

## The type Ludlow Series: Holostratigraphical events

### 1. **Base of the *Neodiversograptus nilssoni* Biozone. Base of the *Leptobrachion longhopense* Biozone. Appearance of the *Glassia obovata* Association. Base of the Ludlow Series and Gorstian Stage. Base of the Lower Elton Formation.**

The base of the Ludlow Series and the Gorstian Stage coincides with the base of the Lower Elton Formation at Pitch Coppice Quarry.

Graptolites from the lowest 0.25 m of the Lower Elton Formation at Pitch Coppice Quarry indicate the *Neodiversograptus nilssoni* Biozone. As a result, the base of the Ludlow Series is correlated with the base of the *nilssoni* Biozone. It should be noted, however, that no graptolites have been recorded from the upper 40 m of the underlying Wenlock beds.

The base of the *Leptobrachion longhopense* Biozone is correlated with the base of the series, but the evidence for correlation has not been published.

There is a gradual change in the shelly fauna across the Wenlock-Ludlow boundary, with the appearance of the *Glassia obovata* Association, dominated by small brachiopods, at about the base of the series.

See: [Neodiversograptus nilssoni Biozone](#), [Leptobrachion longhopense Biozone](#), [Glassia obovata Association](#), [Boundary stratotype for the base of the Ludlow Series and Gorstian Stage](#), [Lower Elton Formation](#), [Pitch Coppice Quarry](#).

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### 2. **Base of Chitinozoan Biozone 2.**

The base of Chitinozoan Biozone 2 is estimated to be 14.8 m above the base of the Lower Elton Formation in the Goggin Road section of the type Ludlow area.

See: [Chitinozoan Biozone 2](#), [Goggin Road](#).

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3. **Base of the *Synorisporites libycus*-*Lophozonotriletes? poecilomorphus* Biozone. Base of the *Chelinospora obscura* Sub-Biozone.**

An accessory reference section for the base of the *Synorisporites libycus*-*Lophozonotriletes? poecilomorphus* Biozone is situated in the upper part of the Lower Elton Formation, 6.4 km SW of Ludlow.

The *Chelinospora obscura* Sub-Biozone is the lowest of four subzones recognized in the *libycus-poecilomorphus* Biozone of south Wales, where its base coincides with that of the zone. The *obscura* Sub-Biozone has not been recognized in the type Ludlow succession.

See: [Synorisporites libycus-Lophozonotriletes? poecilomorphus Biozone](#),  
[Chelinospora obscura Sub-Biozone](#).

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4. **Base of the *Tylotopalla pyramidalis* Biozone? Highest occurrence of many Wenlock ostracode species. Base of the Middle Elton Formation.**

The *Tylotopalla pyramidalis* Biozone is reported to correlate with the Middle Elton Formation of the type Ludlow area, but there is no indication of where the base of the zone might be located in a particular section. Correlation with the base of the Middle Elton Formation is therefore regarded as tentative.

Many Wenlock ostracode species form part of the fauna from the uppermost Lower Elton Formation, but ostracodes are sparse in the Middle and Upper Elton formations.

See: [Tylotopalla pyramidalis Biozone](#), [Gorstian ostracode faunas](#), [Middle Elton Formation](#).

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**5. Highest graptolite fauna of the *Neodiversograptus nilssoni* Biozone.**

The highest graptolites assigned to the *Neodiversograptus nilssoni* Biozone in the type area are from the lower part of the Middle Elton Formation, at locality A7 of the Goggin Road section.

See: [Neodiversograptus nilssoni Biozone, Goggin Road.](#)

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**6. Base of Chitinozoan Biozone 3.**

The base of Chitinozoan Biozone 3 is in the Middle Elton Formation of the Goggin Road section in the type Ludlow area. It is variously estimated to be about 23 or 27 m above the base of the formation at locality A10, but in either case lies above the highest graptolites assigned to the *Neodiversograptus nilssoni* Biozone from locality A7 (event 5), and below the lowest graptolites assigned to the *Lobograptus scanicus* Biozone from locality A15 (event 7).

See: [Chitinozoan Biozone 3, Goggin Road.](#)

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**7. Base of the *Lobograptus scanicus* Biozone.**

The base of the *Lobograptus scanicus* Biozone is placed above the base of Chitinozoan Biozone 3, at locality A15 in the Middle Elton Formation of the Goggin Road section in the Ludlow type area.

See: [Lobograptus scanicus Biozone, Goggin Road.](#)

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**8. Base of Chitinozoan Biozone 4 (= base of the *Angochitina elongata* Biozone).**

The base of Chitinozoan Biozone 4 lies within the Middle Elton Formation of the Goggin Road section in the type Ludlow area, at localities A16-A18, and therefore at a level above the base of the *Lobograptus scanicus* Biozone (event 7).

Localities A16-A18 are equivalent to section 2I of Watkins (1979), the higher of two sections in the Middle Elton Formation of the Goggin Road from which he recorded the *Glassia obovata* Shelly Faunal Association. This therefore represents the highest published record of the association in the Ludlow area, although unpublished BGS records suggest that a fauna from higher in the formation, collected from locality A21, also represents the *Glassia obovata* Association (see event 10).

Watkins, R. 1979. Benthic community organization in the Ludlow Series of the Welsh Borderland. *Bulletin of the British Museum (Natural History)*, Geology, **31**, 175-280.

See: [Angochitina elongata](#) Biozone, Chitinozoan Biozone 4, *Glassia obovata* Association, Goggin Road.

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**9. Highest graptolite fauna of the *Lobograptus scanicus* Biozone.**

The highest graptolites assigned to the *Lobograptus scanicus* Biozone in the type area are from the upper part of the Middle Elton Formation, at locality A19 of the Goggin Road section. There is a stratigraphic interval of about 20 m between the highest fauna of the *scanicus* Biozone and the lowest fauna of the *Pristiograptus tumescens*/*Saetograptus incipiens* Biozone (event 12).

See: [Lobograptus scanicus](#) Biozone, Goggin Road.

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**10. Highest fauna of the *Glassia obovata* Association.**

The highest published record of the *Glassia obovata* Association is from about the same level as the base of Chitinozoan Biozone 4 (event 8), in the Middle Elton Formation of the Goggin Road section in the Ludlow area. However, unpublished BGS records suggest that a fauna collected higher in the formation, from locality A21, also represents the *Glassia obovata* Association.

Watkins, R. 1979. Benthic community organization in the Ludlow Series of the Welsh Borderland. *Bulletin of the British Museum (Natural History)*, Geology, **31**, 175-280.

See: [Glassia obovata Association, Goggin Road.](#)

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**11. Base of the *Florisphaeridium castellum* Biozone? Base of the *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone? Base of the Upper Elton Formation.**

The base of the *Florisphaeridium castellum* Biozone is reported to correlate with the base of the Upper Elton Formation, but there is no indication of where the base of the zone is located in a particular section.

The *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone is reported to be present in the Upper Elton Formation of the Millichope-Diddlebury area in Shropshire, and in the Lower Bringewood Formation of the Ludlow type area. The base of the *S. inframurinata* var. *cambrensis* Sub-Biozone is placed tentatively at the base of the Upper Elton Formation on this evidence, although the possible correlation of the *Chelinospora obscura* Sub-Biozone with the lowermost *Saetograptus incipiens* Biozone in south Wales implies that it might be higher.

See: [Florisphaeridium castellum Biozone, Stellatispora inframurinata var. cambrensis Sub-Biozone, Chelinospora obscura Sub-Biozone, Upper Elton Formation.](#)

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**12. Base of the *Pristiograptus tumescens*/*Saetograptus incipiens* Biozone.**

The lowest graptolite fauna assigned to the *Pristiograptus tumescens*/*Saetograptus incipiens* Biozone in the Ludlow area, is from locality A24, about 1 m above the faulted base of the Upper Elton Formation in the Goggin Road section. This level is taken to be the base of the zone in the Ludlow area, although there is a stratigraphic interval of at least 20 m between this fauna and the highest fauna assigned to the *Lobograptus scanicus* Biozone from the Middle Elton Formation (event 9).

See: [Pristiograptus tumescens/Saetograptus incipiens Biozone, Goggin Road.](#)

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**13. Base of Chitinozoan Biozone 5.**

The base of Chitinozoan Biozone 5 lies about the middle of the Upper Elton Formation in the Goggin Road section of the Ludlow type area. There is some uncertainty over its exact position, but this level puts it within the *P. tumescens*/*S. incipiens* Biozone.

See: [Chitinozoan Biozone 5, Goggin Road.](#)

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**14. Appearance of the *Mesopholidostrophia laevigata* Association. Base of the Lower Bringewood Formation.**

The appearance of the *Mesopholidostrophia laevigata* Association was considered by Watkins (1979, fig. 16) to coincide with the base of the Lower Bringewood Formation in the latter's original basal boundary stratotype. In the Goggin Road section, about 1.5 km SW of the original basal stratotype, characteristic species of the association appear over an extended interval, from the highest 1 m of the Upper Elton Formation through the lowest 12 m of the Lower Bringewood Formation.

Watkins, R. 1979. Benthic community organization in the Ludlow Series of the Welsh Borderland. *Bulletin of the British Museum (Natural History)*, Geology, **31**, 175-280.

See: [Mesopholidostrophia laevigata Association, Lower Bringewood Formation, Goggin Road.](#)

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**15. Base of Chitinozoan Biozone 6.**

The base of Chitinozoan Biozone 6 is estimated to be 8 m above the base of the Lower Bringewood Formation in the Goggin Road section of the type Ludlow area.

See: [Chitinozoan Biozone 6, Goggin Road.](#)

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**16. Base of Chitinozoan Biozone 7. Appearance of *Kockelella variabilis*?**

The base of Chitinozoan Biozone 7 is estimated to be approximately 25 m below the top of the Lower Bringewood Formation in the Deer Park Road section of the type Ludlow area.

*Kockelella variabilis* (Walliser) is reported to appear in the Lower Bringewood Formation of the Ludlow area, but no stratigraphical or locality details have been published.

See: [Chitinozoan Biozone 7, Deer Park Road, \*Kockelella variabilis\*.](#)

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**17. Base of Chitinozoan Biozone 8.**

The base of Chitinozoan Biozone 8 is estimated to be approximately 2.5 m below the top of the Lower Bringewood Formation in the Deer Park Road section of the type Ludlow area.

See: [Chitinozoan Biozone 8, Deer Park Road.](#)

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**18. Appearance of the *Kirkidium knightii* Association. Appearance of *Coryssognathus dubius* and *Pelekysgnathus dubius*. Base of the *Apiculiretusispora? asperata* Sub-Biozone? Base of the Upper Bringewood Formation.**

The *Kirkidium knightii* Association is interbedded with and grades into the *Mesopholidostrophia laevigata* Association in the Upper Bringewood Formation. Since the *K. knightii* Association is characteristic of the Upper Bringewood Formation, its incoming is placed at the base of the formation. *Kirkidium knightii* (J. Sowerby) is reported to be very common in a 10 cm band, 1.2 m above the base of the Upper Bringewood Formation in the Deer Park Road section of the Ludlow area.

According to Aldridge (1975), the Upper Bringewood Formation is marked by the appearance of *Coryssognathus* [formerly *Distomodus*] *dubius* (Rhodes) and *Pelekysgnathus dubius* Jeppsson (see also Aldridge *et al.* 1979, fig. 1), but no stratigraphical or locality details have been published.

The *Apiculiretusispora? asperata* Sub-Biozone is believed to span the boundary between the *Saetograptus incipiens* and *Saetograptus leintwardinensis* graptolite biozones in south Wales, but the precise level of the base of the *asperata* Sub-Biozone is uncertain. Its base is placed tentatively at the base of the Upper Bringewood Formation.

Aldridge, R.J. 1975. The stratigraphic distribution of conodonts in the British Silurian. *Journal of the Geological Society, London*, **131**, 607-618.

Aldridge, R.J., Dorning, K.J., Hill, P.J., Richardson, J.B. & Siveter, D.J. 1979. Microfossil distribution in the Silurian of Britain and Ireland. In Harris, A.L., Holland, C.H. & Leake, B.E. (eds) *The Caledonides of the British Isles - reviewed*. Geological Society of London, Special Publication No. **8**, 433-438.

See: [Kirkidium knightii](#) Association, Deer Park Road, *Coryssognathus dubius* and *Pelekysgnathus dubius*, *Apiculiretusispora? asperata* Sub-Biozone, Upper Bringewood Formation.

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**19. Base of Chitinozoan Biozone 9.**

The base of Chitinozoan Biozone 9 is placed at the top of the Upper Bringewood Formation at Sunnyhill Quarry in the type Ludlow area, immediately below the thin shale at the base of the Lower Leintwardine Formation.

See: [Chitinozoan Biozone 9, Sunnyhill Quarry.](#)

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**20. Appearance of the *Sphaerirhynchia wilsoni* Association. Base of the *Saetograptus leintwardinensis* Biozone. Base of the *Leoniella carminae* Biozone. Base of the Ludfordian Stage. Base of the Lower Leintwardine Formation. Changes in the ostracode fauna.**

The base of the Ludfordian Stage coincides with the base of the Lower Leintwardine Formation in Sunnyhill Quarry near Ludlow.

The change from the *Mesopholidostrophia laevigata* or *Kirkidium knightii* Association to the *Sphaerirhynchia wilsoni* Association can be regarded as transitional across the Upper Bringewood to Lower Leintwardine Formation boundary at Sunnyhill Quarry, but is placed at the formation boundary for convenience.

*Saetograptus leintwardinensis leintwardinensis* (Lapworth), indicative of the *Saetograptus leintwardinensis* Biozone, occurs about 0.25 m above the base of the Lower Leintwardine Formation at Sunnyhill Quarry, and in basal beds of the formation in the neighbouring Aymestrey and Leintwardine districts, but has not been found below the Lower Leintwardine Formation. On this evidence the base of the *leintwardinensis* Biozone is considered to approximate to the base of the stage.

The base of the *Leoniella carminae* Biozone is placed at the base of the Lower Leintwardine Formation, although no details have been published.

Ostracode faunas are more diverse in the Ludfordian Stage than in the Gorstian. An ostracode fauna with *Neobeyrichia nutans* (Kiesow) and *Hemsiella* cf. *loensis* Martinsson characterizes the Lower Leintwardine Formation.

See: [Sphaerirhynchia wilsoni](#) Association (upper phase), [Saetograptus leintwardinensis](#) Biozone, [Leoniella carminae](#) Biozone, Ludfordian ostracode faunas, Boundary stratotype for the base of the Ludfordian Stage, Lower Leintwardine Formation, Sunnyhill Quarry.

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**21. Highest occurrence of *Kockelella variabilis*.**

The highest record of *Kockelella variabilis* Walliser is between 0.5 and 0.9 m above the base of the Ludfordian Stage in the stratotype section at Sunnyhill Quarry.

See: [Kockelella variabilis, Sunnyhill Quarry.](#)

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**22. Base of the *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone?**

Burgess & Richardson (1995, p. 32) believed the *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone to cover part of the *Saetograptus leintwardinensis* Biozone, extending upwards to the top of the Ludlow Series. The exact level of the base of the subzone within the *leintwardinensis* Biozone is uncertain. The level shown on the holostratigraphical chart is therefore tentative.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Stellatispora inframurinata var. inframurinata Sub-Biozone.](#)

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**23. Base of Chitinozoan Biozone 10.**

The base of Chitinozoan Biozone 10 is located between 7 and 8 m above the base of the Lower Leintwardine Formation, in the section above Sunnyhill Quarry in the type Ludlow area.

See: [Chitinozoan Biozone 10, Sunnyhill Quarry.](#)

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**24. Appearance of the *Shaleria ornatella* Association.**

The *Shaleria ornatella* Association appears about 2 m below the top of the Lower Leintwardine Formation on The Whitcliffe at Ludlow.

See: [Shaleria ornatella Association, The Whitcliffe.](#)

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**25. Base of Chitinozoan Biozone 11.**

The base of Chitinozoan Biozone 11 is located just below the top of the Lower Leintwardine Formation on The Whitcliffe, variously estimated at 0.6 to 0.84 m below the top of the formation.

See: [Chitinozoan Biozone 11, The Whitcliffe.](#)

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**26. Change in the ostracode fauna. Base of the Upper Leintwardine Formation.**

The Upper Leintwardine Formation contains the stratigraphically important ostracode *Neobeyrichia lauensis* (Kiesow), along with *N. confluens* Shaw and *N. scissa* Martinsson.

See: [Ludfordian ostracode species, Upper Leintwardine Formation.](#)

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**27. Base of Chitinozoan Biozone 12 (= base of the *Eisenackitina philipi* Biozone).**

The base of Chitinozoan Biozone 12 occurs 0.46 m below the top of the Upper Leintwardine Formation on The Whitcliffe at Ludlow.

See: [Chitinozoan Biozone 12, \*Eisenackitina philipi\* Biozone, The Whitcliffe.](#)

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**28. Appearance of the *Protochonetes ludloviensis* Association. Base of the *Bohemograptus bohemicus* Biozone? Base of the *Visbysphaera whitcliffensis* Biozone. Change in the ostracode fauna. Base of the Lower Whitcliffe Formation.**

The appearance of the *Protochonetes ludloviensis* Association coincides with the base of the Lower Whitcliffe Formation on The Whitcliffe and in the Deer Park Road section of the Ludlow area.

There are no records of identifiable graptolites from either the Lower Whitcliffe or Upper Whitcliffe formations in the type area, so no direct evidence for the vertical extent of the *Saetograptus leintwardinensis* Biozone, but the *Bohemograptus bohemicus* Biozone is suggested to correlate with a level above the Upper Leintwardine Formation.

The base of the *Visbysphaera whitcliffensis* Biozone is placed at the base of the Lower Whitcliffe Formation, but no details have been published.

The Upper Leintwardine ostracode fauna, with *Neobeyrichia lauensis* (Kiesow) and its associates, is replaced in the Lower Whitcliffe and Upper Whitcliffe formations by a fauna characterized by *Calcaribeyrichia torosa* (Jones).

See: [Protochonetes ludloviensis Association, The top of the leintwardinensis Biozone in the type Ludlow succession, Visbysphaera whitcliffensis Biozone, Ludfordian ostracode faunas, Lower Whitcliffe Formation, The Whitcliffe, Deer Park Road.](#)

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**29. Appearance of *Ozarkodina remscheidensis eosteinhornensis*, *O. snajdri* and *O. wimani*.**

*Ozarkodina remscheidensis eosteinhornensis* (Walliser), *O. snajdri* (Walliser) and *O. wimani* (Jeppsson) appear less than 1 m below the top of the Lower Whitcliffe Formation on The Whitcliffe at Ludlow.

See: [Conodonts from the Lower Whitcliffe Formation, \*Ozarkodina remscheidensis eosteinhornensis\*, \*Ozarkodina snajdri\*, \*Ozarkodina wimani\*.](#)

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**30. Highest chitinozoans assigned to Chitinozoan Biozone 12 (= the *Eisenackitina philipi* Biozone).**

The top of the biozone has not been defined, but the highest chitinozoans from The Whitcliffe at Ludlow, attributed to Biozone 12, were collected about 2.4 m above the base of the Upper Whitcliffe Formation in its basal boundary stratotype section.

See: [Chitinozoan Biozone 12, \*Eisenackitina philipi\* Biozone, The Whitcliffe, Upper Whitcliffe Formation.](#)

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**31. Occurrences of *Eisenackitina barrandei* and *Ozarkodina cf. crispa*.**

A specimen of *Eisenackitina barrandei* Paris & Kríz, possibly representing the *E. barrandei* Biozone, has been found between 0.23 and 0.26 m below the top of the Ludlow Series, near Downton, west of Ludlow. *Ozarkodina cf. crispa* (Walliser) occurs 0.15 to 0.3 m below the top of the Upper Whitcliffe Formation at Ludford Corner (Whitcliffe Road).

See: [Eisenackitina barrandei Biozone, Conodonts from the Upper Whitcliffe Formation, \*Ozarkodina crispa\*, Whitcliffe Road.](#)

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### 32. **Base of the Prídolí Series.**

The base of the Downton Castle Sandstone Formation approximates to the base of the Prídolí Series in the Ludlow area.

The top of the *Visbysphaera whitcliffensis* Biozone is considered to approximate to the top of the Ludlow Series.

There is a change in the ostracode fauna across the lithostratigraphical boundary, with the almost monospecific fauna of *Calcaribeyrichia torosa* (Jones) in the Upper Whitcliffe Formation being replaced by a fauna with *Frostiella groenvalliana* Martinsson, *Londinia arisaigensis* Copeland, *Londinia fissurata* Shaw and *Nodibeyrichia verrucosa* Shaw at the base of the Downton Castle Sandstone Formation. *Frostiella* provides evidence for the indirect correlation of the Downton Castle Sandstone Formation with the Prídolí Series.

See: [Local base of the Prídolí Series, \*Visbysphaera whitcliffensis\* Biozone, Ostracodes and correlation of the base of the Prídolí Series, \*Frostiella groenvalliana\*, Whitcliffe Road.](#)

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### 33. **Highest occurrence of the *Protochonetes ludloviensis* Association. Base of the *Synorisporites tripapillatus*-*Apiculiretusispora spicula* Spore Biozone.**

A transported fauna of the *Protochonetes ludloviensis* Association is present in the Ludlow Bone Bed Member at the base of the Downton Castle Sandstone Formation, and represents the highest occurrence of the association.

The base of the *Synorisporites tripapillatus*-*Apiculiretusispora spicula* Biozone is placed immediately above the base of the Downton Castle Sandstone Formation.

See: [Protochonetes ludloviensis Association, Synorisporites tripapillatus-Apiculiretusispora spicula Biozone, Whitcliffe Road.](#)

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