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Biostratigraphical dating of the Ingleton Group, northern England

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Biostratigraphical dating of the Ingleton Group, northern England

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Summary

Palynological slides from rocks assigned to the Ingleton Group in the Beckermonds Scar Borehole and from the Ingleton Group at outcrop have been examined in an attempt to replicate the Arenig date assigned to the borehole section. No microfossils have been seen in slides from borehole samples, apart from those originally used to date the section in 1982, from a sample at 396.20 m. However, acritarchs have been observed in slides from three outcrop samples, one from the vicinity of Thornton Force and the other two from the River Doe section above Ingleton. The acritarchs are similar in preservation to those from the borehole. Most specimens recorded are simple acanthomorph acritarchs that are not especially diagnostic of age, but two specimens of *Veryhachium trispinosum* were recorded from one of the samples from the River Doe. The species has its first appearance in the latest Tremadoc (Early Ordovician) and is also present in the Beckermonds Scar assemblage. The acritarchs provide the first biostratigraphical evidence for the age of the Ingleton Group at outcrop, and strengthen the case for the

Beckermonds Scar specimens being *in situ*. Together, the outcrop and borehole material provide consistent evidence that the Ingleton Group is no older than Early Ordovician.

1 Introduction

The Beckermonds Scar Borehole (SD88SE/1 [NGR SD 8635 8016]) was drilled in August–September 1976 to test a belt of magnetic basement rocks on the southern flank of the Weardale Granite (Wilson and Cornwell, 1982). It passed through Lower Carboniferous strata of the Askrigg Block, into a steeply dipping succession of mudstones, siltstones and greywacke sandstones that yielded an acritarch assemblage, dated as Arenig by R E Turner (*in* Wilson and Cornwell, 1982). The rocks in the borehole were described in the same paper as ‘closely resembling’ the Ingleton Group. As a result, the Ingleton Group at outcrop has also been regarded as Early Palaeozoic in age, and has been correlated with other Lower Palaeozoic rocks in northern England, notably the Skiddaw Group.

N J Soper and F W Dunning, in a paper submitted recently to the *Proceedings of the Yorkshire Geological Society* (not yet published), agree that the basement rocks in the Beckermonds Scar Borehole are the Ingleton Group, but question the age that this implies for the group as a whole. They argue that the Ingleton Group at outcrop displays evidence for a protracted geological history that predates Acadian (Devonian) deformation and is incompatible with the mid Ordovician record of southern Britain, and that the depositional age of the Ingleton Group is more likely to be Neoproterozoic. They point out that only one out of 25 palynological samples taken from the borehole had yielded acritarchs, and suggest that the acritarch evidence should be discounted unless and until it can be replicated.

There have been attempts in the past to replicate the acritarch evidence from Beckermonds Scar. Figure 1 shows samples plotted against depth. An initial batch of 15 samples bearing the numbers MPA 2225–2239 was supplemented by a further batch of 10 samples bearing the numbers MPA 3132–3141. Together these comprise the 25 samples that Wilson and Cornwell (1982, p. 67) reported as having been processed. An additional three samples, bearing the numbers MPA 16481–16482, were processed at a later date, and a further sample MPA 53694 is currently in the palynological processing laboratory at BGS Keyworth. So far, acritarchs have only been recorded from the sample on which the original date was based (MPA 2234, 396.20 m), although MPA 3134 was collected from the same depth, and MPAs 16481–16483 bracket that depth (MPA 16481, 395.50–396.00 m; MPA 16482, 396.00–396.50 m; MPA 16483, 396.50–397.00 m). MPA 53694 is from 396.05–396.15 m.

Although data from MPA 53694 are not yet available, new biostratigraphical evidence relevant to the age of the Ingleton Group at outcrop has come to light during this investigation. If the Beckermonds Scar acritarchs are not *in situ*, they would have to have been introduced into the sample by contamination of some kind, most probably in the laboratory. However, this begs the question of where could they have come from. In an attempt to identify possible sources, the BGS register containing details of the Beckermonds Scar samples (MPA 1) was scanned for records (Table 1). All samples going through the palynology and micropalaeontological processing laboratories at the time would have been registered in either the MPA or a concurrent series, and any onshore Lower Palaeozoic samples would almost certainly have been given MPA numbers. The first thing to note from Table 1 is that relatively few Lower Palaeozoic samples were processed immediately prior to the first batch of Beckermonds Scar samples (with the productive MPA 2234), in contrast to much higher numbers of Carboniferous, Triassic and younger Mesozoic and Cenozoic samples. Eighty-six samples out of more than 2000 were processed, although not all of the latter would necessarily have gone through the palynology laboratory, some probably being micropalaeontological samples. Some of these 86 samples can be eliminated as being too old to be a source of the Beckermonds Scar specimens (e.g. those from Tremadoc and older rocks), or as coming from rocks that are at too low a metamorphic grade for the preservation seen in Beckermonds Scar (e.g. MPA 463–467 from the Silurian of

Gotland). Others are apparently barren, based on a quick scan of slides in the BGS collection (e.g. MPA 1573–1575, MPA 1651–1652).

A possible source from which the acritarchs could have been introduced into the Beckermonds Scar sample has not yet been identified, although this does not rule out the possibility. More significantly, however, the register also contains details of 51 samples from the Ingleton Group at outcrop, registered immediately after the Beckermonds Scar samples. Some of these samples had been examined previously and reported to be barren (BGS report PDL/83/181; 1:50 000 sheet 50, Hawes), but the opportunity was taken to scan these slides as well. Acritarchs were seen in slides from three samples.

2 Results

Samples were collected by Dr B Owens in 1973. Slides have not been logged systematically, merely scanned quickly and partially. Nevertheless, specimens have been photographed (Fig. 2) and their locations on the slides have been recorded. The slides provide the first biostratigraphical data relevant to the age of the Ingleton Group at outcrop.

2.1 MPA 2246

MPA 2246 is one of a batch of seven samples collected in an E–W traverse of the Ingleton Group exposed on the north side of the pool below Thornton Force [approx. SD 696 752]. It was previously reported to be barren (PDL/83/181), but very poorly preserved acanthomorph acritarchs were recorded (Figs 2f–h).

2.2 MPA 2282

MPA 2282 is one of a batch of 25 samples collected from exposures by the path along the River Doe section, from upstream of the quarries at Storrs Common to Beezley Falls [approx. SD 700 738 to SD 705 748]. Its location is about [SD 705 745]. Acritarchs observed include *Veryhachium trispinosum* (Figs 2j–k), *Micrhystridium?* (Fig. 2i) and a possible sphaeromorph acritarch (Fig. 2l).

2.3 MPA 2287

MPA 2287 is from the same batch of samples as MPA 2282. Its location is about [SD 705 747]. Very rare, poorly preserved acanthomorph acritarchs were recorded (Figs 2m–n).

2.4 BIOSTRATIGRAPHICAL DATING

Most of the specimens observed so far in these samples provide little evidence for age, although they suggest an Early Palaeozoic rather than Neoproterozoic age. The most significant finding is the record of two specimens of *Veryhachium trispinosum* from MPA 2282. Trispinose veryhachiid acritarchs such as these make their first appearance in the latest Tremadoc, and therefore suggest an oldest possible age of Early Ordovician for the Ingleton Group. One of the specimens (Fig. 2k) clearly shows the triangular form of the body, although the processes are broken. The second specimen (Fig. 2j) is broken, but its form is characteristic of poorly preserved trispinose veryhachiids. Similar forms occur in the sample from the Beckermonds Scar Borehole (Figs 2a, e).

3 Comparison with Beckermonds Scar

There are similarities between the assemblages from the Ingleton Group outcrop and that from Beckermonds Scar. The acritarchs from Beckermonds Scar are reported to be sparse, as they are in the Ingleton Group samples, and their preservation is similar (Fig. 2). There are also similarities in assemblage composition. The occurrence of trispinose veryhachiids in samples from the Ingleton Group and Beckermonds Scar is noted above, and although not determined (and perhaps undeterminable), similar acanthomorph acritarchs occur in the samples from the borehole and outcrop (compare Figs 2b, f and h).

4 Discussion

Acritarchs recorded from outcrop samples of the Ingleton Group suggest an Early Ordovician age. Although not replicating the original observation of Turner (*in* Wilson and Cornwell, 1982) on borehole material, they are nevertheless consistent with the dating of the basement rocks in Beckermonds Scar and strengthen the case for the acritarchs in both sets of samples being *in situ*. Nevertheless, it would be worthwhile re-preparing the productive outcrop samples, if material is available in the BGS collections, to confirm this. Furthermore, the productive slides from the Ingleton Group outcrop ought to be logged systematically for additional age-diagnostic specimens and for closer comparison with the Beckermonds Scar assemblage.

References

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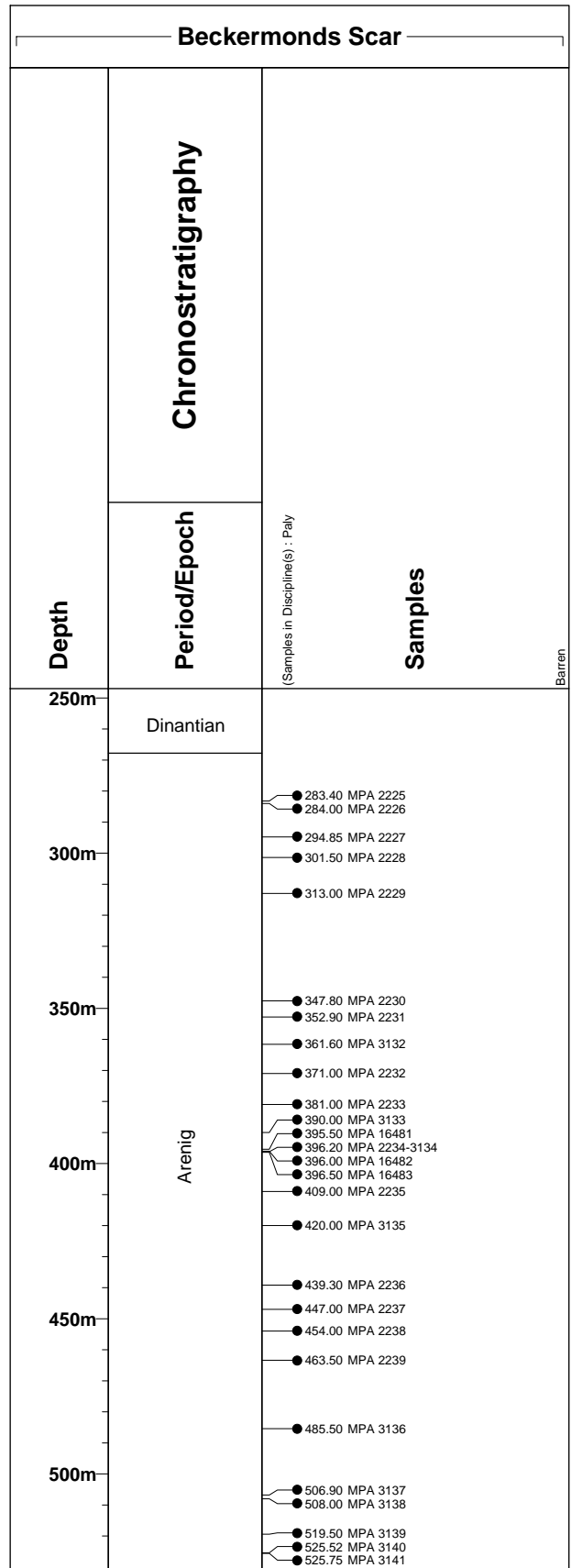


Figure 1. Palynological sample points in the pre-Dinantian section of the Beckermonds Scar Borehole.

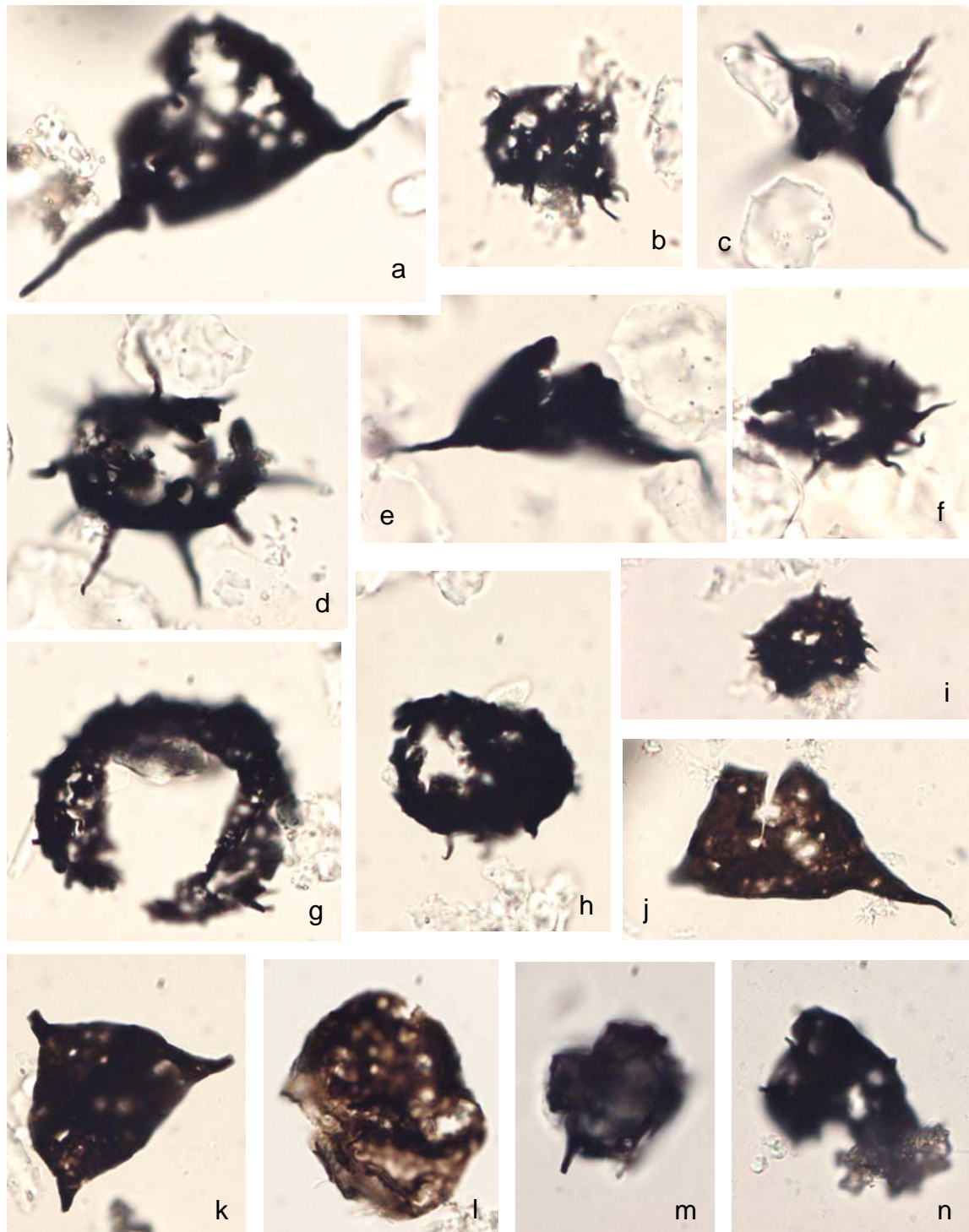


Figure 2. Acritarchs from the Ingleton Group in the Beckermonds Scar Borehole (a–e) and at outcrop (f–n). All specimens $\times 1000$.

- a. *Veryhachium trispinosum* (Eisenack) Stockmans & Willièrè 1962. MPA 2234. Beckermonds Scar Borehole, 396.20 m. England Finder slide co-ordinates W57/1.
- b. *Micrhystridium?* sp. MPA 2234. Beckermonds Scar Borehole, 396.20 m. Co-ordinates W54/1.
- c. *Veryhachium lairdii* Deflandre ex Loeblich 1970 group. MPA 2234. Beckermonds Scar Borehole, 396.20 m. Co-ordinates F39/4.

- d. *Polygonium?* sp. Beckermonds Scar Borehole, 396.20 m. Co-ordinates R59/3.
- e. *Veryhachium trispinosum*. Beckermonds Scar Borehole, 396.20 m. Co-ordinates P52/1.
- f. *Micrhystridium?* sp. MPA 2246. Thornton Force. Co-ordinates L60/0.
- g. acanthomorph acritarch. MPA 2246. Thornton Force. Co-ordinates L63/0.
- h. *Micrhystridium?* sp. MPA 2246. Thornton Force. Co-ordinates H34/2.
- i. *Micrhystridium?* sp. MPA 2282. River Doe section. Co-ordinates Q51/4.
- j. *Veryhachium trispinosum*. MPA 2282. River Doe section. Co-ordinates W63/4.
- k. *Veryhachium trispinosum*. MPA 2282. River Doe section. Co-ordinates J43/0.
- l. sphaeromorph acritarch. MPA 2282. River Doe section. Co-ordinates J65/4.
- m. acanthomorph acritarch. MPA 2287. River Doe section. Co-ordinates S58/0.
- n. acanthomorph acritarch. MPA 2287. River Doe section. Co-ordinates E40/3.

Sample numbers		Number of samples	Stratigraphy	Locality	1:50k sheet
Start	Finish				
MPA 36	MPA 47	12	Skiddaw Group?	Lacra Bank	48
MPA 419	MPA 426	8	Type Llandovery Series	Llandovery	212
MPA 427	MPA 440	14	Ashgill-Llandovery	Lake District	30,38,39,49
MPA 463	MPA 467	5	Ludlow	Gotland	
MPA 468		1	Tremadoc	Poland	
MPA 469		1	Wenlock	Belgium	
MPA 471	MPA 475	5	Ludlow	Bohemia	
MPA 476		1	Riband Group (Arenig)	SE Ireland	
MPA 477		1	Caradoc	SE Ireland	
MPA 478		1	Shinerton Shales (Tremadoc)	Shropshire	
MPA 497	MPA 502	6	Tremadoc?	Cooles Farm Bh.	252
MPA 529		1	Tremadoc	Park Hill Bh.	169
MPA 530	MPA 533	4	Tremadoc	Ten Shilling Wood Bh.	184
MPA 534	MPA 543	9	Tremadoc?	Cooles Farm No. 1 Bh.	252
MPA 547	MPA 549	3	U. Silurian-L. Devonian	Highworth Bh.	252
MPA 1559		1	Tremadoc	Runcil Lane Bh.	184
MPA 1560		1	Upper Cambrian	Berry Field Farm Bh.	169
MPA 1561	MPA 1566	6	?	Highworth Bh. (1"252)	252
MPA 1571		1	U Cambrian-Tremadoc	Rotherwood Bh.	155
MPA 1573	MPA 1575	3	Skiddaw Group	Peter House Farm, Bassenthwaite	23
MPA 1651	MPA 1652	2	Offrwm Volcanic Formation	North Wales	135
Total (pre-Beckermonds Scar)		86			
MPA 2225	MPA 2239	15	Ingleton Group	Beckermonds Scar Bh.	50
MPA 2240	MPA 2290	51	Ingleton Group	outcrop	50
MPA 2358	MPA 2359	2	Llandovery	North Wales	94

Table 1. Lower Palaeozoic samples registered in the MPA series prior to the Beckermonds Scar samples.