Little Matlock Gorge, Bradgate Park: a review of drainage discordance in Charnwood Forest

Colin Baker

Abstract: Little Matlock Gorge is an interesting feature of the River Lin valley at Bradgate Park, Leicestershire. A number of points of drainage discordance exist within the Charnwood Forest district of which Little Matlock Gorge is one. The gorge cuts through a resistant outcrop of Precambrian diorite. Previous explanations for this anomaly include superimposition from a Triassic mudstone cover, exhumation of a pre-Triassic palaeovalley, and glacial modification. The evidence is reviewed and a multi-phase evolutionary model proposed. In particular this highlights: (a) the potential role of buried fault lines within the basement, and (b) the persistence of these alignments by repeated valley-in-valley episodes. Slickensides at Wishing Stone Crag appear to confirm the presence of a faulted fracture zone, exploited by an ancestral River Lin which seems therefore to have been fault-guided. A recent translational rockslide is reported. A stream bank section in the River Lin suggests intense Late Devensian solifluction postdating the river terrace that passes through the gorge. Archaeological evidence indicates that the gorge may have served as a natural corridor for wild animals intercepted by Late Upper Palaeolithic hunter gatherers around 14 ka BP.

Bradgate Park forms part of the Charnwood Forest landscape with its distinctive rolling hills, craggy summits and Triassic-based valleys (Carney 2007). Located at the south-west corner of the Park (and accessed readily from the Newtown Linford car park) 'Little Matlock Gorge' is a picturesque feature of the River Lin valley. It is not clear when the nickname (alluding to Matlock Gorge itself in Derbyshire) was first coined. Described as a fashionable 'Victorian designed landscape' (McGrath 2004; bradgatepark.org), it was planted in the mid-19th century with exotic trees such as cedar and araucaria, and the river's course was landscaped into a cascade of small pools and weirs at about the same time as the construction of Cropston Reservoir in 1860. It was an attraction drawing hundreds of visitors annually (Hollings 1846, p 37); a lithograph by B. F. Scott (Fig. 1) suggests that it was already a notable beauty spot as early as 1800. Today, the River Lin SSSI is identified in the Leicestershire and Rutland Biodiversity Action Plan as a clear, fast-flowing stream valued for its specialist fauna including brook lamprey and European crayfish (Newtown Linford Parish Council website).

The gorge runs in a SW–NE alignment for about 500 m through resistant South Charnwood Diorite, narrowing to 40 m at one point. An inner trench, cut into a broader valley profile, is confined between Wishing Stone Crag (north side) and the deer sanctuary (south side) (Fig. 2). In places the natural stream bed runs directly over diorite. Figure 3 shows cross profiles at two sections (A-A' and B-B') across the gorge. At section A the entrenched inner gorge is clearly visible, between 18 m and 24 m deep, possibly caused by glacial meltwater having incised into the older pre-Triassic palaeovalley. This has resulted in a shouldered valley-in-valley morphology. At section B the trench widens to 90 m and shallows to 7 m, before opening out into the broader Bradgate Park Lawns area at around 95 m OD. A Late Upper Palaeolithic archaeological site was identified here (Cooper 2012).

Figure 1. *(Left) a lithographic print (c.1800) by British artist, B. F. Scott, entitled 'Forest View, Bradgate Park', reproduced in Hollings (1846) (source: University of Leicester Special Collections). (Right) a modern image at the same location, looking south-westwards towards Newtown Linford from SK 5245 0993.*

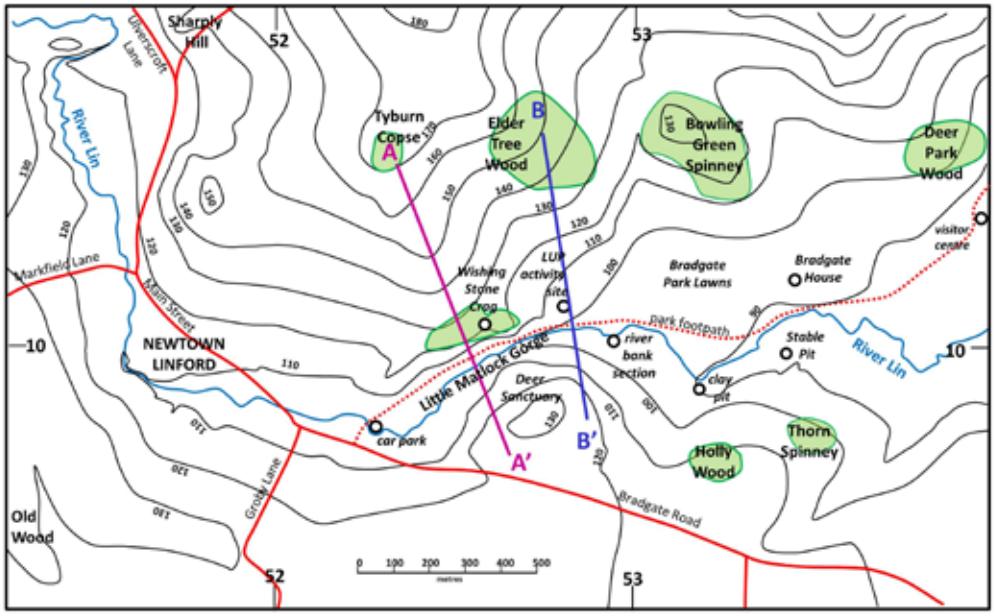

***Figure 2**. Topographic context of Little Matlock Gorge. Contours (m OD) based on OS Maps API (via National Library of Scotland).*

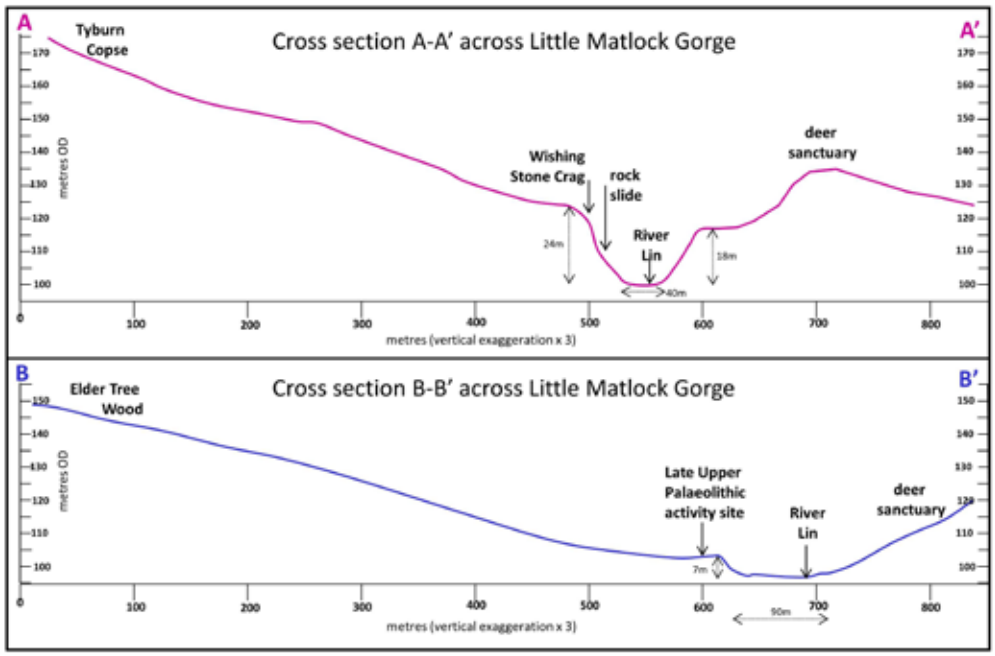

***Figure 3**. Cross-sections across Little Matlock Gorge (adapted from Beamish 2021, with permission from ULAS; LiDAR source Environment Agency, 2014).*

Steep slopes at Wishing Stone Crag are noticeably unstable. According to park rangers, rock falls occur from time to time, for example, in early 2023 when a translational (or planar) rockslide took place (Fig. 4). This appears to have failed along an inclined joint plane, with a large detached block of diorite (1.9 m x 1.2 m x 1.2 m) tumbling downslope about 20 m, probably triggered after the exceptional snowfall in early March (see also Fig. 9). Diorite surfaces within the gorge are thus still active, degrading gradually towards slope equilibrium.

Outcrops of Triassic mudstone and Pleistocene till stop short of the gorge itself (Fig. 5); a clay pit (at SK 532 099) reveals at least 9 m of red mudstone with green skerry bands (Worssam & Old 1988) at 90 m OD just 200 m downstream of the gorge exit. Almost certainly mudstone and till did pass through the gap at one stage, but were later eroded out, probably by glacial meltwater. The River Lin is thought now to be in the process of exhuming the pre-Triassic palaeovalley, a classic example of 'fossil' topography (Carney 2010).

The geological context (Fig. 5) is one of Precambrian and Cambrian basement strata folded within and on the fringes of a plunging anticline (Charnwood Anticline) and widely concealed beneath mudstones of the Mercia Mudstone Group (Gunthorpe Member) and Pleistocene tills (Thrussington and Oadby tills) (Carney 2010). Bedded and cleaved volcaniclastic rocks (Maplewell Group, Beacon Hill and Bradgate formations) are framed to the south and south-west by a broadly concordant, sill-like intrusion of South Charnwood Diorite (formerly Markfieldite), and to the southeast by faulted fragments of Cambrian rocks (Brand Group, Swithland Formation and Stable Pit Member).

***Figure 4**. Translational rockslide that took place on 13 March 2023 at Wishing Stone Crag. (A) landslide scar showing the failed planar surface at site 6 (see also Fig. 9); (B) detached block of diorite displaced 20 m downslope (tape measure 1 m)*

Drainage network

The stream network of Charnwood Forest has attracted attention as an example of drainage discordance for well over a century (Watts 1903, 1947; Bennett et al 1928; Bridger 1968; Rice 1972, 1981). Overall, it could be described as semi-radial in character (Fig. 6) reflecting to some extent the structure of the Charnwood Anticline (possibly a dome structure originally, the north end of which was later down faulted). About a dozen pinch points exist where streams flow discordantly across Precambrian inliers. For example, the upper section

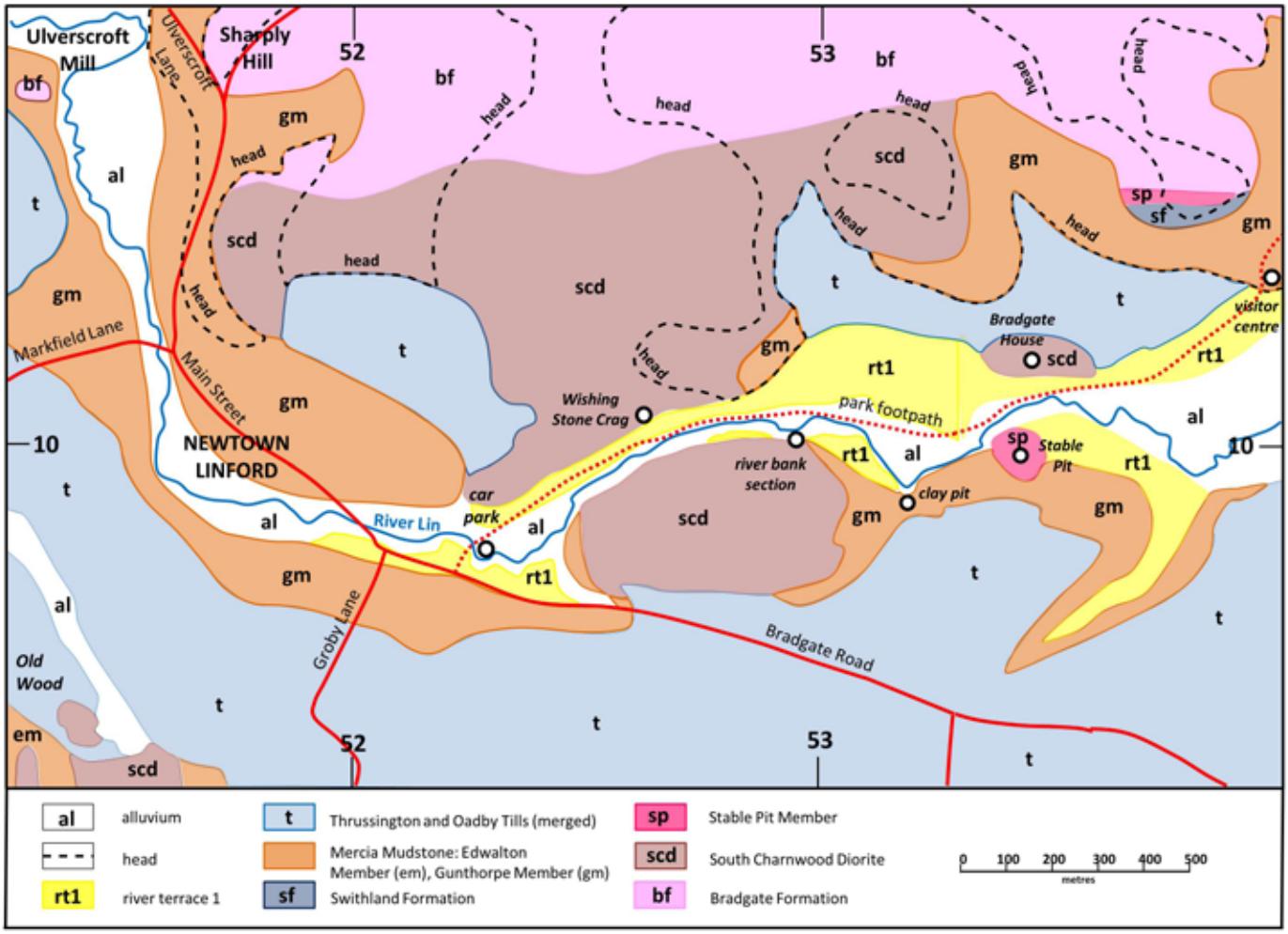

***Figure 5**. Geological context of Little Matlock Gorge. Mapped boundaries taken from BGS 1:50 000 Series Sheet 155. Reproduced with permission of the British Geological Survey © UKRI [2025]. All Rights Reserved.*

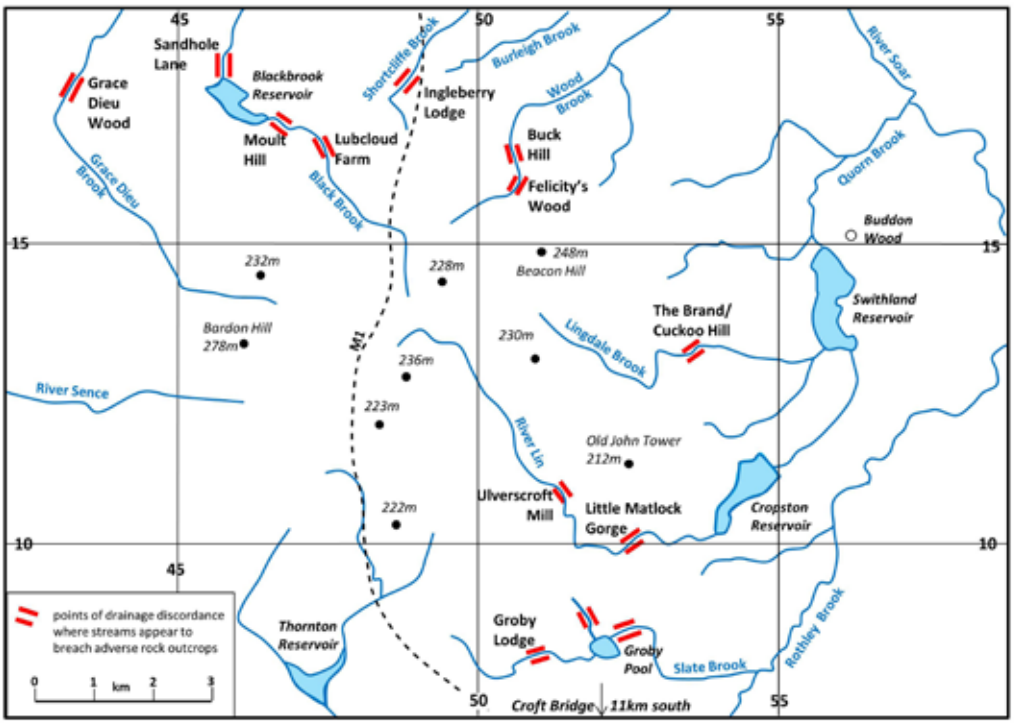

***Figure 6**. The semi-radial river network of Charnwood Forest, and points of drainage discordance, based on Bennett et al (1928), Watts (1947) and Rice (1972). SK and SP grid references.*

of the River Lin (previously known as the Ulverscroft stream), has worked its way through a breached ridge of Bradgate Formation between Sharply Hill and Ulverscroft Mill (Bridger 1968), while the middle section (Little Matlock Gorge itself) breaches South Charnwood Diorite.

Watts (1903, 1947) and Bennett et al (1928) recognised that this discordance must reflect to some extent the underlying nature of the Precambrian-Triassic unconformity. This was thought to relate to (a) superimposition, that is a supra-Triassic drainage network imprinted onto underlying structures as Triassic strata were progressively eroded away, and, eventually, (b) the exhumation of underlying Charnian palaeovalleys ('underliers' in Watts' terminology) when all or most of the Triassic sediments had been removed. When such pre-Triassic palaeovalleys were passively infilled by Triassic red beds they adopted 'catenary bedding' (Watts 1947) or differential hydro-compaction (Baker 2024) resulting in surface linear depressions preferentially guiding rivers that re-excavated the 'underliers'. Varying degrees of adjustment to structure were apparent; Watts describes some streams, rather anthropomorphically, as having 'lost their way' by following structurally inconsistent lines, perhaps where hydro-compaction of thicker mudstone overburden was less well-differentiated. Fine examples of clear discordance were recognised at Moult Hill (Black Brook) and Cuckoo Hill (Lingdale Brook) (Fig. 11). The radial pattern itself was probably imposed by erosional downcutting, not primarily through Triassic deposits, but through domed overlying Jurassic and Cretaceous strata now completely removed but originally draped across the Charnian massif (John Carney, pers. comm.), a process of superimposition analogous to that proposed by Sissons (1960) for the Lake District.

Subsequent work (Ford 1967; Bridger 1968; Douglas et al 1981) highlighted the additional importance of Pleistocene glaciation, recognised in the district since 1960 following the discovery of exposures of till in M1 motorway cuttings (Poole 1968). Charnwood could no longer be regarded as an ice-free nunatak as previously assumed (Watts 1947; Rice 1963). BGS revision (Sheets 155 and 156) confirmed this with widespread mantles of Oadby Till, Thrussington Till and their variants. Direct glacial scour, meltwater channelling, overflow from impounded proglacial lakes and superimposition from a till mantle could all have contributed in some way to the overall stream network. Both models, geological and glacial, appear to be necessary to explain the nature of drainage discordance throughout Charnwood Forest.

Sutherland et al (1983) summarised four possible hypotheses for the origin of Little Matlock Gorge: (1) an exhumed pre-Triassic palaeovalley or wadi; (2) a superimposed river course, originating from drainage initiated on overlying Triassic mudstone; (3) glacial diversion, that is, a former Pleistocene course originally flowing south from Newtown Linford but diverted eastwards by a plug of glacial till; and (4) fault guidance.

Local faulting context

There has been considerable faulting in the local Precambrian/Cambrian basement (Moseley & Ford 1985; Worssam & Old 1988). Most fault lines, concealed beneath thick mantles of Triassic and Quaternary deposits, are unmapped and inferred. For example, the Newtown Linford Fault offsets the Benscliffe Breccia and Sliding Stones Slump Breccia by between 800 and 1200 m (Strange et al 2010; Scotney et al 2012). The

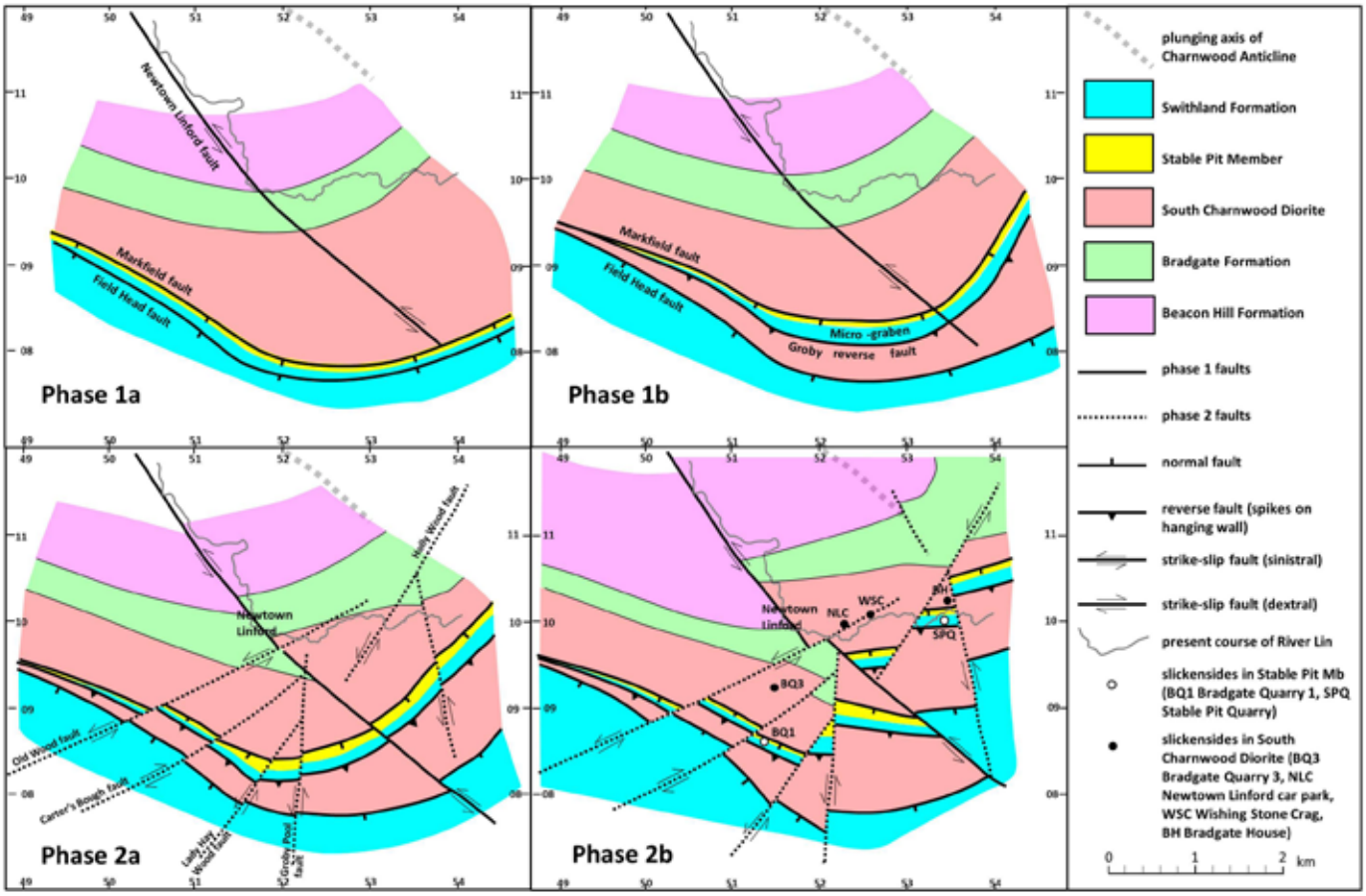

***Figure** 7. Proposed restoration of faulted diorite blocks, based on Scotney et al (2012, figs 1 and 2) and positions of mapped slickensides. Phases 1a and 1b could be contemporaneous or staggered. Phases 2a and 2b are cross-cutting offsets that progressively 'wrap around the nose of the Charnwood Anticline'. Some fault lines have been assigned local names here to aid description.*

Newtown Linford Fault (Fig. 7), formerly referred to as the Hammercliffe Fault, was regarded by Watts (1947) as a reverse fault. Many of Watts' 14 suggested faults, however, were questioned by Worssam and Old (1988), but the line of the Newtown Linford was accepted, and reinterpreted as a high-angle normal fault with a throw of ~750 m. The fault is now recognised as a strike-slip (wrench) fault with sinistral (left lateral) displacement, traceable south-eastwards in gravity and magnetic anomalies (Carney et al 2009; Strange et al 2010). Its NW–SE alignment lies between the Thringstone Fault to the west, and the axis of, and cleavage direction in, the Charnwood Anticline to the east.

Charnwood's fault network has been described as Late Caledonian in age, i.e. late Silurian (~430–420 Ma), with the likelihood of repeated reactivation in the Acadian orogeny (late Devonian, ~360 Ma) and Variscan orogeny (late Carboniferous, ~300 Ma). There were several deformation phases of the Caledonian orogeny involving ocean closure on more than one side of the Avalonia microplate (Carney 2007; Pharaoh et al 2011). A more accurate term for Charnian deformation could be Brabantian (Nick Chidlaw, pers. comm.). The Brabantian Event (Herbosch & Verniers 2015) refers to the north-eastern flank of Avalonia that 'soft docked' with Baltica, closing the Tornquist Sea. On its north-western flank, Avalonia collided with Laurentia, closing the Iapetus Ocean, with its signature SW–NE alignment. The Thringstone and Newtown Linford faults have the Brabantian alignment typically associated with the Tornquist suture line (NW–SE); they are described as Phase 1 faults by Scotney et al (2012), having originated in the end-Silurian compression but with possible later (Variscan) reactivation. Cross cutting the Phase 1 faults are smaller secondary SW–NE faults, termed Phase 2 (Fig. 7).

Scotney et al's (2012) fault analysis involved evaluation of 173 exploratory boreholes and visible contacts in five quarry exposures in the Groby area. Key proposals were (a) a micro-graben that could have duplicated Cambrian strata within the diorite outcrop, (b) an intrusive (rather than faulted) contact between the South Charnwood Diorite and Bradgate Formation, and (c) the two-phased history of faulting. Figure 7 is an attempt to restore faulted diorite blocks based on this scheme; the net result (Fig. 7, phase 2b) appears to account for the way in which the faulted Cambrian sedimentary units 'wrap around the nose of the Charnwood Anticline' (*ibid*, p 44). The two Cambrian outcrops, Stable Pit quarry and Deer Park Wood (Fig. 5), are expressions of this wedged configuration.

Fault line guidance

Some faults have been assigned local names here to aid description (Fig. 7). Local Brabantian Phase 1 fault lines include the Newtown Linford, Markfield, Groby Reverse and Field Head Faults. Fault-guidance may have had a controlling influence on the trend of the River Lin's upper section that follows the strike of Triassic mudstone (Worssam & Old 1988). Scotney et al (2012) suggested about six cross-cutting Phase 2 faults but none of them were thought to be exposed. Of particular interest is the Old Wood Fault, a strike-slip fault with sinistral displacement of between 100 and 300 m, cross-cutting and offsetting the Newtown Linford Fault. It should also be noted that, in crossing the main valley, the Old Wood Fault aligns with Little Matlock Gorge, hinting at a potential fracture zone that initiated the route through the gap. It is proposed therefore that fault-guidance (as suggested by Sutherland et al 1983) could be a feasible explanation.

Modern analogues of fault-guided river channels crossing active strike-slip fault lines have been investigated by Dascher-Cousineau et al (2021) and McEwan et al (2023), where drainage is clearly re-routed by lateral movement. Different forcing mechanisms have been suggested, including fault-scarp damming, overbank flow (avulsion), headward erosion and river capture. No single fluvial response to lateral faulting can be confidently predicted: resultant river channel directions seem to toggle between fault-perpendicular and fault-parallel. Similarly, in the case of Little Matlock Gorge, drainage alignment in its SW–NE trajectory could have been fault-guided, being both perpendicular to Phase 1 but also parallel to Phase 2.

Local evidence for fault plane slickensides

A few sites of fault plane slickensides (i.e. polished, striated and fibrous surfaces aligned with the motion of faulted blocks) have been found locally: two in the Stable Pit Member and four in South Charnwood Diorite (Fig. 7). At the Stable Pit type site (Sutherland et al 1983, Carney et al 2000, Ford 2003, Carney 2010) sub-horizontal slickenlines show strike-slip fault displacement at the diorite dyke/sandstone junction on the northern side of the quarry. The WSW–ENE fault plane strike runs slightly oblique to the host rock strike (SW–NE), a possible rotated Phase 1 alignment. A Late Ordovician age for dyke intrusion has been suggested. In Stable Pit sandstone near Bradgate Quarry 1 (Scotney et al 2012) prominent slickensided faces have been identified in steeply-dipping faults associated with shear zones of the conjectured micro-graben; the bounding faults, Markfield Fault and Groby Reverse Fault, are considered here to be Phase 1 alignments. Fault planes strike WNW–ESE, with dips of 64° and 70° respectively; slickenlines run down-dip to SSW.

At Bradgate Quarry 3 (Scotney et al 2012) a narrow shear zone entirely within South Charnwood Diorite again has a fault plane strike of WNW–ESE with very steep southerly dip (82°). Abundant sub-parallel slickenlines and slickenfibres run down-dip to SSW, and roughness criteria (i.e. slickenfibres are usually smoother in the direction of movement) show a normal fault motion similar to that of the Markfield Fault. Within Bradgate Park itself, mapping by Kelk and Old (1982) identified fault plane slickensides in diorite at two locations: Bradgate House and Little Matlock Gorge. At Bradgate House they recorded 'granodiorite with strong slickensides in various orientations'; the presence of slickensides here is also mentioned by Ford (2003), Carney (2010) and Ambrose (2014). Within Little Matlock Gorge itself 'granodiorite with vertically plunging slickensides' was noted, and a further comment (Worssam & Old 1988, p 75) adds that the valley was 'possibly eroded along a fault line'. Sutherland et al (1983) refer to another site, a small disused quarry near the car park (SK 523 098), with noticeable jointing and slickensiding on some surfaces.

Wishing Stone Crag

Wishing Stone Crag, midway along the north side of Little Matlock Gorge, is a readily accessible outcrop of South Charnwood Diorite displaying clear slickensides (both polished surfaces and striations) at six points within a small area (0.25 ha) (Figs 8 and 9). Site 1 (Fig. 8, 1) shows sub-horizontal strike-slip motion along a NNW–SSE alignment. The fault plane dips very steeply at 81° to ENE; slickenlines run parallel to strike, plunging gently (5°) to NNW. Relative strike-slip motion could be sinistral or dextral. Site 2 (Fig. 8, 2), has a prominent W–E orientated strike with down-dip slickenlines dipping 54° to N. Superficially, the protruding hanging wall conveys the impression of a reverse fault, but it could, alternatively, be the exposed underside of a normal fault; roughness criteria are inconclusive. An added complication is that later reactivation of faulted structures has occasionally reversed the direction of throw (Strange et al 2010). Sites 3 and 5 (Fig. 9) reveal dip-slip motion on low angle faults, probably cutting the Site 2 fault; slickenlines run perpendicular (NNE) to fault plane strike (WNW–ESE). Sites 4 and 6 show similar orientation, but are striated obliquely across SW–NE strikes, suggesting possible rotation. It is recognised that slickensides must be indicative of only the latest of a series of movements on any particular fault, and that faults have long and complex histories (Roy Clements, pers. comm.).

In summary, it appears that faulting was indeed complex, involving strike-slip, normal, oblique and possibly reverse motions. Site 1 strike could be associated with Phase 1 faulting, perhaps a detached fragment of the Newtown Linford Fault. The remaining sites have fault plane strikes more in keeping with Phase 2, postdating and cross-cutting Phase 1. It is

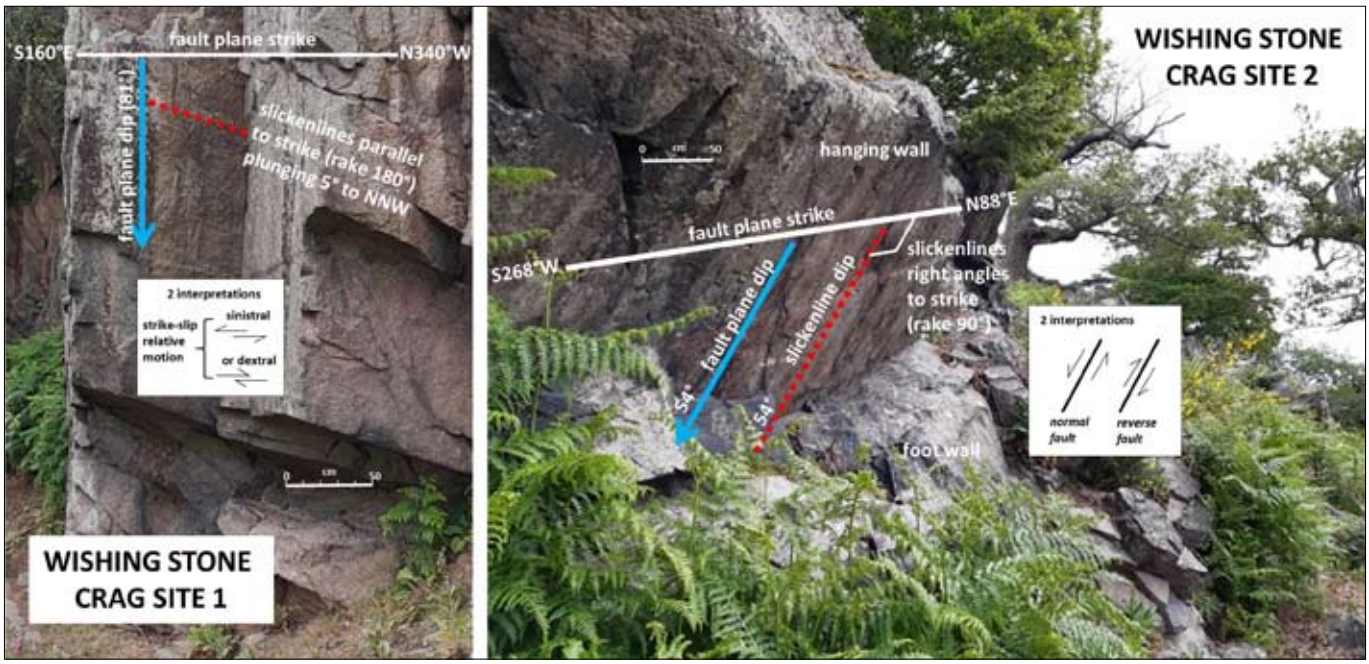

Figure 8. *Wishing Stone Crag sites 1 and 2. Detail of fault slickensides.*

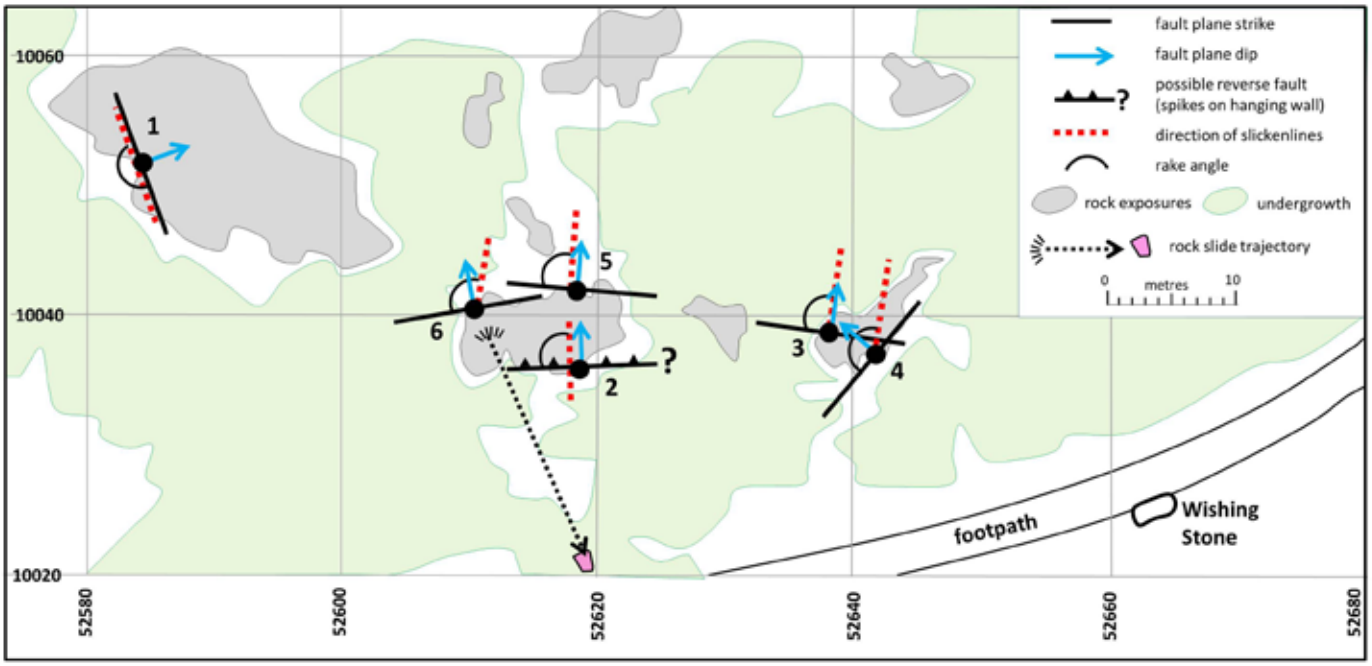

Figure 9. *Analysis of slickensides at six sites on exposed diorite at Wishing Stone Crag. Grid references are within SK 5210. Outcrops are based on Google Earth imagery 7/3/2006, centred on 52°41'08"N, 1°13'23"W. Also, the trajectory of the 2023 translational rockslide.*

suggested that this indicates a complicated fracture zone in Little Matlock Gorge, probably tens of metres wide, running broadly parallel with the valley line. It represents a continuation of the Old Wood Fault (Fig. 7) and therefore points to fault-guidance as the most likely reason for initial alignment. This would have been well established during or after the Brabantian Event. Final movement at nearly all points (Fig. 9) appears to be predominantly S–N, superimposed over earlier W–E movements, suggesting later reactivation during the Acadian or Variscan orogenies.

Nested valley-in-valley forms

The concept of 'valley-in-valley' is occasionally mentioned in the literature; some use of it is made by Li et al (2001) and Selkirk et al (2001), and a similar idea is referred to by Magrani et al (2020) as 'nested' valleys. It implies a situation in which smaller valleys are embedded in and aligned with larger ones, such as a postglacial river incised into a larger glacial trough. Nested valley-in-valley forms can result (to borrow a Russian dolls analogy) in multiple smaller

valleys repeatedly contained within larger precursors. Charnwood Forest provides a number of examples of this where wadi-like palaeovalleys of Permian age, cut into the basement, have been infilled with Triassic mudstones, but which in turn have influenced the direction of later glacial or subglacial processes, and finally been re-occupied by postglacial drainage.

A good example of a nested valley with drainage discordance can be found at Croft Bridge (SP 510 959), described briefly by Ford (1967) and Rice (1981). Here the upper Soar follows an angular course before passing into a narrow rock-walled gorge (300 m in length) incised through South Leicestershire Diorite (Bridge et al 1998). In detail (Fig. 10A), a double channel can be seen to cut across the rock spur, partly infilled with mudstone (Edwalton Member) and tills of both Thrussington and Oadby character. Alluvium and river terrace sands and gravels occupy one channel. There may be structural guidance inasmuch as there are joint systems running W–E and SW–NE through the diorite, dipping steeply to north at about 60° (Eastwood et al 1923). Glacial flow was funnelled through these channels; intense and complex flow resulted in rafted mudstone erratics (up to 5 m long and 1 m thick), low-angled glaciotectonic shear planes and a striated surface with SW–NE alignment (Rice 1981), Oadby Till ice advancing from the NE. The most parsimonious explanation for this stratigraphy is that structurally-guided palaeochannels were initially cut into basement diorite, infilled passively by Triassic mudstones, partly exhumed by superimposition, re-channelled by sub-glacial meltwater, infilled with glacial deposits, and finally re-occupied discordantly by postglacial drainage. A series of three stages of valley cut-and-fill thus contributed to a nested valley-in-valley form.

Another example can be found at Buddon Wood, Mountsorrel Quarry (SK 567 145) (Carney et al 2009), although this route was never reoccupied postglacially and thus drainage discordance does not apply (Fig. 10B). The quarry southern face showed 15 m of Oadby Till exposed within a palaeochannel resting with sharp contact on mudstone (Gunthorpe Member) which itself occupied a pre-Triassic palaeovalley (see Carney et al 2009, plate 19a). The granodiorite exhibits prominent fracture belts (many slickensided) with easterly orientations, though some have SW–NE and NW–SE orientations. One major fracture zone with SW–NE orientation is inferred from the offset of intrusive dolerite; this structural grain (Phase 2-aligned) may have influenced the direction of later palaeochannels. Initial basement channelling adopted the SW–NE grain, later passively buried by mudstone; post-Triassic downcutting followed, maintaining a line later exploited by subglacial erosion. Finally, glacial till was deposited. A nested valley-in-valley sequence can again be recognised.

In addition to Little Matlock Gorge, notable sites of multi-phased drainage discordance within Charnwood include Black Brook at Moult Hill and Lingdale Brook at Cuckoo Hill (Fig. 11). Bennett et al (1928) and Watts (1947) referred to these as ‘remarkable’ and ‘beautiful’ examples of former Triassic valleys from which most or all evidence of Keuper Marl (Mercia Mudstone) had been removed. They are clearly discordant to basement structure but have adjusted differently to the pre-Triassic relief. Black Brook has cut into and revealed a gorge-like pre-Triassic wadi, with marl practically cleared out (Watts 1947). Lingdale Brook at Cuckoo Hill has cut a 30 m gorge directly into a

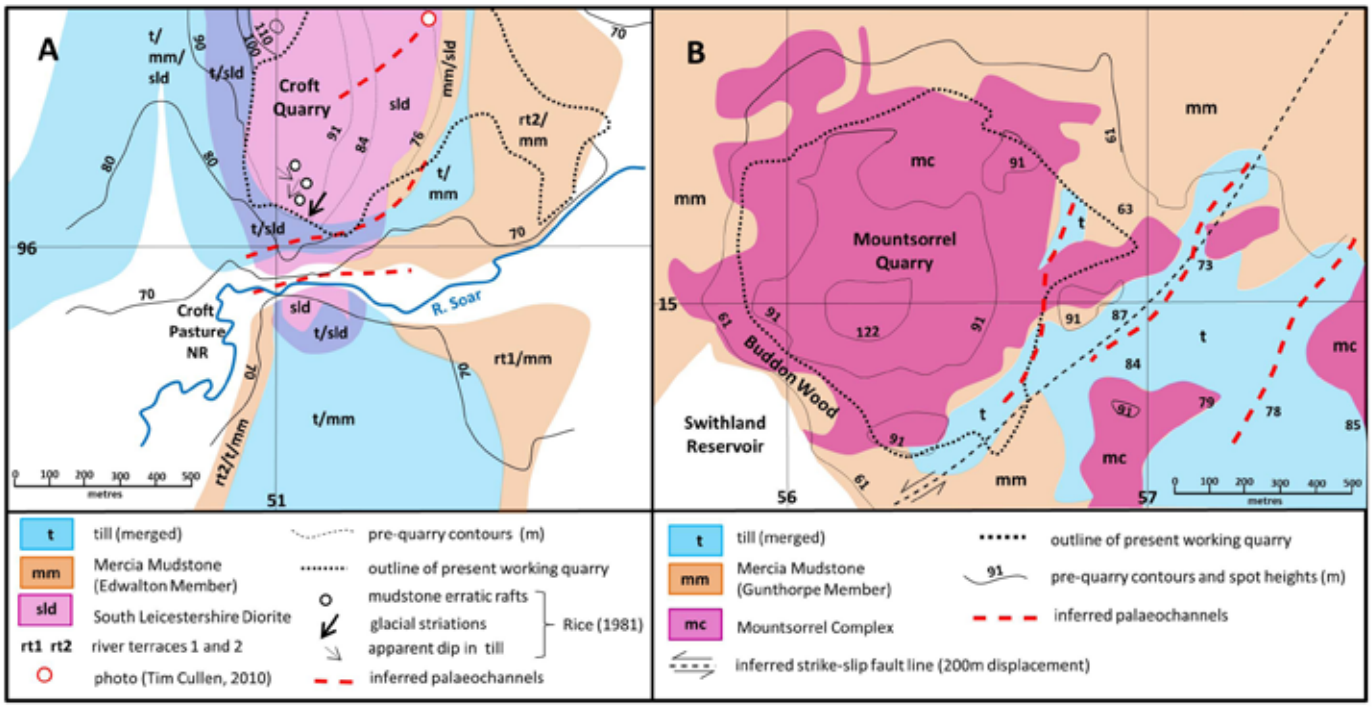

***Figure 10**. Examples of nested valley development: (A) Croft Bridge (SP 510 959) based on BGS Sheet 169 (Coventry) and Rice (1981); (B) Buddon Wood (SK 567 145) based on BGS Sheet 156 (Leicester) and Carney et al (2009).*

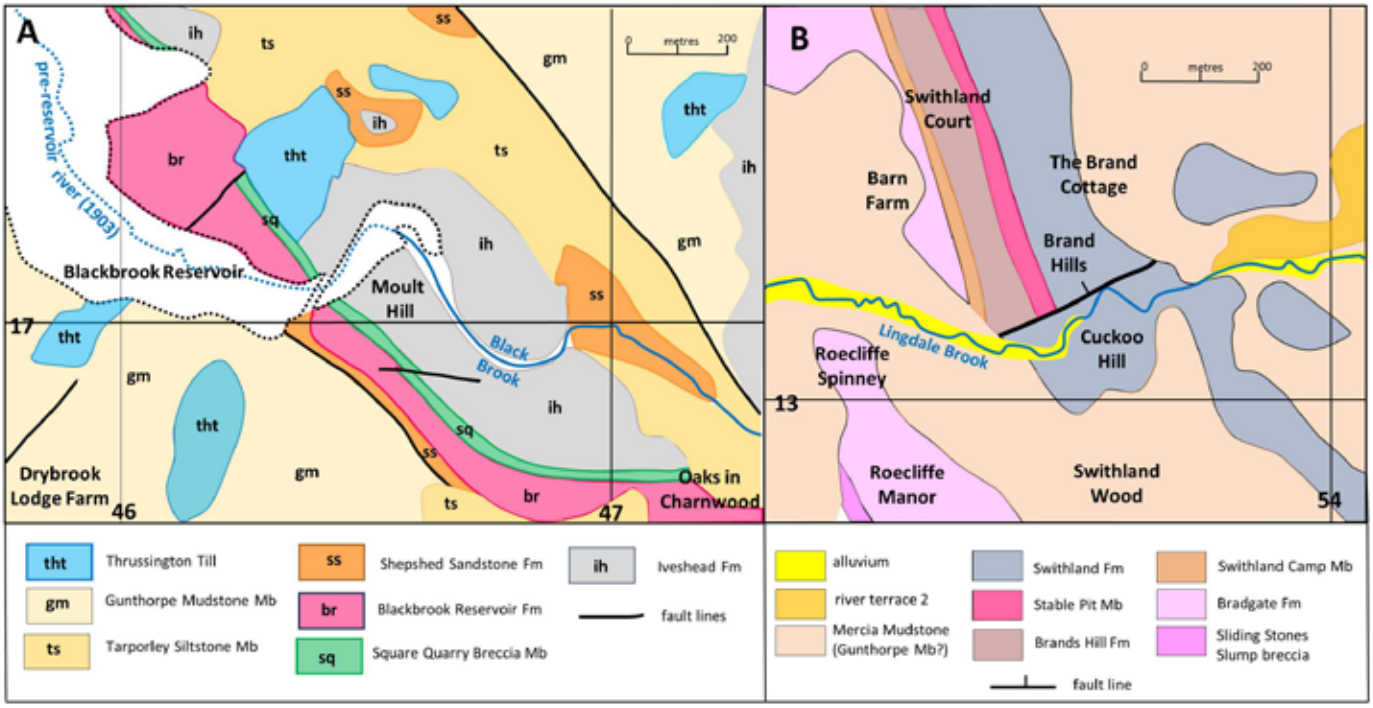

***Figure 11**. Two main examples of drainage discordance recognised by Bennett et al (1928) and Watts (1947): (A) Black Brook at Moult Hill (SK 465 170), outcrops based on BGS Sheet 155 (Coalville); (B) Lingdale Brook at Cuckoo Hill (SK 537 132), outcrops based on BGS Sheet 156 (Leicester).*

rock barrier, but not entirely in line with a nearby pre-Triassic wadi. Black Brook therefore is an example of superimposition and exhumation combined, while Lingdale Brook exemplifies superimposition with incomplete exhumation. Thus, there are varying degrees of adjustment to the underlying Charnian basement; fractured fault zones however do seem to have played a significant role initially in most cases.

A multi-phased evolutionary model

Figure 12 is a hypothetical model for this nested valley-in-valley scheme. In phase 1 a pre-Carboniferous drainage network is envisaged, exploiting Brabantian fracture zones within the Precambrian/Cambrian basement. Carboniferous burial, uplift and exhumation intervene between 1 and 2. In phase 2, Permian desert conditions result in wadi-like ravines between fretted inselbergs. Passive burial of Triassic mudstones follows (3), infilling palaeovalleys, and (4 and 5) late or post-Triassic drainage is guided by syn-depositional hydro-compaction, reflecting the buried relief contours. Superimposition proceeds (5) eventually exhuming the basement. Jurassic and Cretaceous burial, uplift and erosion intervene, with Cainozoic drainage development, between phases 5 and 6 (Carney 2007). Full glacial conditions follow (6) with subglacial meltwater preferentially directed along deepened channels; traction tills are deposited (7), shallower on interfluves but deepening within channels with glaciotectonic disturbance. Finally in phase 8, postglacial development sees a network of modern streams established, largely following routes already established in the subsurface buried relief. Little Matlock Gorge may have undergone similar phases of such nested valley incisions.

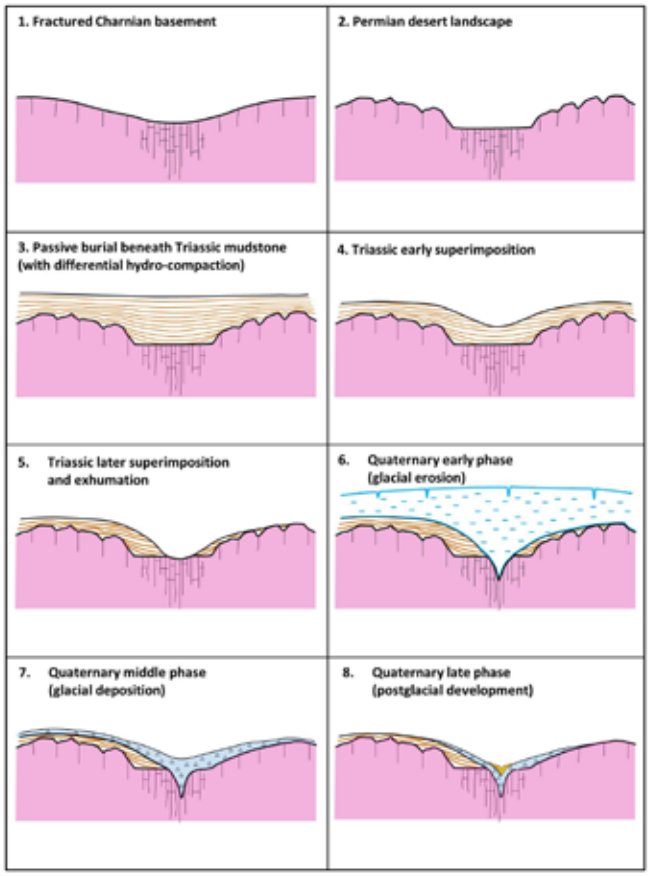

***Figure 12**. A proposed evolutionary model for Charnwood drainage (a phased nested valley-in-valley approach)*

The origin of Charnwood Forest's divergent drainage pattern (Fig. 6) is, in one sense, a separate issue to the persistence of alignments by repeated valley-in-valley episodes. A radial network could have arisen in the pre-Triassic interval (1/2) or post-Triassic interval (5/6). John Carney (pers. comm.) comments as follows:

1. This could have been formed during the Permian, from drainage superimposed when up-arched Carboniferous Coal Measures strata were stripped away. But in this case the Triassic palaeovalleys would also be radial, which is very difficult to prove due to the present extent of Trias cover.

2. Or, perhaps more likely, it was superimposed from gently up-arched Mesozoic cover strata (uppermost Trias, Jurassic and also perhaps Cretaceous) when the latter were removed during Cainozoic uplifts associated with Atlantic opening and the ripple effect of the Alpine orogenesis. In this case, the modern drainage would probably cut across the older Trias palaeovalleys, although possibly following the latter in part as tributaries would tend to cut back into rocks less resistant than the Charnian.

Indeed, the radiating streams of Charnwood Forest do display varying degrees of adjustment to the Charnian basement structure. Some segments of the radial pattern would have readily adopted underlying palaeovalley directions where their geometries resonated, but those segments in conflict with the Brabantian structural grain would more likely have developed discordance. Additionally, those segments with an inherited SW–NE alignment would more easily have facilitated and directed glacial flow and subglacial incision when Oadby Till ice advanced from the north-east, reinforcing the alignment. Many of the discordances (Fig. 6) align in this manner, Little Matlock Gorge among them.

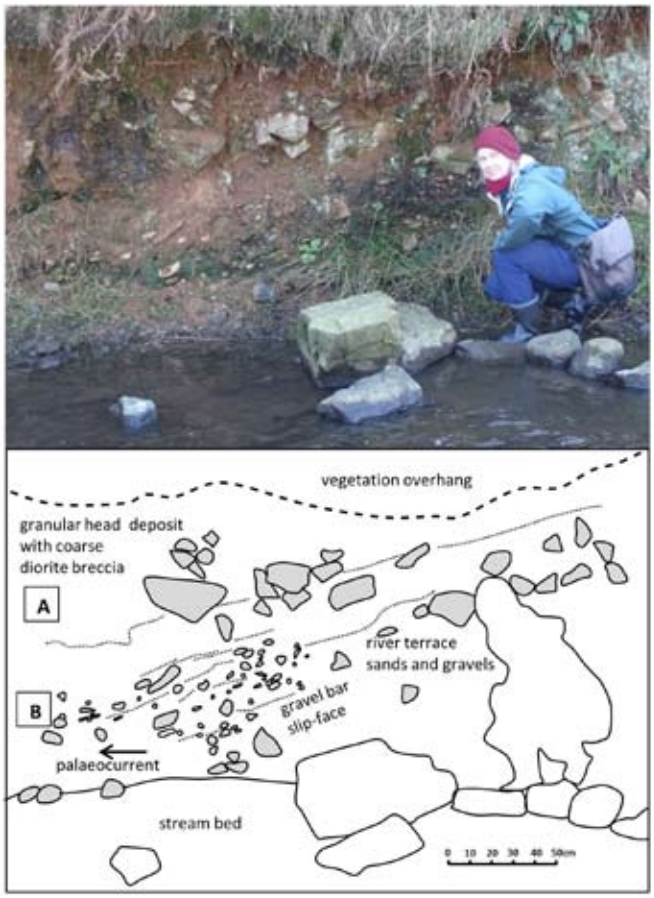

***Figure 13**. River Lin stream bank section at SK 5291 1002, just downstream of Little Matlock Gorge (Fig. 5).*

River terrace deposits

The only superficial deposits within Little Matlock Gorge are a narrow strip of alluvium and sands and gravels mapped as River Terrace 1 (Fig. 5). A stream bank section along the River Lin's course (SK 529 100) reveals stratigraphy at a point just downstream of the river's exit from the gorge (Fig. 13). Incidentally, this meander bend also exposes a cross-section of the medieval park pale (Stevenson & Squires 1999). In layer B current-bedded terrace sands and gravels consist of rounded, sub-rounded and sub-angular coarse gravel (clasts 5–12 cm) in a sandy matrix; elongate stones run parallel to the bedding planes suggesting a slip-face at the front of a gravel bar advancing right to left (west to east) in keeping with the palaeocurrent through the gorge. Overlying these river sediments there is a coarse granular head or breccia (layer A) consisting of angular and sub-angular diorite cobbles and boulders (clasts 8–40 cm) in a red sandy clay matrix made up of weathered mudstone. Detached cobbles and boulders of this material have fallen into the stream bed. Layer A is interpreted as a coarse periglacial solifluction deposit that has slumped downslope under conditions of extreme continuous permafrost probably in the Late Devensian sub-stage (Last Glacial Maximum, MIS2, dated at 24 ka to 15 ka BP). A later cold phase (Younger Dryas at 12.9 ka to 11.7 ka BP) could have seen similar mass movement, but with less severe conditions (discontinuous permafrost) solifluction head would probably have been finer-grained. The implication is that River Terrace 1 probably equates with, or predates MIS 2, and could therefore correlate with the Syston Terrace in the Soar valley dated to about 33.4 ka cal BP (Westaway et al 2015).

Late Upper Palaeolithic archaeology

At one point overlooking the gorge (Figs 2 and 3) Cooper (2012) has revealed an internationally-important flint scatter, interpreted by lithic typology to Late Glacial Creswellian with affinities to Farndon Fields and Creswell Crags (Leicestershire and Rutland HER ref. MLE9435). The gorge would have been an ideal location for interception of prey such as migratory wild horse moving along a natural corridor; the valley constriction, like Creswell Gorge, could have even allowed wild animals to be corralled. Beamish (2021) provides a good summary. Further archaeological investigations have been conducted (Cooper & Garton 2022), and work is ongoing.

Conclusions

This review of Charnwood's drainage pattern has highlighted the importance of fault-guidance in basement rocks (Precambrian and Cambrian) associated with late Silurian orogenesis (Late Caledonian/Brabantian Event), meaning that some elements of the network must possess distinctly ancient origins. The upper Lin follows the line of the Phase 1 Newtown Linford Fault, while the middle section (Little Matlock Gorge) appears to have exploited a fractured fault zone aligned with the Phase 2 Old Wood Fault. Evidence for slickensides is visible within the gorge, especially so at Wishing Stone Crag. Angularity within the river's course may be related to fault-perpendicular and fault-parallel behaviour as shown in present-day analogues. A hypothetical model of nested valley-in-valley incisions illustrates how, once formed, a river's course might have been perpetuated by re-cutting and re-occupation, especially during the Permian wadi phase, and during later glaciation. The divergent Charnwood streams exhibit varying degrees of adjustment to underlying structure, and it is helpful to consider the different responses of the upper Soar (Croft Bridge), Black Brook and Lingdale Brook, as well as evidence at Buddon Wood. Unfortunately, Little Matlock Gorge lacks residual mudstone and glacial till, evidence of which may have been flushed out by meltwater discharge. The only superficial deposits in the gorge appear to be shallow current-bedded sands and gravels overlain by coarse solifluction breccia, suggesting a possible MIS 2/MIS 3 age for terrace development. The 2023 translational rockslide shows that the steep valley side slopes are unstable and still undergoing slope degradation towards an equilibrium profile. In their opinion of the history of Little Matlock Gorge, Sutherland et al (1983) felt that 'in the absence of any real evidence, one can only speculate'. New data reported here go some way to reducing this level of uncertainty, but much still remains unknown about its origins and subsequent development. Enduring fascination merely adds to the charm which continues to attract so many visitors to Bradgate Park. Interestingly, as John Carney has noted (pers. comm.), the Triassic-infilled palaeovalleys revealed around Groby (Scotney et al 2012) are similarly quite steep-sided, so potentially there are other 'Little Matlock Gorges' hidden away beneath Trias cover, yet to be revealed in the far future.

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Colin Baker
Chilwell
cabaker135@aol.com