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THE LLANDOVERIAN GRAPTOLITE SUCCESSION IN BRITAIN,

by O. T. Jones (Cambridge).

Charles Lapworth (1878) (7) was the first to work out a graptolitic zonal succession of the rocks which in the South of Scotland lie between the top of the Ordovician and the base of the Wenlockian.

The rocks consist of shales and greywackes which were divided into the Birkhill group and the Gala group.

The Birkhill group was subdivided in ascending order into the zones of *Diplograptus (Akidograptus) acuminatus, D. (Mesograptus) modestus, Monograptus gregarius, Diplograptus (Cephalograptus) cometa and Monograptus spinigerus* (= *sedgwicki)*. The Gala group (8), (9), (10) comprised the zones of *Rastrites maximus, Monograptus exiguus* and *Cyrtograptus grayae.*

J. E. Marr and H. A. Nicholson (1888) (12) applied to the rocks of equivalent age in the Lake District (The Stockdale Shales) a more detailed subdivision. The Stockdale Shales were divided into the Skelgill beds and the Browgill beds. In the former they recognized the zones of *Diplograptus (Akidograptus) acuminatus, D. (Dimorphograptus) confertus, Monograptus fimbriatus. M. argenteus, M. convolutus* (including *Cephalograptus cometa*) and *M. spinigerus* (= *sedgwicki*). In the latter they established the zones of *Monograptus turriculatus*

and *M. crispus* which is separated from the Wenlockian by some barren beds. F. W. SHOTTON (16) found the higher zone of *Monograptus crenulatus* above these barren beds in the Cross Fell inlier north east of the Lake District.

In the Lake District the relations between the zones of *Monograptus fimbriatus* and *D. confertus* are complicated by faulting and the succession is probably incomplete.

In Central Wales, the Llandoverian rocks are of great aggregate thickness. The Graptolite zones are more widely spaced and it has been found possible to establish a detailed graptolitic succession from the base to the summit of the Llandoverian (1), (2), (5), (6), (11), (13), (14), (15), (17).

The following graptolite zones have been established in this region : *Glyptograptus persculptus, Akidograptus acuminatus, Monograptus atavus* (formerly referred to *M. tenuis), M. acinaces, M. cyphus* (s.s.), *M. triangulatus, Mesograptus magnus, Monograptus leptotheca, M. convolutus, Cephalograptus cometa, Monograptus sedgwicki, Rastrites maximus, Monograptus turriculatus, M. crispus, M. griestonensis* and *M. crenulatus.* The last named is overlain by the zone of *Cyrtograptus murchisoni* which is adopted as the basal zone of the Wenlockian.

A correlation has also been established between the subdivisions of the Llandoverian based on shelly fossils and those based on the graptolitic succession. The Llandoverian in the type area of Llandovery (4) is divisible into Lower, Middle and Upper subdivisions separated from one another by well marked unconformities.

A subdivision called the Tarannon Shales or Tarannonian has been used by certain authors. In the Tarannon (or more correctly Trannon) area the name was first applied by W. T. AVELINE to a group of green and purple mudstones which conformably underlies the Wenlockian. Rocks of somewhat similar lithology were mapped by AVELINE for the Geological Survey from Trannon to Conway in North Wales. It was subsequently found (17) that the purple and green mudstones of Trannon correspond to the zone of *Monograptus crenulatus* only whereas at Conway the somewhat similar mudstones include the zones from *Rastrites maximus* to *M. crenulatus.* The use of the name has consequently led to much confusion and it should therefore be discarded or retained merely as a local name in the Trannon area (3).

Not far above the base of the Upper Llandoverian at Llandovery where it rests unconformably on the Lower Llandoverian there is a shale band which contains *Monograptus sedgwicki* and other species belonging to that zone (4). The Upper Llandoverian is consequently regarded as covering the interval between the base of the *M. sedgwicki* zone and the base of the Wenlockian. It is therefore broadly equivalent to the Trannon shales of Conway, but not of Trannon; to the Gala together with a part of the Upper Birkhill of the South of Scotland; to the Upper Skelgill and the Browgill of the Lake District and to various local subdivisions in other areas where the graptolitic facies prevails.

The boundary between the Middle and Lower Llandoverian has not been fixed so precisely. The *Monograptus acinaces* zone is represented by *M. Sandersoni* some distance below the top of the Lower Llandoverian, while the Middle Llandoverian contains at some distance above its base the fauna of the *Monograptus convolutus* zone (4).

The most striking lithological change in Wales occurs between the black shales of the *M. fimbriatus* zone and the grey or mottled mudstones with thin shale bands of the zones of *Mesograptus magnus* and *Monograptus leptotheca* or its equivalent the *M. argenteus* zone of the Lake District. It has been suggested therefore that the shale band containing *Mesograptus magnus* in abundance should be adopted as the base of the Middle Llandoverian on the graptolitic scale.

The Lower Llandoverian then includes the zones from *Glyptograptus persculptus* to *Monograptus fimbriatus*. The separation of the Lower Llandoverian from the uppermost Ordovician is based on a sharp lithological and physical change just below the band with abundant *Glyptograptus persculptus*. The underlying Ordovician rocks contain at a considerable depth graptolites of the zone of *Dicellograptus anceps* (13).

These correlations between the major subdivisions of the shelly facies and those of the graptolitic facies greatly simplify the classification of the Llandoverian rocks and make redundant a large number of local names which have been applied to these rocks in various parts of Britain.

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