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## Bach-y-graig

[SO 0726 6095]–[SO 0708 6105]

### Introduction

This section is the only one in the Builth–Llandrindod inlier in which the boundary between the graptolite zones of *Didymograptus murchisoni* and *Hustedograptus teretiusculus* is exposed. A radiometric U-Pb age of  $460.4 \pm 2.2$  Ma (Tucker and McKerrow, 1995) was obtained from zircon crystals from a tuff close to the boundary (Sheldon, in Ross *et al.*, 1982), making it the oldest of several sections collected exhaustively by Sheldon (1987b) during his work on gradualistic evolution and populations in trilobite lineages in the Builth area.

Bach-y-graig was described in detail by Elles (1940), who recognized the *murchisoni*–*teretiusculus* zonal transition here. She believed (p. 407) that the section was unfaulted, but this opinion was challenged by Jones and Pugh (1949, p. 87), who stated that a strike fault crosses the stream at the position of the boundary. The presence of a fault was confirmed by Sheldon (in Ross *et al.*, 1982, p. 142), but it was considered to cut shales of the *teretiusculus* Zone 4 m above the zonal boundary. R.A. Hughes (1989, p. 16) logged graptolite ranges in the *murchisoni* Zone and in the basal *teretiusculus* Zone as far as the fault, whilst C.P. Hughes (1969, 1971, 1979) described trilobites from this section. Ranges for both the trilobites and graptolites were given by Hughes and Sheldon (in Fortey *et al.*, 1991), who discussed briefly the merits of this section as a stratotype for the base of the Llandeilo Series; they concluded that it was too short and not wholly suitable for this purpose.

### Description

The section lies about 1 km east of Llandrindod Wells and extends for some 90 m from the outcrops of shales of the *murchisoni* Zone, up-sequence into the lower part of the *teretiusculus* Zone (Figure 8.28). The whole succession falls within the lowest part of the Llanfawr Mudstones Formation and is described working downstream, based in large part on unpublished work by Sheldon (1987b, pp. 30–42).

The rocks are dark-coloured, laminated mudstones without bioturbation that are exposed in the banks and bed of the stream, with the oldest shales exposed at [SO 0724 6097] assigned to the *murchisoni* Zone. Sheldon (1987b, p. 37) noted the youngest specimens of *Didymograptus murchisoni* from his locality BG23, the top of which is 19 cm below the 'calcareous ash' at which Elles (1940) drew the zonal boundary.

Shales of the *murchisoni* Zone have also yielded *Cryptograptus* ex gr. *tricornis* (Carruthers), *Pseudoclimacograptus angulatus sebyensis* Jaanusson and *Diplograptus? decoratus* (Harris and Thomas). Trilobites are scarce in the *murchisoni* Zone, but Sheldon (1987b) and Hughes and Sheldon (in Fortey *et al.*, 1991) reported *Ogygiocarella*, *Ogyginus*, *Barrandia*, *Platycalymene* and *Segmentagnostus*.

Elles (1940, p. 407) took a 'calcareous ash' as marking the base of her 'zone of *Glyptograptus teretiusculus* and *Ogygiocaris buchii*'. Sheldon (1987a, b) showed that a strike fault cuts out strata 4 m above this ash, within the *teretiusculus* Zone, so that it does not affect the zonal boundary itself, which is drawn a short distance below the ash at the last occurrence of *D. murchisoni*. Sheldon (1987b, p. 36) recognized the fault by a well-developed fault breccia on the left bank of the stream (his loc. BG45). Farther upstream, on the right bank (his loc. BG46), he was able to identify by excavation a narrow zone of brecciation and shearing that he interpreted as being the upstream extension of the same fault. Tuff bands are frequent in the shales belonging to the lowest part of the *teretiusculus* Zone. Elles' (1940) 'calcareous ash' is a 14 cm-thick soft bentonitic unit that is only very mildly effervescent with dilute HC1. Using zircon crystals from this unit, Ross *et al.* (1982) obtained fission-track ages of  $476 \pm 10$  Ma and  $478 \pm 12$  Ma. Other zircons from their sample subsequently yielded a U-Pb age of  $460.4 \pm 2.2$  Ma (Tucker and McKerrow, 1995).

Beds belonging to the *teretiusculus* Zone occupy the right bank north of the fault and the left bank above the bentonitic tuff at BG25; downstream the entire section is within successively younger beds of the *teretiusculus* Zone, dipping NW or WNW at approximately 40°. Faunally there is no change at the base of the *teretiusculus* Zone, other than the disappearance of *D. munchisoni*; the other graptolites and trilobites continue upwards through the succession, trilobites becoming much more common (Figure 8.29). Small lingulate brachiopods, including *Lingulella* cf. *disposita* Williams, occur throughout.

The trilobites listed above are joined by other taxa in the *teretiusculus* Zone, and the type localities for *Cnemidopyge parva* Hughes, *Protolloydolithus reticulatus* (Elles), *Barrandia expansa* Hughes and *Rorringtonia kennedyi* Owens are all in the Bach-y-graig section, many from points between 35 m and 45 m from where the footpath enters the western end of the wood. A few cyclopygid trilobites, rare in the Builth Inlier, have been found in this section: *Emmrichops? extensus* Hughes and *Microparia lusca* Marek.

## Interpretation

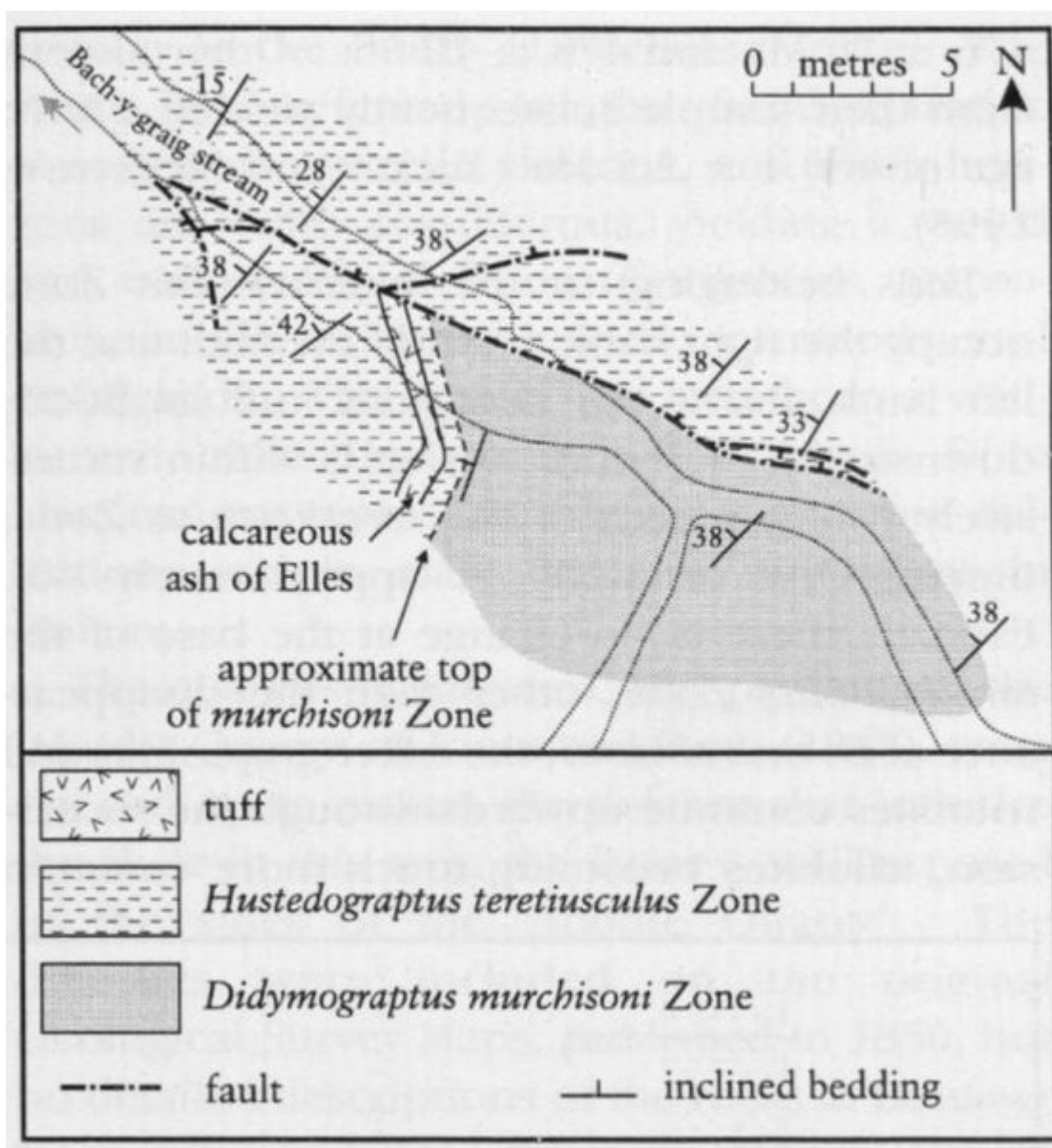
Sheldon (1987b, p. 41) interpreted the environment of deposition of the well-laminated and unbioturbated Llanfawr Mudstones Formation at Bach-y-graig as being of low energy in poorly oxygenated water, with intermittent influxes of volcanic ash. He inferred that any currents were weak, since the graptolites are not aligned and the tuffs are undisturbed, the latter having been produced by distant volcanic eruptions (see also site report for Llanfawr Quarry).

Biostratigraphically, the importance of this section lies in the presence of the *murchisoni*–*teretiusculus* zonal boundary, recognized by the disappearance of the widespread species *Didymograptus munchisoni*. Palaeontologically it is significant on three counts: first, for being the type locality for four trilobite species; secondly for furnishing two of the sections from which Sheldon (1987a, b, 1988) collected large numbers of specimens during his work on gradualistic evolution and population structure in trilobites (these are the lowest of seven sections that contributed to his analysis); and thirdly in yielding graptolites that afford correlation of part of the *teretiusculus* Zone of the Builth sequence to areas outside Britain: *Pseudoclimacograptus angulatus sebyensis* Jaanusson known from Scandinavia and *Diplograptus? decoratus* (Harris and Thomas) from Australia were both reported for the first time from Britain by Hughes (1989).

## Conclusions

This section is nationally important because it is possible to identify there the base of the internationally recognized *teretiusculus* Zone in a single succession of uniform facies (contrast the Newmead site); this base has been dated accurately by means of radioactive isotopes. Bach-y-graig is also the original site for four species of trilobites and for certain large trilobite populations used in the study of their evolution.

## [References](#)



(Figure 8.28) Sketch-map of the Bach-y-graig stream section, from Sheldon (1987b, unpublished).

