Langdale Caldera & Scafell Caldera Margin

Leaders: Clive Boulter and Dave Haselden 19 June 2021

This excursion followed on from the excursion led by Clive Boulter in 2018 (Boulter 2020) which introduced the existence of the Langdale Caldera (See Note 1).

The purpose of this physically fairly challenging excursion was to examine the former Side Pike Complex that was in the process of being mapped by the authors. The geological map is shown in Figure 1 and a simplified stratigraphy is reproduced in Figure 2. (See Note 2). In his usual style Clive, supported by Dave, had prepared a comprehensive excursion guide which was used as a basis for the excursion (see references for link).

The group met in the National Trust car park at Blea Tarn between the Great and Little Langdale valleys on a bright but cool day. The excursion route (Figure 3) climbed up through the Rakerigg area above Blea Tarn to examine the stratigraphy of the eastern side of the former Side Pike Complex and two significant volcano-tectonic structures. The route then climbed up the east side of Blake Rigg through a significant fault zone with a hydro-clastic breccia to examine evidence for a rhyolitic lava dome near the summit of Blake Rigg before visiting the exposure described in Boulter et al (2020) where a significant reinterpretation of the geological setting had prompted the mapping project. Finally, the route returned to the National Trust car park via another major volcano-tectonic structure overlooking Redacre Gill.

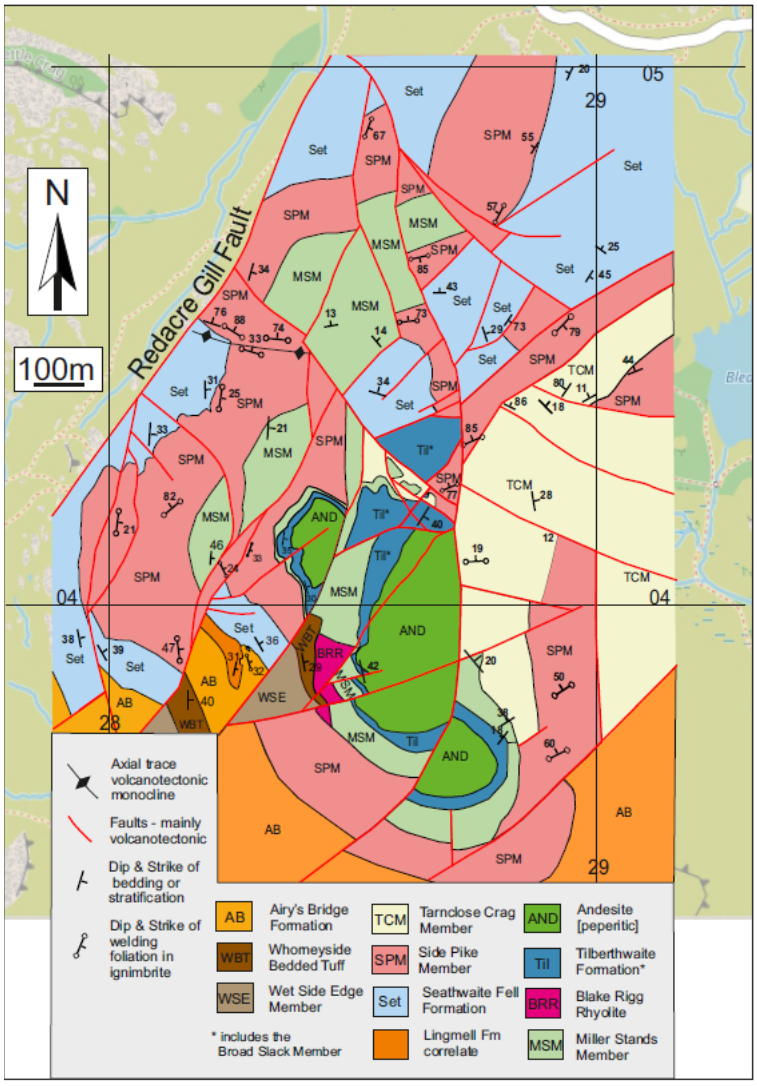


Figure 1. Geological map of the Langdale Caldera margin in the excursion area. Virtually all the faults are volcano-tectonic in origin most of which have some limited later displacement.

Locality 1: NY 29055 04419 Side Pike Ignimbrite/ Tarn Close Crag Member contact.

On this side of Blake Rigg, the Side Pike Ignimbrite displaying characteristic textures is overlain by tens of metres of dark-weathered lapilli-tuff informally named the Tarn Close Crag Member which is variably but commonly weakly-welded. Above Locality 1 a 30 m section of the Tarn Close Crag Member is very weakly-stratified or massive with intermittent white-weathered tuff layers. At NY 29033 04450 the group examined a pod, or disrupted layer, a couple of metres in extent of white-weathering tuff with 4/5 mm accretionary lapilli. Figure 4

Locality 2: NY 28920 04425 Tarn Close Crag Member and evidence for block rotation and piecemeal collapse.

Evidence for further soft-sediment deformation was found on the way to Locality 2 where a steeply dipping white-weathered tuff layer in the face of the outcrop provided evidence for block rotation during piecemeal caldera collapse.

Locality 3: NY 28881 04377 White weathered stratified accretionary lapilli tuff.

The upper part of the Tarn Close Crag Member is dominated by a white-weathered rhyolitic stratified-accretionary lapilli- tuff. The gradational change to this unit from the more typical dark lapilli-tuff indicated that two eruption sources with separate magma storage zones were active at the same time. The rhyolitic tuff is possibly equivalent to the Miller Stands Member found in the west of the area.

Locality 4: NY 28896 04470 A belt of generally sub-vertical welding fabric in Side Pike Ignimbrite – a big VTF!

This locality is within a 500 m long by 70 m wide belt of steeply-dipping welding fabric in the Side Pike

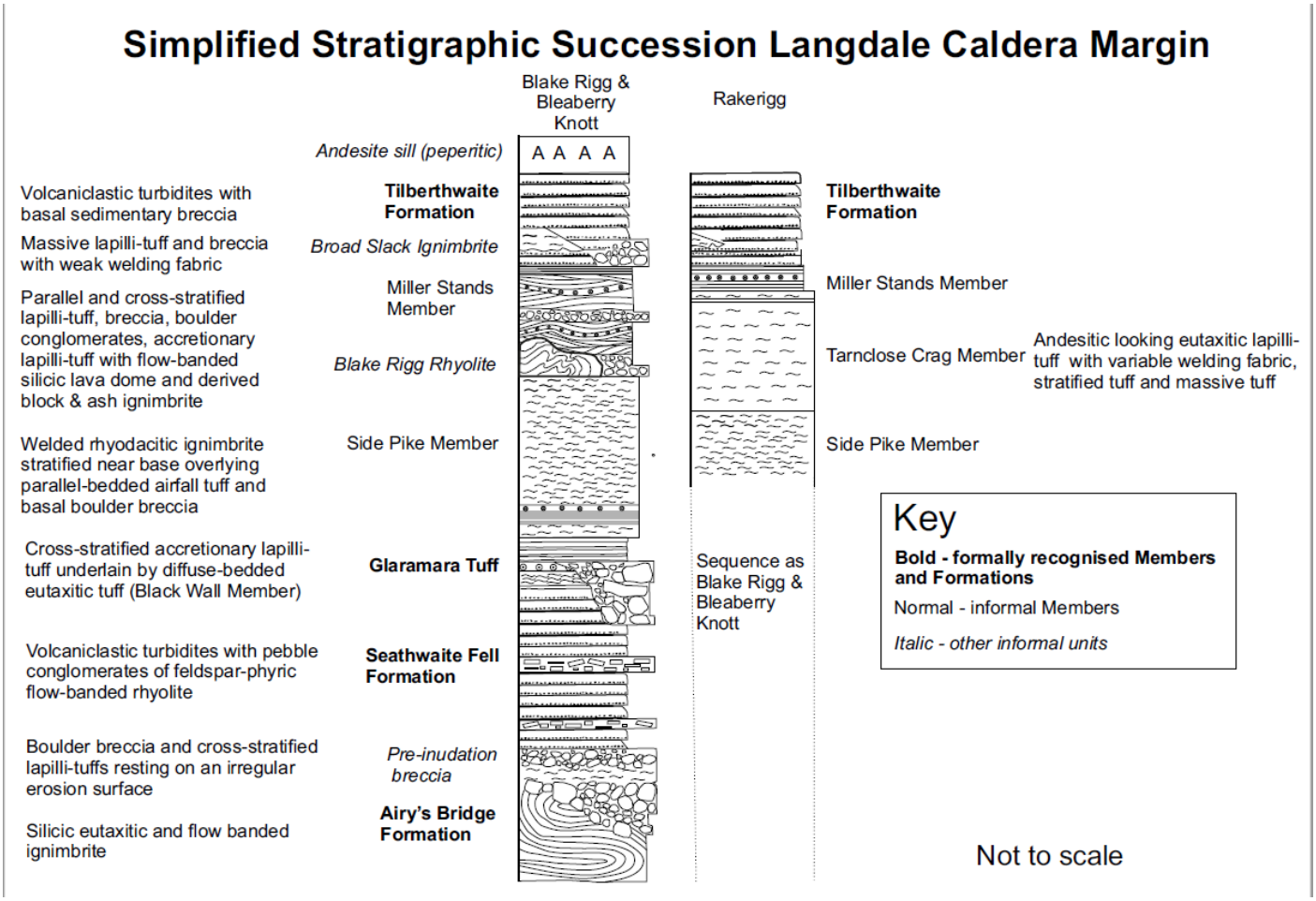


Figure 2. Simplified stratigraphic diagram for the Langdale Caldera margin showing the Langdale Caldera succession unconformably overlying the Scafell Caldera 'basement'.

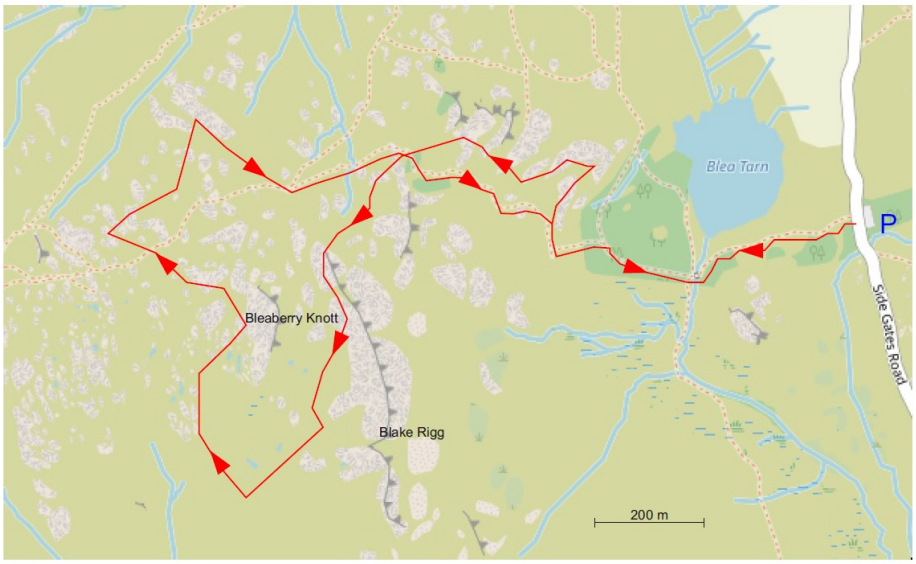


Figure 3. Location map showing the route followed by the excursion.

Ignimbrite bounded either side by discreet volcano-tectonic fractures. The belt is interpreted as a southeast facing monocline formed by folding of hot and ductile Side Pike Ignimbrite across an active volcano -tectonic fault.

Locality 5: NY 28808 04511 Volcano-tectonic faulting involving Seathwaite Fell Formation.

This locality is another volcano-tectonic fault this time involving turbiditic sandstones from the Seathwaite Fell Formation where bedding abruptly becomes sub-vertical next to a sharply-incised slack delineating the fault. The sandstones are hydrothermally altered to produce extensive epidote nodules.

On the way to Locality 6 there was a good view of the Langdale Pikes showing the major volcano-tectonic Grave Gill fault and the Langdale thrust first identified during the BGS survey in the 1980-90s.

Locality 6: NY 28665 04403 A small patch of Glaramara Tuff defining the Seathwaite Fell Formation/Side Pike Ignimbrite contacts.

On the top of the ridge there are some small exposures of the accretionary lapilli Glaramara Tuff. These were key to identifying the underlying massive turbiditic



Figure 4 Leaders Clive and Dave introducing the Side Pike Ignimbrite at Locality 1. (photo Myles Hamilton)

sandstones as Seathwaite Fell Formation. This is overlain by stratified rhyolite identified as the airfall tuffs at the base of the Side Pike Member.

Locality 7: NE Ridge of Blake Rigg NY 28557 04243 and NY 28537 0425.

The ridge exposed several areas of breccia whose formation was currently under discussion. Initially the breccias were thought to have a hydroclastic origin formed at the contact of an andesite intrusion. However, this was now considered to be a massive tuff rather than an andesite sill and highlighted the challenge of identifying rock types in the field, in particular when they have been subject to hydrothermal alteration. The breccias were probably formed as injectites prior to complete lithification.

Locality 8: NY 28435 03925 Blake Rigg

Several localities were visited close to the summit of Blake Rigg. The first at NY 28435 03925 is an excellent exposure of white-weathered rhyolite with well-developed flow-stratification and folding. This is interpreted as a rhyolitic lava dome extruded after the climactic eruption of the Side Pike Ignimbrite. At NY 28439 03933 the rhyolite is overlain by a thin eutaxitic tuff and at NY 28420 03942 there is a spectacular meso-breccia involving metric scale welded ignimbrite blocks. This is interpreted as a block and ash ignimbrite from collapse of the lava dome though it may have formed as an apron of talus as the dome was eroded. Figure 5.



Figure 5 The spectacular meso-breccia at Locality 8 is thought to be a block and ash ignimbrite deposit. (photo Myles Hamilton)

Locality 9: NY 28410 03937 Evidence for the Lava Dome

The BGS had mapped the flow-banded rhyolite at this locality as the rheomorphic Oxendale Tuff since it rested on Whorneyside Tuff Formation bedded tuff (Millward, D., et al.(2000) and British Geological Survey. (1996)). However, at Locality 9 Dave demonstrated that the flow-banded rhyolite oversteps the Whorneyside bedded tuff to rest on the Side Pike Ignimbrite across a significant volcano-tectonic fault showing that the rhyolite was part of the later Langdale Caldera.



Figure 6 Examining the eutaxitic lapilli tuff of the Scafell Caldera Airy's Bridge Formation at Locality 10. (photo Myles Hamilton)

Locality 10: NY 28282 03919 Scafell Caldera Margin

This locality had been described in detail in the Cumberland Geologist No 1. (Boulter et al. (2020)). Initially documented in Branney and Kokelaar (1994) as evidence for inter-block collision in the Side Pike Complex mega-breccia, the outcrop had been re-interpreted by the excursion leaders as being a steep-sided caldera collapse topography in the marginal zone of the Scafell Caldera. Clive demonstrated the intricate contact between the ignimbrite of the Airy's Bridge Tuff Formation and the turbidites of the overlying Seathwaite Fell Formation and the general absence of significant soft-sediment deformation. It was the reinterpretation of this locality that prompted the excursion leaders to embark on mapping the remainder of the former Side Pike Complex (Haselden and Boulter 2022). Figure 6.

The group made its way over Bleaberry Knott and down to Locality 11 overlooking Redacre Gill.

Locality 11: Volcanotectonic-monocline

At NY 28106 04280 there is a well exposed section through the basal Side Pike Ignimbrite into the Seathwaite Fell Formation. The top seven metres of the latter are turbidites and below that is 25 m of the informal Black Wall member. The contact between the Seathwaite Fell turbidites and the Side Pike Ignimbrite was followed downhill until at NY28252 04507 an 80 m wide belt of sub-vertical welding in the ignimbrite marked another significant monocline over a volcano-tectonic fault.

The rather tired party made there way back to the car park where the leaders were warmly thanked for an excellent excursion. Some members of the group found their way to the Old Dungeon Ghyll Hotel for refreshments.

Note 1: The first reference to the use of the name "Langdale Caldera" we can find is in the VMSG Newsletter Number 15 (2011). It is clearly the caldera first identified by Brown (2001) and the one discussed by Branney in Brenchley and Rawson (2006).

Note 2: The latest versions of the geological map (Figure 1) and the simplified stratigraphy (Figure 2) are presented here, consistent with Haselden and Boulter (2022)