

The Explosive Volcanics of Round How

Cumberland Geol Soc Excursion
11 June 2023

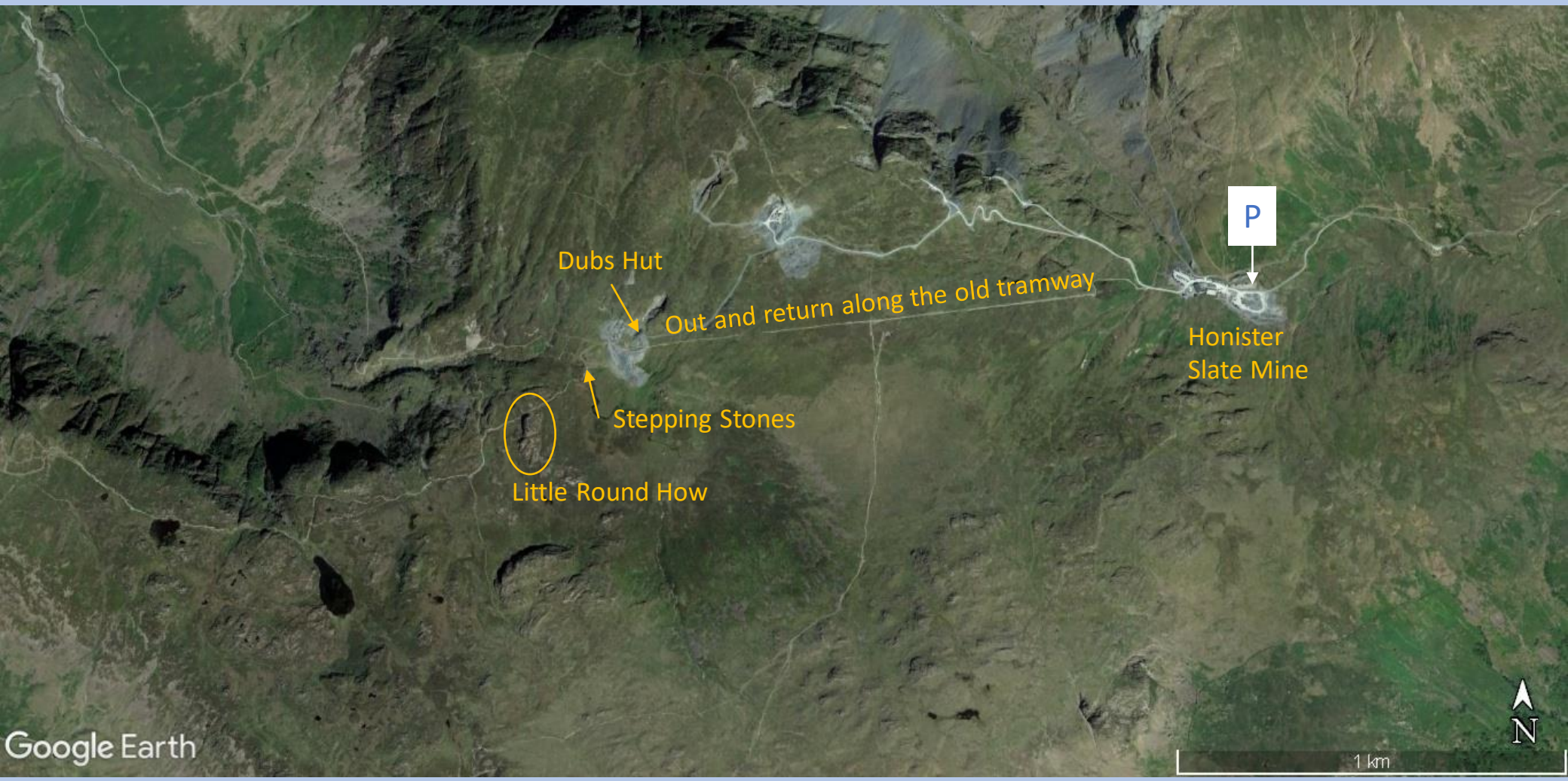
Leader

David Haselden

(Some content credited to the late Clive Boulter)

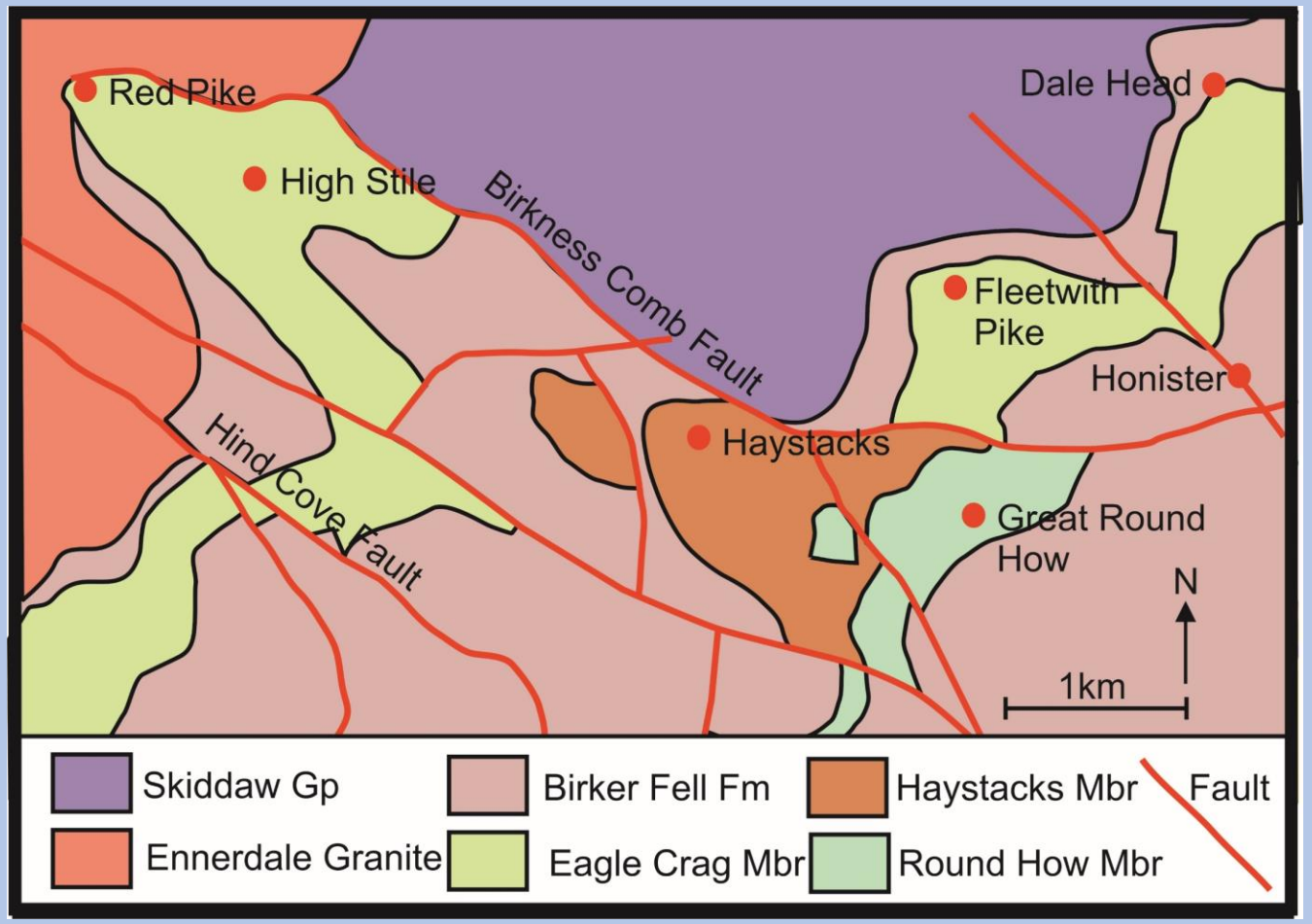
Logistics

Meet at 10 am at the National Trust car park at Honister Pass (NY 2258 1352), unless the weather is poor then we shall meet in the Slate Mine café. Parking is free to members, but for non-members it is cheaper to park in the Honister Slate Mine carpark (£5/day). The day will entail around 6 km of walking with an ascent/descent of around 500m mainly on mountain paths and sheep tracks but with sections of open fell (heathery and possibly boggy) and a stream crossing at Wharnscale Beck (stepping stones – poles will help). Depending on weather/enthusiasm etc the trip will last 4-6 hours. As of 31 May 2023 conditions were quite dry underfoot and the stream crossing straightforward.



Regional Context

The Round How Member (RHM) is within the lower Borrowdale Volcanic Group (BVG); the Birker Fell Andesite Formation which rests unconformably on the Skiddaw Slate Formation on Fleetwith Pike. To the west of Buttermere the contact between the Skiddaw Slate Formation sedimentary succession and the Borrowdale Volcanics is faulted. This fault – the Birkness Comb Fault – is interpreted as a major tectonic structure that shows evidence of multiple phases of movement. It downthrows the Eagle Crag Sandstone Member by about 2.5km to the south west. This means the approach to Little Round How is over the Eagle Crag Sandstone Member and at Wharnscale Beck you cross onto a younger part of the Birker Fell Formation, the Haystacks Andesite Member and the Round How Breccia Member.



The Haystacks Member comprises feldspar phyric flow-banded and flow-folded andesite lavas with a flow brecciated margin and is interpreted as lava dome surrounded by an apron of andesitic breccia. Reconstruction of the Haystacks Member around Blackbeck Tarn and Little Round How suggests a steep side of a brecciating lava pile. The Round How Breccia Member overlies the brecciated lavas although at Little Round How the relationship is complicated by apparent slumping whereas at Locality 2 the contact is more straightforward.

Simplified map of the regional geology showing location of the Round How Breccia member within the lower BVG stratigraphy

Introduction

The BGS has now made the 1:10000 survey maps available online via the BGS Maps Portal. The 1:10000 sheet for Round How is NY21SW and is worth a look to see what was recorded by the survey.

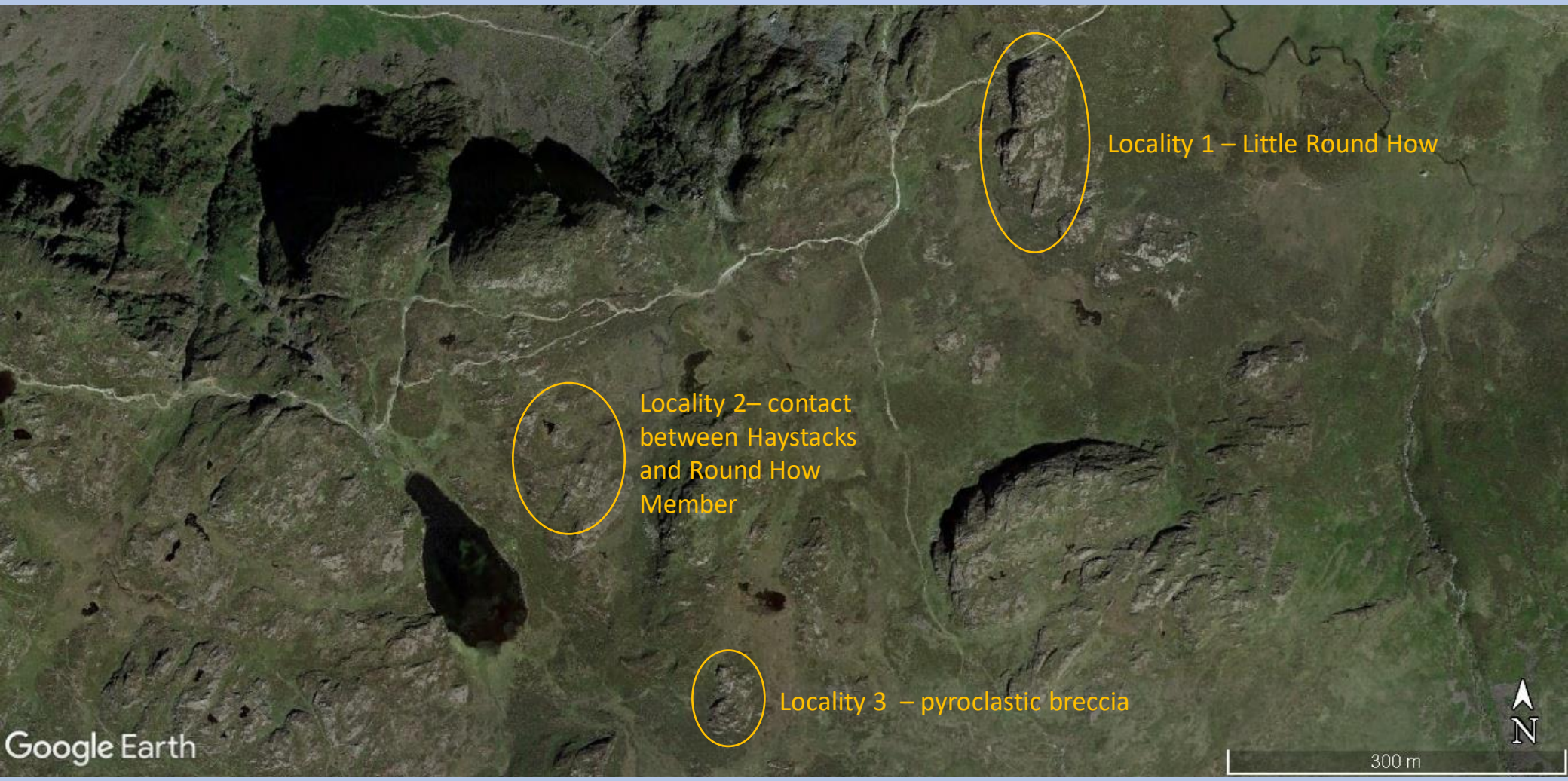
The Round How Member [RHM] of the Birker Fell Formation is typically described in terms of sedimentary nomenclature [e.g. sandstones etc]. Virtually, if not all, the clasts are andesitic in composition though they vary from igneous textures to welded ignimbrite.

We believe that the Round How Breccia Member is virtually all primary pyroclastic in nature. Hence terminology should be tuff, lapilli tuff, etc. Our interpretation is based on the presence of abundant impact sags, abundant coated lapilli, widespread ultra-fine rim type accretionary lapilli with rim fragments in some layers, upper flow regime cross-bedding, eutaxitic textures, and layers that thicken into troughs in the manner of pyroclastic density current (PDC)/ignimbrite deposits. The troughs are rounded, a morphology compatible with erosion by pyroclastic currents.

There is very little documentation available about the Round How Member [RHM]. McConnell & Kneller [1993] provide the most information and this account appears to have been the basis for the subsequent publications mentioned here. Two localities are briefly described by Tuffen [2008] and the area is covered by an excursion in 'Lakeland Rocky Rambles' by Bryan Lynas [1999]. Otherwise the member has been very briefly mentioned in the Explanation Booklet for the Keswick 1:50,000 sheet [Woodhall 2000] and the British Geological Survey's British Regional Geology, Northern England [Stone et al. 2010]. The latter two publications provide little detailed comment and leave an overall interpretation of the member ambiguous. The BGS 1:10,00 survey maps are now available online and provide interesting insight into the interpretation of the geology. McConnell & Kneller [1993] use sedimentary terms [sandstone, etc.] in describing the deposits in the member and interpret the RHM as coarse fragments formed by autobrecciation of an inflating, and autobrecciating, andesite lava pile; the coarse detritus was then washed into a shallow lake. Our interpretation is that most if not all the RHM is primary pyroclastic formed in a tuff-ring or maar like setting. The widespread coated lapilli and common accretionary lapilli suggest very moist, low temperature [<100^{o}C] pyroclastic currents. Virtually all of the lapilli are angular and have igneous textures meaning that the explosivity was created when magma encountered external water probably groundwater in an aquifer. Typically this eruptive style involves decades to 100s of years between eruptions because the water supply has to be replenished. Each eruption started with fragments being ballistically ejected and an eruption column of sufficient height to produce pyroclastic currents when the column collapsed.

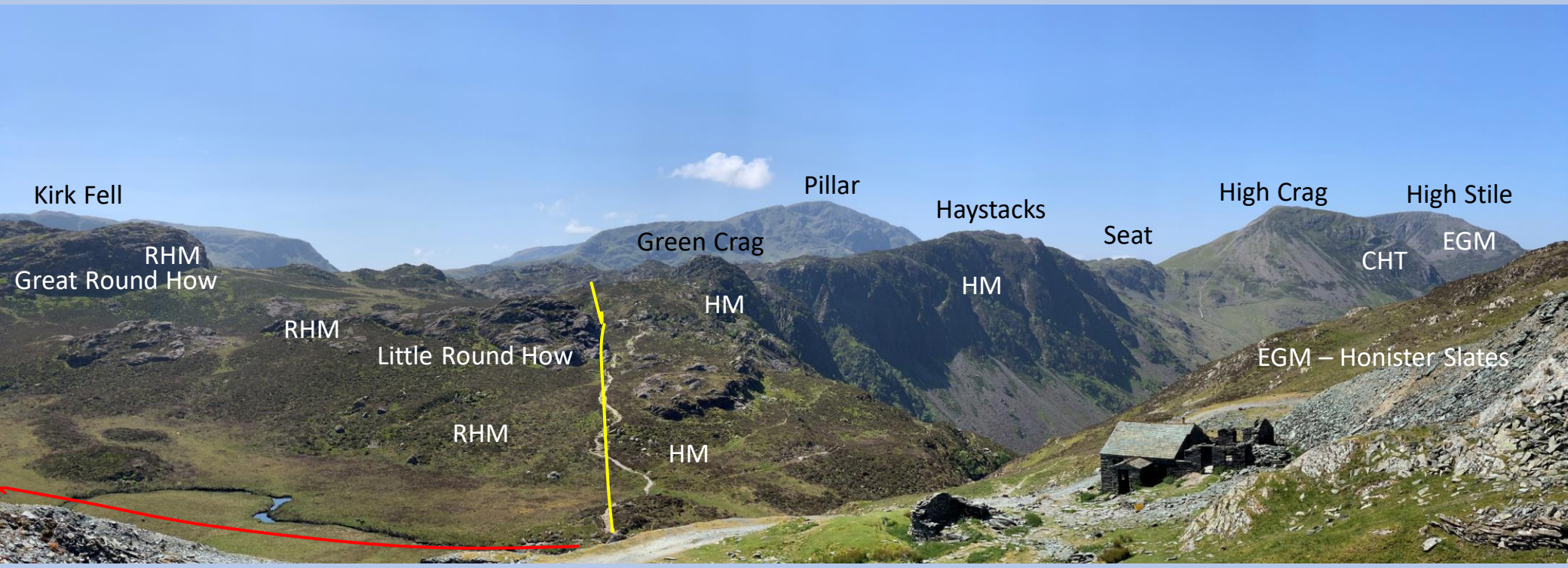
Itinerary

The proposed localities are shown below. We shall start with an regional overview near the Dubs Hut where there is opportunity to examine the turbidite sandstones of the Honister Slates which is part of the Eagle Crag Sandstone Member and will provide a good comparison to the geology once we cross the Burtness Comb fault. We shall examine the contact between the Haystacks Member – interpreted as an andesite lava dome – and the Round How Breccia Member which we have interpreted as a pyroclastic succession produced by a tuff ring or maar vent. There will be plenty of opportunity on the excursion to test this interpretation.

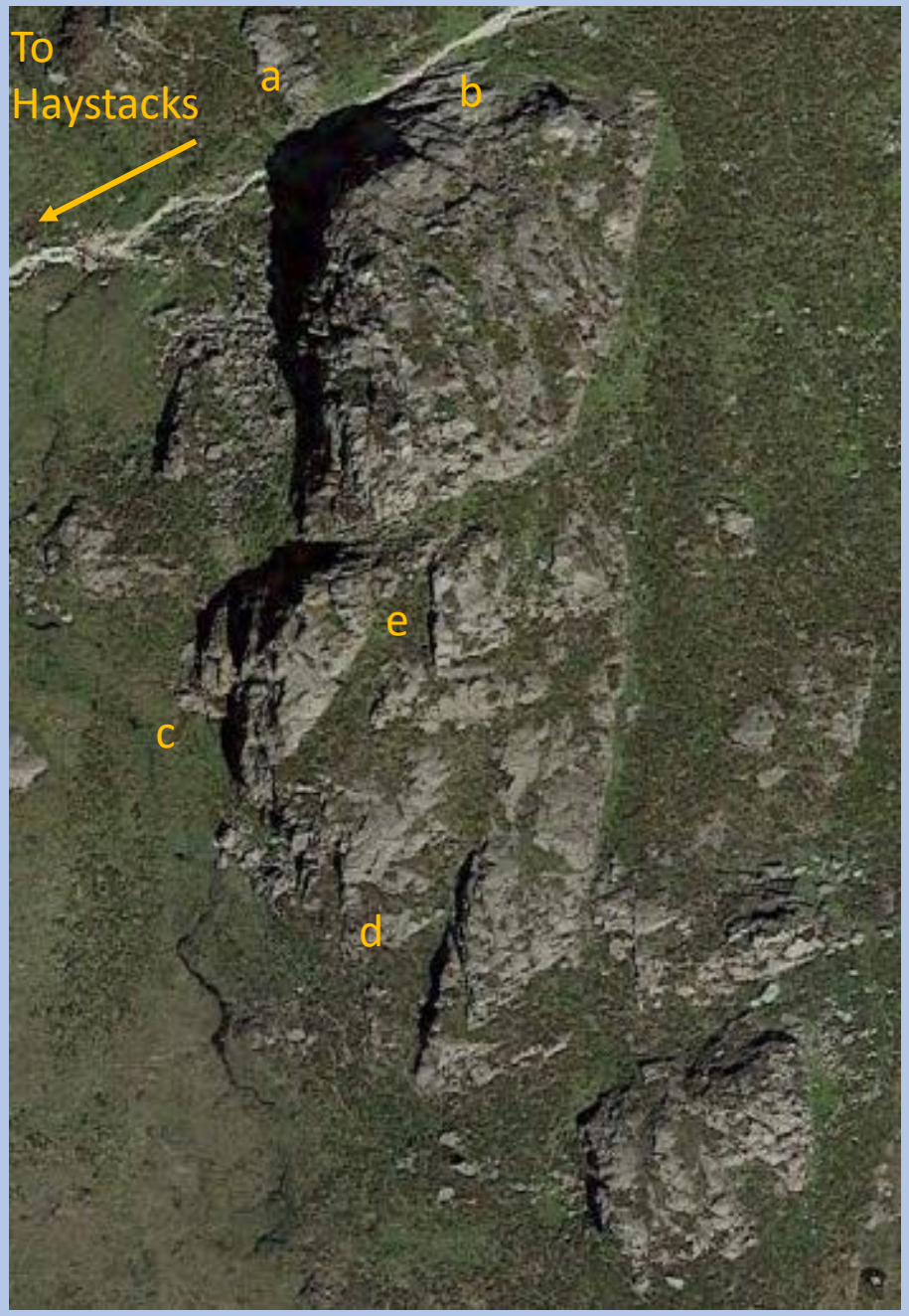


Regional Overview

The view from the quarry road just above Dubs Hut provides a good vantage point to introduce the geology. The Eagle Crag Sandstone Member (EGM) outcrops on High Stile overlain by the Craghouse Tuff ignimbrite (CHT) on High Crag. Seat, Haystacks and Green Crag comprise the lavas of the Haystacks Andesite Member (HM). Resting on this (approximate contact shown in yellow) is the Round House Breccia Member. In the foreground the Eagle Crag Sandstone Member outcrops again as the Honister Slates offset from the outcrop on High Stile by the Birkness Comb Fault (shown in red)



Locality 1 – Little Round How – NY 2069 1324



This locality could occupy most of the day if we let it – there is a lot to see and interpreting the north side of the exposure (b) and the sediments at (e) could provide much entertainment.

Locality (a) is brecciated andesite interpreted by the BGS as part of the breccia apron to the lava dome.

The contact between this and the overlying Round How Breccia Member occurs part way up the north face of Little Round How at (b). The contact is steeper than elsewhere and is complex. The BGS interpretation is that the lava dome continued to inflate after deposition of the Round How Member had commenced resulting in the steep contact and slumping of the RHM sediments.

At Locality (c) there is a broad channel cutting the surrounding sediments – this shows layers thickening into the trough in the manner of PDC deposits – or is it fluvial consistent with the BGS interpretation?

At locality (d) there are 3 impact sags on very different scales.

Locality (e) is another site where much time can be spent with a plethora of features and bedforms. The interpretation provided here is based on detailed study by the late Clive Boulter.

Locality 1(a) Brecciated Andesite



Blocks of recessive andesite in an andesitic volcanoclastic matrix.
Auto-brecciated lava or part of the surrounding breccia apron?

Locality 1(b) Contact between Brecciated Andesite and the Round How Breccia Member (RHM)



This locality is described in 'Lakeland Rocky Rambles' by Bryan Lynus under the sub-title "Chaos and confusion at Little Round How" – he's not wrong!

Lynus describes the volcanoclastic breccia and underlying smaller fragments with broken up beds 'floating' raft-like in the surrounding fragmented material one of which has been folded into a tight 'V' and interprets the exposure as a mass flow deposit in line with the BGS interpretation.

However, another interpretation is that the breccia is part of a lava flow from which the Round How sediments have sloughed off and are resting adjacent to the lava rather than under it. As Lynus points out there are no feldspar phenocrysts in the andesite clasts – unlike the andesite breccia at Locality (a).

Parts of the breccia exhibit an apparent jigsaw fit between clasts and mechanisms to create this need to be considered e.g.:

- a peperitic margin
- an autobrecciaed lava
- a primary pyroclastic breccia with hot, ductile fragments that meld together

The exposure doesn't exhibit other features of a peperite. The absence of feldspar phenocrysts suggests another source than the lava.

Above this exposure there is plenty of evidence for soft sediment deformation due to slumping.

Locality 1(c) Open channel cut by a low density pyroclastic density current (PDC)



Open channel in volcanoclastic sediments – the channel is consistent with those formed by PDCs; beds thicken towards the centre and lithofacies are identical to other localities interpreted as primary pyroclastic deposits

Locality 1(d) Impact sags on all scales



Three impact sags within 2m demonstrate the different scale of the ballistic impactors

Centre is a very large impact sag with compass-clino for scale. The impactor is a andesite block 55 x 33cm which has penetrated 50cm.

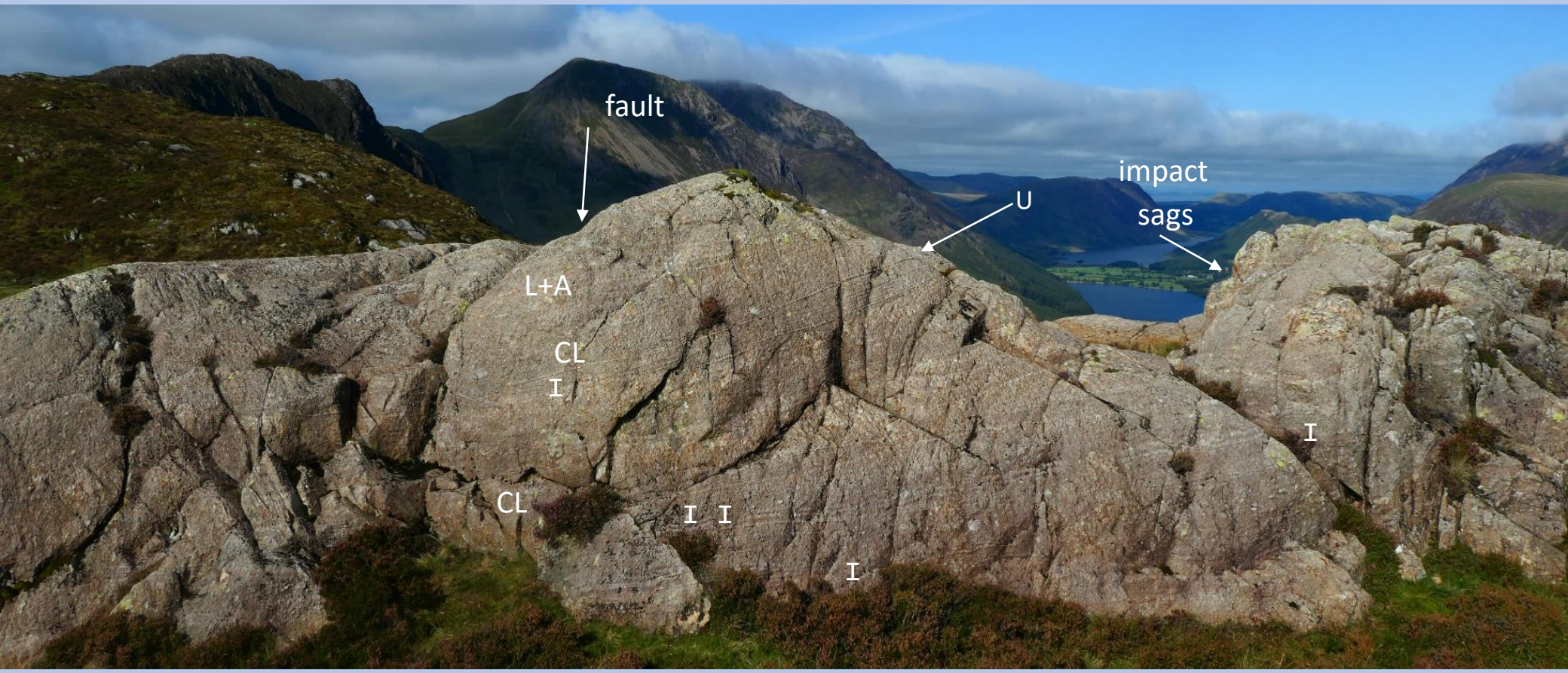
Circled is an impact sag created by 6 x 5cm block and below an impact sag created by a 1 x 0.5cm fragment.

These and many other examples attest to the explosive volcanism effecting the area.



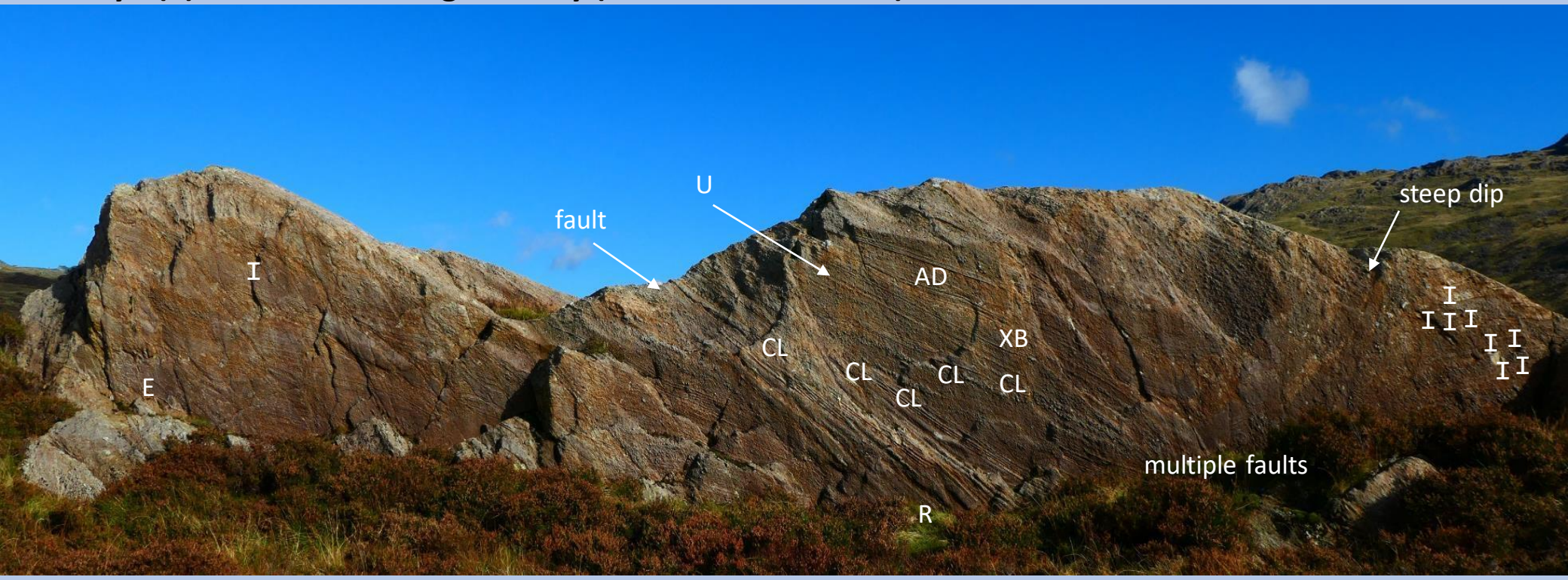
Locality 1(e) - viewed looking westerly (Credit Clive Boulter)

At this point we have a topographic trough filled with heather and correlation from one side to the other is impossible. A detailed study of the two sides of the trough could take hours but here are some key features that taken together demonstrate the primary pyroclastic nature of the deposits.



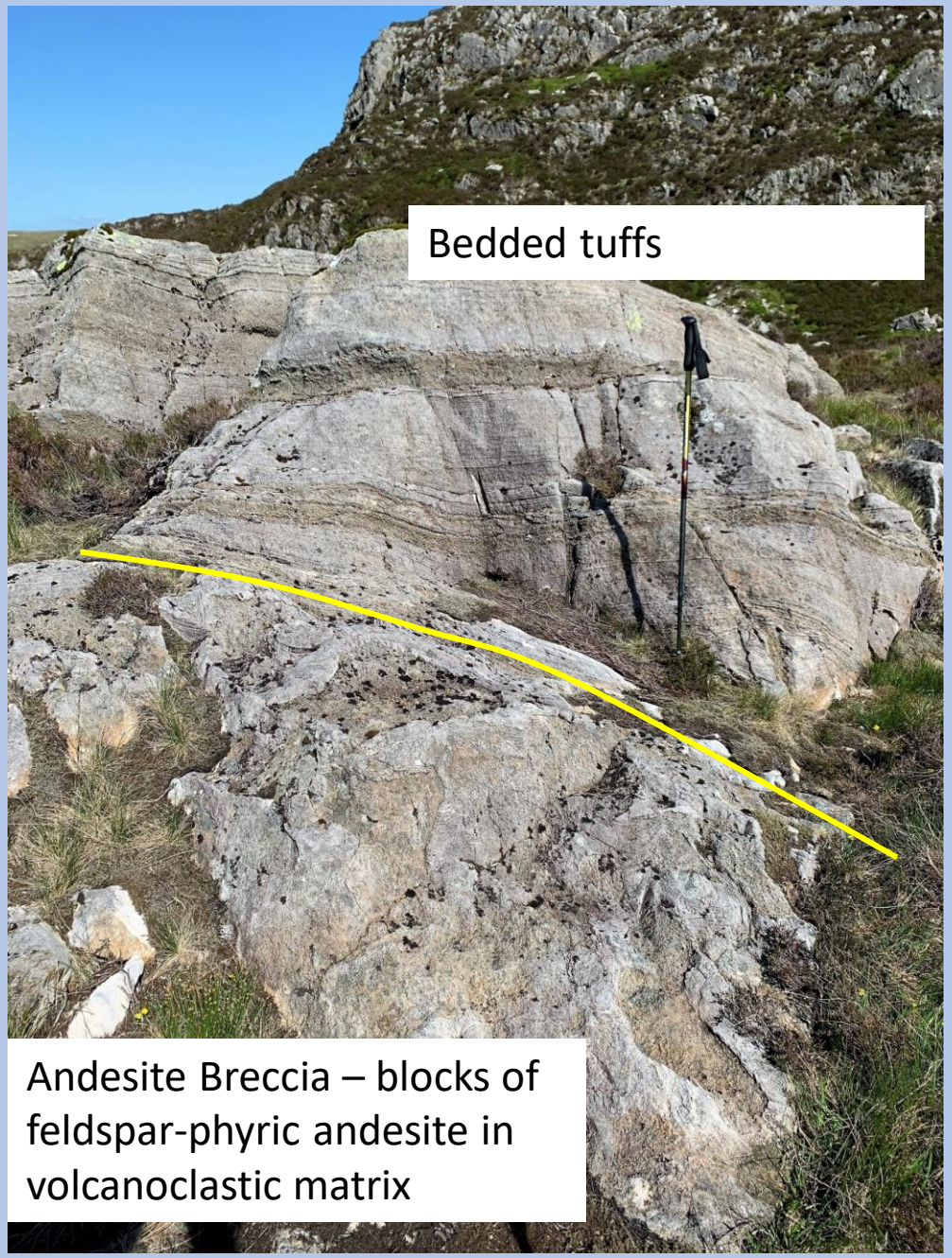
Low angle cross-bedding characterises the whole exposure; I shows the location of impact sags [once called bomb sags]; the uppermost one has a penetration depth measured in millimetres, whilst the others are much more substantial; U points to a bed less than a centimetre thick which is crowded with mm-scale ultrafine-rimmed accretionary lapilli of the style generated by the interaction between eruption columns and pyroclastic density currents; several other thin beds have similar characteristics. CL indicates coated lapilli – lapilli sized pyroclasts coated in ash sized particles. L+A is an unusual texture of similar sized lapilli set in a matrix of ash-sized pyroclasts; the lapilli can be matrix supported in some examples.

Locality 1(e) - viewed looking easterly (Credit Clive Boulter)



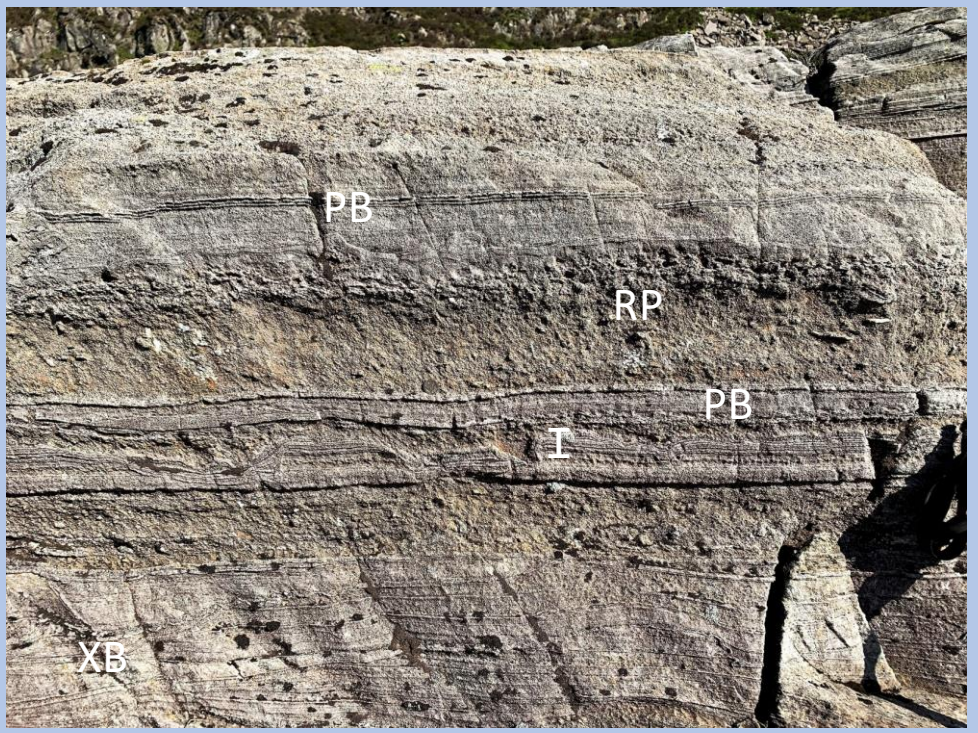
This crag face is disrupted by faulting; there are several small-displacement contractional faults such as R. The plane labelled “fault” could be a footwall ramp of a thrust and the steep dips labelled at the southern end could be related to thrust-propagation folding. E is a set of steeply dipping microfaults which overlap [extensional stepovers] and in those zones there are large numbers of tension fractures. The “multiple faults” zone is complicated and could be a mixture of contractional and extensional faults and possibly some impact sags. The zone of multiple impact sags at the southern end of the crag mainly involves small-scale, limited penetration impacts. The impact sag near the northern end has a seven cm impactor and above it a wedge of coarse lapilli tuff. This is a fairly common pattern in the Round How Member and it appears the initial explosivity blasted out projectiles ballistically followed by a PDC and the coarser components of the pyroclastic current were trapped in the depression created by the impact. Several very thin layers of ultrafine rim accretionary lapilli make ribs that are more resistant to erosion than the background lapilli tuff. The better stratified material is locally cross-bedded. Antidune bedforms AD indicate upper flow regime deposition.

Locality 2 Contact between the Haystacks Member lavas and the RHM - NY 2028 1288



The deposition of the RHM is thought to involve sediment washed off the spalling andesite dome of the Haystacks Member into a shallow lake. Hence much of the RHM is interpreted as fluviatile/lacustrine i.e. reworked deposits.

In contrast with this interpretation the bedded tuffs above the contact with the Haystacks Member show features indicative of primary pyroclastic deposits, e.g. parallel bedding (PB), low-angle crossbedding (XB), poorly sorted beds with reverse graded pumice (RP) and impact sags (I).



Locality 3 Volcanoclastic Breccia - NY 20415 12684

A fascinating and spectacular exposure of volcanoclastic breccia. The breccia includes a wide range of clast sizes form 0.5m down and varies from clast to matrix supported. The vast majority of the clasts are flow banded andesite with occasion 'exotic' clasts of eutaxitic welded tuff. The fabric in the clasts is not aligned. In places the clasts appear to have a jigsaw fit indicating they may have been soft and ductile , i.e. hot when deposited, but were not molten forming spatter.



Locality 3 Volcanoclastic Breccia cont..

This exposure is in the background on the previous slide. An apparent channel of coarse breccia is in discordant contact with the surrounding deposits. The interpretation of this structure is problematical and the views of members would be appreciated. There are a series of low angle faults with slickensided quartz throughout the outcrop. These are probably volcano-tectonic in origin but have been reactivated during the Acadian orogeny. The apparent channel could therefore be a volcano-tectonic fault that has been affected by later Acadian movement. The breccias themselves are interpreted as a volcanoclastic deposit possibly from a maar type vent.



References

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