mine of Wanlockhead and the Susanna Mine of Leadhills as illustrated on the map page 9. Due to the poor surface geological exposures he could not be certain of its continuation Northwards.

The fieldwork of the present thesis mapped the area north of Leadhills to the large scale of 25 inches to the mile. The geological features encountered are described together with the evidence that the postulated thrust plane may continue northeastwards from Leadhills.

The thrust plane passes along the western edge of the Bailgill Mining District with the probability that it was also a major ore control for this District. The long-abandoned trials and mines were an additional means of tracing the course of the thrust plane.

To obtain information regarding the Bailgill mines which operated in the 18th and 19th centuries generally before the use of gunpowder in mining, a desk study of many hitherto unpublished mining records was made and brought to light the fact that the development of the Bailgill District was somewhat neglected due to the proximity of the immensely rich Susanna Mine.



Leadhills Wanlockhead Mining District. Approximate position of Low-angle Reverse fault outcrop after Mackay, R.A. 1959. Symposium on The Future of Non-Ferrous Mining in Great Britain & Ireland. The Inst of Mining & Metallurgy.

The Bailgill Mines were included in the same lease as the Susanna Mine.

With a view to awakening new interest in this field, the history, production and features of the Bailgill Mines are given: also, since there seems the possibility of sub-parallel veins, the engineering problems of exploring the field by driving a new adit, both for exploration and possible extraction of ore, are detailed. Furthermore, as the thrust plane may continue beyond the Bailgill District the likelihood of discovering more ore in that direction is investigated.

Finally during the geological mapping the presence of a second major non-parallel fault line was suspected. This taken together with the lateral strike slip movement mapped could account for the presence of the Wanlockhead, Leadhills, Bailgill mineralized zone as a whole and is therefore described.

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(1) Sept, 1958. The Institution of Mining and Metallurgy Symposium on 'The Future of Non-Ferrous Mining in Great Britain and Ireland'.

Chapter 1

General Geology of the Bailgill District

This chapter opens with an illuminating quotation by Mackay [1] when presenting his paper.

> 'The other main point to be emphasized was the difficulty which had been experienced in geological mapping. Short of drilling which would have to be done for purely scientific reasons and would not be justifiable, the area seemed to be virtually un-interpretable. Even from gully to gully, contacts could not be confidently connected. Consequently, it was not possible to accept the rendering of the maps which had been issued by the Geological Survey. They were done a long time ago and it was understood that they were intended as generalization but owing to the use of full lines the tendency was for them to suggest that more was known about the area than actually was known. In view of the fact that much of the mapping was done by Peach and Horne, it must, of course, be taken very seriously, but it was essentially based on extrapolation. The area was heavily covered with moss and the close structures portrayed on the map could not possibly have been mapped as shown.'

The author agrees heartily with Mackay's comment on the difficulty of mapping the geology of this type of terrain but has nothing

but admiration for Peach and Horne who almost three-quarters of a century ago edited 'The Silurian Rocks of Britain'. Vol. 1. Scotland,[2] after prospecting most of the Southern Uplands of Scotland. They were not car-borne geologists who explored the coast-lines and extrapolated their findings across-country but men who tramped these remote hills in the customary inclement weather, writing up their notes in indifferent accommodation after a hard day's work in the field.

The exposures they describe are still to be found and references to their great work were of immense use to the author in making his own large-scale geological survey of the area. It is true however that to some extent they were obsessed by 'isoclinal folding' and used it as an answer for any difficult to understand phenomenon encountered in the field.

As only 6" to one mile topographical maps were available, these were enlarged by draughtsmanship to 25" to one mile and are presented in Volume II of this thesis. Most of the geological survey work was of necessity carried out in the stream beds where some solid rock exposures were to be encountered. For this reason a pair of fishing waders was an essential item of equipment. A 100' Surveyor's chain was used as the method of longitudinal control as 'pacing' in such difficult country was not accurate. The higher ground was examined for 'float' working up through the peat from solid rock below but in general no great reliance was placed on this type of exposure.

Instead of describing each exposure or run of exposures in detail, the author prefers to let the large scale 1/2500 Map of Volume II 'speak for itself' and only make general comments, pointing out some of the more interesting features.

The most modern stratigraphical sequence for the Bailgill Area

is taken from Greig D.C. 1971. 'British Regional Geology. South of Scotland' (Third Edition) and is as below:-

Ordovician
- Caradoc. Shales, Greywakes and Conglomerates
- ?Llandeilo. Lavas, cherts and mudstones
- Arenig. Lavas, pyroclastic rocks, cherts and mudstones; basic and acid intrusions.

It will be noted that the large scale map plotted from field observations confirms the general outline of the geology as given on the 2½" to one mile scale map on page 15 This geology was taken from the 1" Geological map of the Geological Survey. Dealing with the Bailgill area in general the most evident feature is that the bedding is almost without exception in a vertical or near vertical position. Peach and Horne explained this by intense isoclinal folding and on page 16 is a photograph of a typical psuedo-anticline which would tend to convince less able geologists that this was so. No doubt there has been powerful thrusting shearing and uplift due to orogenesis and Peach and Horne describe schistose basalts which have been re-located during the present survey in squares D7, G6, H2 and I2 of the large scale map. The pressure and shearing are confirmed by 'augen' structure when thin rock sections are examined under the petrological microscope.

Walton, 1963 (3) gives an alternative interpretation to replace Lapworth's 1889 Anticlinorium and Synclinorium explanation of the isoclinal structure of the Lower Palaezoic rocks. Walton bases his hypothesis on alternate zones of steeply dipping beds, becoming younger to the north west, and of closely folded beds in which the 'faltenspiegel' is horizontal or dips at a low angle to the south-east. For a full description and diagrams of this rather complicated hypothesis reference

The Bailgill Mining District.
N.E. Leadhills.

Scale:- 1/25,000 or 2½" Inches to one Mile.

¼ ½ ¾ 1 MILE 2 MILES

Key Map of the District & surrounding Country for transferring references in text of Volume I to large Scale 1/2,500 Maps enclosed in Volume II.

b^3 Ordovician. Caradoc Shls & Greywakes

b^{1a2} Ord. Llandeilo. Mudstones, Cherts & Blk Shls
Ord. Arenig. Lavas & Basic Intrusions.

(15)

Drake Law
Old Quarry
To Abington 1 MILE
White Hill
From Glasgow
River Clyde
To Carlisle
Glencaple
Glencaple Burn
1,100'
Green Knowes
Chapel (Site of)
1,300'
Lettershaws
Glengonnar Water
Craig Dod 1431
Laggengill Rig
Kirk Gill
Windgate Burn
over cleuch
1329
Kirkton Rig.
Raven Gill.
Glengonnar Rig.
Cleuch Burn
Laggen Gill.
1546
1300
Ravendill Dod 1765
Glencaple Burn
Hershaw Burn
Black Hill 1344
The Breaks
Cleuch Scar
Carle Gill.
Brown Dod. 1602'
Caple Gill
Coom Burn
1606
Sandy Cleuchs
Burnt Cleuch
1632'
Harrybum Brae.
Pin Stone. 1614'
Gled Knoll 1747
Clowgill Dod 1342'
Clow Gill
Dun Grain
Coom Dod 1814'
1820'
Dun Moss
Wellgrain Dod
Bellgill Burn
Aits Drift
Bulmers Mines.
Long Cleuch
Peat Hill. 1501'
Shortcleuch Burn
Craggy Brae.
To Crawford 1½ MILES
Water Head 1559
Little Gill
Little Wool
Glendonnar Water.
Bulmer Moss.
Middle Wood
Middlegrain Mines
The Bailgill Sett Mining District
Howkwood.
Longcleuch Mine
North Short Cleuch
Toddle Moss.
Wool Law 1810
Big Wool Gill
Goldscaurs Mine
Nether Cleuch
Overcleuch Mine
Over Cleuch
Old Railway Track
Short Cleuch Burn
Leadburn
Big Wool Gill Mines
Brown Law 1684'
Risping Cleuch
Risping Cleuch & Straight Brae Mines
1533'
Leadburn Rig
Lead Burn
Lousie Wood Burn
Brown Law Mines
Susanna Mine.
Leadhills
Thief Slack Mass Mines
Glen Eas Mine
Glen Eas Burn
Glen Aise Burn
Glen Eas Hill
Black Cleuch
Lousie Wood Law. 2028'

Psuedo-Anticline in Greywakes.
Near Exposure 19, Square N.4.

is better made to Greig [4] from Walton.[3]

The latest explanation advanced is that the structure of orogenic belts is due to 'plate tectonics' as the causative mechanism and is well described and illustrated in 'The Story of the Earth' Inst. Geol. Sciences 1972 [5] The author finds this latter explanation more acceptable having observed bull-dozers cleaning semi-set cement silt from concrete batching yards. In the field during the large scale survey the author did not observe the crest or trough or an isocline nor yet the 'faltenspiegel' or north-west facing mono-clines of Walton, but of course realizes he was examining a comparatively small area of the Lower Palaezoic Rocks.

The Lead and Zinc deposits are confined to the hard greywakes of Caradocian Age which are particularly fine-grained in the Bailgill Area. Thin rock sections suggest that the hardness and toughness of the greywakes is due to the chloritic cement which becomes darker as the veins are approached. The increased content of chloritic cement is probably caused by wall-alteration due to hydrothermal fluids.

The hardness and toughness of these greywakes is remarkable and they have been mistaken for volcanic dykes. The present 1" geological map Sheet 15 of the area records volcanic dykes which on examination of thin rock sections under the petrological microscope prove to be simply well graded greywakes.

Geikie J. (1886) [6] wrote 'It is often impossible to distinguish the granular texture of the finer-grained varieties without the aid of a strong lens. Occasionally the rock takes on an incipient crystalline texture. This is especially the case with felspathic varieties, which are sometimes mistaken for igneous rocks. Frequently solution or fusion of the grains and minute angular

fragments seems to have taken place rendering the rock extremely hard and compact.'

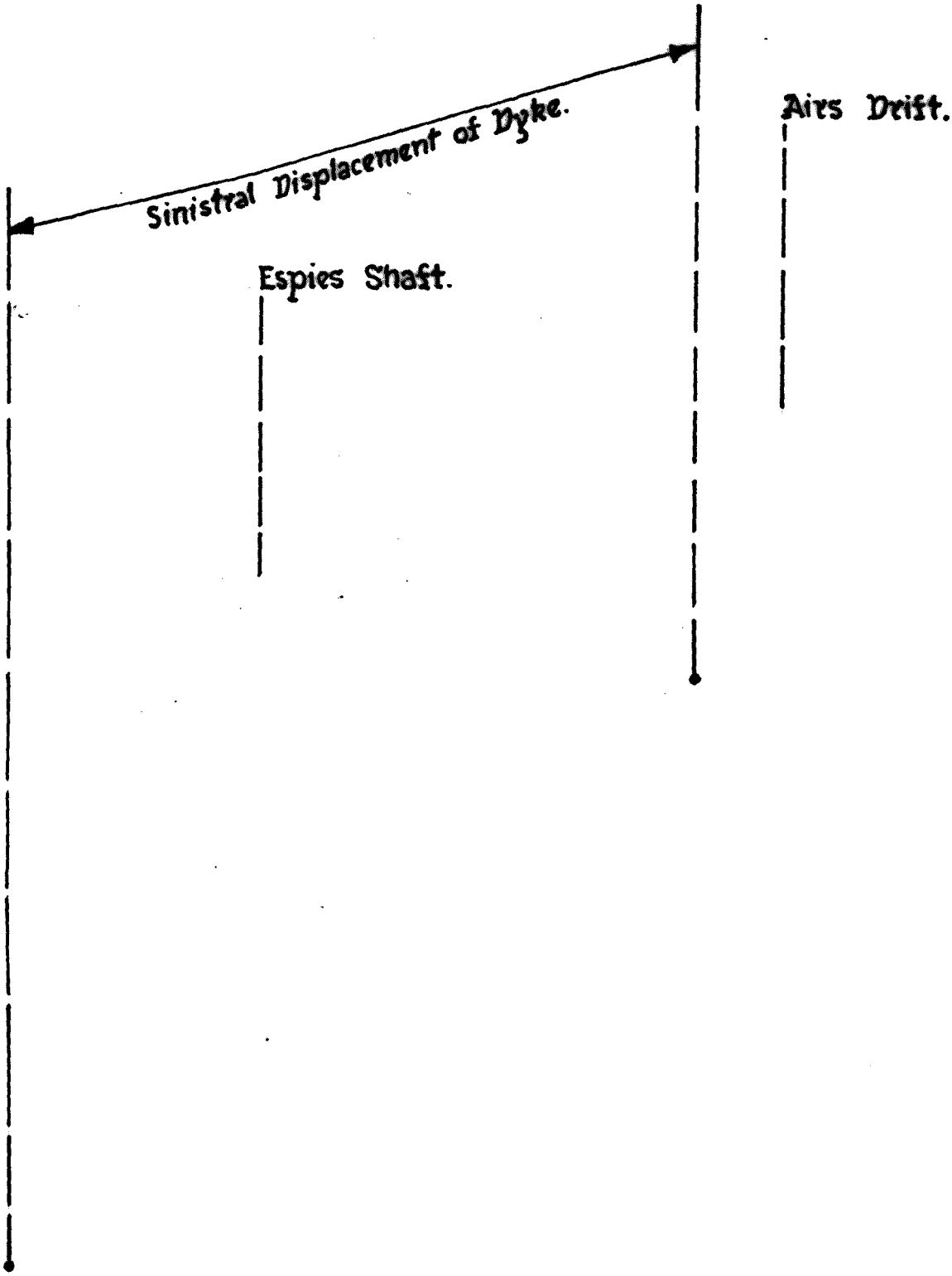
Only one example of sole marking was noted during the whole survey, (photograph on page 19). This was in square J4 Exposure No 1 of the large scale map and represents longitudinal ripple-casts on the underside of a bed of Ordovician Greywåkes. A great amount of transcurrent shearing along bedding planes was observed particularly in the Chert and Shale zone (see exposure 23 of square E5, exposure 19 of square H4, exposures 14, 47 and 66 of square I3 and the photograph in Longcleuch Burn on page 20 The shear drag was such as to indicate sinistral movement which is confirmed by Temple (7) and also by Mackay. (1)

On page 21 is a photograph of the location in square 4 of the large scale map, where Middlegrain Vein crosses Middle Grain Gorge. It demonstrates the sinistral shear movement which has occured along the vein structure as registered by the transverse dislocation of a dyke. In the background may be seen a level box and other equipment sitting on one end of the dislocated dyke. In the foreground and on the opposite side of the gorge a walking-stick may be seen protruding from a cleft in the continuation of the dyke. This feature is mentioned by Temple (7) but the large scale map should be consulted in square J4 to illustrate the total amount of sinistral shear that seems to have occurred at this point.

On page 22 is given a full size cross-sectional sketch of a fold mullion in greywåke shale found in the upper portion of Wellgrain. These fold mullions, indicating shear drag, are common along the stream beds but not one was found 'in situ', i.e. no definite outcrops, only 'float'.

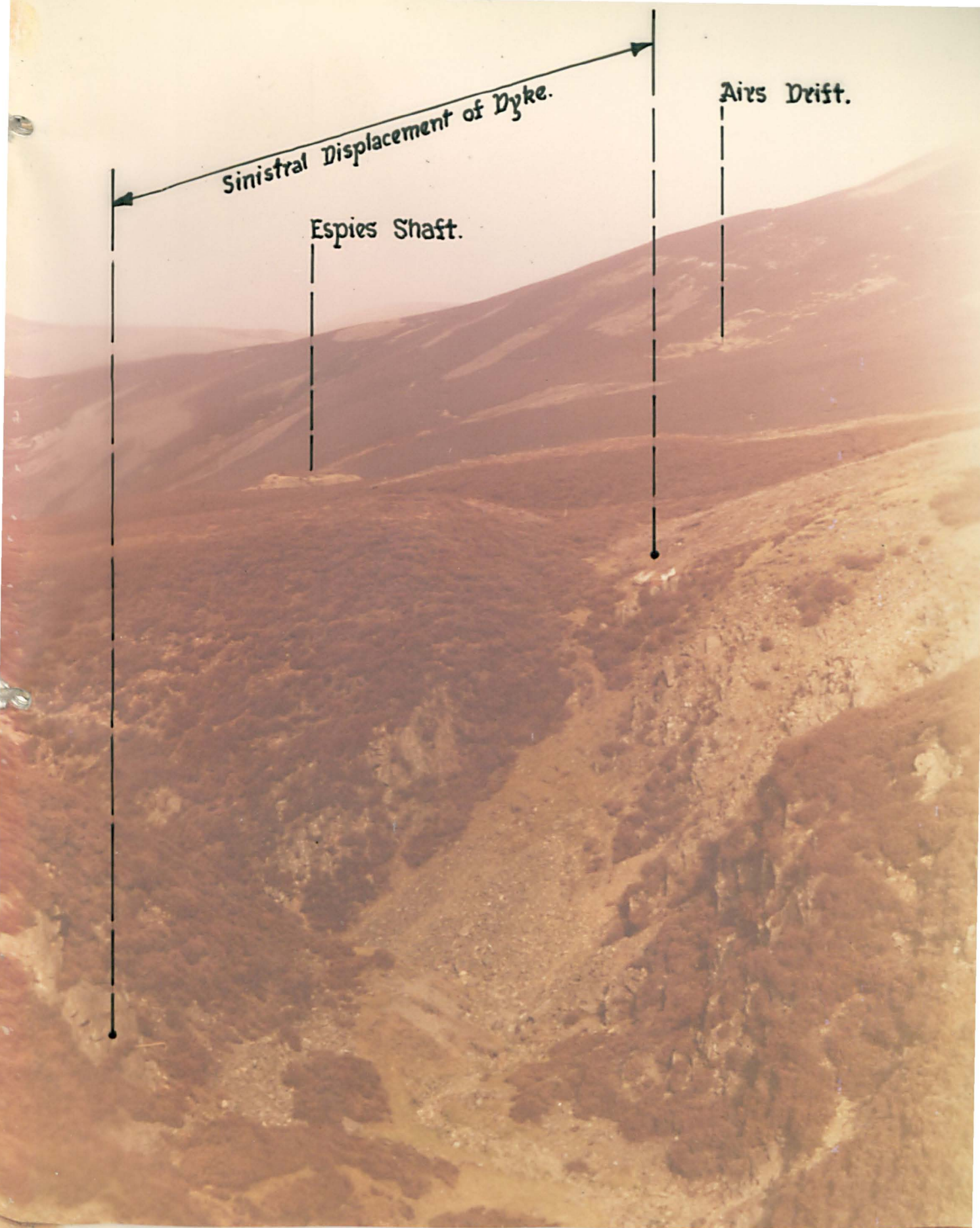
Longitudinal ripple-casts on the underside of Greywakes. Exposure 1, Top Left, Square J.4.

Exposure 2, Square J.9. Longcleuch Burn.
Bottom to top, Main Jointing in Greywakes.
Left to right, typical shear cleavage band
probably along bedding planes.


Sinistral Displacement of Dyke.
Airs Drift.
Espies Shaft.

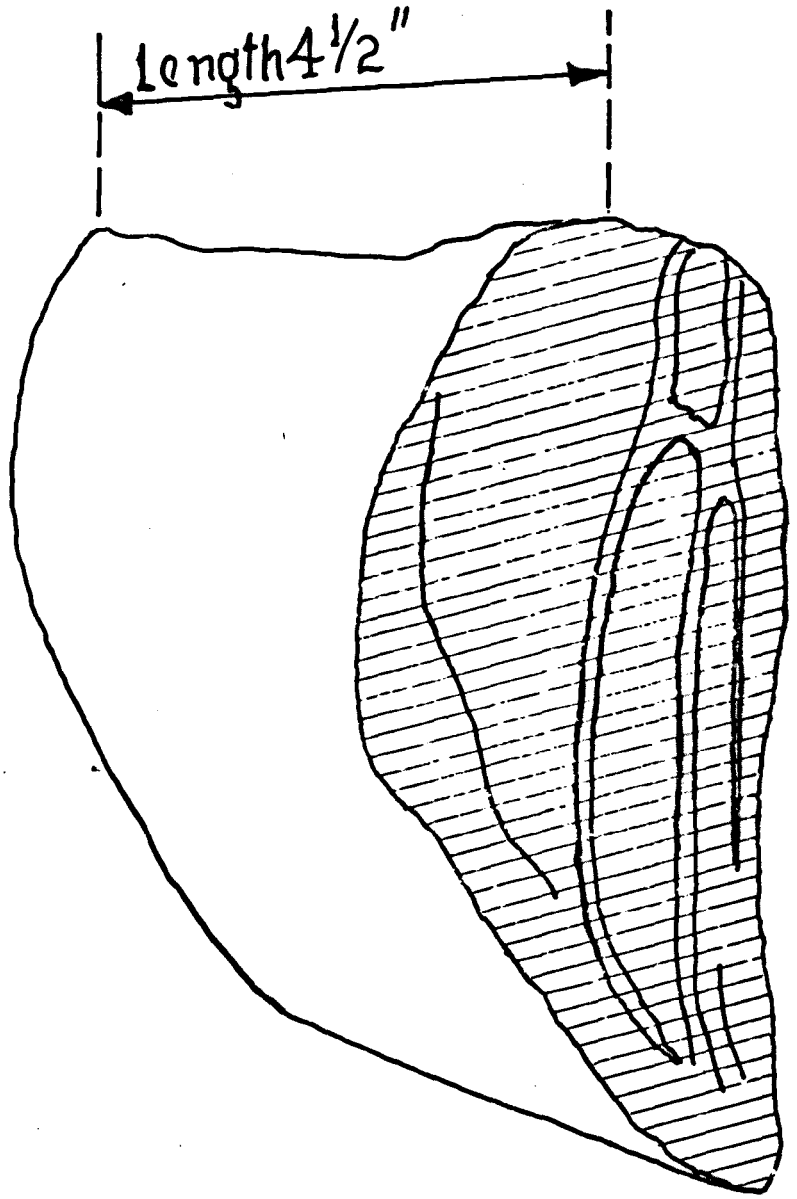
View along Middlegrain Vein at Crossing of Middle Grain Gorge.

PHOTOGRAPHED FROM NEAR EXPOSURE 25 OF SQUARE J.4.



View along Middlegrain Vein at Crossing of Middle Grain Gorge.

PHOTOGRAPHED FROM NEAR EXPOSURE 25 OF SQUARE J.4.



Fold Mullion in Shale or Greywacke Shl.

Scale:- Cross-Section is Full Size.

This transcurrent shear along bedding planes, particularly in the chert-shale zone, often left, through weathering, deep cleuchs with free upstanding slabs of rock. For example. see Cleuch Scar of square G4, photographed on page 24

In spite of Mackay's comments given previously on the non-continuity of exposures between burn and burn, the author has been able to draw straight lines on the large scale map of the chert-shale zone connecting the outcrops of massive cherts. Some of these chert outcrops are impressive, e.g. that in square C8 photographed on page 25 The junction between the chert-shale zone and the greywakes is marked by a line of hard greywakes causing rapids in the tributaries just before they join the Glengonnar Water. This contact is also marked by a straight line drawn on the large scale map.

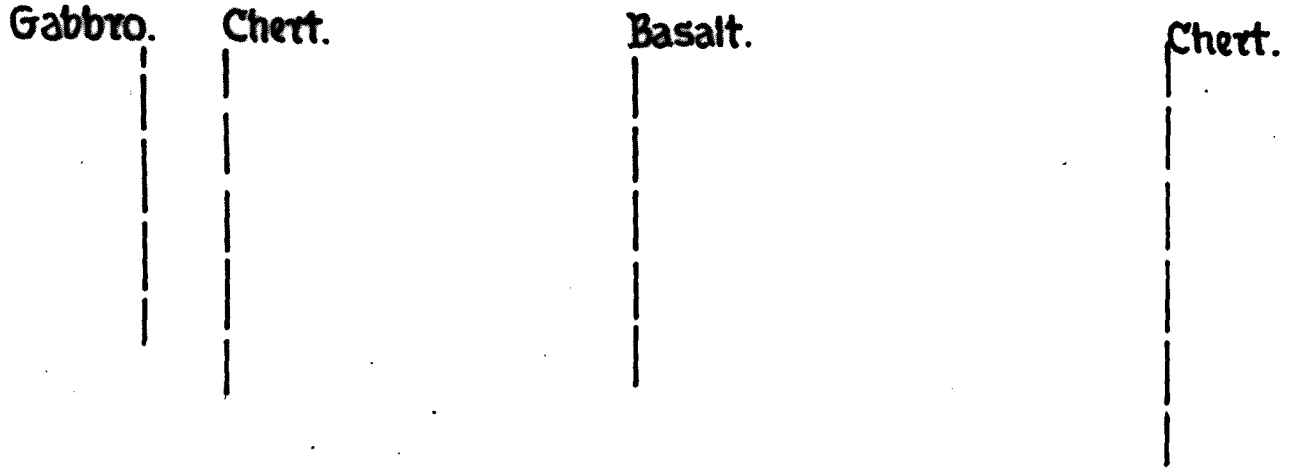
In square A9 exposure No 7 marks this contact and, by the description written against it, may provide part evidence of the geo-fracture postulated to run along this valley as described later in this thesis. In the north-west corner of the Bailgill Area are exposures of gabbros, basalts and dolerites near Craig Dod, a photograph of which appears on page 26 Peach and Horne (2) state that these volcanic rocks are Arenig in age because of the Arenig cherts associated with them. If, as Mackay (1) states, that contacts are tectonic rather than stratigraphic, doubts are thrown on the age of these volcanics and may be related to the geofracture in Glengonnar Valley, postulated later. The schistose basalts of Peach and Horne mentioned earlier in this chapter also lie approximately on a straight line, therefore in spite of Mackay's statement regarding non-continuity of exposures, the author maintains that there is a rough pattern about the chert-shale zone.

Strike-Faulting in Shales, Greywacke Shales & Cherts, at Cleuch Scar.

PHOTOGRAPHED FROM TOP RIGHT OF SQUARE G.4.

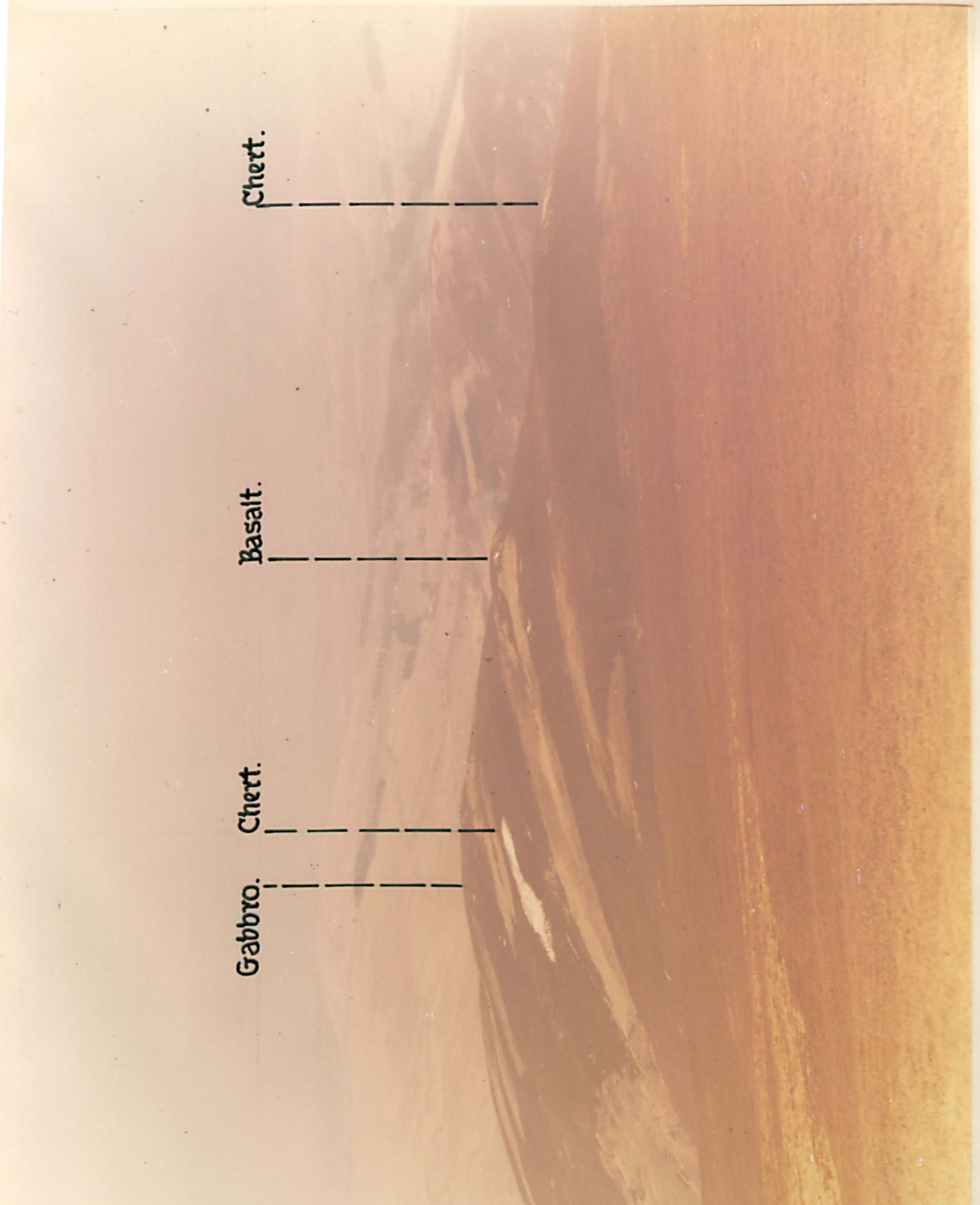
Banded Cherts.

Exposure 21. Square C.8.


Gabbro.
Chert.
Basalt.
Chert.

Craig Dod.

PHOTOGRAPHED FROM RAVENGILL DOD IN SQUARE E.8.



Craig Dod.

PHOTOGRAPHED FROM RAVENGILL DOD IN SQUARE E.8.

A thick felspathic dyke was traced from square E10 through square F9 into Sandy Cleuchs of squares F8 and G8 where it seems to have been changed by weathering or hydrothermal action to kaolin and there seems a worth-while quantity for extraction in these cleuchs.

It will be observed that the Bailgill District is crossed by two tertiary dykes whose only surface evidence seems to be 'float', in spite of their hardness as they do not stand above the country rocks. However the valley of the Shortcleuch seems to be narrowed in square L8 probably by the greater resistance to weathering of this particular dyke.

Some attention was given to the valley of the Lead Burn between squares J11 and N9 as Cherts and Shales are shown outcropping there and at one time the author considered the possibility of these outcrops representing a klippe left behind after the weathering away of an overthrust from the chert-shale zone to the west. The exposures however are very poor and few in number so that no conclusion was reached in spite of the straightness of the Lead Burn Valley (see photograph 28). What was found to be of greater interest was the large alluvial fan of Toddle Moss in square J11 deposited by the Lead Burn in the Valley of the Shortcleuch Water (named Elvan Water at this point). From the photographs on pages 29 and 30 the deposit seems alluvial rather than glacial in view of the meandering nature of the Shortcleuch. A 'fossil' portion of Lead Burn may be seen in square K11 (Toddle Burn).

Lead Burn Valley

PHOTOGRAPHED FROM S.W. CORNER OF SQUARE N.9.

Alluvial Fan from Leadburn.

PHOTOGRAPH TAKEN FROM SQUARE J.9.

Alluvial Fan from Lead Burn.

PHOTOGRAPH TAKEN FROM SQUARE J.12.

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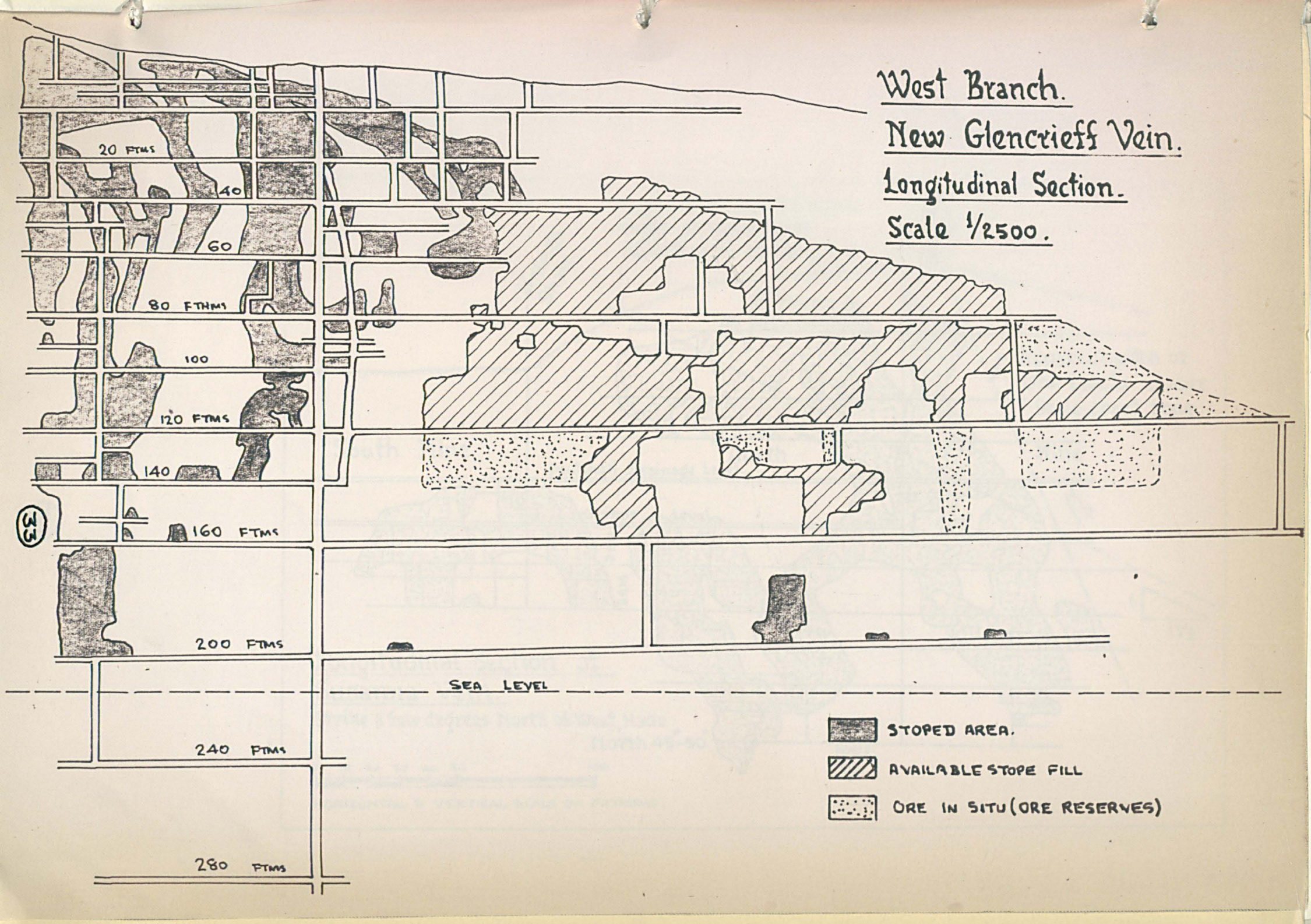
Chapter 2

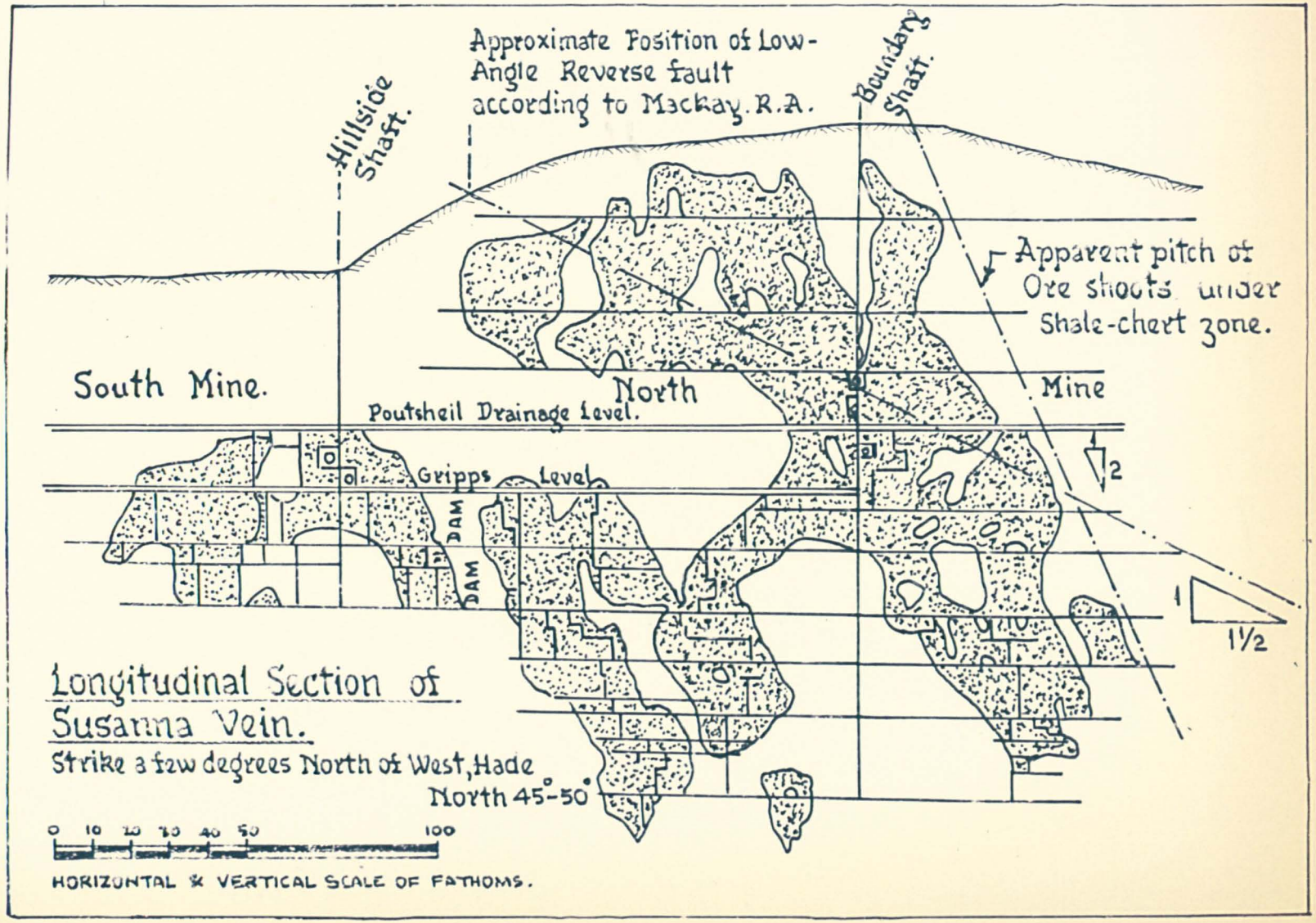
The Examination of the Possible Extension of the Plane of Dislocation or Disturbance to the North-East

Mackay [1] qualified his map (page 9) of the outcrop of the reverse fault crush zone by adding that ' it was deduced from all available evidence but the fact should be remembered that any slight change of dip in this area of strong relief would cause a considerable variation in the outcrop position'. In his paper Mackay called this major control of the district variously as, a complex zone of disturbance, a possible thrust plane, a low angle reverse fault, a zone of movement and a zone of dislocation but as far as the Bailgill District is concerned it is proposed to call it simply a zone of disturbance until more positive evidence can be deduced.

Mackay also gave various angles of dip for the plane such as 45° and 30-40° all in a north-westerly direction. For the purposes of this field investigation of the possible extension of the zone of disturbance into the Bailgill District a dip of 33° was adopted for the simple reason that it is near enough a slope of 1 vertical to 1½ horizontal which is very convenient for plotting a possible outcrop line by dip and strike methods.

It is most evident that in fact the angle of dip varies considerably by examining the Abandonment plans for the Western Branch of the New Glencrieff Vein and for the Susanna Vein. The stoping sections of these plans are given on pages 33 and 34, and are at opposite ends of the outcrop line as delineated by Mackay. The stoping sections certainly suggest that there is an area of dead and


West Branch.
New Glencrieff Vein.
Longitudinal Section.
Scale 1/2500.
20 FTMS
40
60
80 FTHMS
100
120 FTMS
140
160 FTMS
200 FTMS
240 FTMS
280 FTMS
SEA LEVEL
STOPED AREA.
AVAILABLE STOPE FILL
ORE IN SITU (ORE RESERVES)


Approximate Position of Low-Angle Reverse fault according to Mackay. R.A.
Hillside Shaft.
Boundary Shaft.
Apparent pitch of Ore shoots under Shale-chert zone.
South Mine.
North Mine
Poutsheil Drainage Level.
Gripps Level
DAM
DAM
2
1
1½
Longitudinal Section of Susanna Vein.
Strike a few degrees North of West, Hade North 45-50°
0 10 20 30 40 50 100
HORIZONTAL & VERTICAL SCALE OF FATHOMS.

unproductive ground dipping to the North West but the difference in dip between the stopes of the West Glencrieff Vein and those of the Susanna Vein is most obvious.

To attempt to trace the outcrop of the Zone of Disturbance to the North-East from Susanna Vein, the simplest procedure seemed to be to choose a suitable strike line and, adopting a dip of 1 to 1½, to plot a hypothetical outcrop and finally to examine a band of country either side of it to search for confirmatory evidence of its existence and if so, its true nature.

The first inclination was to run the strike line as near as possible to the juxtaposition of the metalliferous greywakes and the zone of black-shales with Cherts and volcanics which stratigraphically underlie the greywakes but at least in the Wanlockhead District are tectonically above them. The general mapping had been largely completed so this seemed an easy procedure particularly as the 'grain' of the country is generally S.W. - N.E.

However by closer examination of the mapping and by walking the Bailgill District greater precision seemed possible. In the North-West Sector of Square M1 of the large scale map, a massive chert/shale contact was found approximately on the 1500', O.D. contour line in Lady Manner's Scar above the Susanna Vein. This seemed a fairly definite point from which to run the proposed strike line at an altitude of 1500'.

In square H5, Wellgrain Dod, examination showed a cluster of old trial pits (photographed on page 36) which had failed to locate the extension of Bulmers Vein which in square I5 had been very productive of galena at Bulmers Works a few yards to the south. This suggested that the vein had been cut off in the non-productive shales and so

Trial Pits sunk in Shoulder of Wellgrain Dod to search for continuation of Bulmer's Veins.

PHOTOGRAPHED FROM SQUARE H.7.

provided a second point of fixture for the 1500', O.D. Strike line.

Examination of the topography at the North East end of the district showed a saddle in a ridge which suggested the exposed sole of the zone of disturbance (photographed on page 38). This 'saddle' lies in square D11 between Green Knowes and Kirk Rig. Although a little nebulous, this feature served as a fixture for the 1500', O.D. strike line where it leaves the district.

Once the tentative strike line had been fixed and using the adopted dip of 1 to 1½ it was a simple operation to find the intersection of the dip with the topographical contours and so plot a hypothetical outcrop for the zone of disturbance. This hypothetical outcrop is coloured purple on the large scale plan and gave the approximate band of country that had to be searched for confirmatory evidence.

It is now proposed to follow the hypothetical outcrop and discuss geological details either side of that line which may possibly confirm, refuteor limit its existence and extension.

Returning to Square M1, the stope section of the abandonment plan of the Susanna Vein (see page34) rather disagrees with Mackay's position and dip of the zone of disturbance. On the other hand the outcrop of the zone roughly coincides with the line of Gripps Adit. As will be described in a later chapter on the history of the Bailgill Mines, the excavation of Gripps drainage adit was an extremely slow process and the 'Old Men' would have been only too ready to follow any plane of weakness such as would be provided by the disturbance zone.

The next significant check on the position of the disturbance zone is given by the chert outcrop mapped alongside the shaft in the

'Saddle' or 'Wind-Gap' between
Green Knowes & Kirkton Rig.

PHOTOGRAPH TAKEN FROM SQUARE E.9.

south-east corner of square K1. Mackay [1] states 'There is also good but not certain evidence of it (the zone) in the Gripps Adit' but Mr. George Borthwick, a principal geologist of the Siamese Tin Syndicate and who geologically mapped the Gripps Adit is far more positive in a chapter he contributed on the Leadhills and Wanlockhead Districts to a small volume entitled 'Edinburgh Geology, An Excursion Guide' [2] He states 'Round the old mine shaft occurs a chert outcrop (884/166). This can be seen underground to be in faulted contact with the greywake'.

In exposure No 1 of Square K2, sheared black shales are to be seen on a shaft dump suggesting it lies near the outcrop of the zone of disturbance. The strikes of exposures Nos 2 to 9 inclusive suggest the direction of the disturbance is approximately correct but they are somewhat distant from the hypothetical outcrop. The presence of felsite dykes (Exposures 2 and 3) in addition to emphasizing the presence of the zone of disturbance, invite the question as to whether or not they link up with the felsite dyke which formed the hanging wall of the Susanna Vein (See page 125 of Chapter 6).

In the centre of Square K2 high up on the slopes of Wool Law are two abortive trial levels which may have been driven in search of the upward extension of the Wool Gill Vein. On stripping the turf from the dumps only shale and chert debris could be found and suggests that the hypothetical zone of disturbance is in an approximately correct position.

The old mining plans from Hopetoun House included one dated 1773; of which reproduction of this included in Volume II of this thesis, suggests that Wool Law Gill Vein of Square K2 was worked deep under the flanks of Wool Law and yet was not picked up by the two trial

levels referred to previously in this square. It is generally accepted that the lithology of the formations is an important secondary ore control inasmuch as the metalliferous veins cease to be ore-bearing when the fissures enter the chert-shale area because they become blocked by the softer crushed rocks. (Wilson[3]). (Mackay [1])

The implication is that the greywakes carrying the productive Wool Gill Vein must lie beneath the Chert-Shale Zone explored by the two abortive trial levels mentioned above. The Chert-Shale Zone is stratigraphically older than the greywakes and thus adds weight to the hypothesis of a North West dipping zone of disturbance and on the large scale map, it will be noted that the Wool Gill Vein in greywakes extends north of the hypothetical outcrop.

During the field work, the eastern slope of Wool Law was examined for chert 'float' which might be suggested by the line taken by the hypothetical outcrop. Every sheep-lie was examined carefully for rock because there were no outcrops but without positive result. On examining the west side of Wool Law two abrupt changes in slope are visible in square J3, indeed one of them has signs of a very old prospect level driven into it. These abrupt changes of slope suggest that the outcrop of the zone of disturbance may pass along the west side of Wool Law Summit and not on the east side as indicated by the hypothetical outcrop. There are two other factors that lend weight to this argument, the first being that in the upper reaches and scar of Little Wool Gill (Squares J2 and J3) there is considerable float of chert and felsite. The second factor is to be found in the Old Mining Plan from Hopetoun House entitled 'Survey of Belgale Burn, 1751', a reproduction of which is included in Volume II of this thesis. This plan shows the expected course

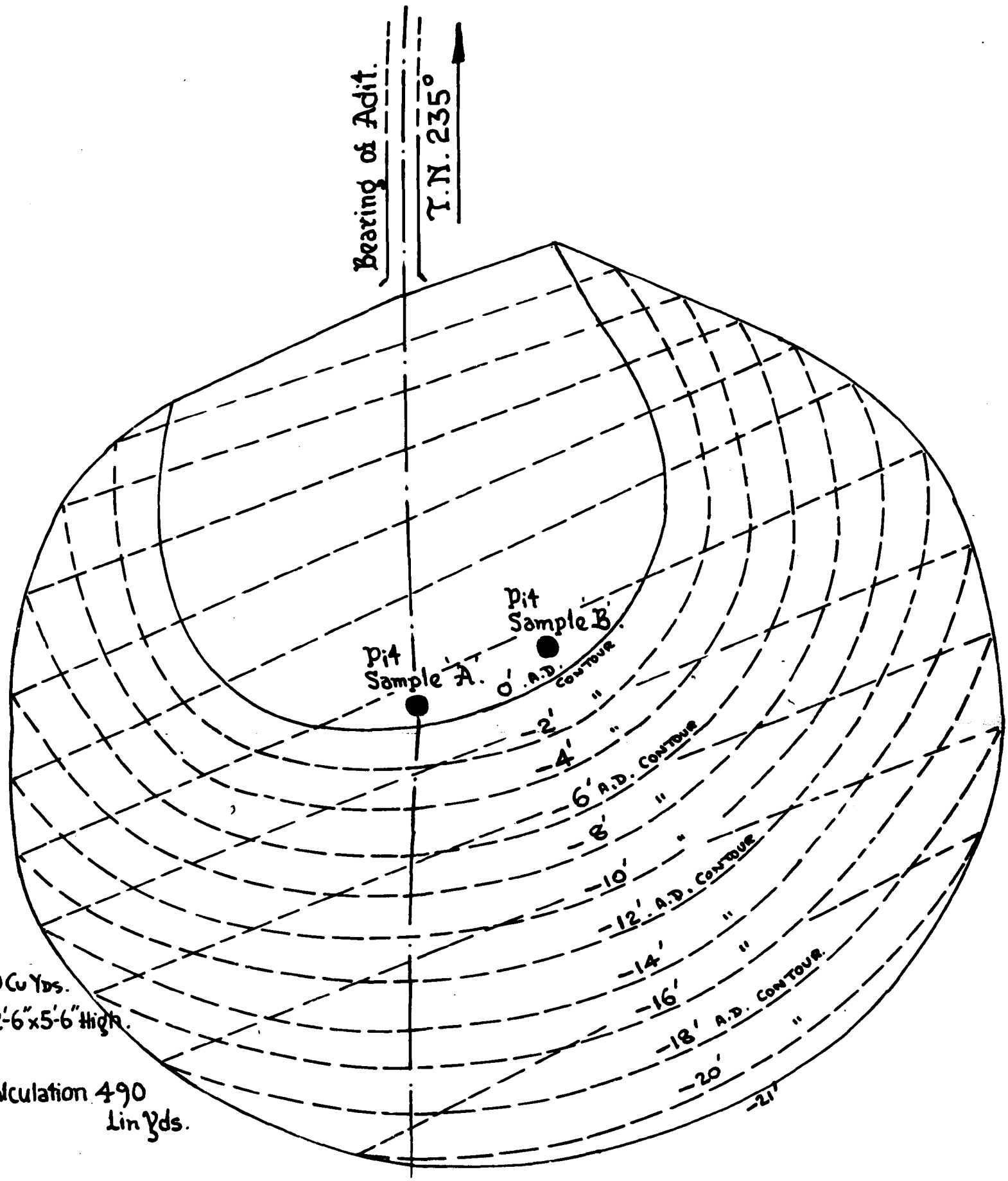
of the 'Burn-head Vein' running between Bailgill Mine and the head of Rushy Grain which suggests that Greywakes were expected to persist along that line and that the zone of Disturbance did not persist as far to the east as Rushy Grain. It is suspected that the 'Well-Eye' Exposure No 13 in square J3 is in fact spring-water flowing from this or one of the sub-parallel veins shown as extending southwestwards from the Bailgill Mine to the head of Rushy grain where indeed strong iron staining was noted during the field survey. The Old Mining Plan dated 1773 shows an 'insett' at the head of Rushy Grain which is the old word for a trial level.

At the Bailgill Mine Dump itself an attempt was made to locate the zone of disturbance more accurately. Bailgill Mine Dump is located in Square J4 of the large scale map and there is a photograph of it on page 42 The dump itself has been superimposed above the older working shown on the 1751 mining plan and was probably a trial to examine the veins shown thereon.

The direction of the prospecting level was measured, the dump surveyed and contoured as on page 43 and its volume of excavated material calculated. Assuming appropriate dimensions for the level, with appropriate bulking and compaction coefficients the approximate length of the level was estimated and plotted in square J3. Using a 'Pioneer Corps' trenching tool the dump was sampled and the excavated material examined on the basis of what came out of the level last probably lies on the outer edge of the dump. After washing the excavated material, besides a few pieces of haematite and greywakes the predominant material was sheared black shales which suggests that the level ended in or near the zone of disturbance after passing through the greywakes.

Bailgill Mine.

PHOTOGRAPH TAKEN FROM TOP LEFT, SQUARE J.4.



Volume of Dump 980 Cu Yds.
Assumed X-Section of Adit. 2'-6"x5'-6" High.
Bulk Coeff 1·3.
Approx length of Adit by calculation 490 Lin Yds.

Plan of Countours of Dump from Bailgill Adit.

0' 5' 10' 20' 30' 40' 50'
Scale of Feet.

The next exposure of the zone should be found where it crosses Bellgill Burn but although exposure No 66 (Square I3) shows sinistral transcurrent shear in Greywakes as described in Chapter I and is nearest to the hypothetical outcrop, more appropriate exposures are to be found in the burn bed at exposure No 32 (Square I3) and at exposures No 47 (Square I3) especially the latter.

It is possible that the exposures Nos 32 and 47 both form part of the zone as it is unlikely to be the single sharp walled fissure so often illustrated in text-books. The photograph on page 45 illustrates what is thought to be the course of the disturbance zone down the northern slopes of Wool Law but is of little assistance in deciding the point where it crosses Bellgill Burn. From exposure No 32 and various geological phenomena to be described it is believed that the major branch of the disturbance zone passes up Stinking Cleuch, a photograph of which is given on page 46 The disturbance here seems to take the form of a thrust fault because it brings up the stratigraphically lower black shales and massive ironstained cherts against the stratigraphically and topographically higher greywakes and greywake shales all as shown in square I3 of the large scale map. The photograph on page 47 was taken about half-way up the eroded thrust fault zone.

Of particular interest is exposure No 8, a massive ironstained outcrop of chert overlain by soft black shales while the underside of the outcrop exhibits load cast features such as are sometimes found on the underside of greywake beds. The other point to remark upon is its low dip of 45° amongst the other formations which almost invariably have a near vertical dip. For this reason it is assumed that it is a very large block of chert detached during

Possible Course of Zone of Disturbance around N.E. Shoulder of Wool Law.

PHOTOGRAPHED FROM LEFT HAND SIDE OF SQUARE I.4.

Stinking Cleuch. Summit of Wellgrain Dod to right.

PHOTOGRAPH TAKEN FROM CENTRE OF SQUARE I.3.

Half-Way up Stinking Cleuch.
Square I.3.

fault movement. The massive chert may be seen roughly in the centre of the photograph, (page 47).

Just downstream from where the photograph on page 47 was taken some harder greywakes showed signs of the linear grooving of slickensides but these grooves were too shallow to photograph successfully. Nevertheless the strike of the rock face carrying the suspected fault slickensides was True-North 88° and the dip of the grooving was 45° on a north-west bearing.

Some of the black-shales in the fault zone have graptolitic markings but are too metamorphosed for identification. Near the top of the cleuch the fault zone bifurcates and on page 49 is a photograph of the left hand branch in which the outstanding feature is free-standing slabs of shales. The right hand branch is more interesting as a low angle reverse fault appears in its left hand wall (photograph on page 50).

Above this point the gorge shallows until it reaches the peat line but that it follows the zone of disturbance is emphasised by the yellowish weathered shales on the left hand side whilst on the right hand side, greywake and greywake shales predominate; the contrast in colouring is most remarkable.

Before following the zone northeastwards it is well to note that the hypothetical outcrop of the zone passes to the south of the dominant height of Wellgrain Dodd in square I4 and I5 while as suggested by the present mapping, more probably the outcrop passes to the north of it. To investigate this more fully, it was decided to measure the direction of Airs Prospect Level of Square I4, evaluate the cubical contents of its dump to estimate the probable length of the level and to sample the dump to learn what formations

Left-hand Branch of Stinking Cleuch.
Square I.3.

Low Angle Thrust Fault.
Exposure 11, top right hand corner of Square I.3.

had been penetrated and in what order. A photograph of Air's Dump appears on page 52, a contoured plan and level approach trench on page 53. From the cubical contents of the dump and assuming a probable bulking factor and likely cross-sectional size for the now collapsed level, it was possible to estimate its probable extent which together with direction are plotted on the large scale map.

Referring to the plan of the dump on page 53, Trial Pit No 1 was excavated to a depth of 18" and the excavated material taken to a nearbye spring for washing. Quoting the field book record "After washing the contents were found to be mudstones, ironstained mudstones greenish mudstones, some black shales, harder greywake shales with some mullion rodding amongst shales but on the whole, disappointing".

Trial Pit No 2 on plan was excavated to a depth of 3'. After washing the excavated material, it consisted of sheared black soft greywakes, soft black cleaved shales, some fragments of harder materials amongst the shales but none of the material would seem suitable for deposition of lead ore.

Trial Pit No 3 was excavated to a depth of 3'6". Quoting again from the field book "All material soft and clay-like but with some specimens. Excavation was easy in this yellow-brown clay. Is this weathered material due to piece-meal excavation in pre-gunpowder days followed by two and a half centuries of weathering in the dump? After washing, the clayey debris from trial pit No 3, the chief materials were dolerite from the tertiary dyke, felsite from a pink/yellow dyke which was also moderately hard".

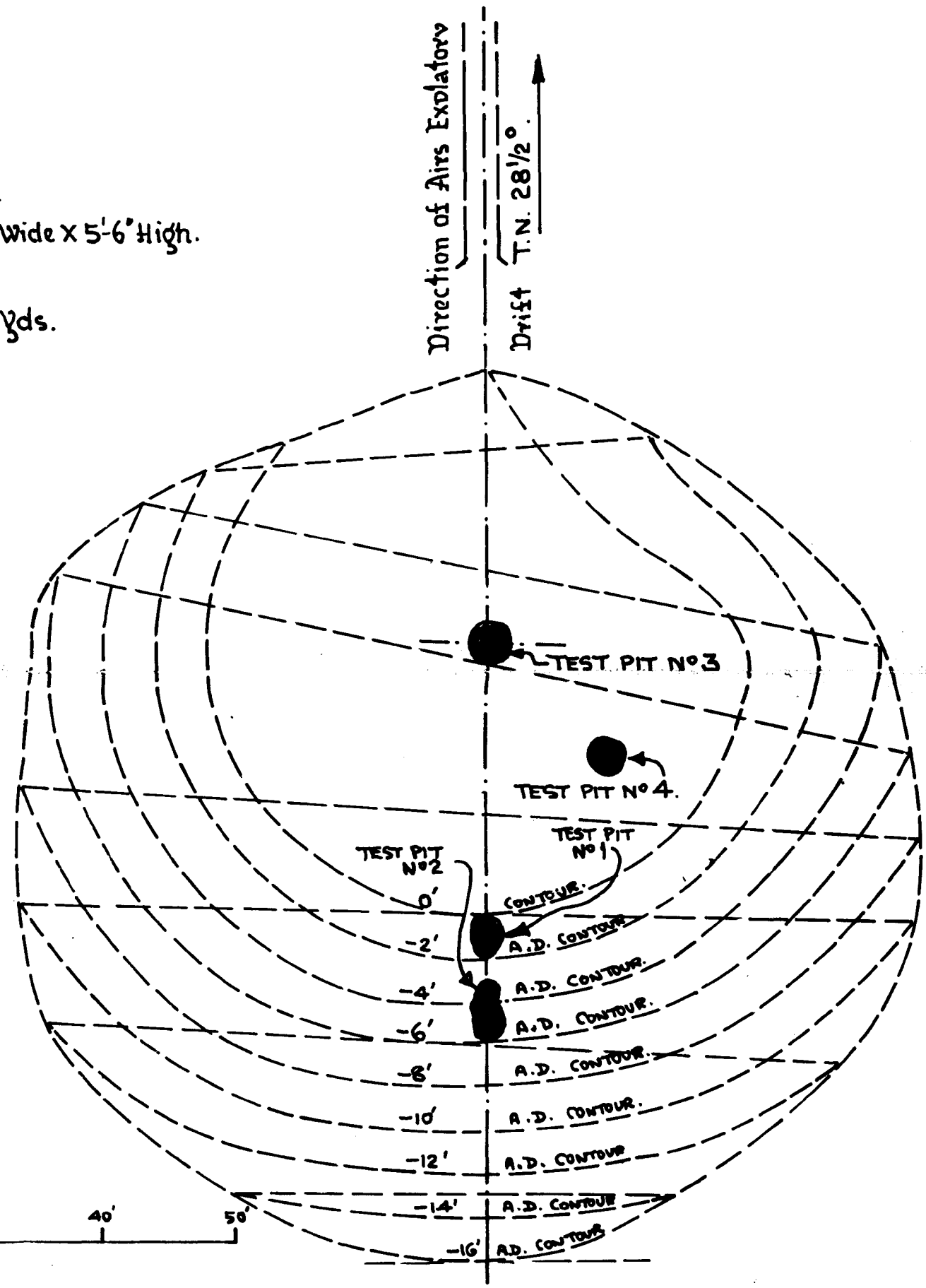
The conclusion reached is that Airs Prospect level penetrated the greywakes and Tertiary dyke and approached or attained the true position of the disturbance zone on the North West side of Wellgrain Dod.

Airs Prospecting Level.

PHOTOGRAPH TAKEN FROM BOTTOM RIGHT OF SQUARE I.4.

(53)

Volume of Dump 520 Cu Yds.
Assumed X-Section of Drift 2'-6" Wide x 5'-6" High.
Bulking Coeff 1·3
Approx length of Drift 264 Lin Yds.



Plan of Contours of Dump from Airs Prospecting Drift.

Returning now to the left hand bifurcation of the suspected fault at the head of Stinking Cleuch; this most northerly branch can be traced into Clow Gill by the springs of water, Shear drag in cleaved black shales of exposure No 19 in the bed of the burn, so on into Gled Knoll by exposure No 18, all in square H4. However the main interest lies in the right hand branch of the disturbance zone leaving the head of Stinking Cleuch as this branch has the stronger features and may be the continuation of the postulated zone of disturbance although it is as much as 400 yards away from the Hypothetical Outcrop.

If the topographical contours of squares H3 and H4 are examined, it will be noted that the head of Clowgill Valley turns into the line of the fault or disturbance zone and that the main flow of Clow Gill issues from a main spring which as seems possible, lies on and originates from the zone of disturbance. A photograph of the dry head of Clowgill appears on page 55 taken very roughly in the direction of the line of disturbance but the exposures mapped in squares H4 and H5 give a better understanding of its geology. The main features are the jasperoid impregnated shales on the left hand side of the gulch proceeding uphill. Their appearance is very much like the 'gossan' or 'Iron Hat' noted in leached outcrops of veins in other mining districts. The presence of the jasperoid is suggestive that hydrothermal solutions have traversed this zone of disturbance. On the right hand side going uphill, the greywakes come in near the top of the saddle between Wellgrain Dod and Gled Knoll. As will be observed in square H5 a felsite dyke separates the greywakes from the mudstones and the strike of the dyke seems to coincide with what is thought to be the true course of the zone of disturbance.

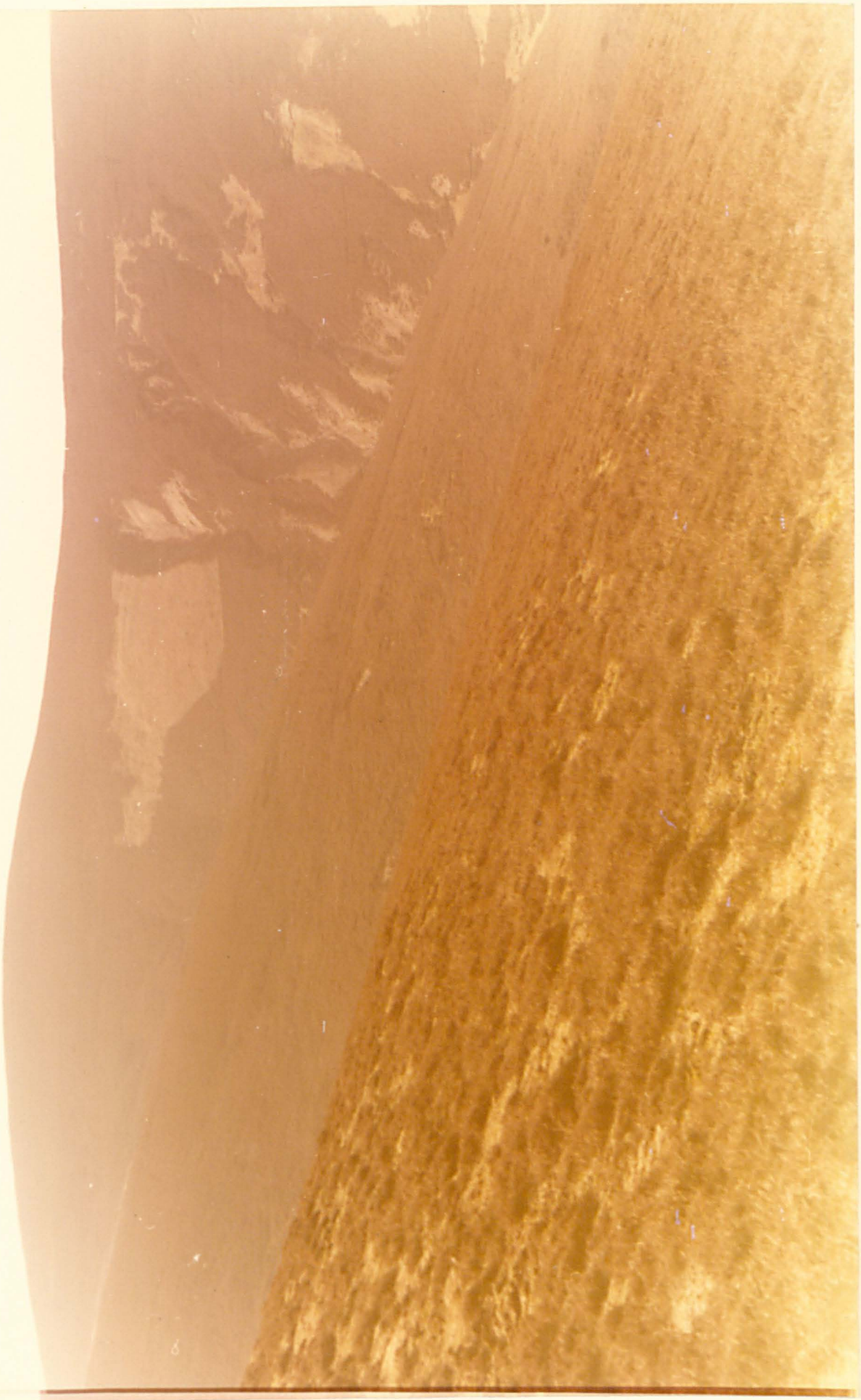
Head of Clow Gill.

PHOTOGRAPH TAKEN FROM SQUARE H.3.

In square H5 appear some very old trial pits which were used in an attempt to trace the extensions of Bulmers Veins through the east shoulder of Wellgrain Dod. These pits are barren of any trace of ore and as the greywakes only are amenable to deposition of ore and not the shales it is possible that the disturbance zone passes near these trial pits as the productive mine in Greywakes at 'Bulmers Works' in only a few yards to the south. A photograph of these trial pits with Wellgrain Dod in the background is given on page 36

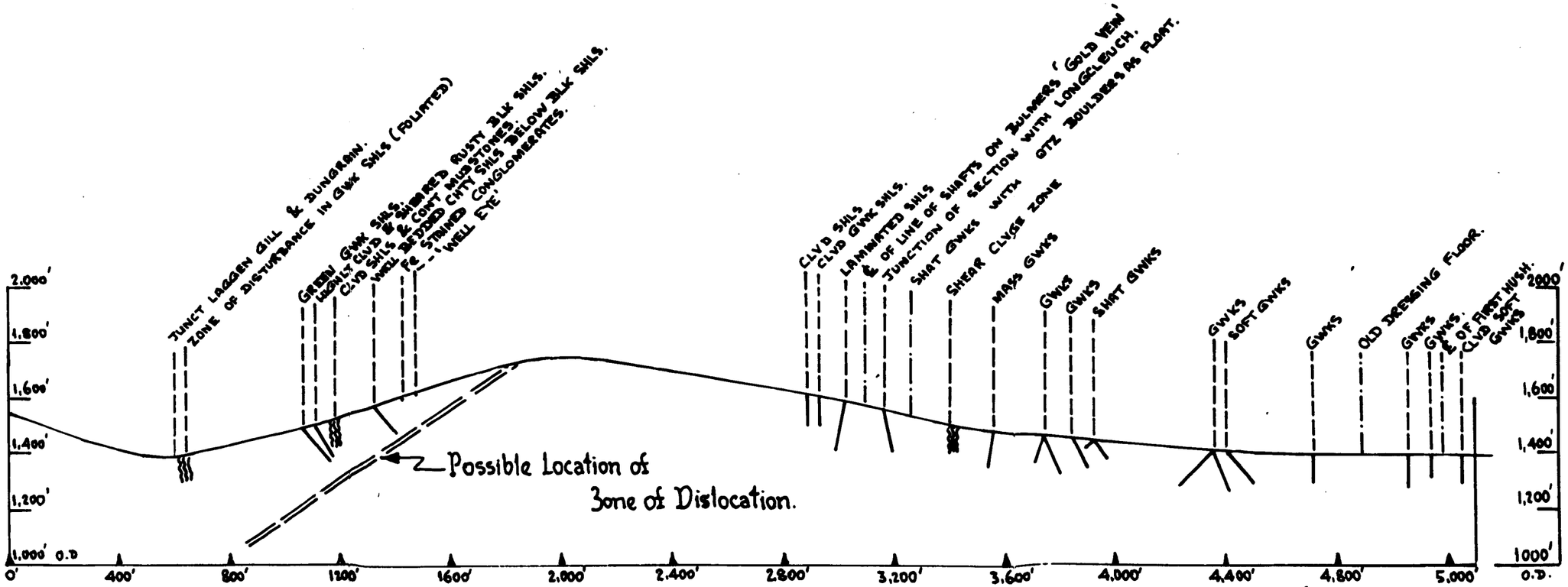
In the centre of square H5 two cleuchs lying along the strike of the chert and shale zone may represent the continuation of the line of disturbance into the headwaters of Laggen Gill. Page 57 shows a photograph of these two cleuchs which are not far removed from the hypothetical outcrop of the disturbance zone. In the bed of Laggen Gill there is too much loose debris to give a definite exposure of the zone but some indication of its presence is given by exposure No 1 of square H5 where heavily ironstained cherty shales cause a small waterfall.

The next exposures of interest are in Dun Grain of square H7 where cleaved and contorted mudstones are noted in its bed. Higher up and near the top of the grain there is an outcrop of well-bedded cherty shales dipping to the south west. In view of the topographical height of these cherts and the southerly 50° or 60° dip of other exposures mapped in the same grain, the presence of a thrust fault is suggested in this area. The hypothetical outcrop of the Disturbance zone also passes very near the outcrop of the Cherty Shales and it is therefore instructive to draw a cross-section up Dun Grain across Coom Dod Ridge and down to the definitely greywake strata of Shortcleuch Burn. This is given to a natural scale on page 58, together with



Two Scars behind Wellgrain Dod which may lie on outcrop of Disturbance Zone.

PHOTOGRAPH TAKEN FROM SQUARE G.6.



Section across Fault-Scarp of Coom Dod from Jct Laggen Gill & Dun Grain to Long Cleuch.

Scale:- 1" = 400' (Natural).

58

a postulated position of the disturbance zone up which the shales and cherts were thrust. In the whole district the bedding of the strata is found to be invariably near vertical. Any departure from near vertical dips, especially to near 45° is immediately a point of great interest especially if the exposure is so deep that it is unlikely to be caused by creep. The thrust fault of the disturbance zone would be formed somewhat later than the forces responsible for the general vertical attitude of the strata. This would account for the angle of dip of the bedding noted in the exposures of Dun Grain lying above the thrust plane.

One point difficult to explain is the presence of the hard greywakes in Laggen Gill above its junction with Coom Burn, i.e. in square G6. These greywakes lie north of the probable thrust fault scarp and may represent the sole of the thrust plane.

In squares G6 and G7, it will be noted that Coom Burn turns its course gradually through about 90° to run in the direction of the hypothetical disturbance zone. The photograph on page 60 shows in the cleuch to the left hand side of the picture, the probable extension of the disturbance zone. Other indications are the presence of a number of 'well eyes' or copious springs.

In the north-east quadrant of square G7, Chert float 13 and Greywake float 14 lie close together and the disturbance zone outcrop may run between them, being not far removed from the hypothetical position.

Beyond the square G7 the actual position of the outcrop of the Disturbance Zone is far less certain and may be dying out. However the fault scarp seems to persist and in square F8 the hypothetical outcrop lies roughly parallel to a linear exposure of chert float.

Head of Coom Burn. Left hand Scar may represent Continuation of Disturbance Zone.

PHOTOGRAPH TAKEN FROM SQUARE G.6

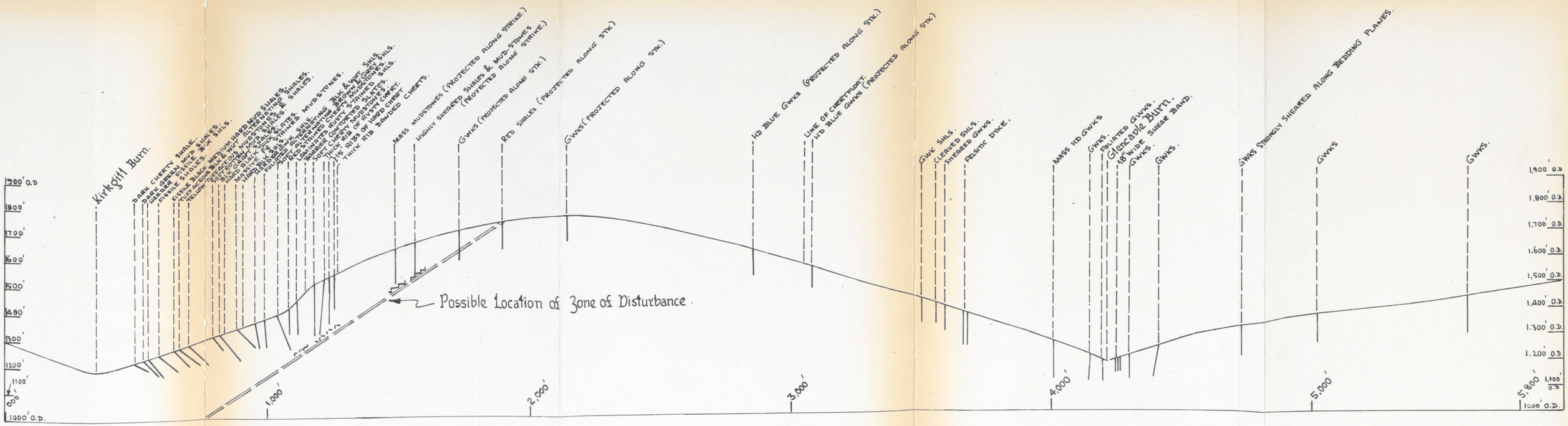
The presence of this line of chert float is possibly explained as the remains of the overthrust portion which has long been weathered away. The felsite dyke coursing between squares F9 and E10 may represent the continuation of the zone of disturbance but indications of the next paragraph suggest it still lies in the fault scarp to the west.

On page 62 is a section drawn up the un-named cleuch in square E7, over the postulated fault scarp of Ravengill Dod to the head of Burnts Cleuch. In this un-named cleuch dips of 45° to the south east are noted, the same as in Dungrain of theprevious section on page 58 At first it was suspected that these dips were the effect of creep on softer less competent rocks but the depth of the cleuch below the surrounding hill-side (40 feet or so) renders this unlikely. As in the case of Dungrain and for the same reasons a tentative reverse fault can be drawn on the section in a position not very far removed from the hypothetical outcrop of the disturbance zone.

At the head of Raven Gill in square D9 a high angle fault throws mudstones against greywakes to the south.

In square D10, the first exposure of hard Greywacke No 45 is encountered in Glencaple Burn and is followed by a gorge in the same hard greywackes (exposures Nos 46, 47 and 48) which could well represent a fault plane along the strike of the greywackes and again is not far distant from the hypothetical outcrop of the disturbance zone.

Finally within the area of the map comes the suggested exposed sole of the disturbance zone between Kirkton Rig and Green Knowes (see again the photograph on page 38). Exposures show that the sole plane, if such it be, is of greywackes, the only other exposure is in a small quarry in the dolerite of the tertiary dyke which also traverses this gap.



Section across Fault-Scarp of Ravengill Dod.

From Kirk Gill to head of Burnts Cleuch. (Squares E7 to G10)

Scale 1/2500. (Natural.)

62

To recap the course of the postulated zone of disturbance a set of air photographs with descriptive overlay are given on page 64

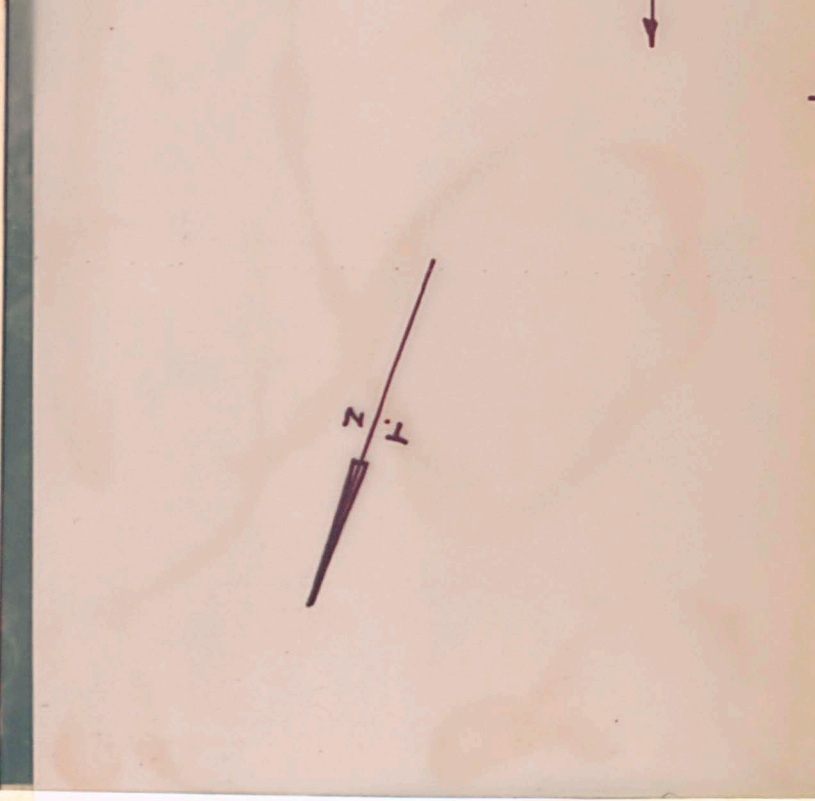
The only conclusions which may be put forward at the end of this chapter are that the zone of disturbance is more evident between the Susanna Vein and Coom Burn and thereafter tends to die out evidence-wise towards Kirkton Rig. The indications are that it has the nature of a high-angle reverse fault because it brings up older strata alongside or higher topographically than younger strata. The dip does not seem to remain constant but tends to flatten as the zone extends to the North-East.

Concerning its effect as an ore control for the Bailgill Mining District its influence seems to end at Coom Burn where definite evidence of its presence ceases and which also coincides with the present northern edge of this mining district.

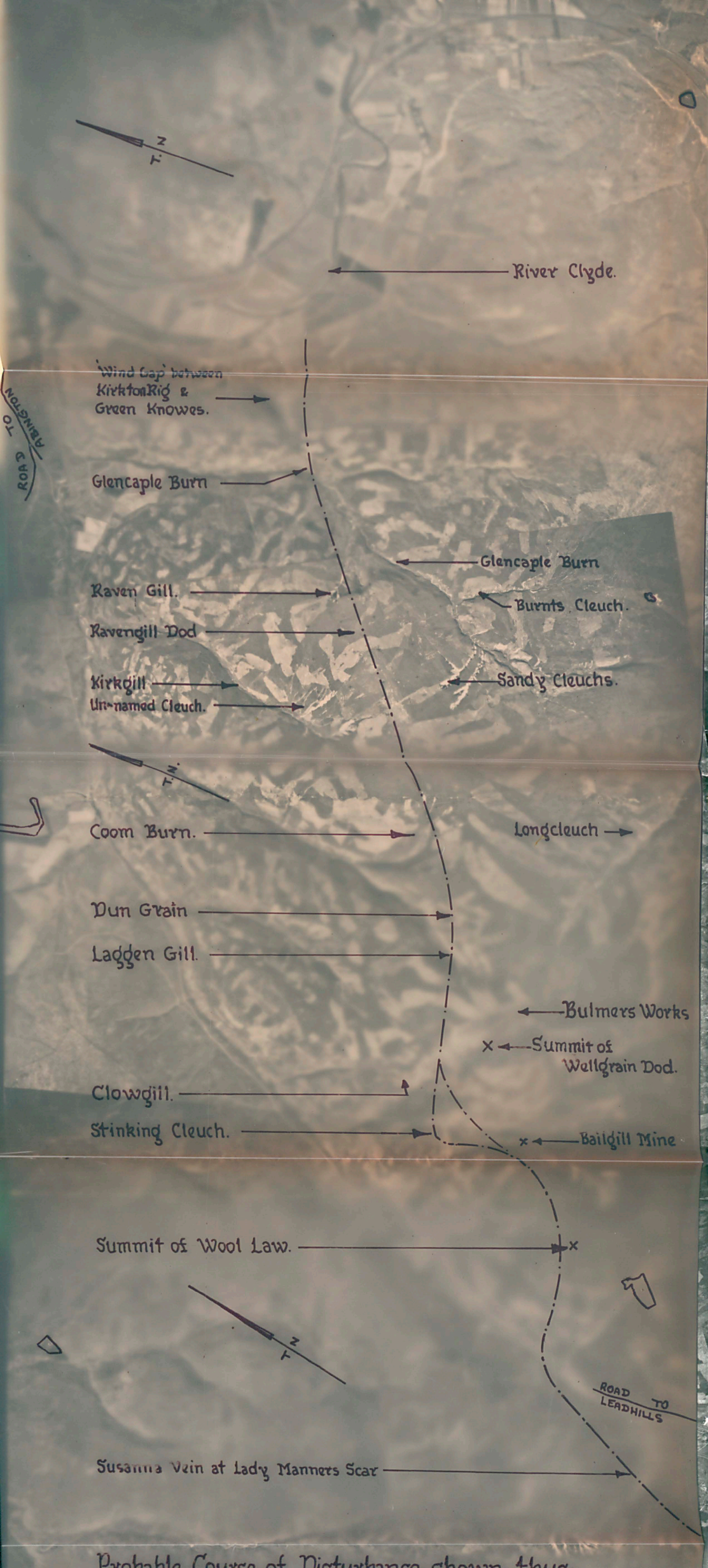
Proceeding northwards the dip of the zone of disturbance seems to flatten which suggests that there would be greater opportunity for hydrothermal ore bearing fluids to permeate upwards through the overlying mantle of cherts and shales.

However if the course of the Shortcleuch Water is compared with that of the Glengonnar Water it will be noted that whereas the former has a meandering course that of the latter is sufficiently straight; to suggest it runs along the course of a fault or further disturbance. There are no truncated spurs, abandoned meanders or hanging valleys to suggest glaciation as a possible cause of its straight course.

This postulated fault together with the zone of disturbance traced above could have a marked joint effect on the structural geology with consequent control of ore deposition but this will be brought forward for consideration in a separate chapter.

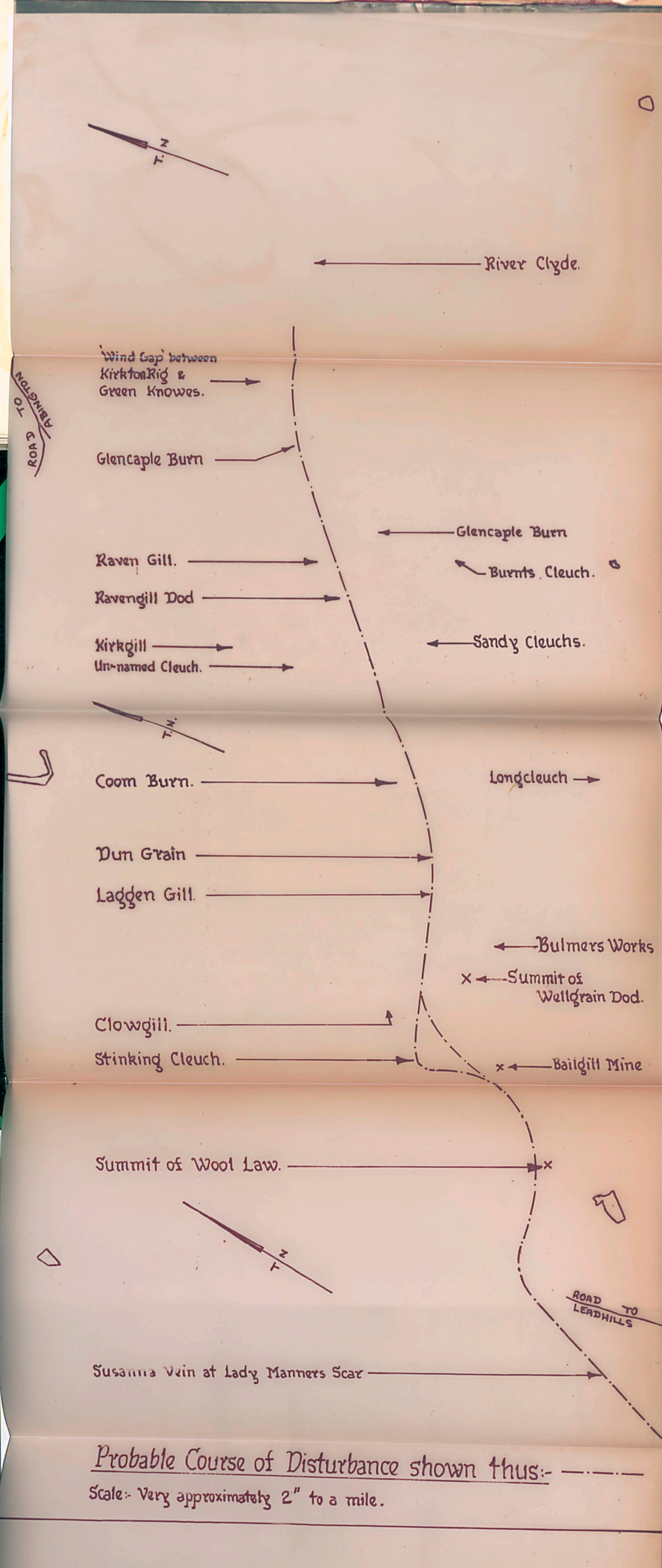


Air-Photographs with Overlay showing postulated course of Reverse Fault.



Probable Course of Disturbance shown thus:- —·—·—

Scale:- Very approximately 2" to a mile.



Probable Course of Disturbance shown thus:- —·—·—

Scale:- Very approximately 2" to a mile.

To finalise this chapter a quotation is taken from Robert Jameson's 'Mineralogical Description of the County of Dumfries' Edinburgh 1805'.

'Nearly at the entrance of the valley of Leadhills, there is a mighty rock mass of flinty slate, through which none of the veins have been observed to pass; indeed it is said by the miners to cut them off.'

It is interesting in view of the above examination of the zone of disturbance to speculate if Jameson was referring to Wool Law of Square K3.

Glossary Float. Weathered material which is still at, or near, its point of formation.

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3. Wilson, G.V., 1921. The Lead, Zinc, Copper and Nickel ores of Scotland. Spec. Rep. Mineral Resources, 17. Geol. Surv.

CHAPTER 3.

Structural Geology and Ore Control of the Wanlockhead, Leadhills and Bailgill Districts considered as a whole.

Anyone examining the sketch map on page 3 must wonder why this single metalliferous area should be located in the midst of Southern Scotland where the geology is relatively simple and where batholiths or large scale satellitic structures are not exposed. This chapter is an attempt to suggest a reason and is based on site observations and the writings of others.

Chapter 2 concerned itself in tracing the course north-eastwards of the high angle reverse fault which for convenience in this thesis will be named 'Mitchell's' fault in honour of the Mine Captain who first drew attention to its presence at the Wanlockhead Glencrieff Mine in May 1929, (McGreggor,A).(1) The chapter ended by postulating a fault or disturbance running along the straight valley of the Glengonnar Water. (See photograph on page 68). The common answer for such a straight topographic feature is valley glaciation, but in this case there are no signs of truncated spurs or hanging valleys and the question must be entertained as to why Glengonnar Valley should be so straight while the neighbouring valley of the Shortcleugh has such a meandering course.

To trace the run of this postulated fault or disturbance in the Glengonnar Valley it is necessary to commence at Thornhill, some ten miles to the south of Leadhills. In 'British Regional Geology. The

Straight Valley of Glengonnar Water.

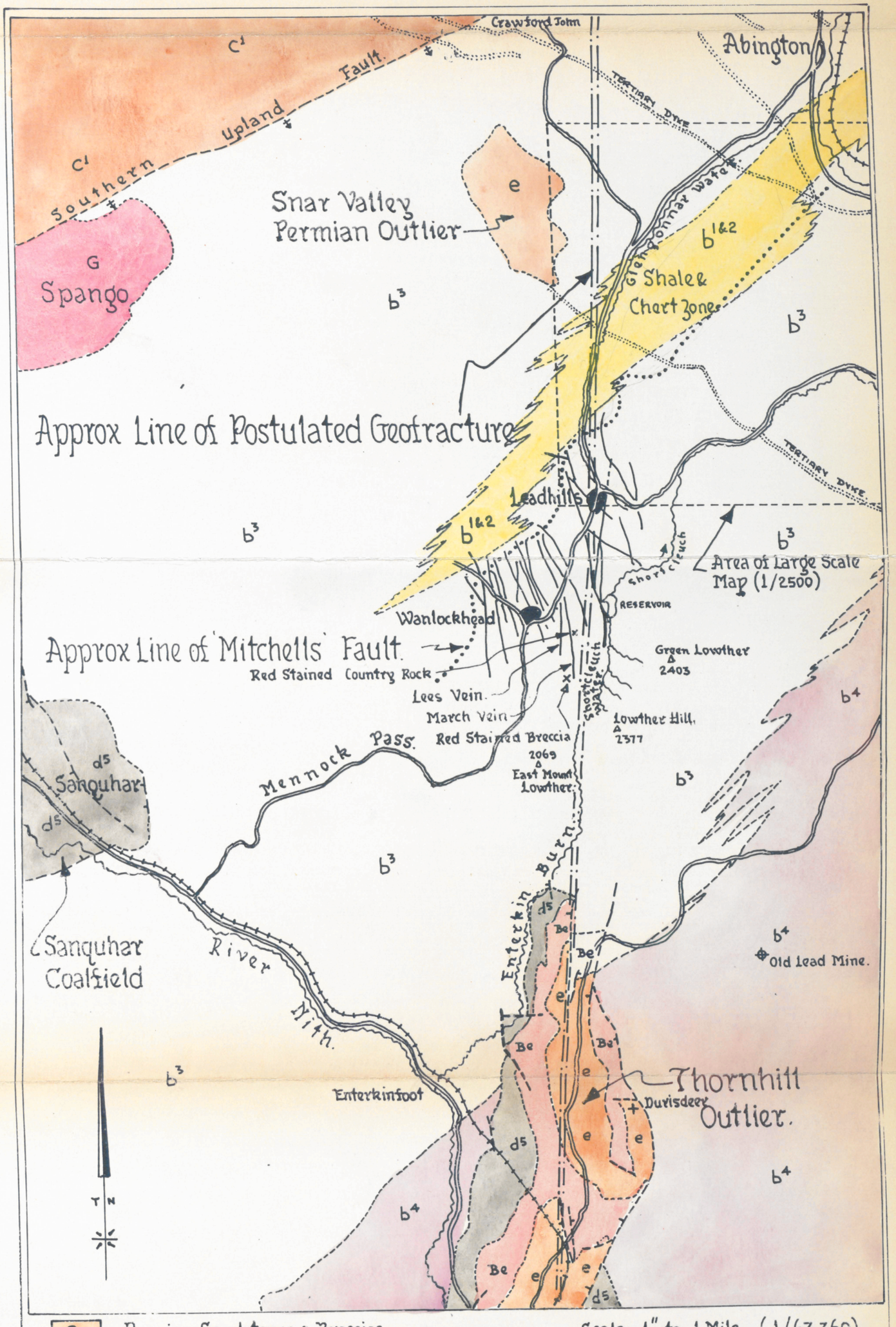
TAKEN FROM TOP LEFT CORNER OF SQUARE E.4.

South of Scotland' (Second Edition 1948). Pringle describes on page 3, "an important hollow in Nithsdale which runs across the Southern Uplands from the Solway Firth by way of Dumfries and Thornhill northwards to Durisdeer and perhaps as far as the Snar Valley." Thornhill has an important Outlier of Carboniferous Strata while the Snar Valley contains an outlier of Permian coarse breccias occupying a depression in Ordovician rocks. The course of this 'important hollow' may be traced on the 1" scale geological map, page 70 . It is noteworthy that the third edition (1971) of the above mentioned memoir, makes no mention of this hollow but Russell (1971) in a contribution to the Scottish Journal of Geology[3] entitled, 'North-south geofractures in Scotland and Ireland' suggests that a geofracture runs in a northerly direction from Thornhill through Wanlockhead and Leadhills to Alva on the Ochil Fault, a total distance of about 60 miles.

Spencer[4] in 'Introduction to the Structure of the Earth' defines Geofractures thus, "Many of the 'en echelon' fold and fault systems found in sedimentary rocks have been interpreted in terms of strike slip movements on deep-seated transcurrent faults (also called Megashears, Geofractures or shatter zones) which presumably extend deep into if not through the crust."

The present Writer would not care to extrapolate such a geofracture to Alva which is well beyond the Southern Uplands Fault but prefers to confine himself to its possible course between Thornhill and Snar.

Referring therefore to the 1" scale geological map, page 70 , examination will be made first of the Thornhill Outlier of Carboniferous Strata



e	Permian Sandstones & Breccias.
d5	Coal Measures
C1	Lower Old Red Sandstones.
b4	Silurian Greywakes, Shales & Conglomerates.
b3	Ordovician. Caradoc. Greywakes.
b1&2	Ordovician, Blk Shales, Mudstones & Cherts.
G	Granodiorite. Be Permian Basaltic Lavas.

Scale:- 1" to 1 Mile. (1/63,360)

Part of Sheet 15 (Sanquhar).

of which there is a very detailed description in, 'The Geology of the Sanquhar Coalfield and Adjacent Basin of Thornhill' a memoir of the Geological Survey published in 1936.[5] There is also a summarised version in the most recent'British Regional Geology. The South of Scotland' (Third Edition 1971).[6]

The relevant and salient points as to the Thornhill Outlier are as follows. The Carboniferous strata are partially concealed below basaltic lavas and sandstones of the Permian Period. The Passage Group is present but with evidence of unconformities and non-sequences suggesting these grits were deposited during periods of instability caused by earth movement. The beds of the whole outlier are reddened allegedly through oxidation of their iron content together with some brecciation of the fine-grained sediments. The coal beds of the Productive Measures pre-existed but have been oxidised to a gossany rubble.

The reddening of the Carboniferous strata is a most interesting phenomenon and has been ascribed to deeply extending oxidation during Permian times when desert conditions existed throughout Great Britain.

A few miles to the west of the Thornhill Outlier is the Sanquhar Coalfield; also an outlier of Carboniferous strata, which represents a complete contrast in having productive coal seams without any reddening of the confining strata. It is true that the productive coal measures here are surmounted by the upper barren red measures but this is a normal feature of most Scottish coalfields.

At Thornhill however, the reddening extends down to the Ordovician and Silurian basement, destroying such coal seams as pre-existed. It is worthy of observation that in other areas of Great Britain, coal has been worked successfully in Carboniferous strata lying below a shallow cover of Permian rocks.

Regarding the Permian Lavas and sandstones of the Thornhill Outlier, the lavas are in a state of decomposition, caused allegedly by the same migration of underground waters during the desert period as caused the destruction of the coal-seams and reddening of the Carboniferous measures beneath.

This downward extension of desert weathering many hundreds of feet below the surface of the desert is accepted only with difficulty by the writer who suggests that alternatively the reddening and oxidation came from below via the postulated geo-fracture in the earth's crust.

Iron frequently occurs as an indicator gangue mineral in the epithermal zone of mineral deposits. To some extent it appears as a primary anhydrous oxide in the form of red earth haematite, hydrous oxides such as goethite and other similar minerals grouped under the name limonite. To a greater extent iron is deposited in the epithermal zone as siderite which is a carbonate, but with the oxidation from the desert surface and the passage of some surviving oxygen of magmatic origin, this would be converted also to the form of red earth haematite according to the formula,[7]

$$4\ Fe\ CO_3 + O_2 = 2\ Fe_2O_3 + 4CO_2$$

Thus if as the author suggests the Thornhill Outlier lies astride of the postulated geofracture, an emanation of hydrothermal superheated fluid could be responsible for the reddening, loss of coal seams by distillation and decomposition of the Permian Lavas. The same fracture could also be responsible for the position of these Permian Lavas in the first place.

On the 1" Geological Map, page 70 the Thornhill Outlier appears as an elongated basin with a north-south axis and it will be noted that the important faults of the outlier also have a northerly orientation. To the north-west of the Outlier, the 1" Map shows a lead mine which may have some connection with the presence of the postulated geofracture.

The Outlier together with faults enters the exceptionally deep Enterkin Pass and ends there on Ordovician strata. The greywakes and greywacke shales exposed in the pass are very confused and lie at all angles. The pass runs more or less north-south. The author maintains by this it represents the northwards extension of the postulated geofracture. The pass can only be travelled on foot and the most dangerous portion for travellers is near its head where there is a slope dipping at 60° from the footpath to the stream some 300 feet below.

After leaving the head of the pass a walk of three-quarters of a mile or so brings one well past the head of Shortcleuch Water and on to the hills overlooking Wanlockhead.

This point is also the commencement of the March Vein of the Wanlockhead Mining District and of the Brow-Brown's Rake complex of several overlapping veins having a possible strike length of 11,000 feet which bring the postulated geofracture through Leadhills to the Susanna Vein and the comparatively straight valley beyond of Glengonnar Water.

It is convenient to return to the commencement of the March Vein as shown on the 1" Geological Map, page 70 . Brown, in 'The History of Sanquhar' 1891 gives some information on the content of the southerly portions of March Vein, thus, "No lead ore has as yet been found in this vein, nor is it expected that any will be procured while her soils continue to be impregnated with such a proportion of iron as has hitherto been found in the different places where trials have been made. That species of iron which occurs is generally called Haematite, and assumes the appearance of kidney formed balls; colour, brownish red, and sometimes approaching to steel grey." The 1912, 6" Geological Survey map of Wanlockhead (The only one published of this area) also shows 'red-stained country-rock' and 'red stained breccia' at the southern end of March Vein all of which suggests a connection with the postulated geofracture and the Thornhill Outlier.

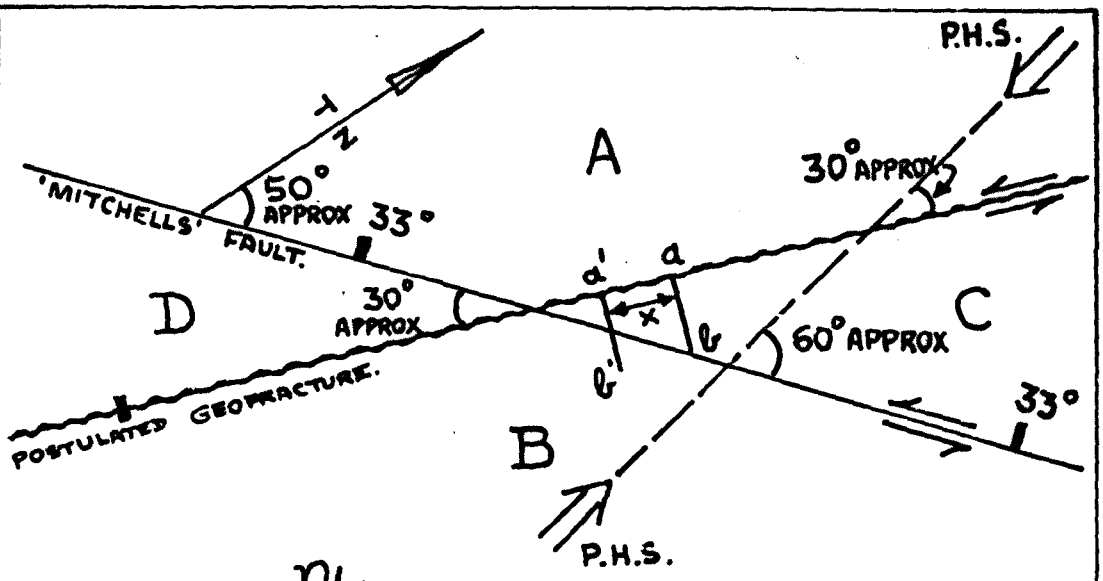
If the existence of the postulated geofracture is accepted a plan of the geofracture, crossed scissors-fashion by 'Mitchell's ' fault together with the direction of principal-stress may be plotted as on

page 76 . The directions are taken from the field evidence of the large 1/2500 scale map, using a long steel straight edge placed to lie best amongst the plotted strikes of bedding, joint planes and faulting. The author is aware that it is common practice to assume that the direction of principal stress (horizontal in transcurrent faulting) bisects the angle between observed shear jointing. However, in the present case, after observing the crushing of concrete cubes where there is no confining pressure and the plattens are lightly lubricated, the author has chosen to assume that the horizontal principal stress is parallel to the strike of the observed jointing particularly as in most cases this single major pronounced jointing is the only one that can be observed with any sense of security.

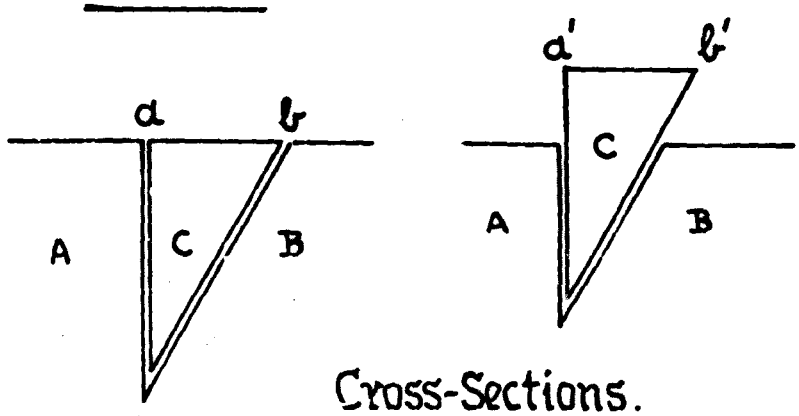
Reference is made now to a paper by Lensen, 'A Method of Graben and Horst Formation'[9] which is summarised by Price in 'Fault and Joint Development in Brittle and semi-brittle Rock'.[10]

Using the diagram plotted on page 76 it will be expected that the principal horizontal stress (PHS) would cause sinistral movement along the two transcurrent faults, indeed, sinistral movement has been noted in several field exposures. The mechanism of Graben and Horst propounded by Lensen depends on the assumption that frictional resistance along the transcurrent fault between blocks C and B is less than on the fault between blocks A and C, so that blocks A and C will tend to move together relatively to block B.

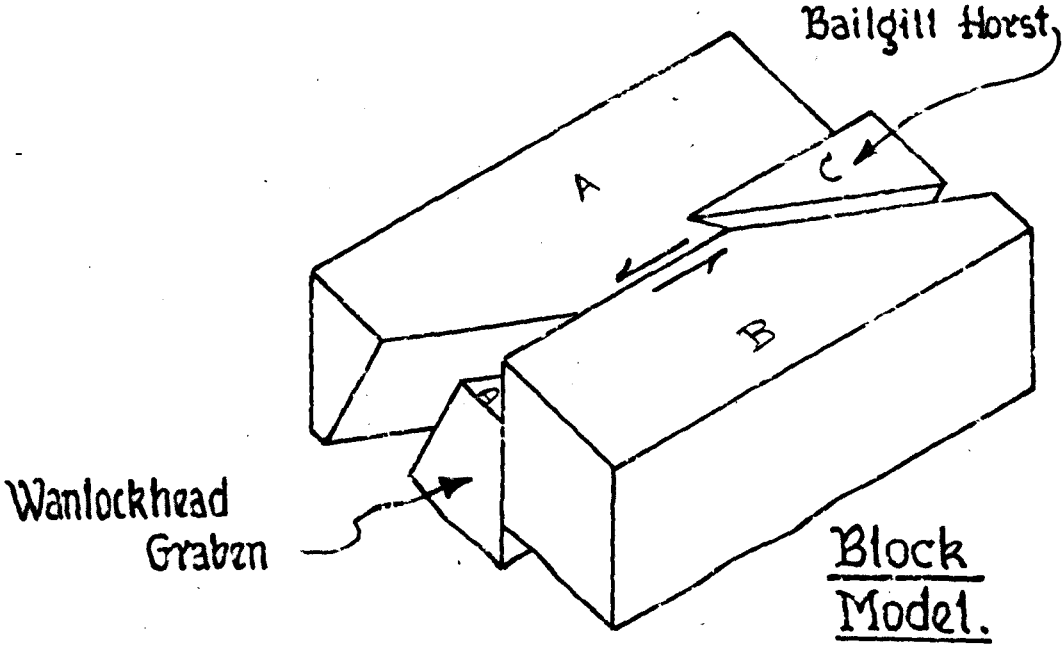
In the present instance, if the rock was perfectly homogeneous this



Plan.



Cross-Sections.



Block Model.

Jensens concept of formation of Horst & Graben by Transcurrent Faulting.

would not be so as blocks B and C would tend to move together in a sinistral direction. However, at Wanlockhead, Leadhills and Bailgill, 'Mitchell's'fault is along the strike of the bedding planes of the chert and soft shale zone while the geofracture is across the bedding planes of the hard greywakes for most of its length. Thus because of the increased frictional resistance in transcurrent faulting between blocks A and C, they would indeed tend to move as one, forcing block C upwards on block B to form a horst. The diagram on page 76 illustrates this movement.

If the block C is displaced sinistrally through distance x, the reference line a - b will move to position a' - b' by moving obliquely up the reverse fault plane of 33^{o} dip to form the horst shown in the corresponding cross-section.

In the same manner blocks B and D would experience more frictional resistance to transcurrent faulting than between blocks A and D and therefore block D would drop as a graben and tend to be forced under block A. The formation of horst and graben by intersecting transcurrent faulting is best demonstrated by a model in wooden blocks but perhaps the isometric sketch on page 76 will give an idea of the mechanism.

These are the reasons put forward by the author for the elevation and subsequent erosion by weathering of the chert-shale zone at Bailgill and the thrusting of the metalliferous greywakes under the chert-shale zone at Wanlockhead.

Lensen (1959)[11] in a further paper also pointed out that the displacement of intersecting transcurrent faults in addition causes local compression and tension in the rock in the vicinity of their intersection. In this respect the Susanna Vein, which was the richest vein in the whole area falls somewhere near the intersection of 'Mitchell's' fault and the postulated geofracture. The vein is unusual in that it had 'bellies' of ore up to 45 feet wide, was never bottomed due to water-pumping problems and most important of all, its strike is approximately east-west and dips 45° north, whereas the majority of veins had a NNW strike and dipped to the east.

Lensen (1959)[11] also pointed out the presence of secondary transverse faults inside transcurrent graben and horst. This could account perhaps for the WNW strike of some of the veins in the Leadhills District and the WNW courses of some streams in the Bailgill District.

One of the more important points of this thesis is to emphasize that if the presence of the geofracture is accepted, 'Mitchell's' fault astride its course, is the prime structural control of mineralisation in the Wanlockhead, Leadhills, Bailgill area. The belt of impervious cherts and shales brought up by 'Mitchell's' fault would act as the underside of a roof and channel any ore bearing fluids from the geofracture into the faulted and shattered greywakes where the mineral content would cool and precipitate to form the veins.

Just Northwards of the belt of cherts and shales, hard greywakes are to be found in Square A6 and D6, roughly on the line of the postulated

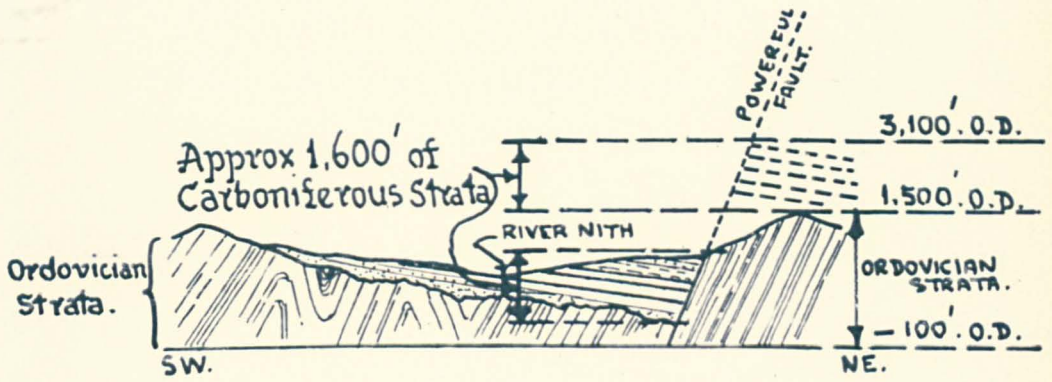
geofracture. It is interesting to note that the Scots Mines Company during the years 1748 - 1753 drove prospecting levels here and found lead ore but not in payable quantities.

This area of the Southern Uplands of Scotland has been heavily eroded by weathering and surface level during the time of mineralisation must have been several hundred feet higher. A rough estimate of the minimum original height above sea level can be obtained from a section on Page 317 of 'The Scenery of Scotland' Geikie, A.1901.[12]

This section is reproduced on Page 80 and if the thickness of the carboniferous strata of the Sanquhar outlier is taken as 1600', original surface level would have been at least 3100' O.D and as Geikie states, "If these rocks could be returned to their original horizontal position they would doubtless spread over all the surrounding country."

This increased original surface height at Bailgill is important because 'Mitchell's Fault outcrop, at the time of mineralisation, would be much further to the east and with the Chert Shale zone above it, would have given cover to the formation of mineral veins perhaps as far east as Glen Eas Hill.

A recent paper by Ineson and Mitchell, entitled 'K - Ar Isotopic age determinations from some Scottish Mineral Localities'[13] gives for Wanlockhead-Leadhills Ores a mean age of 297 M.Y, the youngest 265 ± 4 M.Y. and the oldest 343 ± 8 M.Y. Thus mineralization may have started during the early Carboniferous, reached a high point in



Section across the Sanquhar Coal-field.

(After Geikie A. 'The Scenery of Scotland' 1901.)

the mid-Carboniferous and concluded in about the Mid-Permian Period. The faulting preparing the ground for mineralization probably took place during the Caledonian Movements and the mineralization itself during the build up of the Hercynian Movements.

Regarding Zoning of Mineralisation, in the north of the Bailgill District, copper ore and galena were mined together, in the south of the district some calamine was mined together with galena in the Wool Gill Mines, but over the district generally, galena was mined alone. However, after consultation, it was realized that there was nothing extraordinary in this assemblage (Park and MacDiarmid).[14]

Temple, AK 1956. 'The Leadhills-Wanlockhead Lead and Zinc Deposits'[15] gives much useful information on the paragenesis of the ores. Three of his statements are of use to this thesis, that the order of the temperature of mineralization was 143°C to 281°C, that the veins were deposited between 1800 feet and 3600 feet below ground surface which was at approximately 3000 feet OD at that time and finally quoting his words, "If the deposits are regarded as generally associated with the Hercynian Orogeny, the deposits would necessarily have been derived either from a high level in the tholeiitic layer or from the granite crust. The geochemical assemblage supports a derivation from both sources, ie. the top of the tholeiitic and the base of the granitic layers."

Temples final statement confirms to some extent the author's belief in the possible presence of a geofracture running northwards through

the area. Finally Davison[16] gives a list of the 'Leadhills' Earthquakes recorded and these are given in Appendix 2. The author suggests that these earthquakes are not due to the Southern Uplands Fault as Davison writes because in such cases they would be also registered in the Industrial Towns of the Central Belt of Scotland. Perhaps they were caused by movement on the postulated geofracture.

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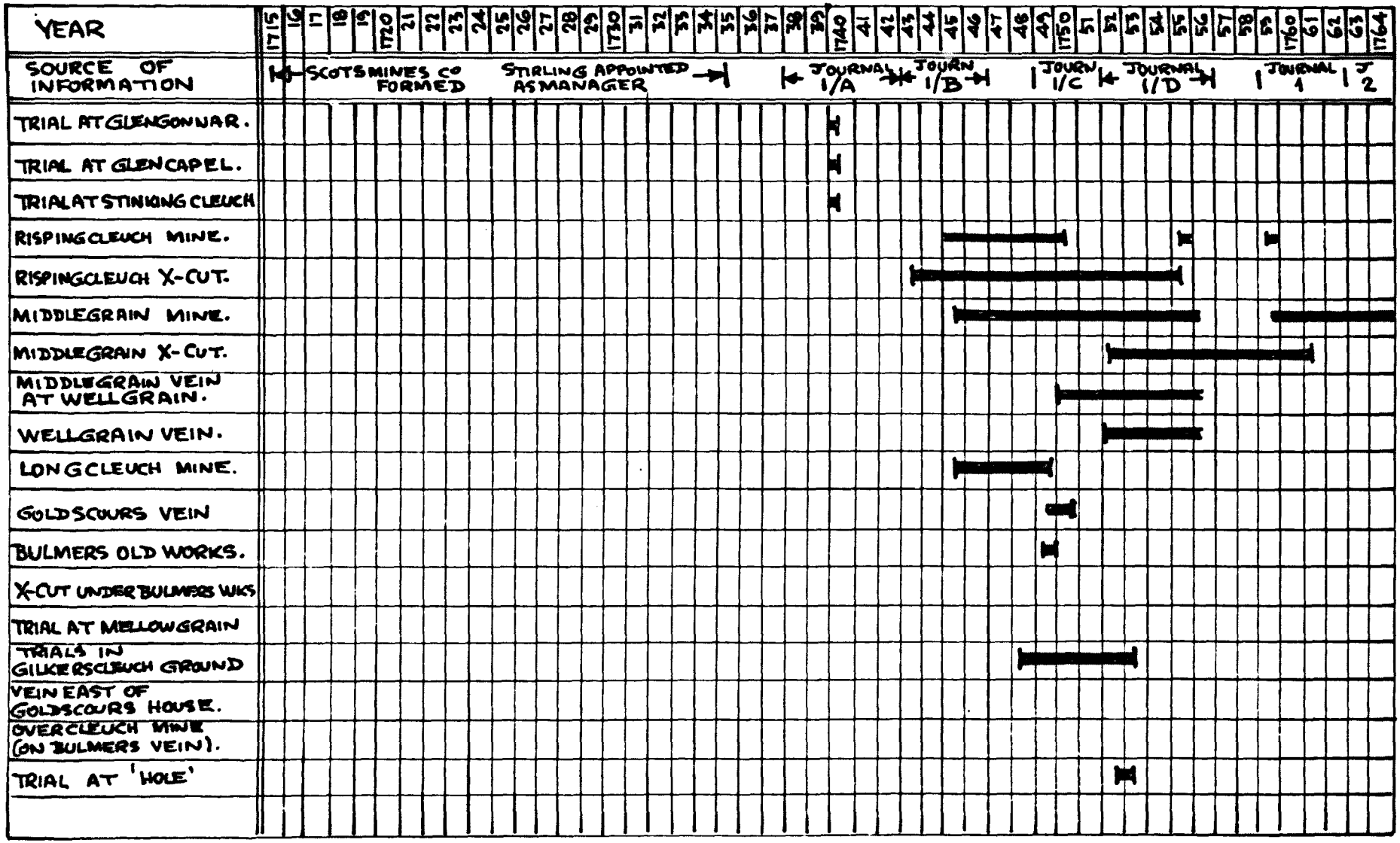
Chapter 4.

History and Details of the Ancient Mines and Prospects of the Bailgill District

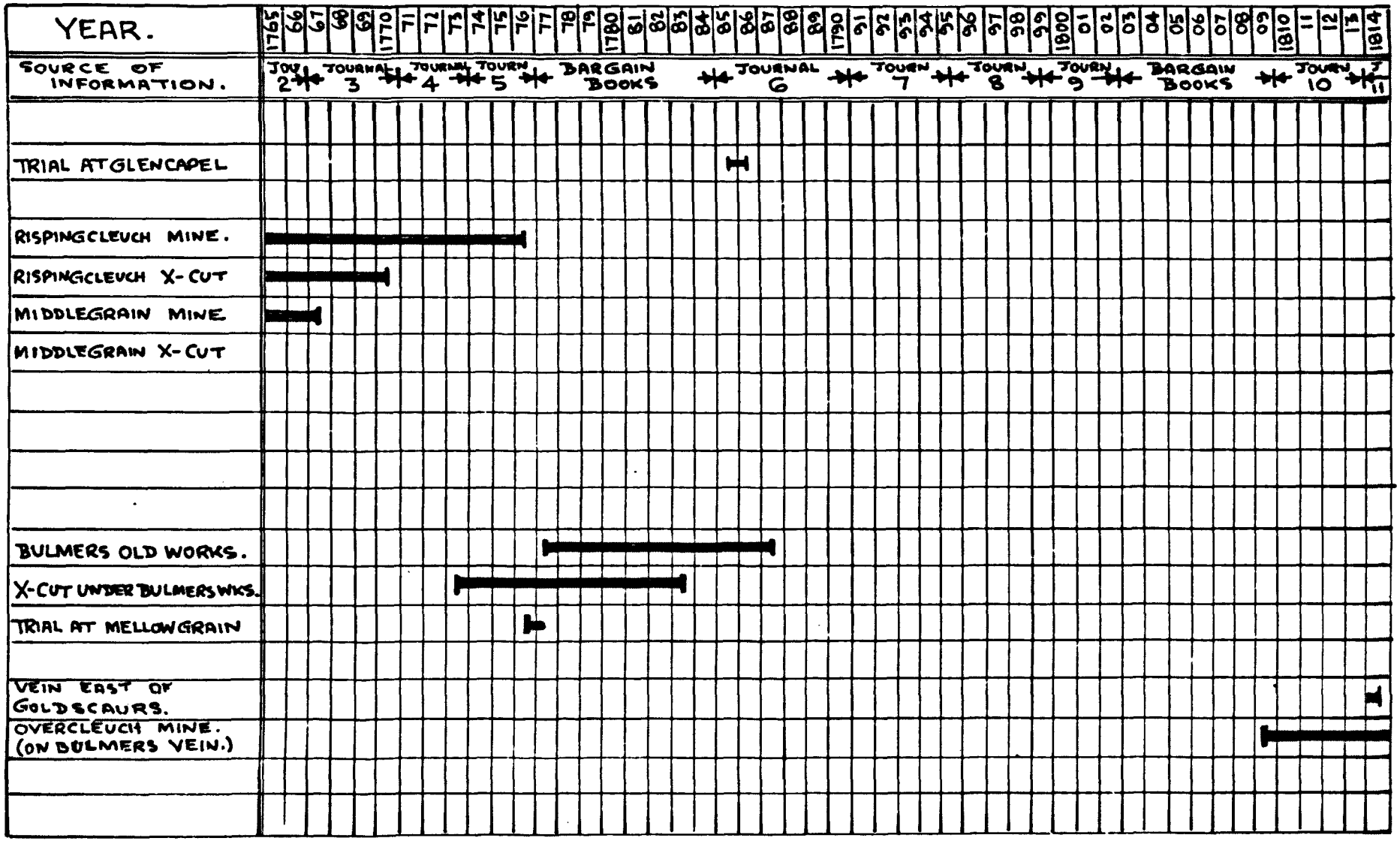
When these old mines of the Bailgill District were being prospected and developed, it should be noted that the Scots Mining Company had in 1729 leased this district and the Susanna Mine from the Earl of Hopetoun and first employed Sir John Erskine of Alva as manager.

In 1735 the Court of Directors appointed James Stirling, mathematician and friend of Sir Isaac Newton as Mine Manager. His early work took place during the turbulent times of the '45 rebellion and in the Miners Library at Leadhills, the so-called 'Leadhills Diary' by an unknown writer gives an interesting vignette of one episode. It reads

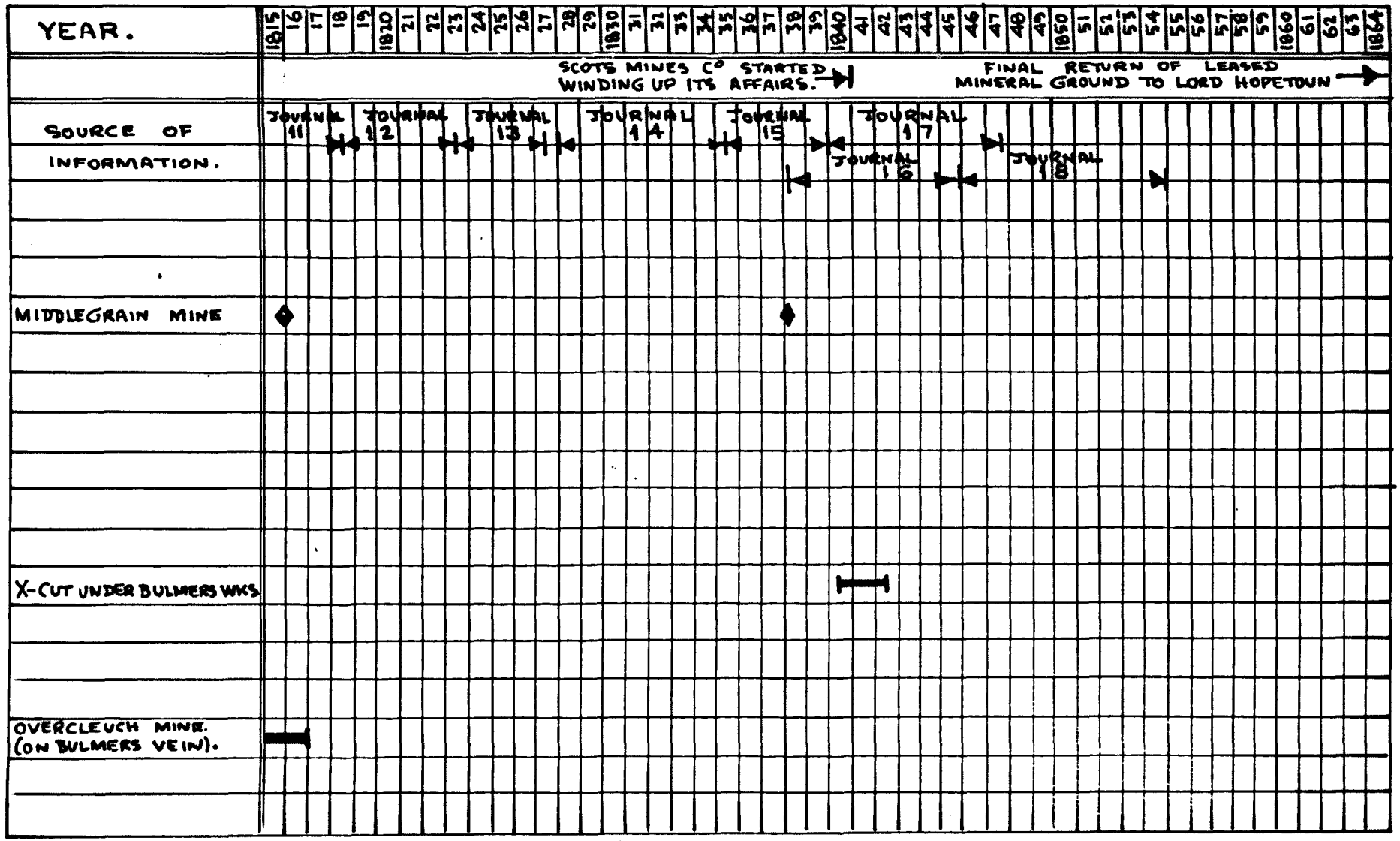
> '4th November 1745. The post coming up about 2 o'clock this morning alarmed the whole town by telling that a small party of the Highlanders were coming directly up this way up Clyde. Immediately all got out of bed and nothing was to be seen but people carrying burthens of their moveables and hiding them in Shafts and Levels underground till day appearing, the pannick was in great measure dispelled with the sable curtains of the night. But when we were least aware, three men (who called themselves Hussars) two of them in Highland Cloathes,



Chronology of the Bailgill Mining District. Sheet 1.



Chronology of the Bailgill Mining District. Sheet 2.



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Chronology of the Bailgill Mining District. Sheet 3 & final.

all on Horseback and well armed came to the town.'

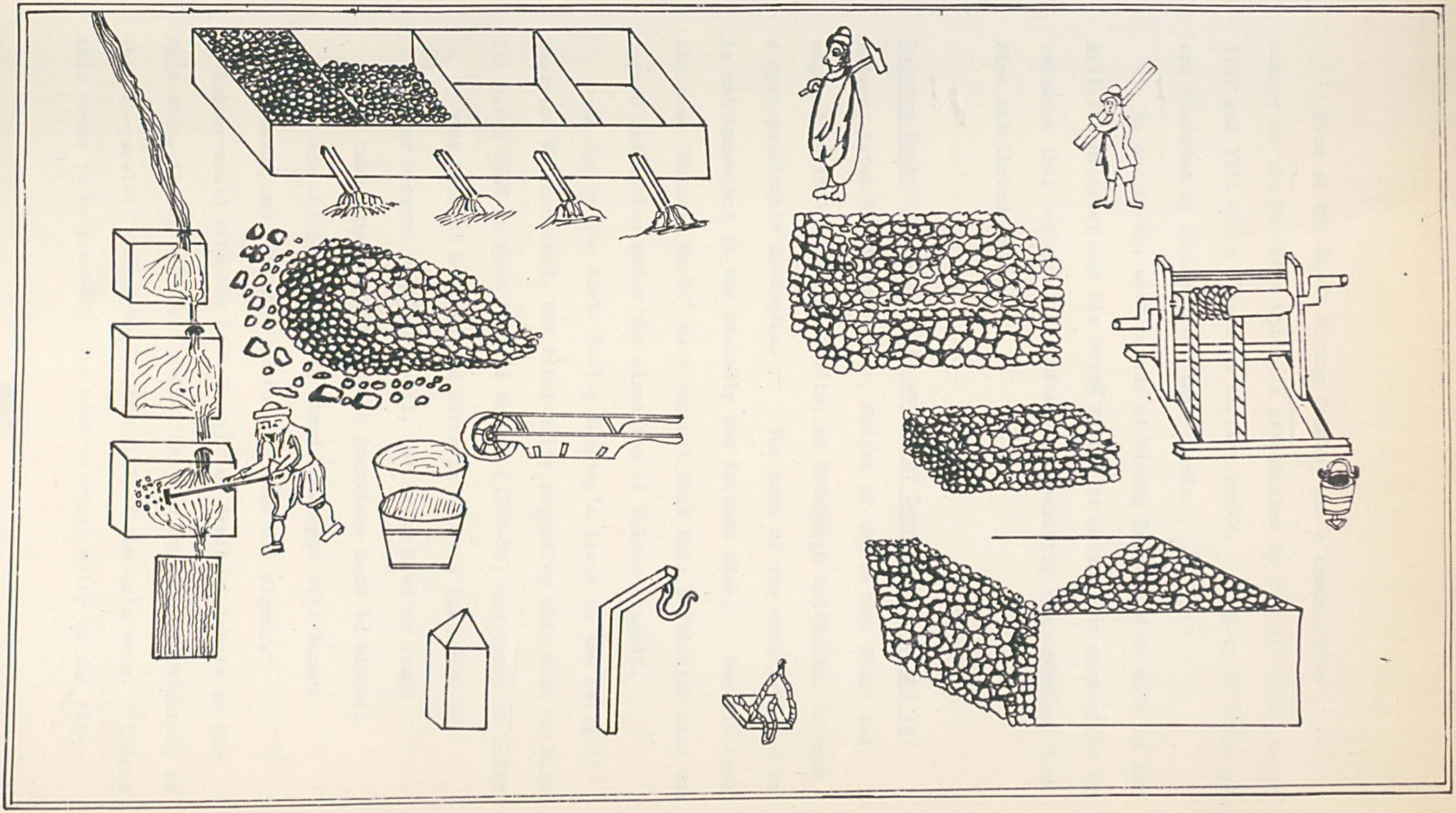
Amongst the Stirling of Garden family papers there is some information of this episode in a letter from the London Court of Directors which reads:-

'London 2/1/$174^5/_6$ To James Stirling.

We are sorry to hear of the visit made you by the Highland Party and hope you have escaped a second interview in the neighbourhead of Glasgow, at which place they kept their Christmas.'

The methods of mining in the early days of the whole Wanlockhead, Leadhills, Bailgill District were most primitive. To illustrate this point, on page 90 there is a pictorial inset from a Leadhills plan dated 1741 showing miners, mining implements and ore-washing methods. It could quite well have been taken from the woodcuts of Georgian Agricola's Great Work 'De Re Metallica' of the year 1556.

The usual means of excavation was by gad and wedges or stope and feather: to demonstrate the slow rates of driving, the Mine Journals show that it took 23 years to complete one mile of the Gripps Drainage Adit to the main Leadhills District. The location of this particular adit runs through squares J1 and M1 of the large scale map enclosed in Volume II of this thesis. In soft ground progress in driving could be 2-3 fathoms per week but in hard rock progress could be reduced to 1/2 fathom per week. Gunpowder to blast the rock did not seem to be introduced into the District until quite late. In Mine Journal No 13, the issue of gunpowder and candles is specifically mentioned during the week ending the 9th February 1839.



Pictorial Inset from Sectional Plan of the Earl of Hopetoun's Works (Raick Vein) at Leadhills. 1741.

Even so the Scots Mining Company was a comparative late-commer to the District which is illustrated by two old plans dated 1751 and 1773 which show even earlier works. Copies of these plans are included in Volume II of this thesis.

As one of the most famous of Mining Engineers to work in the Bailgill District was Sir Bevis Bulmer it would seem convenient to commence this survey of old mines by describing the principal Lead Mine attributed to him.

Bulmers Works (See Squares I5 and J5 of Large Map. Volume II)

Bulmer, later Sir Bevis Bulmer, Knight of the Golden Mines was engaged in 1576 by Thomas Foulis, an Edinburgh Goldsmith, to work a most profitable lead mine. The name of the mine referred to is not known but it was probably the Susanna Mine. Nevertheless the name 'Bulmers Works' does suggest that this particular mine was opened and worked under the direction of Bulmer himself.

As far as the Scots Mining Company's lease of the Bailgill District is concerned, the first entry regarding this mine is dated 1st March 1749 in Mine Journal No 1/C (1749-51) and reads as under

> 'The Vein at Bulmers Old Works is about a foot wide of fine mineral promising soil, but as we have no level to take away the water which increases much in winter, we are obliged to let it stand unwrought till Summer Season and then push it forward with all vigour.'

As Bulmer would probably have brought up drainage levels to the main vein, it may only be assumed that the Journal is referring to the sub-parallel vein lying to the east of the main vein. Indeed this seems to be proved by the next relevant entry on the 11th

August 1749 which reads

> 'In driving the Eastermost vein at Bulmores old works we were put out by water for want of a level, we therefore sank a shaft upon the stretch of the vein about 50 fathoms south from the former workings and we are now driving to the west to cut the vein.'

The shaft is probably that named 'Ramages' on the large scale map of Volume II. It should be explained that to the 'old men', North could be anywhere between North and North-West as known to-day when surveying has become the exact science it now is.

There seems to have been a lull in work at this mine until August 1773 when Journal No 5, 1773-76 gives a statement of the Company's Miners and how employed where there is an item which reads 'Driving a cross-cut for a level under Bulmores Old Works'. This is probably the cross-cut shown on the large scale map of Volume II as running in a south-easterly direction. It seems that four men were employed continuously on this as there are continual entries to this effect from August 1773 onwards.

By April 1774 they had driven 52 fathoms and by March 1775, 74 fathoms which gives an idea of the slowness of progress in driving drifts before gun-powder came into use for blasting. By January 1776, 82 fathoms of the cross-cut had been driven and there remained 50 fathoms or so to drive 'with the forehead very hard'. The last relevant entry in Journal No 5 is for 31/8/76 '4 men at Bulmores Works x-cut'. As there follows a blank in the Mine Journals, recourse has to be made to the Bargain Books of the Company. A Bargain is recorded dated 10th July 1778 to drive six fathoms in the

second roosting of the vein cut by the cross-cut at Wellgrain Head. The south-east cross cut was still being driven in February 1779 and the first vein cut by it was being worked northwards under Bulmers Old Works at 5/- per bing of ore. (At Leadhills a bing was 8 cwts. of material). The same vein was being worked southwards in December 1780.

There is an interesting bargain dated 22nd June 1781 to open out Whitfield's Shaft on Bulmores Works from top to bottom at 10/- per fathom. During the remainder of 1781 considerable work was going on at Bulmers Works judging by the number of bargains and of particular interest is one bargain 'To air the x-cut to Bulmer's Vein with timber at 12 pence per pair'.

Through 1782 a great deal of ore extraction was going on as altogether the working of five successive roostings is mentioned, all at 5/- per bing of ore. The cross cut was still being extended at bargains of 2 fathoms a time at £5 per fathom.

In November 1783 a 'Wester Vein' is first mentioned at Bulmers Works and in July 1784 a bargain was made to deepen Whitfield's Shaft by 4 fathoms to hole into a new low level. During the last year or so, Mine Journal No 6, 1785-90 states that some 333 bings of ore had been raised in Bulmers Veins. The final mention of Work at Bulmers Mine is in February 1787 when 4 men were driving in the Easter Vein. On the 2nd January 1788 occurs the sad entry 'Since our last, a few bings of ore have been got here and no more is expected nor does the vein appear to be worth further trial'.

Bulmers Works seem to have remained moribund until May 1840 (Journal No 17, 1840-47) when more illuminating entries are made as to the nature of this low level cross-cut and are so interesting

they are quoted in full

'25/5/1840. William Russell went underground at Bulmores Vein where James Moffat and Partners are adventuring, they have got the level opened up to the vein. About 105 fathoms from the mouth of the level there is a vein which is driven to the north. Fifty fathoms further they come to a vein which appears to be the principal one which is driven to both ends but as the drift is all down little can be said about it.'

'23/7/1840. William Russell went underground at Bulmore at Six o'clock and visited the place where Moffat and Partners are working, they have been getting some good ore in the roof of one of the old drifts for some days past and there is still considerable quantity in their roost which lies in self pieces among mother.'

'9/6/1842. Where they are opening out to the south of the sump foot, they come to where the ground is wrought in the roof.'

'12/7/1842. William Russell went to Bulmores and visited the men engaged in that mine. Six men are employed at the pumps and it is very difficult for them to keep out the great fall of rain that has been for some days past.'

'13/7/1842. Mr. Borron considered proper to suspend for a time and gave orders to that effect.'

'27/7/1842. William Russell went underground at Bulmores and visited the place where they are working below level where reports said that a good lead was left in the sole of but the water could not be managed.'

It must be mentioned that Mr. Borron was at that time Manager for the Scots Mining Company and that there was intense litigation with Lord Hopetoun over water-rights. Lord Hopetoun was the lessor of the mineral rights and the Scots Mining Company were soon to abandon the whole field entirely. Mr. Borron would therefore not have been anxious to find new ore and there remains the possibility of ore reserves in depth at Bulmers Works.

During the past years the volume of adit water proceeding from Bulmers Old Works has been found to vary from 0.07 Cusecs to 0.20 Cusecs which suggests that the old workings were fairly extensive. The volume of water proceeding from the later cross-cut under Bulmers Works varied from 0.01 to 0.12 Cusecs which suggests there was not much development off it. An assumption is being made here that such a rough correlation exists as the country rock is the same and has a similar fracture pattern.

Bulmers Works lie near the zone of dislocation or contact between greywakes and the shale-chert zone so reference to this mine appears elsewhere in this thesis.

Overcleuch Mine (See Squares J5, K5 and L5 of Large Scale Map)

Bulmers Vein runs southwards from Bulmers Works and over a considerable distance, there being little or no mining upon it until the Overcleuch Mine is reached on the brow of the valley-slope

leading down to the Shortcleuch Water. The 'old men' were probably deterred from prospecting the intervening length by the great depth of overlying peat and the difficulty of bringing water-power to that section.

The first mention of this mine in the Scots Mining Company's records is in Bargain No 73 dated 5/4/1809. 'Agreed with John Reid and Partners to sink 5 fathoms of a shaft in a new vein discovered on the east side of Middlegrain @ 20/- per fathom and 5/- per bing of ore'. There were in the same year further bargains to drive an additional shaft north of Reids Shaft and drives north and south to develop ore shoots encountered. There is an interesting bargain No 23 dated 2nd August 1809 with John Reid and Partners 'to drive ten fathoms to the north from Overcleuchhead in the vein east of Middlegrain Vein which in future will be called Overcleuch Vein at 20/- per fathom'. Perhaps this bargain refers to the driving of the drainage adit level which still debouches abundant water into Overcleuch Burn.

Reids Shaft was later deepened by 3 fathoms and further drives driven north and south at this level. In April 1814, the shaft north of Reids Shaft was deepened to twelve fathoms and became known as 'Telfers Shaft'. In November 1814 intensive roosting or stoping commenced at 55/- per fathom and 5/- per bing of ore. In January 1815 there was a bargain with George Johnston and partners to drive 3 fathoms to the south in a vein cut by their cross-cut on the west side of the low level in Overcleuch Vein at 50/- per fathom and 5/- per bing of ore. Altogether there seem to have been seven stopings or roostings off Telfers Shaft for abstraction of ore. Another shaft named 'Harrie's' seems to have been put down further

north in the vein commencing in May 1816. The Overcleuch Mine was worked intensively and to have ceased production suddenly at the end of 1816 probably due to being drowned out by water.

Since 1969 measurements of the amount of adit water flow have been taken at intervals and found to vary between 0.08 Cusecs and 0.39 Cusecs which suggests considerable development.

Risping Cleuch Mine (See Square L4 and M4 of the large scale map)

Rispingcleuch Mine was an old mine when the Scots Mining Company took over this field. There is an interesting letter from Stirling to the Court of Directors reading thus:

'Gentlemen. Leadhills 14 July 1737

In one of the new tryalls in the ground got from the Edinburgh Society we have fallen upon ore very near the surface, it is of a fine kind and stands from roof to sole between two and four inches wide but for my part I am not slate upon it, not that I have any reason to think it will not continue but because the tryall is not yet sufficient to show the symtoms whereby a judgement can be formed whether it will continue or not.* We also have got one in Risping Cleuch a work which had been left off, when Sir John Erskine gave up the management of the Company's Affairs altho' they knew of this ore. Bagshaw was against the resuming of this work because as he said, the ore left there had not the appearance of continuity, but Whigham was for it,

* This prospect was probably the Middlegrain Vein.

because since tryalls were to be made, he said it was more reasonable to try a vein which carried ore tho' it had not the appearance of continuity, than to make tryal of a new one where no ore was ever seen. This determined the work there. Stirling.'

The 'Leadhills Diary' also throws light on the restart of this old mine.

'22nd June 1745. Went with the overseers and John Williamson and some of the miners where it is proposed to make tryalls this summer. At the old works in Rispingcleuch, there are three shafts nearly in a straight line with one another. William Dunwoody and Samuel Thomson who had both wrought in that place agree that a belly of ore, consisting not of a solid ribb, but loose lumps, began about 5 fathoms to the north of the Middle Shaft and extended northwards five fathoms, that about a fathom before they came to the north end of that belly, a string flew off from the vein on the west side and ran up the hill on a parallel with Rispingcleuch Burn. That there is a string or vein which crosses the cleuch near the head in such a direction that it must meet Rispingcleuch towards the north. Mr. Whitfield seemed to be of the opinion that, as veins are generally observed to be the richest where they join one another, it might not be amiss to trace out these two by their general run to the places where they may be supposed

to meet, and there to sink a few fathoms and drive cross till we cut the vein'.

The Company commenced a cross-cut to drain Rispingcleuch Vein but according to Journal 1/B, 1742-46, '6th July 1743. The cross cut out of Risping Cleuch is very hard and much watered which makes that cross-cut go on slowly.' By January 1744 the cross-cut was estimated to be within 6 or 7 fathoms of the main vein which the miners must have reached by about 23 February 1745 when they obtained 'some very small pieces of ore but of no frequency as yet'.

Evidently not much ore was encountered because at the end of 1745 the Journal states 'We are designed to sink a shaft to the level and then to cut across to the west in order to try for another vein which we cannot try for the present for want of communication'. In addition to its present sense 'want of communication' seems also to have meant want of air. In Journal No 1/C 1749-51 at the end of August 1749, the vein in the high level is stated to be eight inches wide and not very hard. The next entry is in Journal No 1/D, 1752-56 which notes on the 26 July 1755 that the cross-cut has at last cut Rispingcleuch vein on which the miners had 'riven 22 fthms on the vein but without encountering much ore'.

A fresh start seems to have been made at Rispingcleuch on the 6th July 1765 by putting another shaft down to the low level. Development levels were being driven in all directions from the low level and ore was being extracted throughout 1766 and 1767. There is an interesting comment made on the 22nd June 1767 that the Rispingcleuch Vein seems to have a connection with the Bailgill Works. (Middlegrain Mine of Square K4). Work continued on exploration until about January 1770 when there is an interesting comment in

Journal No 4, 1770-73 which reads:-

'The Low-level forehead has been driven through several pieces of ore which is partially wrought out, and there is still the prospect of raising some hundredsof bings more but the vein being soft and the ore lying irregular it cannot easily be explained or estimated. The ore in the sole of the level was not considerable and the water so great that there is no hopes of getting it. As the lowest foreheads are hard and airless and the expense of communication would have been great they have not been wrought for some time past'.

Nevertheless in August 1770 ore was being raised again and by March 1771 over 350 bings of ore had been raised. The miners working in the lower levels seemed to have been worried by 'houses' of water lodging in old trial workings above them. Therefore on 1 February 1772 there is a cryptic entry reading 'The ore we have seen in this vein is mostly taken out above level and last summer a trial was made on the ore under level which proved very indifferent, and the water so great it could not be wrought to any great depth. Neither is there anything promising to be seen in any of the foreheads'.

However development work continued and another shaft sunk 'to air the forehead and make further tryall wherewith ore was got'. Journal No 5, 1773-76 states on 18th March 1775 that about 14 bings of ore were obtained from the new shaft. After June 1776 there is no further mention of Rispingcleuch or as sometimes alternatively written Rispencleuch Mine in the Mine Journals.

The main difficulties at Rispencleuch Mine seem to have been the great volume of water encountered and the lack of air for the

miners as well as the old and dangerously water filled, trials lying above the low level. At varying times between 1969 and the present the flow of water issuing from the collapsed entrance to the Rispencleuch Drainage adit has been measured and the subject is treated elsewhere in this thesis in connection with difficulties likely to be encountered in possible future prospection and development.

The Middlegrain and Wellgrain Mines (Squares J4 and K4 of large-scale Plan, Volume II)

These mines formed in reality one continuous mine-sett and the Middlegrain Mine was the largest and most profitable in the Bailgill District.

Middlegrain Mine

The history of this mine as far as can be ascertained from the Mine Journals is as follows.

In a 'State of the Works' as at 20/7/1745 in Mine Journal No 1/B, 1742-46, the Overseers reported that they were making a trial for a vein at the head of Middle Grain at Bailgill and Thirlaw Grain where some considerable pieces of ore had been found. On the 8th October 1745 they encountered two strings in the cross cut at the head of Thirlaw Grain but neither proved promising so they decided to cut further to the east, 'to try if we can find a vein which several pieces of ore have been broke off and found lying loose amongst the till'. On 11th August 1749 in Journal No 1/C, 1749-51, the Overseers reported 'The Vein in Middlegrain at Bailgill Head is about 2½ feet wide of very promising mineral soil, spar and mineral

stone with pieces of ore'. By 26th August 1750 about 10 bings of ore had been raised from development and the Overseers decided to sink a shaft for 'Communication'. They had also found ore 'under level' but were obliged to leave its extraction 'till a dryer season'. In about February 1751 a belly of ore about nine fathoms in length by a foot thick had been discovered which realised 40 bings of ore. In July 1751 a good prospect was reported, the ore being a foot thick in the sole of the level. From then on bargains were being set continually for development and raising of ore. In March 1752 a new string was discovered to the east in a cross-cut from Whitfields drift. Additional shafts were being sunk and a low level drainage adit commenced in about April 1752.

The Overseers gave a report on the state of the mine at 29th July 1752, Journal No 1/D, 1752-56 which is worth quoting in full.

> 'In the vein at Middlegrain at the head of Bailgill, we have long been carrying out a drift about fourteen fathoms from the surface. About two years ago we came to a belly which yielded about 120 bings by estimation and lately we came to another small belly which has yielded about 2 or 3 bings, both of which widened in going downwards, the first belly was about a foot wide on the sole and the last from six to ten inches which gives encouragement to bring up a lower level which accordingly we are carrying on with all speed, working night and day with a double shift, and will be about 20 fathoms deeper than the present drift'.

Work seems to have been held up pending the completion of the low level drainage adit but on the 26/7/1755 the low level was stated

to be within 60 fathoms of where ore was first won in Middlegrain. The driving of the low level seems to have been slower than expected and work recommenced driving the high level southwards, sinking additional shafts and raising ore wherever it was encountered, as always at the rate of 5/- per bing of ore. Inflation of currency seems to have been an unknown evil in those days. There seems to have been a second vein called Weirs Vein lying to the east of & sub-parallel with Middlegrain Vein. This was also worked.

The Low drainage level was still being driven as at 1st July 1761 and must have been completed shortly afterwards but certainly before 18th December 1764 when a bargain was made 'To repair the low level sufficiently with timber at twelve-pence a pair'.

On the 5th March 1763, Journal No 2, 1762-66, the Overseers reported a belly of ore 17 fathoms long, 6 fathoms high and from 4 to 18 inches wide. Ore appreared in several other places but was 'of no great consequence'. Poor ores were reported in Weirs Vein which is a branch of Middlegrain Vein.

On the 10/7/1764 there was a bargain struck with John McKenrick and seven more to sink 3 fathoms upon a knot of ore in the sole of the high level of Middlegrain Vein on the south side of Aitkens Shaft which on consulting the large scale map of Volume II of this thesis gives an idea of how far southwards the upper workings had been pursued along that Vein.

On the 20th April 1765, the Overseers reported that in Middlegrain Vein 'all the ore above level is wrought out and what is in the sole of the level is about 17 fathoms long and from 4 to 18 inches wide and will be tried in the summer with the help of hand pumps'.

They also reported some poor ore still unwrought in Weirs Vein. In July 1766 (Journal No 3, 1766-70) a drive was made five fathoms to the west of Aitkens Shaft foot in Middlegrain Vein to cut an expected vein there and which in fact was worked southwards and northwards. This was known as Griers Vein. There was also a vein known as Garth's Vein which was also parallel to but to the east of Middlegrain Vein and was approached from Aitkens shaft foot.

There is an interesting entry on the 16th May 1767 which illustrates what seems to have been common practice in those days. 'Both Overseers went underground and dialed part of it and laid it out upon the surface'.

In the State of the Works report dated 22nd June 1767 on those mines paying 1/7th duty instead of the customary 1/6th duty, there is a sad entry. 'Middlegrain and Weirs Veins. In these veins all the ore above and below level is now wrought out and except some poor pickings above the level scarce worth mentioning'.

Nevertheless the Scots Mining Company must have been convinced that ore lay beneath the level of the low drainage adit because in the 14th December 1838, Mine Journal No 16 (1838-46, occurs the entry:-

'Thomas Weir went out to Bulmer and Bailgill old workings and made a general survey. He is perfectly convinced that Bulmer Water may be applied at Bailgill with great advantage in working the mine under level. There is no doubt between 20 and 30 fathoms of pressure and also a good opportunity for Dams for collecting surface water'.

By this time however litigation was in hand between the Mineral Lessor Lord Hopetoun and the Scots Mining Company who were

soon to abandon the field and therefore probably loath to develop further ore reserves for other's gain. Due to the sub-parallel nature of the veins at Middlegrain and the reluctance of the miners to drive cross-measure drifts there are probably other sub-parallel veins which have remained unworked. On pages 21 and 106 there are photographs of the Middlegrain Mine. The deep drainage adit flow of water is discussed under the 'Wellgrain Mines'.

The Wellgrain Mines

After passing the Middlegrain Mine, the Middlegrain Vein seems to have bifurcated and have crossed Wellgrain Burn at two separate points before passing on into Wellgrain Dod itself.

The first relevant entry is on 20th January 1750, Mine Journal No 1/C, 1749-51. 'In Wellgrain we have discovered the vein that is working in Middlegrain, she is about one foot wide in black madder with lumps of fine Spar, and some pieces of ore'. In Journal No 1/D, 1752-56, there is an interesting bargain dated 13 January 1752 'To Joseph Hislop and three more to sink two fathoms deeper in the shaft on the vein in Wellgrain at 20/- per fathom'. It is possible that this is the Shaft named 'Espies', on the large scale map in which case the southern-most branch must be Wellgrain Vein. On page 107 is a photograph of Espies Shaft Dump with Wellgrain Burn below. The flurry of water in the burn is the flow of water from the collapsed adit leading to the burn from the Shaft. After deepening of this shaft a bargain was made to drive eastwards from its foot to connect up with the main Middlegrain Vein.

A bargain made 20th January 1756 reads 'To John Taylor and three more to drive 5 fathoms further to the north in Middlegrain Vein

Middlegrain Mine.

PHOTOGRAPH TAKEN FROM BOTTOM RIGHT HAND CORNER OF SQUARE J.4.

Espies Shaft on Wellgrain Vein in Background.
Adit & Wellgrain Burn in Foreground.
PHOTOGRAPH TAKEN FROM TOP CENTRE OF SQUARE J.4.

on the north side of Wellgrain Burn at 18/- per fathom'. Therefore the northern branch does seem still to have retained the name 'Middlegrain Vein' after the bifurcation had occurred.

Due to the paucity of entries regarding Wellgrain Vein and the extension of Middlegrain Vein into Wellgrain Dodd it is doubtful whether any useful amount of ore was extracted from these sections.

There seems to be some intercommunication of drainage flows from Middle Grain Adit and Wellgrain Adit. Drainage of water from the deep adit at Middlegrain has varied from 0.07 Cusecs to 0.17 Cusecs and the Wellgrain Adit flow has varied from zero to 0.32 Cusecs. It may be that the Middlegrain adit is partially choked and therefore has a more constant flow while the Wellgrain adit drains away the excess during rainy weather.

The Longcleuch Mine (Squares J8 and J9 of large scale map)

This mine is one of the oldest and least worked mines in the district but it is particularly interesting, as it contained both copper and lead ore. One of the first references to it occurs in 'The Leadhills Diary' at the Leadhills Miners Library which is still privately conducted by the villagers. The name of the writer of this diary is unknown. He was probably a trainee overseer because he mentions practising the use of the 'dyall' and must have been of no mean estate because he possessed a pocket watch and took wine with Stirling, the Manager of the Scots Mining Company. The relevant extract reads 'Then we came further down and viewed the workings for lead ore near the foot of the burn (Longcleuch), which had been carried on by the Company's predecessors and afterwards by themselves, but the Overseers seem to have no great opinion of that vein'. As

far as the Overseers were concerned their views are stated in the Mine Journals. 8th October 1745 (Journal No 1/B, 1742-46), 'The vein at Longcleuch is about six inches wide of mineral soil but without ore. It is harder than what it was, we are in good-hope in 30 fthms of driving to meet with ore in this vein'. Again on the 30th November 1745, 'At Longcleuch we have a fine soft vein consisting of fine mineral soil showing pieces of copper ore in it, and we hope the Copper will cut out and lead ore put in especially as this vein has had lumps of copper ore lying near lead in the working which has been wrought formerly'. 8th March 1746, 'The String that lies to the west of the vein at Long Cleuch is harder than it was and has no ore in it'.

The copper ore in this mine and perhaps that in the early trial at Caplegill described later probably proved an embarrasment to Stirling as evidenced in the letter quoted below.

'London 4th October 1749. Mr. Stirling, Leadhills.

The Court of Directors met this morning and had before them your letters of the 13th and 22nd September with the journals and accounts of the 8th and 15th of last month, not thinking it worth their while to have brought up to London the small quantity of copper ore (not half a ton) which you have been able to get out of the works, where they have been making, purely to oblige My Lord Hopetoun, a very expensive and fruitless tryal, desire you will sell it for £24 offerred on the spot if you can get no more. Farquhurson.'

Nevertheless the presence of copper is interesting academically and is discussed elsewhere in this thesis under the heading of zoning of mineralisation. There is a photograph of part of Longcleuch Mine on page 111. Flows from the adit have varied between 0.03 and 0.07 Cusecs and the water has been slightly warmer (a degree Fahrenheit or so than that of the other adits in the Bailgill District).

The Bailgill Mine (See Square J3 of large scale map)

This mine is given this name for the want of a better one. It was probably worked by Lord Hopetoun's servants and not by the Scots Mining Company. In Volume II of this thesis there is a copy of an old mining plan dated 1751 showing the veins that were expected to be encountered inthis mine. On page 42 is a photograph of the mine tip and probable drainage adit. In this thesis this mine is used as a possible indicator of the position of the zone of dislocation or contact between greywakes and chert-shale zone and is therefore discussed elsewhere.

Other Small Mines and Trials

Bulmers Gold Vein (Square I6 of the large scale map)

This mine is at the head of Longcleuch and is only a short distance from Bulmers Works. It consists of three or four shafts lying along the strike of the greywake shales. Bulmer is reputed to have found a small stringer of gold bearing quartz in this locality. The strike of the vein is certainly not in accordance with the customary strike of the lead veins in this District.

Longcleugh Mine & Burn looking downstream.

PHOTOGRAPH TAKEN FROM TOP RIGHT HAND CORNER OF SQUARE J.8.

Bulmers Open-Cast (Squares J6 and J7 of the large scale map)

A shaft was also found nearbye during field work. The only reference to be found is again in the 'Leadhills Diary' of unknown authorship. The entry reads:-

> '22nd June 1745. From Bailgill we went over the hill to the head of Longcleuch, on the west side of which is a pretty wide hollow resembling an open cast which John Williamson told us was called Bulmer's Hole, and that according to tradition it was digged by Bulmer, who is said to have got out of it transparent spar, which being pounded and washed, produced gold'.

Spar is the local name for quartz.

When Bulmer described in the Records of the City of London as an 'ingenious gentleman' first came to Leadhills, he confined himself entirely to the search for lead, but the dazzling pursuit of the richer metals captivated him and he later applied for a patent from the Government to 'adventure and search for gold and silver mines' at Leadhills. It is interesting to speculate whether the short distance between 'Bulmer's Works' and the above two works was responsible for the 'gold fever' which pursued him for the remainder of his life.

Trial for Lead at Head of Longcleuch (Square I7 of large scale map)

During the geological mapping an old collapsed adit was found in the location shown in square I7 of the large scale map of Volume II. The issue of water from this adit amounted from 0.08 Cusecs to 0.09 Cusecs and it was this steady flow which drew attention to it. In January 1773 there was a proposal set down in the respective Mine

Journal to try the Longcleuchhead Vein and perhaps this adit represents the Work of the Edinburgh Company which proceeded the Scots Mining Company.

Trials at Glengonar, Caplegill and the Stinking Gutter

The only one which can be located approximately is that of Stinking Gutter which lies in Square I3 of the large scale plan. There is an entry in Journal 1/A 1738-42 for the 13th June 1740 which reads 'The trials carrying on at Glengonar, Caplegill and Stinking Gutter does not look in no ways promising, therefore we think it proper to employ the men in some other more likely place and let that work stand'. The trial at Caplegill is however more interesting although so far has not been located exactly. (There are possible indications in squares G9 and H8).

The entry in Journal No 6, 1785-90 for 25th June 1785 reads '4 men are driving on the vein at Glencapel Burn Head'. '2nd January 1786. Glencapel Burnhead. In this vein a few fathoms has been driven since our last and some copper ore has been found of little value which may perhaps be tried afterwards'. It will be noted that Glencaple Burn Head is not greatly distant from the Longcleuch Mine where copper was also found and considered a nuisance. The presence of copper in this general locality is discussed elsewhere in this thesis under the heading of zoning of mineralisation.

Mines in Big Wool Gill (Square L3 of large scale map)

These mines were not worked by the Scots Mining Company but by the servants of Lord Hopetoun. They are included because of their

proximity to the dislocation or greywacke/Shale and Chert contact zone which is one of the principal subjects of this thesis. There is an interesting entry in the 'Leadhills Diary' of unknown authorship which reads:-

> '14th July 1745. Walked out this forenoon with James Wells to the top of Wool Law. We went in by my Lord Hopetouns Works in the Woolgill, and I think that all the ore they have yet raised out of that vein does not exceed 5 or 6 bings. It is all very dirty and the ore of a black coal colour'.

Airs Prospecting Level (Square I4 of large scale map)

This work appears elsewhere in this thesis as an aid to delineation of the dislocation zone or contact between Greywakes and the Chert/Shales. The level was probably driven about 1742 from details in a Bargain Book. There is a photograph of the adit dump on page 52.

Other Trials

There were other trials at Hole, Mellow Grain and Goldscaurs but they were of little consequence and soon abandoned. Nevertheless they are marked on the large scale plan of Volume II in squares I10, M4, K6 respectively.

In the Chert-Shale zone there were many abortive trials and were usually carried out by 'Hushing'. If the large scale map is examined, in the Chert-Shale zone, there are many streamlets running at acute angles to the topographical contours and ending in Scars which represent 'Hushes'.

Bibliography

The 'Leadhills Diary'

General — The Mine Journals and Bargain Books of the Scots Mining Company preserved at the Miners Library at Leadhills.

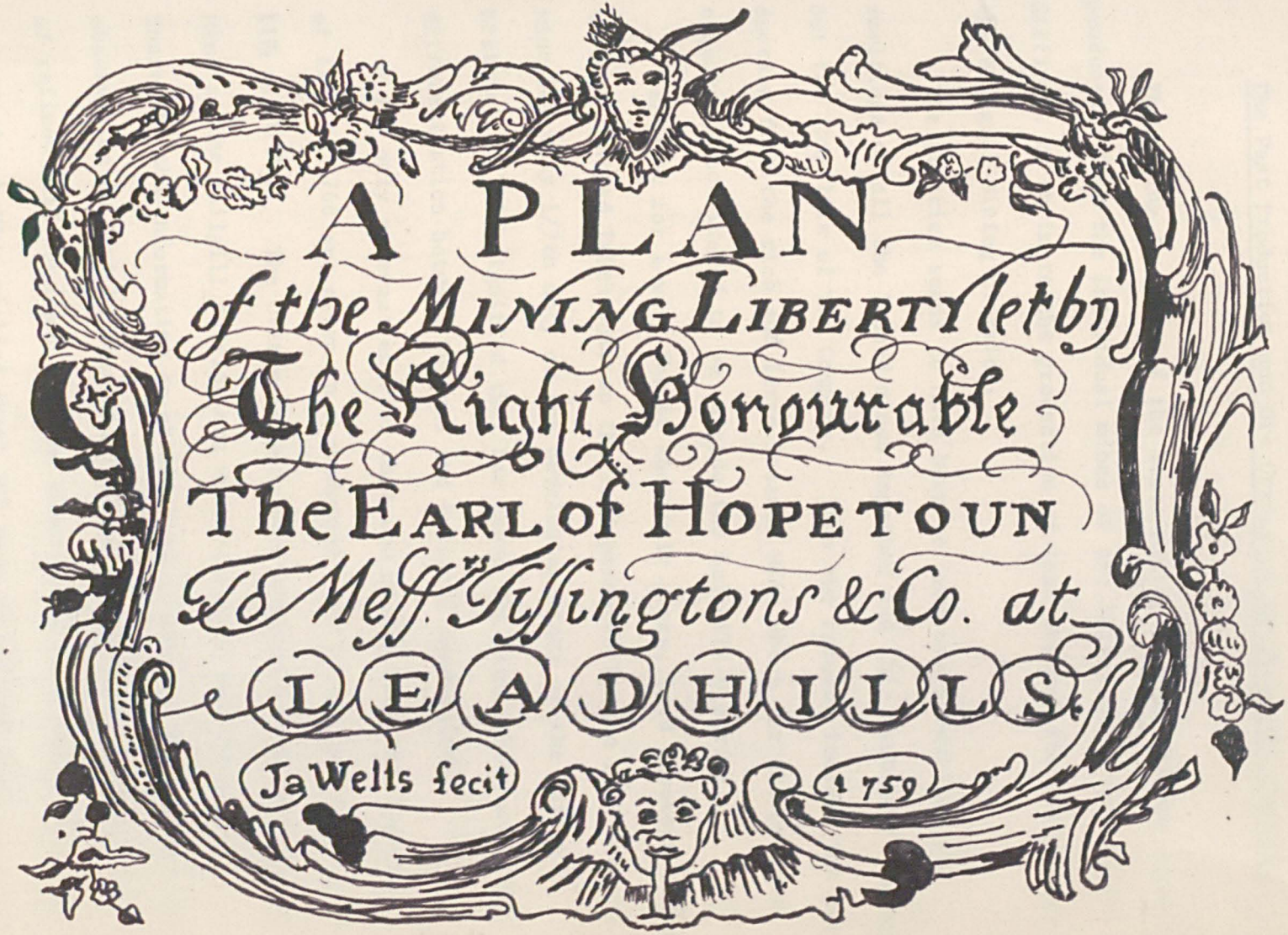
The private family papers of Mr. Stirling of Garden.

Mining Plans made available from Hopetoun house to the Scottish Records Office by the present Marquess of Linlithgow.

County History. Upper Ward of Lanarkshire. Volume I. G.V. Irving and A. Murray 1864

Glossary

Bing	8 cwts. of Material
Drive	A horizontal gallery
House	An open cavity left by previous miners
Mother or Madder	Matrix
Hushing	Prospecting for mineral veins by using rushes of impounded water to wash and scour away superficial deposits off the hillsides.
Roosting	A stope - the removal of ore creates a horizontal opening called a stope.
Spar	In the Leadhills district this signifies quartz.


A PLAN
of the MINING LIBERTY let by
The Right Honourable
The EARL of HOPETOUN
To Messrs. Tissingtons & Co. at
LEADHILLS.
Ja Wells fecit
1759

Chapter 5.

The Past Production and Ore Grades of the Bailgill District

The Mining Journals of the Scots Mining Company did not record production from the individual mines of the lease, so it has proved difficult to estimate the production of lead ore and its grade from the Bailgill Mining District.

The practice seems to have been to lump ore production and smeltings of all the leased mines together and this continued throughout the long life of the Company. Thus the records include the production from the rich and large Susanna Mine which for the present enquiry is considered to be outside the Bailgill District.

However for a very few of the early years, Lord Hopetoun seems to have charged 1/6th duty on the lead produced by the rich Susanna Mine but only 1/7th duty on the developing mines of the Bailgill District. This signified that for these few years there was some differentiation between Susanna and Bailgill Production.

The only relevant entries that can be won from the Journals of 1760 to 1766 are given in a condensed form in the tables of pages 118 and 119. The Overseers were more concerned with the Susanna Mine so the Bailgill entries are unsystematical and incomplete. Therefore the information so obtained is limited. However the first observation is that between mid-1760 and mid-1765 only about 275 tons of refined lead were won from the Middlegrain Mine and in 1766 the Rispingcleuch Mine yielded about 105 tons of refined lead.

THESIS ENTRY Nº	DATE	MINE JOURNAL Nº	PROBABLE MINE.	BINGS OF ORE. 1 BING = 8 CWTS	Nº OF BARS OF LEAD PRODUCED	WEIGHT OF BARS PRODUCED.
①	Q.E. 28/6/1760	Nº1, 1759-62	MIDDLEGRAIN.	156 BINGS	—	STONES — LBS —
②	Q.E. 26/9/1761	DITTO	MIDDLEGRAIN.	—	807 BARS	6,591 — 15
③	Q.E. 31/12/1761	DITTO	MIDDLEGRAIN.	—	789 BARS	6,481 — 12
④	Q.E. 1/10/1763	Nº2, 1762-66	MIDDLEGRAIN.	—	1,047 BARS	8,475 — 6
⑤	Q.E. 31/12/1763	DITTO	MIDDLEGRAIN.	—	1,306 BARS	10,592 — 4
⑥	Q.E. 31/3/1764	DITTO	MIDDLEGRAIN.	—	141 BARS	1,148 — 10
⑦	Q.E. 30/6/1764	DITTO	MIDDLEGRAIN.	—	—	7,756 — 9
⑧	Q.E. 29/9/1764	DITTO	MIDDLEGRAIN.	—	—	501 — 7
⑨	Q.E. 29/12/1764	DITTO	MIDDLEGRAIN.	—	—	857 — 0
⑩	Q.E. 30/3/1764	DITTO	MIDDLEGRAIN.	—	—	NIL
⑪	Q.E. 29/6/1765	DITTO	MIDDLEGRAIN	—	—	1,658 — 5

Production of Certain Mines in Bailgill District. (Sheet 1)

CARRIED FORWARD 44,063 — 12
(ABOUT 275 LONG TONS.)

(115)

THESIS ENTRY Nº.	DATE.	MINE JOURNAL Nº	PROBABLE MINE.	BINGS OF ORE 1 BING = 8 CWT.	Nº OF BARS OF LEAD PRODUCED.	WEIGHT OF BARS PRODUCED.
						STONES — LBS
					BROUGHT FORWARD	44,063 — 12
(12)	Q.E. 28/9/1765	Nº2, 1762-66	—	—	—	NIL
(13)	Q.E. 31/12/1765	DITTO	RISPINGCLEUCH.	—	—	164 — 9
(14)	Q.E. 29/3/1766	DITTO	RISPINGCLEUCH.	—	—	NIL
(15)	31/5/1766	Nº3, 1766-70	?	22	—	1,113 — 13
(16)	7/6/1766	DITTO	RISPINGCLEUCH.	78 1/2	—	
(17)	23/8/1766	DITTO	RISPINGCLEUCH.	20 7/8		
(18)	23/8/1766	DITTO	RISPINGCLEUCH.		61	497 — 8
(19)	30/8/1766	DITTO	RISPINGCLEUCH.	15 3/4	139	1,129 — 10
(20)	6/9/1766	DITTO	RISPINGCLEUCH.	17	132	1,077 — 8
(21)	13/9/1766	DITTO	RISPINGCLEUCH.	25 3/4	132	1,074 — 1
(22)	20/9/1766	DITTO	RISPINGCLEUCH.	40 1/4	128	1,044 — 2
(23)	27/9/1766	DITTO	RISPINGCLEUCH.	14 5/8	141	1,148 — 13
(24)	Q.E. 27/9/1766	DITTO	RISPINGCLEUCH.			5,972 — 0
(25)	Q.E. 31/12/1766	DITTO	RISPINGCLEUCH.			9,600 — 13
(26)	Q.E. 28/3/1766	DITTO	RISPINGCLEUCH.			NIL
					TOTAL	60,915 — 1
					(OR ABOUT	380 LONG TONS)

Production of Certain Mines in Bailgill District. (Sheet 2 & Final.)

It is somewhat foolhardy to extrapolate from these few figures but nevertheless assuming a production of 60 tons of refined metal per year and a total working life of the district of about 40 years, gives a total production during the Scots Mines Company's lease, of about 2,400 tons of lead metal.

To have maintained the Scots Mines Company's interest, output must have been considerably higher. The alternative may be that one of the conditions of the lease from Lord Hopetoun, required the Company to continue prospecting and Working the Mines of the Bailgill District. The Company might have been prepared to do this without much coercion if the highly profitable Susanna Mine were included in the same lease.

From the figures in the tables it is calculated that a bar of lead weighed just a pound or so over one hundredweight. The most important observation to be made is that the ore of the Rispingcleuch Mine is rich; 10 cwts. of ore when smelted gave almost 7½ cwts. of metallic lead. 10 cwts. of Middlegrain Mine ore gave 6½ cwts. of metallic lead.

It would seem that only the richest ores were carried to the Smelter near the junction of Balegill with Glengonnar Water (Square I2 of large scale map). This begs the question of what happened to the ores of lesser tenor.

From an entry in Journal 1/B, 1742-46, it appears that blue, white and brown ores were raised and on the 3rd September 1742 an interesting entry reads:- 'The blue ores which we are now finding and smelting requires a much stronger blast than does the brown and white'.

If the output of the Bailgill District seems to have been small, that of the Leadhills field seems to have been large. Captain Mitchell of the Wanlockhead Mines in a paper [1] dated July 1919 wrote 'From other records I have seen, the production about the year 1790 from Leadhills was 1,400 tons of lead worth £20 per ton.

CMakay [2] gives a table of production of lead ore between 1851 and 1930 which suggests an average production of just over 1,400 tons of lead ore per year.

Mitchell's statement [1] indicates that production from the Leadhills District was higher in the 18th century than in the 19th and 20th centuries. This situation was probably due to the early working of the rich and shallow veins of the Leadhills District and explains to some extent the neglect of the Bailgill District.

According to the Mine Journals, the refined lead was despatched to the Port of Leith near Edinburgh, a distance of 50 miles or so and when necessary a total of 3,000 bars could be transported there in one week. Transport was probably erratic for the poor state of the roads of those days and the rough weather of this upland area would lead to much stockpiling at the smelter during the winter months.

CMakay [2] states that there was no connexion, either physical or managerial between the Leadhills Mines of Lanarkshire and the Wanlockhead Mines of Dumfriesshire. On reading the Mine Journals however, there was evidence of a considerable degree of co-operation. If the roads were impassable between Leadhills and Leith, bars of lead were sometimes despatched to Dumfries for shipment along with the Wanlockhead production.

Bibliography

(1) 'The Wanlockhead Lead Mines' by John Mitchell. Reprinted from the Mining Magazine, London. July 1919.

(2) 'The Leadhills Wanlockhead Mining District' R.A. Mackay. September 1958. Symposium on 'The Future of Non-Ferrous Mining in Great Britain and Ireland'. Institution of Mining and Metallurgy.

CHAPTER 6.

A Proposed Scheme for Re-Exploration and Possible Development of Mining in the Bailgill District

With the high taxation of wasting assets, the present landowner, the Marquess of Linlithgow, may gain more income from the grouse shoots organised over these moorlands than from the working of the lead ore deposits that may lie beneath.

Protection of the environment is also a factor that weighs heavily against all types of mining and in particular, Open-Cast Mining. However the underground mining proposed for the almost vertical lenticular lead deposits of the Bailgill District, if they are found to exist, should be less offensive to the eye: the adit mouth with associated works would be in the Bellgill Burn valley which has a narrow and tree shrouded exit into the Glengonnar Valley, a famous beauty spot much favoured by visitors.

The time may come when national interests will prevail and the Bailgill District re-explored for possible extensions of known ore shoots and blind veins as yet unworked. It is in anticipation of this event, that the present chapter is written.

Methods of Exploration practised in the early days of the Scots Mines Company.

It may well be asked how did the 'Old Men' carry out prospecting in the Bailgill Mining District during the 1700's. The Scots Mines Company's Journals give a little insight into this aspect. In the chapter on the History of the Bailgill Mining District it has been

mentioned that the Middlegrain Vein was located by 'tumblers' of galena broken off the lode which were found in the peat and the search continued somewhat haphazardly by prospect levels.

There is a saying of our mining forbears that 'Moving dirt is the best way to hunt for ore' and to a certain extent this was the practice at Bailgill. The only rock exposures of this district are usually in the burn beds and these were walked carefully particularly after heavy rain storms to search for any leader of black mineral soil which looked promising. This would be followed up by a prospecting level driven along the leader, hoping always for shows or small pieces of lead ore indicating the possibility of a profitable vein ahead. No mechanisation was required and labour was cheap and this method of prospecting is mentioned many times in the Mine Journals.

This preoccupation in following up stringers or leaders of black matter variously called 'madder' or 'mother' is also described in the 'Leadhills Diary' (1) and therein a typical instance of prospection is described as below:-

> '11th July 1745, after 12 took a walk with Wm. Fisher and Tho Hog, two of our labourers to see a new vein in the side of the Wellgrain at the head of Bailgill, which Fisher says he discovered on either Friday or Saturday last. He says moreover that after he had digged a little in order to better to discover the soil and was coming away, Robt Harper one of our miners coming up found the place and now pretends to be the first discoverer, tho' Fisher declares that it had not been touched before he saw it.

'Harper having taken out Mr. Wigham (one of the overseers) this morning to see it, Fisher desired that I should go along with him and see it likewise. When we came to the place he showed me which he had discovered, in the side of the Well Grain, a little above where that rivulet runs into Bailgill Burn. We found the same vein laid open on the north side of the Burn, which had rather a better appearance than the other. The soil was mostly a black matter, intermixed with a pale coloured clay. That on the South Side being about a finger breadth and the other a little wider. But about 5 or 6 fathoms upon the burn from that on the North side we found another vein laid open of the same soil and about a foot wide. These two on the north side we concluded had been opened by Mr. Wigham and Harper for Fisher and Hogg both told me that there had been no trial made of them this morning. When we were coming homeward we found a great many old shafts upon the random of these veins towards the south and very near one-another. Mr. Wigham has a very good opinion of that vein in the Wellgrain'.

This leader and subsequent trial level together with the old shafts can still be traced in the area of square J4 of the large scale map. The 'old men' must have experienced trouble with water in their old shafts as they are only a few feet above stream level nearbye. As will be mentioned later the proposed prospecting/drainage

level is located to pass through this area.

The chemical composition of this black mineral soil or 'Mother' does not seem to have concerned the miners but amongst the 'Stirling of Garden' private papers [2] there is an interesting letter from James Stirling who followed his father as Manager. It reads:-

'The Court of Directors Leadhills 16th April 1796

Gentlemen,

By last post I informed you that I had been making experiments on that substance we have hitherto called here 'Mother of Lead' which from them turns out to be an ore of manganese and which in future shall have that name'.

This information would be of interest if Geochemistry was proposed to re-prospect the Bailgill District but the thick peat deposits would diminish the effectiveness of this method.

In the Bailgill District the 'old men' often drove exploratory levels alongside any dyke of igneous material that crossed a burn. When examining the old productive mines today, felsitic material is often found on the dumps and felsitic dykes found in the burn bed near the lowermost drainage adit.

Even the highly productive Susanna vein may have been discovered this way as it was strongly associated with a felsite dyke as is illustrated by the following passage from 'A Mineralogical Description of the County of Dumfries' by Robert Jameson, Edinburgh 1805.[3]

Tranſition greenſtone.

5. *Tranſition greenſtone.* On the hanging or upper ſide of the Suſanna vein in the valley of Leadhills, I obſerved a bed of rock which at firſt I miſtook for porphyry, but which proved, on more attentive examination, to be greenſtone. It is almoſt entirely compoſed of felſpar, which has uſually a pale fleſh red, or reddiſh white colour: in it there is ſometimes imbedded grains of greyiſh coloured quartz, ſcales of iron black coloured mica, and cryſtals of pale fleſh coloured felſpar. Sometimes the baſis is in a ſtate of diſintegration, and then it reſembles porcelain clay.

During the field work in the District of this thesis, it became apparent that any sudden change or 'upset' in the strike of the greywacke bedding and jointing or indeed any 'disturbance' was sufficient cause for the 'old men' to search for ore by open-casting or cutting a small exploratory level.

The general settings of the mines which were productive in the past, were carefully examined in the field to try and ascertain any similarities. In the case of the Middlegrain, Overcleuch and Bulmers Mines a slight hollow seems to follow the course of the veins where they outcrop beneath the deep peat cover. It is surprising that the 'old men' did not make use of this phenomenon as after extracting the last then known ore at Bulmers Old Works, it seems to have taken them 20 years or so to find the southern end of Bulmers Vein at Overcleuch Mine. It may be that these longitudinal hollows appeared after mining ceased; as since that time there has been continual drainage work on the bogs and peats to obtain better con-

ditions for sheep and grouse production. The photographs on pages 21 and 106 give some idea of the deeper sections of these hollows.

In the case of Rispingcleuch Vein and Longcleuch Vein there is a similar likeness in the setting amidst hard greywacke ribs forming gorges. This typical setting is illustrated in the photographs of the Longcleuch Mine on pages 111 and 129

Straight Brae Vein is aptly named as examination of air photographs shows that it seems to lie parallel to a hard ridge of dark chloritic greywackes. Examination of the line of the vein and topographic contours in square M4 of the large scale map also illustrate this point.

Cross-cutting seems to have been rarely employed by the 'old men' to discover new veins. As an example of this, although very little distance separates the Middlegrain and Overcleuch Mines, the latter was not discovered by cross-cutting although the sub-parallel nature of the veins in the District must have been known to them. There is some excuse for its omission because of the great cost and slowness of driving cross-measure drifts in those days. For example, it took 17 years to drive the 125 fathoms of the Rispingcleuch Drainage Adit. Slightly better progress was obtained with the Middlegrain Mine Drainage Adit, where 210 fathoms of cross-measure drifting took 9 years.

Prospecting by 'hushing' was carried out to some extent, chiefly in the shale-chert zone but there is no evidence that any mineral veins were discovered. In the greywacke zone, 'hushing' was not practical because of the topography.

Longcleuch Burn alongside Longcleuch Mine,
showing Greywacke Ribs.

PHOTOGRAPHED FROM NEAR EXPOSURE Nº 8 OF SQUARE J.9.

Present Prospecting

Based on the general observed surface likenesses, the only area suitable for immediate operations would be Burnts Cleuch in squares F9 and G10 of the large scale map. It has the same hard ribs of greywacke and general appearance of Longcleuch alongside the Longcleuch Mine. Burnts Cleuch has also an interesting lamprophyre dike but, as discussed in an earlier chapter, page 63 this site may be near the northern limit of mineralisation in the Bailgill District.

The obvious possibility that Bulmers Vein may extend across the Short Cleuch Valley into Glen Ea's Hill was considered. During the present geological mapping an old mine windlass was discovered in the dry-stream bed as shown in square N6 of the large scale map and a photograph is given on page 131. Subsequent conversation with the Head Game Keeper revealed that as the result of a very heavy rainstorm in the early 1930's, the stream bank was eroded away and exposed a freshet of galena, which was worked by the Marr Brothers in a shallow shaft. However the Marquess of Linlithgow forbade further work as it lay on a favourite grouse shoot. It would seem quite possible therefore that this old windlass lies on the extension of Bulmers Vein.

In Mackay's paper (4) it is noted that a 'Turam' Survey was carried out in the North-East part of the Leadhills District. During the present examination, location stakes for the survey were found as far north as Hershaw Burn in square F11 of the large scale map. Apparently the geophysical survey did not obtain conclusive results as anomalies were probably caused by the large numbers of dykes in the area and the amount of upland bog-water.

Old Mine Windlass on Possible continuation of Bulmer's Vein into Glen Eas Hill.

PHOTOGRAPHED FROM NEAR EXPOSURE 37 OF SQUARE N.6.

Future Prospecting Development

Reasons why the Bailgill District may be worth future serious consideration and development are outlined as follows. 'Ore in depth' used to be the cry of disreputable financiers hoping to raise share capital on what were in fact exhausted mines. Often too the phrase was the last resort of the exasperated mining engineer trying to extend the life of a mine for a few extra years. Herbert C. Hoover in his 'Principles of Mining' 1909, page 31 (5) gives some very practical advice in the general sense of to what depth payable ore is likely to persist.

> 'A study of the shape of a great many ore-shoots in mines of fissure type indicates that when the ore-shoots or ore-bodies are approaching vertical exhaustion they do not end abruptly but gradually shorten and decrease in value, their bottom boundaries being more often wedge-shaped than even lenticular. If this could be taken as the usual occurrence, it would be possible to state roughly that the minimum extension of an ore-body or ore-shoot in depth below any given horizon would be a distance represented by a radius equal to one half its length. By length is not meant necessarily the length of a horizontal section, but of one at right angles to the downward axis.'

An examination of the large scale maps of the Bailgill District shows the probably longitudinal extent of payable ground by the plethora of shafts. It should be realized that the 'old men' had only sledges and wheelbarrows to transport ore horizontally through their twisting and tortuous passageways formed by following the vein.

They preferred therefore to sort the ore in the stopes and then haul it up vertical shafts. For the 'old men' vertical shafts were easier and quicker to sink than drive horizontal levels because it was easier to drive vertical holes where the weight of the hammer assisted progress rather than having to be carried when driving horizontal blows.

Taking first the Middlegrain Mine, Drainage Adit level is about 1375', O.D. while ground surface at the mine is roughly 1550',O.D. The strike length of ore-bearing ground, judging by the distribution of shafts, is about 1500' which by the above rule suggest that payable ore extends down to possibly 800',O.D.

At Bulmers Old Works, the lowest drainage adit level is at about 1500', O.D. but as surface level at that mine is 1700',O.D. and strike length of ore-bearing ground is limited it may well be that the ore-shoots have been bottomed here. At Rispingcleuch Vein the drainage adit level is at 1275',O.D. approximately and surface level is about 1475',O.D. with a possible strike length of payable ore of 1500' so that ore can be expected to extend down to about 725'.O.D.

The Overcleuch Drainage Adit is at a comparatively high altitude of 1375',O.D. surface level at the mine is about 1500',O.D. with a known strike length of ore-bearing ground of about 2000', so ore may extend down below adit-level to perhaps 500',O.D.

From the Chapter on the history of the Bailgill Mines, it will be recalled that the productive mines were worked down to natural drainage level only and that although ore could be seen in the soles of the levels, the hand pumps of the day did not permit sinking and winning ore below the drainage adit level. There was a complete lack of adequate drainage, haulage and ventilation equipment.

On the dumps of the once-productive Bailgill mines there are still to be found specimens of galena but a noticeable absence of zinc-blende. This in itself is a good indication of continuance of ore in depth as the temperature conditions for zoning would thus be favourable. Calamine is in fact present on the lowest dumps of the Woolgill Mines of Square K2 of the large scale map. (Reference Wilson [6]).

Other important facts are the sub-parallel nature of the veins of the Bailgill District and the reluctance of the 'old men' to drive cross-measure drifts to search for them. It was more by accident than design that sub-parallel veins were discovered and the history of Bulmers Old Works, Middlegrain and Overcleuch Mines are good instances. It must be borne in mind however that the 'old men' were working on a tribute of 5/- per bing of ore and so intent on obtaining a livelihood that they would often be forced to pass small 'leads' or 'stringers' that could have led to more sub-parallel veins. Modern horizontal diamond drilling and cheap cross-cutting might have discovered such veins but the expense and slowness of cross-cutting in the pre-gunpowder days has already been stressed.

Proposed Means of Future Prospecting and Development

The first temptation is to suggest the use of diamond drilling or of Geophysical Investigation to prove the presence or absence of fresh ore in the Bailgill District. There is no doubt that both these methods have improved greatly, particularly in the proving of large massive deposits but the Bailgill ore-shoots are tabular, narrow, near vertical and patchy. Galena is friable and core-recovery is difficult except where extremely experience and conscientious drilling

crews are used. Indeed sometimes the impression is gained that to 'kill' a prospect, diamond drilling and geophysical prospection are often used, when our fore-fathers would have simply excavated to prove or disprove.

In the Transactions of the Institution of Mining and Metallurgy, Volume XLVI, 1936-7, Varvill [7] made some remarks on this subject which are true today in spite of all the technical advances that have been made. Summarising his remarks, diamond drilling has little application except for limited investigation from the underground workings of existing mines. Ore-bodies are so patchy and ore and gangue so soft, also possibly cavernous, that core recovery is in many cases impossible. As regards geophysical methods, some types of ore-bodies are too small and distribution too irregular to set up the strong anomalies required. In this particular context his closing remarks are extremely applicable in spite of the years that have elapsed since he made them.

'The present day mining engineer is therefore restricted to the same principles of exploration as his predecessors with two important exceptions:-

(1) He benefits from their experience.

(2) He can explore by sinking and driving far more rapidly and to greater depths than they could and thus by multiplying his points of attack he can greatly increase his chances of finding ore.'

Therefore in view of the sub-parallel nature of the known veins and possibly the presence of further 'blind' veins an exploration policy by exploration/drainage adits is advocated especially as the

lands belong to one land-owner and no expensive way-leaves will be required. Needless to say a Mining House prepared to risk some capital will be required but with a fair expectation of reward. During the hey-day of the Leadhills and Wanlockhead Mining fields, labour costs were low; taxation was low or non-existent, Royalties were as high as one-third and power used in mining except for pumping was minimal. Today Royalties are usually lower than one-twelfth and man-power assisted by powered machinery is more efficient. Therefore if ore reserves are proved at Bailgill, the setting up of a new mine using as an integral part the new exploration/drainage levels may prove an attractive economic proposition.

The layout of the proposed exploration/drainage levels is as shown on the large scale map and is designed to cross the strike of any veins as near as possible at a right angle. The gradient of the levels is taken at a constant 1 in 500 as large volumes of water are to be expected. As the adits will be driven in hard greywakes only moderate support is likely to be required.

The Main Adit Portal would be in Balegill Burn at the point where the massive vein-bearing greywakes commence (in square I3 of the large scale map) and the adit will pass mostly under those areas of Bulmers Moss where ore has been won in the past. The vein to be first encountered will be Wigham's Vein as already mentioned in the beginning of this chapter.

It is proposed that two new shafts be sunk down to the new exploration/drainage level rather than open and deepen existing shafts.

The details would have to be left to the Mining Engineering Profession but a rough estimate of the cost of the exploration/drainage adit at today's prices would be somewhat as under bearing in mind that mining expertise in the Leadhills-Wanlockhead Area is by this

time non existent. A suitable cross-section for the adit would be 8' x 8' with a drainage grip 2'6" x 2'6" to one corner and the light rail track to the other all as shown in the rough sketch on page 116

Estimated Cost per foot run

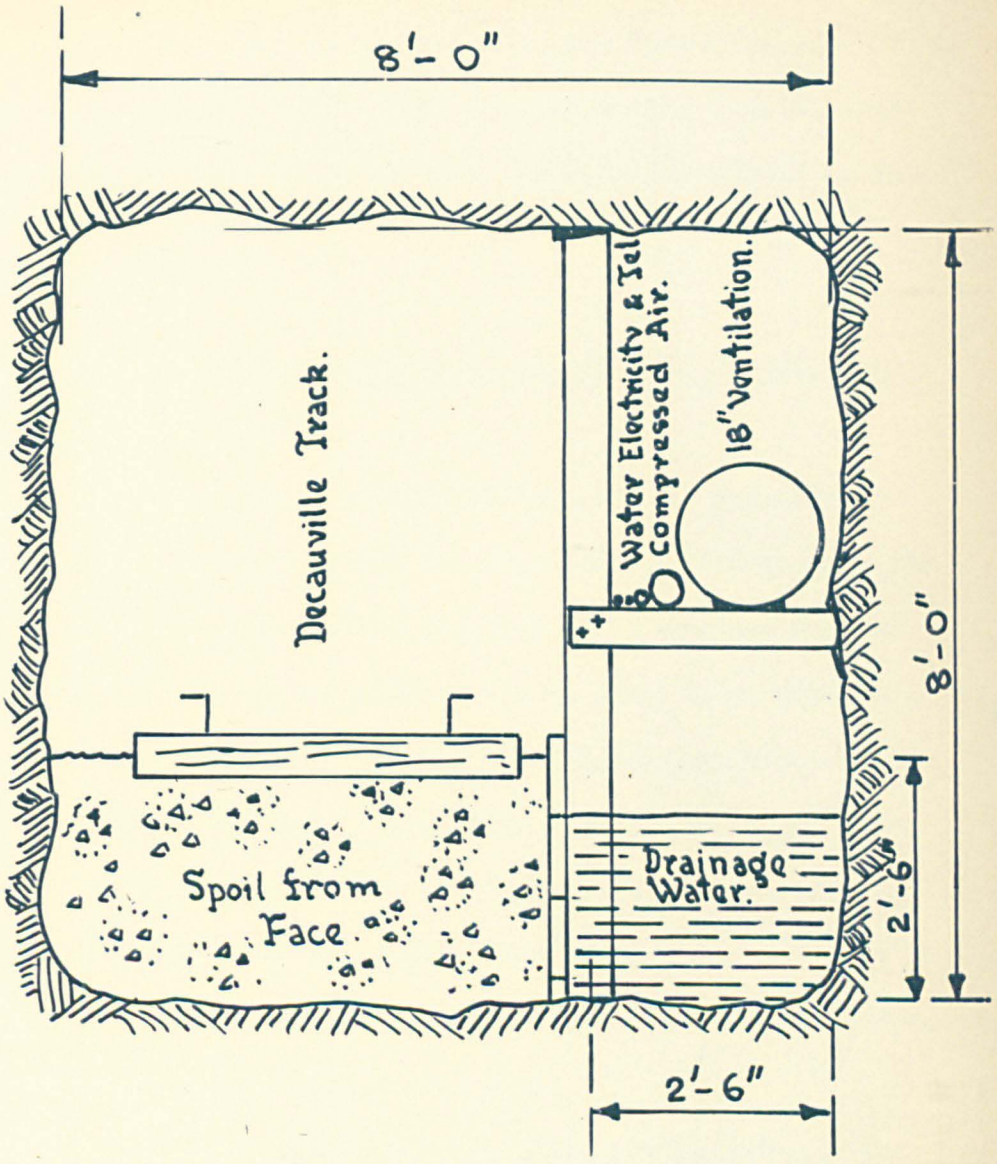
A	Drilling and Mucking	£66
B	Underground Transport	£13
C	Mechanical. Electricity and Plant	£14
D	Establishment Charges	£ 5
		£98

Note:- As at 4/6/74, the Price of Gold was $ 157¼ per ounce & 1£ = 2·3982½ $.

say £100 per foot run

Average progress would be about 50 yards per week. Therefore the total cost for the 9,200 lin ft or so of exploration/drainage adit proposed and as shown on the large scale map together with two shafts would be about one million pounds and take between 18 months and two years to complete. The invert level of this adit commences at about 1.170', O.D. and rises to 1,184', O.D.

K.C. Dunham in his paper 'The Production of Galena in the Northern Pennines' (8) gives some useful information on past ratios of Development to Production. In the Beaumont Mines in Weardale, Co. Durham between 1818 and 1876, where long drainage levels were used for working also, for each fathom of development in unproductive ground, 3.71 tons of lead concentrates were ultimately obtained and presumably that organisation made a profit. In the present proposal there are



Cross Section of Proposed Exploration / Drainage Adit.

1,525 fathoms of development and there would have to be further development to extract any ore encountered, as it would be advisable to adopt a figure of 8 tons of concentrates per fathom of adit if the project is to be a viable one. This signifies that a final total production of 12,000 tons or so of lead concentrates should be aimed for.

Difficulties likely to be encountered in driving the Exploration/ Drainage Adit

In the chapter on the History of the Bailgill Mines, the chief difficulties in obtaining ore from the soles of the drifts were the great amount of water encountered, the lack of 'communication' and lack of air for the miners. Usually where a mine is particularly wet, there is no shortage of air as long as blasting is not resorted to. In the Bailgill Mines however, the surface covering of thick peat must have prevented the ingress of air with precipitation and perhaps even introduced deleterious gases from the decaying mass of peat above. There was also the danger of old water filled trials above the operating levels of the mines.

As will be observed from the large scale geological map the jointing and bedding planes of the greywakes are principally vertical. The greywakes were also so faulted and shattered to form eventual receptacles for the mineral veins. All these factors allow water of precipitation to penetrate downwards to the mines with a great degree of ease.

On page 140 is given the rainfall of the District by courtesy of the Agent and Head Game Keeper. On page 141 are given the flows of water from Rispingcleuch Adit which were measured whenever possible

Nat Grid Ref NS(26) 888/153 Station No 6462. Lat 55°-25' N
Leadhills. Snow No 42. Long 03°-45' W.
Rainfall in Inches. Height above Sea Level 1270 Ft.

Year	1969	1970	1971	1972	1973	1974			Average.
Jan	4·75	6·49	6·14	7·60	4·02	18·11			'69-'73 INCL 5·80
Feb	1·80	5·43	4·88	4·69	3·33	7·08			4·03
Mar	1·35	3·17	3·60	4·25	2·37	3·03			2·95
Apr	1·93	4·15	2·22	7·67	4·29				4·05
May	5·60	3·42	3·66	6·14	5·08				4·78
June	4·97	4·06	2·89	6·10	2·21				4·05
July	3·95	6·96	4·25	2·43	3·60				4·24
Aug	3·24	3·27	4·84	3·28	4·46				3·82
Sept	2·68	6·64	1·72	0·92	2·72				2·94
Oct	4·95	5·88	6·57	2·76	3·47				4·72
Nov	5·82	7·82	5·07	7·14	4·80				6·13
Dec	6·29	3·12	3·88	7·06	5·98				5·26
Totals	47·33	60·41	49·72	60·04	46·33				52·77

Rispingcleuch Adit.

Flow of Water in Cusecs

	from Adit.						In Stream above Adit.	
	1969	1970	1971	1972	1973	1974	1974	
Jan		0·16	0·15	*	*	0·32	·08	
Feb		0·14	0·11	*	*	0·49	0·16	
Mar		0·09	0·09	*	*	·25	0·00	
April		·05	·04	0·08	·04			
May		·02	*	*	·03			
June		·01	*	*	·01			
July		·03	*	*	·01			
Aug		·04	*	0·03	·02			
Sept		·08	*	*	·04			
Oct		·09	·08	*	·06			* AUTHOR AWAY IN NIGERIA.
Nov	·10	·15	*	*	·08			
Dec	·15	·15	*	*	·11			

as near to the middle of the month. It will be noted that there was exceptional rainfall in January 1974 which was reflected almost immediately by an exceptional flow of water from the adit. The rainfall and Rispingcleuch Adit flows are plotted together on page 143 and it will be noted that during normal periods of rainfall there is roughly a month's lag between 'cause' and 'effect' probably because of the depth down to adit level and the thick surface covering of peat.

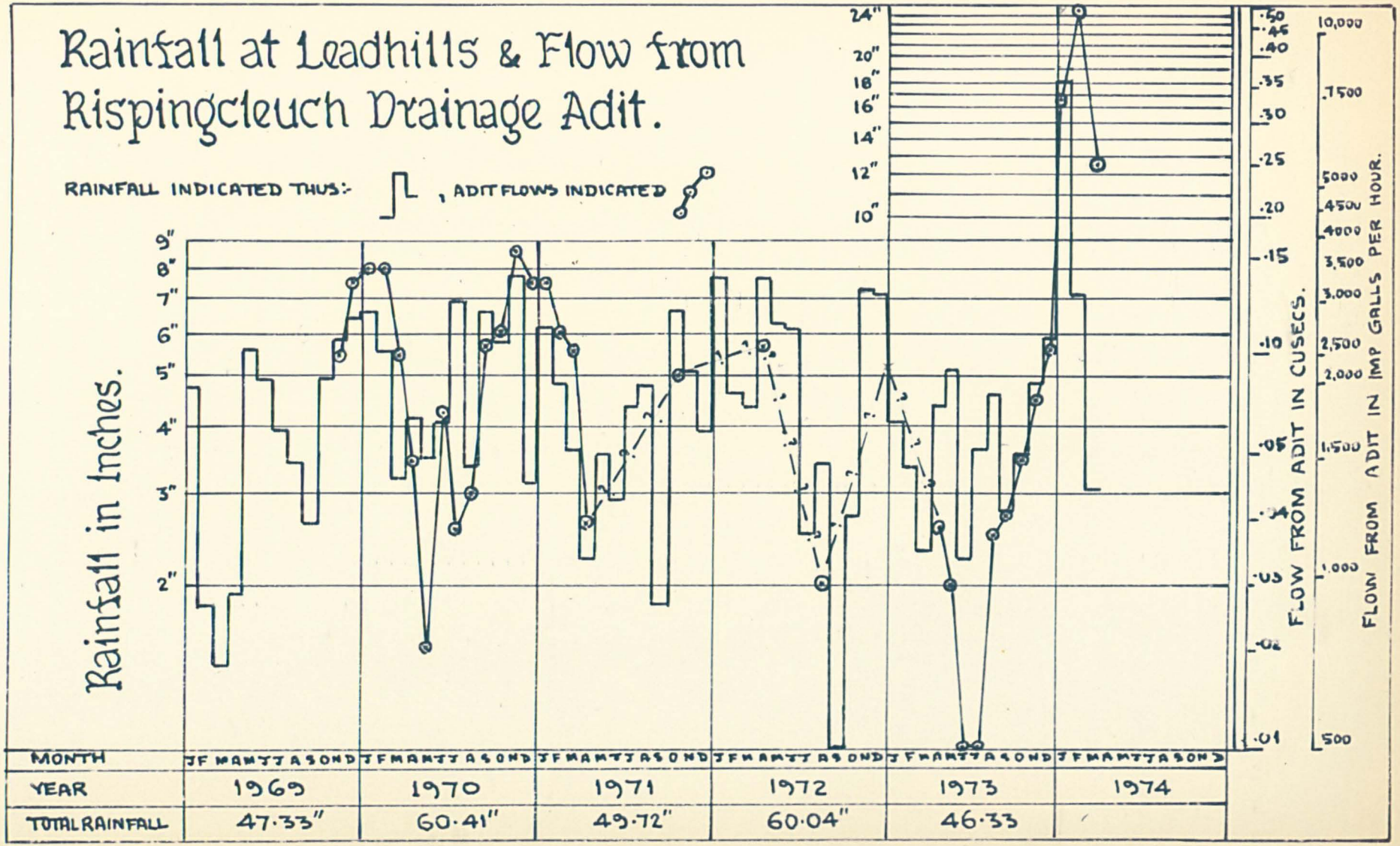
The temperature of the adit water remained fairly constant between 42°Fah. and 44°Fah. during both summer and winter. The flow and temperatures of other adit-waters in the Bailgill District were also measured but Rispingcleuch Adit received most attention because of its greater flow and easy access from the neighbouring road.

It was most obvious that for the majority of adits, flow from them was continuous all year but that the streams passing the adit mouths were dry for the greater part of the year and when flowing the amount of water in them was minimal. To illustrate this point a few measured stream flows are inserted against the corresponding flows from the Rispingcleuch Adit. The suggestion is that between 50% and 75% of precipitation water finds its way underground where mining works have been carried out below. For this reason the drainage grip of the proposed exploration/drainage adit has been designed to permit a flow of 17 Cusecs or 6,000 gallons per minute. The Wanlockhead Glencrieff Mine had a 'make' of 18,000 gallons of water per hour which had to be pumped through a total lift of 144 fathoms (Mackay [4]), and made the mine uneconomic to work at the then price of lead.

The Glencrieff Mine was being worked in greywackes beneath the cover of the shale-chert blanket which must have reduced considerably

Rainfall at Leadhills & Flow from Rispingcleuch Drainage Adit.

RAINFALL INDICATED THUS:- ⊓ , ADIT FLOWS INDICATED ⟋



MONTH	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
YEAR	1969	1970	1971	1972	1973	1974
TOTAL RAINFALL	47·33"	60·41"	49·72"	60·04"	46·33	

the amount of percolation into that mine. The Bailgill District does not have such cover and so water is likely to be a continual problem and an expensive one if lead is later worked beneath the proposed exploration/drainage level.

The air problem would be overcome by blowers and ducting but more care would be needed when passing beneath old workings and de-watering them. Pilot Bores would have to be carried ahead and to the flanks.

To finalise this chapter it is fair and interesting to give Mr. W.G. Borron's views on levels versus shafts as he was the last manager for the Scots Mines Company. The letter quoted below was found amongst loose papers in the Leadhills Miners Library.(9)

'27th June 1893 To Mr. Newbiggin.

The report by you left me is clever and well described but his ideas of levels are good for the Landlord but not for the Lessees. Levels occupy too much time besides very little was ever discovered by Gripps Level (it ran along the strike - Authors Note) and cost my Old Company immense sums, better sink down by Engines and Machinery on the portions of Veins where it has been proved that ore exists, and when that portion is exhausted remove your engines to another portion of the vein. In many of the English Districts where the veins contain a long course of ore-bearing ground, Levels are very appropriate but much less so in mines like Leadhills where the ore bearing portions of the veins are short in length and distinct from each other.'

Borron.

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9. Loose papers in Leadhills Miners Library.

Appendix No. 1

During the desk study in the Leadhills Miners Library an old document was discovered amongst some loose papers and, as it concerns the litigation between the Lessor of the Mineral Rights Lord Hopetoun and the Scots Mining Company together with the end of that fruitful association, it is considered worth while to quote it in full. It explains to some extent why mine exploration and development of the Lease including the Bailgill District ceased. It is realized that this document, probably written by W.G. Borron himself, only gives one side of the Litigation, which more or less paralysed all the Leadhills Mining District for some years. The document is worth preserving if only as an appendix to this thesis.

'Testimonial. From the Hon. the Governor and Company for Working Mines, Minerals and Metals in Scotland, constituted by Royal Charter and commonly called the Scots Mines Company, to William Geddes Borron, Esq. Manager of their Mines and Works at Leadhills, Lanarkshire. N.B. This testimonial is signed sealed and dated at the Sun Fire Office, Cornhill, London, the joint offices in London both for the said Scots Mines Company and the Sun Life and Fire Assurance Company and bears the date the 20th May 1840. 'To W.G. Borron, Esq. Leadhills. My Dear Sir, The period having at length arrived when your connection with the Scots Mining Company is brought to a termination, I am

directed by the Court to express to you their entire satisfaction with the manner in which you have fulfilled the duties of your appointment at Leadhills during the six years you acted as manager of the mines and bear testimony to the zeal, ability, integrity and firmness which you displayed throughout the whole time you were employed by the Company. I am, my dear Sir, Yours faithfully, Charles B. Ford, Secretary and Managing Director in London for the aforesaid Scots Mining Company, also the Managing Director and Secretary of the Sun Fire Office Company of London etc.'

It may be further stated that the Hon, the Governor and Company presented to Mr. Borron an 'Honorarium' of 300 guineas for winding up their affairs at Leadhills, and closing the litigations instituted against them by the Law Agents of the landlord, Lord Hopetoun, as before stated, litigation which had existed in the High Courts of Session etc. in Scotland, and the House of Lords in England, extending over many years.

Seal of the Royal Charter for working Mines, Minerals and Metals in Scotland. Granted to the Hon. the Governor and Company by his Majesty George II. The said Hon. the Governor and Company also presented Mr. W.G. Borron an Honorarium of 300 guineas in acknowledgement of his services in the adjustment and Winding up of their affairs at Leadhills and in compromising and bringing to a conclusion the Litigations and differences with Lord Hopetoun, and in connexion with his other Mining Lessees against the Scots Mining Company which had been in existence for thirty years.

A Testimonial also of a Solid Silver Candelabrum was presented to the before mentioned W.G. Borron, by the Miners of Leadhills and others connected with the Mines and Works, and bearing the following

Inscription engraved thereon, together with the miners coat of arms and their Motto 'Hope the best, and leave the rest to Heaven'. It has been mentioned that, long prior to 1840 very serious Litigation existed on the part of Lord Hopetoun and the Scots Mines Company and Mr. Borron in the Sheriff's Courts and the Court of Sessions and the House of Lords, with respect to the state of the Mining Works, the Rights of their leases for working the mines, and in particular the Rights of Water for driving the Engines and Machinery, and working the ores and Mines, which rights were greatly interferred with by Lord Hopetoun's Manager acting in conjunction with a Tenant of his Lordship's in adjoining Mines, to the great loss and damage of the Scots Mines Company and Mr. Borron. After these litigations had been in dependence some years it was mutually settled and agreed between his Lordship and the Scots Mining Company, and Mr. Borron to refer all disputes and differences to Arbitration for complete and final settlement, and Mr. Sopwith, an eminent Mining Engineer of Newcastle-on-Tyne, Manager of Mr. Beaumont's very extensive lead mines in the Counties of Cumberland, Northumberland and Durham, to Arbitrate and decide all differences with power of appeal by either party from Mr. Sopwith's judgement to John Taylor Esq, Mining Engineer of London, and superintendent of the extensive Lead Mines belonging to the Commissioner of Greenwich Hospital Estates in Durham, and other Counties in the North of England, his decision to be the final, and conclusive between the parties.

Mr. Sopwith took as his assistant, Mr. Stephen Eddy, M.A., Manager of the Duke of Devonshire's Lead Mines at Grassington in Yorkshire and of his Grace's Iron and Coal Mines in Lancashire, Derbyshire and other parts of England, and he, Mr. Sopwith, and Mr.

Eddy proceeded forwith, personally to survey and strictly examine all the Scots Mining Company's Mines and Works at Leadhills, carefully investigated above and below ground in the mines and works and all the differences and disputes between the Parties in Relation thereto.

Several years were occupied in their careful investigation and in hearing evidence from Witnesses and others, and ultimately Mr. Sopwith gave his decision entirely in favour of the Scots Mining Company and Mr. Borron, and adverse to Lord Hopetoun and subjecting his Lordship in damages. This decision, notwithstanding his being bound to fulfill and submit to, his Lordship, and his Law Agents and Manager refused to obey, and accordingly an appeal was taken by him and them to the final Umpire, Mr. John Taylor of London.

Mr. John Taylor undertook the Arbitration and having reviewed the same, he gave his decision entirely in favour of the Scots Mining Company and Mr. Borron, as Mr. Sopwith had done before him, but notwithstanding Lord Hopetoun and his Managers and Lawyers peremptorily refused to obey or acknowledge Mr. Taylor's award, and immediately again had recourse to law and raised actions in the Court of Session against the Scots Mining Company and Mr. Borron to have the decision of Mr. Taylor and everything relating thereto ordained and declared Null and Void, and of no effect.

A variety of pleas and objections to the awards were raised on behalf of Lord Hopetoun, three of these objections only out of a total of eight had been tried by the court, when the compromise hereafter mentioned was made, these three objections were tried in presence of the whole thirteen judges of the Court of Session all assembled, and the decision of these several objections taken separately, and at different meetings of the Court, when all were decided in favour

of the Scots Mines Company and Mr. Borron, on each occasion by twelve of the thirteen judges, the only one dissenting being the Judge Hercules Robertson, who had been, as before mentioned, one of Lord Hopetoun's advisers in these litigations.

This conduct on the part of Lord Hopetoun and his law advisers, in repudiating and rejecting the awards IN TOTO, after solemnly binding and pledging themselves to abide by and fulfill whatever awards Mr. Sopwith and Mr. Taylor should determine and declare, and again resorting to Litigation and interference with the Water and other essential Rights of their leases for properly Working the Mines, so disgusted and dissatisfied the Scots Mines Company and Mr. Borron, that they resolved to suspend their mines and works, and to surrender their leases, and Whole Mining Property at Leadhills according to the liberty given them to do so by Mr. Taylor's Award and directing the same to be taken by Lord Hopetoun at a valuation, this course, however, his Lordship and his Advisers, conspicuously the Honble. Charles Hope and Mr. John Hope, to reject and refuse and peremptorily to prosecute their litigations which had already lasted more than thirty years, and been a cost to the Scots Mines Company and Mr. Borron in defending themselves, of little short of £15,000 to say nothing of damages to their Works and Mines by interference with their Water Rights and other rights for working their mines etc., consequently under these circumstances the Company and Mr. Borron resolved if possible to compromise the litigations and interferences and accordingly they agreed to surrender a transfer to his Lordship and his other Mining Lessees associated with him.

Ultimately an agreement was made by which their whole leases, which otherwise extended to 1871, and their entire plant and mines,

Engines, Machinery and apparatus, and in general their entire property at Leadhills, and the mines, was sacrificed and transferred over to Lord Hopetoun and his other Tenants, thus disposing to them for a mere nominal sum compared with their real value as a going concern, and the large Capital, the Scots Mines Company and Mr. Borron had invested, applicable to present and future workings, and thus compromise and agree to terminate a connexion which the Company had continuously carried on at Leadhills for over one hundred and seventy years, with Lord Hopetoun and his Ancestors.

For one lease alone Lord Hopetoun was paid a premium of £10,000 besides royalties. The second lease the Company undertook to make levels and other Works mainly for the future operations of the Mines at a cost exceeding that amount. The Royalties were one-third of the produce of the Mines, smelted.

It may be stated that the Law Agents and Advisers on the part of the Company and Mr. Borron, throughout these litigations were Gibson, Craigs, Dalzelt, Brodie, W.S, Robert Ainslee W.S., and their advocates were Messrs Maitland Young, Dease, Neaves, Inglis and Penny, all subsequently Judges of the High Court of Session, and in England, Mr. Roundell Palmer, afterwards Lord Chancellor and Richards, Loch and Connell, Solicitors, while Lord Hopetoun's Law advisers were John and James Hope W.S., particularly the former, the great Temperance leader, the Honble Charles Hope, Advocate, and an uncle of Lord Hopetoun, and Hercules Robertson, Advocate.

The Governor and Company originally began their leases at Leadhills in about 1715. John Bagshaw living at Dead-Burn House the first Manager, followed by the two Stirlings of Garden, down to 1800, then by Mr. Irving of Newton, afterwards Lord Newton, for

twenty years followed by Mr. Miesson and by John Arthur Borron of Woolden Hall, in Lancashire, and his son Mr. W.G. Borron who were appointed in 1828, and the latter remained down to 1864 when the Mines and Works as before stated were transferred to Lord Hopetoun, the Landlord. It may be noted that Mr. Borron came to reside at Leadhills in 1828, his father only visiting the mines at intervals of two months.'

Thus ends this interesting somewhat shortened history of the Scots Mines Company and its Litigation with Lord Hopetoun as seen from the last Manager's point of view.

Bibliography

Loose papers in Leadhills Miners Library.

APPENDIX 2

LIST OF LEADHILLS EARTHQUAKES

(Taken from 'A History of British Earthquakes' C Davison 1924)

1 1748, about the end of October. Cat No 97 (London Magazine 1749, p 141). A Shock at Leadhills

2 1749, February 14th, between 8 and 9 am. Cat No 98; intensity 5 (London Magazine, 1749. P 141). A shock accompanied by a noise like the falling of a house, at Leadhills. It was also felt at Wanlockhead (1 mile SW of Leadhills) and Penpont (12 miles south), and also in the mines at Leadhills. The shock was evidently of some duration. Leadhills lies 5½ miles and Wanlockhead 6 miles from the Glen App fault on its SSE side.

1812 October 17-18, at night, an instantaneous movement unaccompanied by any noise, was felt a few miles up the Nith (Gent. Mag. Vol 82, 1812, P 487).

3 1820 May 20th, Cat No 298 (Milne, Vol 31, p 118)
A shock at Wanlockhead.

4 1820 Nov 28th, about 8 am. Cat No 300 (Phil Mag. Vol 56,1820, P 463; Edin Phil. Journ, vol 4, 1821, P 215).
A slight shock, accompanied by a hollow rumbling noise at Leadhills and Wanlockhead, and felt 8 or 10 miles to the east and 3 or 4 miles to the west of those places. Miners working at a depth of 150 fathoms heard the noise.

5 1820, Nov 28, about 11pm. Cat No 301. A shock stronger than the

preceding, felt at Leadhills and Wanlockhead, and accompanied by a rushing noise.

6 1826 Dec 25th, 2 pm. Cat No 322 (Milne, Vol 31, Page 119, Perrey P 154). A shock felt at Leadhills and Crawfordjohn (6 miles N of Leadhills). At the same time a shock, clearly independent, was felt at Ardvoirlich on the south side of Loch Earn and 70 miles N of Leadhills.

7 1828 May 20th. Cat No 324 (Milne, Vol 31, P 119). A shock felt in the mines at Wanlockhead and also at Dumfries (24 miles S of Wanlockhead).

1865 Jan 2nd, 1.30am. Twice, at short intervals, windows and doors were shaken at Cargen (Dumfriesshire) as if by a sudden gust of wind, and another observer was awakened by a noise as of a carriage passing. The night was calm and still and no carriage passed.

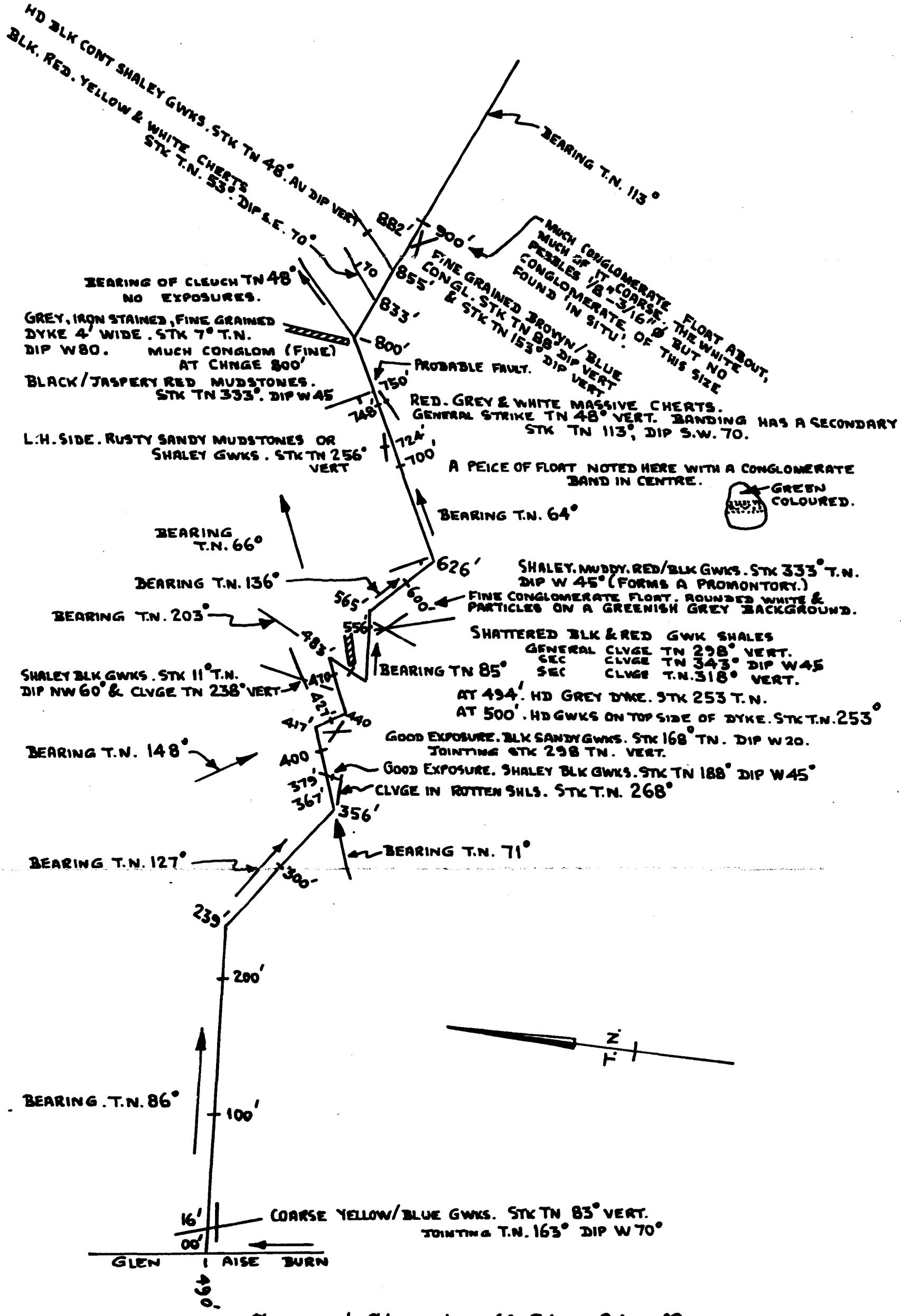
(Times, Feb 9th; etc)

8 1872 Dec 24th. Cat No 765 (Nature Vol 8, 1873, P 5)

A slight tremor felt in some parts of Upper Nithsdale.

Intensity Scale used was Rossi-Forel scale

Intensity 5). The observers seat perceptibly raised or moved.



Second Cleuch off Glen Aise Burn.

(Squares M7 & M8 of Large Scale Map)

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