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Murchison in the Welsh Marches: a History of Geology Group field excursion led by John Fuller, May 8th – 10th, 1998

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FULLER, J.G.C.M. & TORRENS, H.S. (2010). Murchison in the Welsh Marches: a History of Geology Group field excursion led by John Fuller, May 8th – 10th, 1998. *Proceedings of the Shropshire Geological Society*, **15**, 1–16. Within the field area of the Welsh Marches, centred on Ludlow, the excursion considered the work of two pioneers of geology: Arthur Aikin (1773-1854) and Robert Townson (1762-1827), and the possible train of geological influence from Townson to Aikin, and Aikin to Murchison, leading to publication of the *Silurian System* in 1839.

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BACKGROUND

The History of Geology Group (HOGG), one of the specialist groups within the Geological Society of London, has organised a number of historical trips in the past. One was to the area of the Welsh Marches, based at The Feathers in Ludlow, led by John Fuller in 1998 (8–10 May). This paper describes the itinerary of that excursion, providing a record of the discussion and providing a basis for future study.

HOGG was inaugurated in October 1994 to encourage interest in the lives and work of those scientists and philosophers who influenced both the study and the practice of geology. The Group is open to anyone with an interest in the history of geology, and the events and personalities that have shaped the way in which it is studied and practiced today [www.geolsoc.org.uk/hogg].

INTRODUCTION BY PROFESSOR CHARLES LAPWORTH

"Below the Old Red Sandstone of Shropshire comes that enormous series of Lower Palaeozoic and pre-Palaeozoic strata first described as a whole by Murchison in the classical pages of the *Silurian System*. He pointed out that this series was constituted of two grand members -- namely a basal and Barren series of the Longmynd area below (which he correlated with Sedgwick's "Cambrian") and an overlying and Fossiliferous series above (which he erected into his original "Silurian System"). This Silurian System as thus defined was divided by him into two parts -- an "Upper Silurian" shading up into the Old Red Sandstone above, and a "Lower Silurian" shading down into the basal "Cambrian" (Longmynd) below. The theoretical line of division between his Upper and Lower Silurian ran vaguely across the low ground of Central Shropshire from the neighbourhood of the Craven Arms to Wellington, and along this line the rocks and faunas of the Lower and Upper Silurian were supposed to graduate the one into the other.

As most geologists are aware, the progress of discovery soon led Murchison to recognise the fact of a general unconformity, in Shropshire, between his "Lower" and "Upper Silurian," and the work of the Geological Surveyors demonstrated the fact of a corresponding palaeontological break. This break, however, was supposed to be bridged elsewhere by a transitional formation, the Llandovery, which was assigned in part by Murchison to his "Lower", and in part to his "Upper Silurian". At present, however, this Llandovery formation is by general consent united wholly to the latter. This plan was first proposed by Sir Charles Lyell, and the system thus constituted by the Llandovery, Wenlock, and Ludlow formations is the typical Upper Silurian of the text-books". "The limits of Murchison's three great systems, as figured on the maps of the Geological Survey, are shown in the [accompanying] map (Figure 1)".

This map (Figure 1) was drawn by W.W. Watts, then Professor Lapworth's assistant, following instructions given in a letter from Lapworth dated June 12, 1894:

> "Get the map done in three colours, -- 1. showing Upper Silurian, Murchison; 2. Lower Silurian, Murchison; 3. Cambrian, Murchison."

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> "The excursionists ... would see what is so desirable for them to see; namely the three fundamental facts, (1st) that Murchison's Cambrian is not Cambrian at all, (2ndly) that his Lower Silurian includes both the Cambrian and the Ordovician, and (3rdly) that his Upper Silurian is unconformable on everything else."

"Throughout the whole county the horizontal or gently sloping basement layers of the [Upper] Silurian rocks creep in turn over every one of the successive zones of the eroded older geological formations."

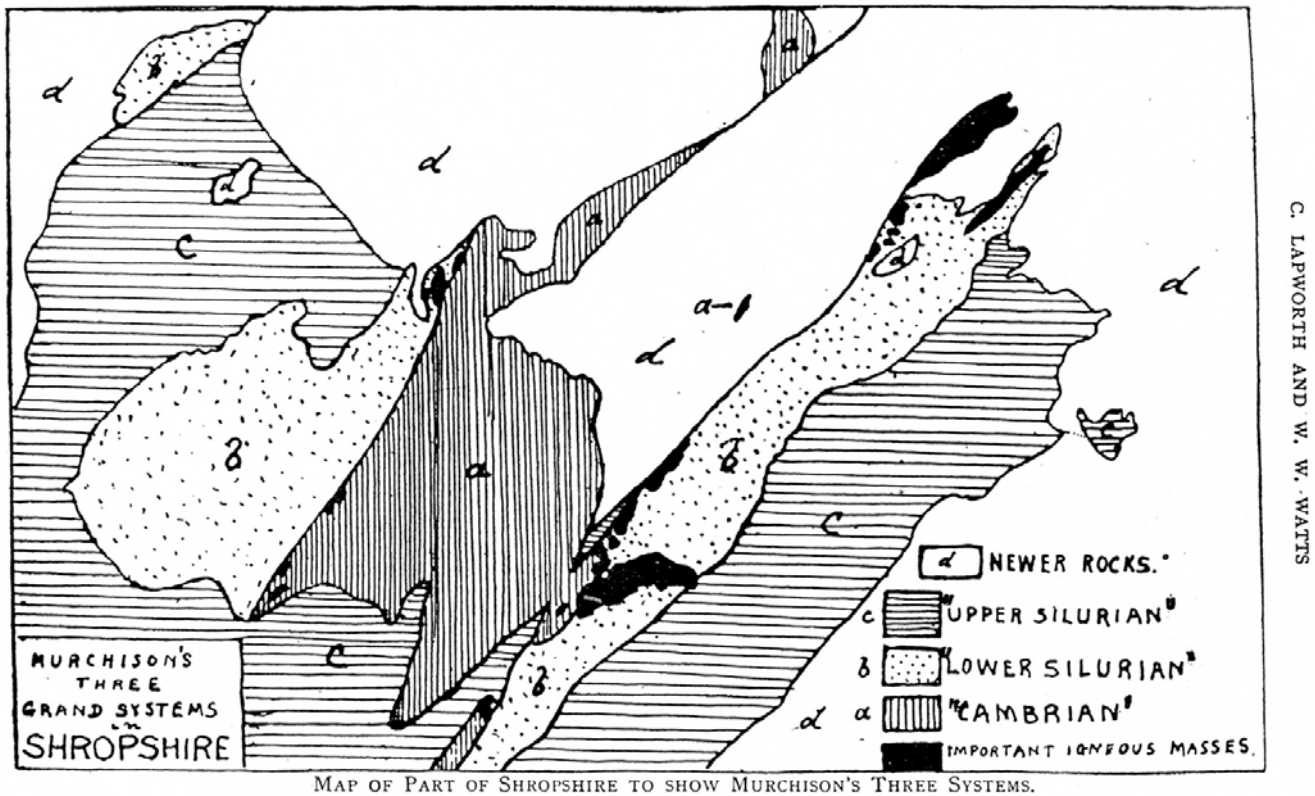
"It is idle here to enter on the history of the wearisome controversy as to the proper use of the names Cambrian and Silurian, or to point out how natural it was for the followers of Sedgwick to term the first and second of these systems Lower and Upper Cambrian; and for the followers of Murchison to term the second and third Lower and Upper Silurian. The facts remain the same whatever may be the nomenclature adopted." (Lapworth & Watts, 1894a,b).

SOUTH SHROPSHIRE GREYWACKE
Friday afternoon, May 8th, 1998

The bus proceeded from Ludlow to visit sites on the line of Aikin's 1810 cross-section (Figure 2). The route followed B4365 and B4368 by Corfton, Diddlebury, Millichope Park, Brockton, to East Hope. Thence over Wenlock Edge to Heywood Common, Hope Bowdler, Church Stretton, and the Cardingmill Valley.

Note on Arthur Aikin and Robert Townson

Long before Murchison set foot in Shropshire, two pioneers of geology were at work in the area north of Ludlow. They were Arthur Aikin (1773-1854) and Robert Townson (1762-1827). Aikin, a one-time Unitarian minister, traveller, author and lecturer in chemistry, was a founding member of the Geological Society. In 1810 he issued his *Proposals for a mineralogical survey of Shropshire*, which included a specimen map and cross-section of local strata (Figure 2).



MAP OF PART OF SHROPSHIRE TO SHOW MURCHISON'S THREE SYSTEMS.

Figure 1. Sketch map drawn by W.W. Watts, Professor Lapworth's assistant, entitled "Murchison's Three Grand Systems", following instructions given in a letter from Lapworth dated June 12, 1894. *[Reproduced from Lapworth & Watts, Proceedings of the Geologists' Association]*

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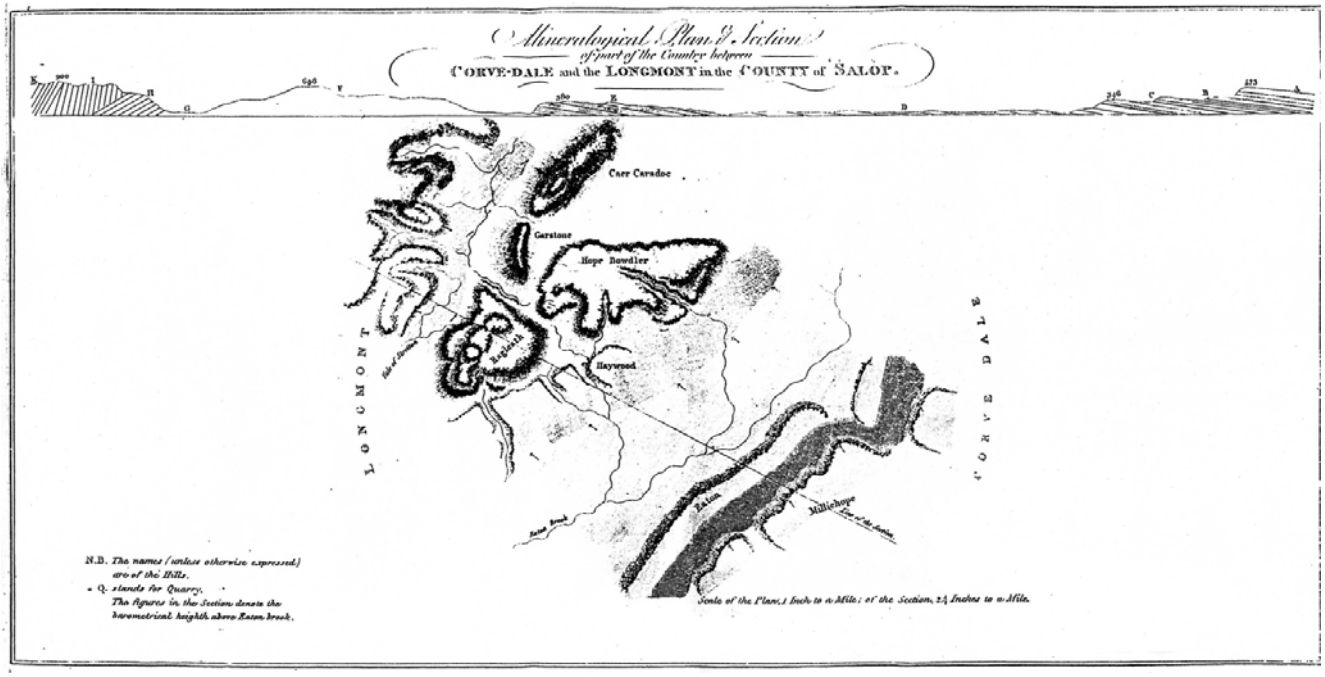

Figure 2. The geological map in part of South Shropshire drawn by Arthur Aikin for his *Proposals for a mineralogical survey of Shropshire* (1810).

Aikin's *Proposals* contained a description of ten stratigraphic subdivisions in the heart of the south Shropshire Greywacke. Though he employed Werner's system of nomenclature, still in vogue in 1810, his stratigraphic and structural work, including measurements of dip, strike, and bed-thickness, were hugely valuable to Murchison. "Mr Aikin's notes appear to us to coincide with Mr Murchison's descriptions . . . " remarked the Edinburgh Review, pointedly (Fitton, 1841).

The Table below, comparing Aikin's and Murchison's stratigraphic nomenclature, owes much to Torrens (1983). See Figure 3 for Murchison's standard Silurian cross-sections, 1835 and 1839.

ARTHUR AIKIN, 1810		MURCHISON, 1839 (and later authors)	
Newest Floetz Limestone Formation	A Limestone	AYMESTRY LIMESTONE	UPPER SILURIAN
	B Soft limestone and Slate-clay	LOWER LUDLOW SHALE	
	C Limestone	WENLOCK LIMESTONE	
	D Blue slate-clay	WENLOCK SHALE	
	E Reddish-brown Flagstone and Sandstone for building	(Acton Scott Beds) CARADOC FORMATION (Cheney Longville & Chatwall Sandstone)	LOWER SILURIAN (Ordovician)
Trap Formation	F Unstratified Red felspar	ERUPTIVE TRAP (Uriconian)	(Precambrian Volcanics)
Primitive Series	G K Purple & green H Clay-slates & I Greenstones	CAMBRIAN, or BOTTOM ROCKS (Longmyndian)	(Precambrian)

Table 1. Comparison of Aikin's with Murchison's stratigraphic nomenclature.

Robert Townson, of Lydleys Hayes, near Penkridge Hall, was known to Arthur Aikin, certainly by 1800; and he probably had a significant effect on Aikin's geological work. Townson was a naturalist and a student of animal physiology. He travelled widely, and studied the geology and mineralogy of Shropshire from about 1785. In 1799 he published a forty-five page work of meticulously careful observation entitled *A Sketch of the Mineralogy of Shropshire*.

There is a possible train of geological influence here: *viz*., from Townson to Aikin, and Aikin to Murchison, which is only now being properly explored (Torrens in Rózsa, 2000).

"Of the few memoirs . . . relating to parts of the region illustrated, the earliest are by Mr. A. Aikin," wrote Murchison. "He no sooner heard of the progress I was making in the present work, that he placed at my disposal his original notes and drawings . . . In truth, at the early period when Mr. Aikin undertook the task, it was almost hopeless to attempt to unravel the structure of Shropshire" (Murchison, 1839).

The modalities supporting this view of history invited comment, by Hugh Torrens (Friday evening at the hotel).

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Stop 1, Pedlars Rest (Grid SO 486 844)

Corve Dale to the east is floored by Old Red Sandstone. In the distance rise flat-topped masses of Titterstone Clee and Brown Clee, each capped by an outlier of Carboniferous rocks and tough greenstone.

Immediately east of Pedlars Rest, at the junction of B 4365 and B 4368, the top 4 ft of Downton Castle Sandstone (the basal unit of the Old Red) was at one time visible low down in a now disused quarry.

Stop 2, Sun Inn, Corfton (Grid 495 852)

In the Sun Inn car-park an outcrop of micaceous olive-coloured Upper Ludlow Shale comes into view. There are further outcrops along the road approaching Millichope. All dip toward the east, under the Old Red. At Diddlebury the bone-bed at the top of the Upper Ludlow Shale is present, though hard to find. This curious deposit, a few inches of sediment packed with fish fragments and shell debris still awaits satisfying explanation.

Stop 3, Entrance to Millichope Park

The southeastern end of Aikin's 1810 section is placed at Millichope Hill. It shows strata at "A" which he described as limestone alternating with soft slate clay, containing corals. "The limestone is of a yellowish-gray colour, in compressed irregular nodules, and apparently almost wholly composed of bivalve shells and other organic remains." This is Aymestry Limestone, which is here less strongly developed than toward the south.

Stop 4, Easthope

The road from Brockton to Easthope crosses Upper Ludlow Shale, Aymestry Limestone ("A" of Aikin), Lower Ludlow Shale ("B" of Aikin, described as soft limestone alternating with earthy slate clay) and, at the summit, Wenlock Limestone ("C" of Aikin), much quarried along the escarpment. There is a site one mile north of Easthope.

Stop 5, Soudley Pools

Aikin's unit "D" is mainly Wenlock Shale, described by him as a bluish brown slate-clay "easy of decomposition; hence the surface forms a fertile tract of bluish clay, celebrated for its growth of wheat, but infamous for its roads."

Bed "E" is a reddish brown sandstone with "impressions of bivalve shells, mostly small pectinites." The lower part was quarried for building stone. The place marked Haywood on the section is Upper Heywood or Heywood Common near the edge of the (Orthis) *alternata* Limestone. Murchison called it the Hollies Limestone, and regarded it as the highest calcareous part of the Caradoc formation. It passed, he said, conformably upward into the lowest member of the Upper Silurian. He later admitted, by means of a footnote added to Siluria, that Government Surveyors had detected, on the banks of the Onny, "a small amount of unconformity."

Stop 6, Cardingmill Valley, the Longmynd

The road from Soudley and Hope Bowdler passes through the Stretton Hills, a range of whale-backed features composed chiefly of tough Precambrian volcanics. The section marks the Ragleth-Hope Bowdler mass at letter "F". Aikin noted it to be "mainly tile-red compact feldspar," i.e. a rhyolite. These rocks as a whole were given the name Uriconian by Charles Callaway in 1879, echoing the name of Roman Virconium (Wroxeter) to the north.

West of these hills, where Aikin's section enters the Longmynd, four units or subdivisions are shown, viz., G, H, I, and K. They are "stratified rocks, differing greatly both in their age and direction from those already mentioned," and consist of primitive clay-slate, greenstone slate, and reddish-purple indurated clay-slate.

Even allowing for the inherent peculiarities of Werner's nomenclature -- "Primitive", for example, meaning pre-Transition or pre-Greywacke -- Aikin was closer to the geological truth than Murchison, who claimed afterwards that Longmyndian rocks belonged to the Cambrian. Indeed, Murchison opened Chapter 3 in the 4th edition of *Siluria* (1867) asserting grandly that in Shropshire "Cambrian rocks are more largely developed than in any other part of England and Wales." Poor battered Sedgwick.

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Stop 7, Comley Quarry, Lapworth's *Olenellus* discovery

In 1878, seven years after Murchison's death, Charles Callaway announced the discovery of unidentifiable trilobite remains from Comley quarry. The rock in which they were found, according to Murchison and the Survey, was Caradoc Sandstone (i.e. Lower Silurian), though doubts were accumulating since Callaway's earlier find of Upper Cambrian fossils in nearby strata that also had been grouped with the Caradoc Sandstone.

Lapworth soon began to devote attention to these Comley trilobites, and when in 1888 the International Geological Congress met in London, he had by then found a sufficient number of fragments to convince himself that he was in possession of a species of *Olenellus*, in fact the first to be found in Britain. At the same Congress, when C.D. Walcott stated the American view that *Olenellus* marked a Lower Cambrian horizon, Lapworth followed it with an announcement of his Comley discovery.

The general configuration of strata were elucidated subsequently by Cobbold (1927) (Figure 4).

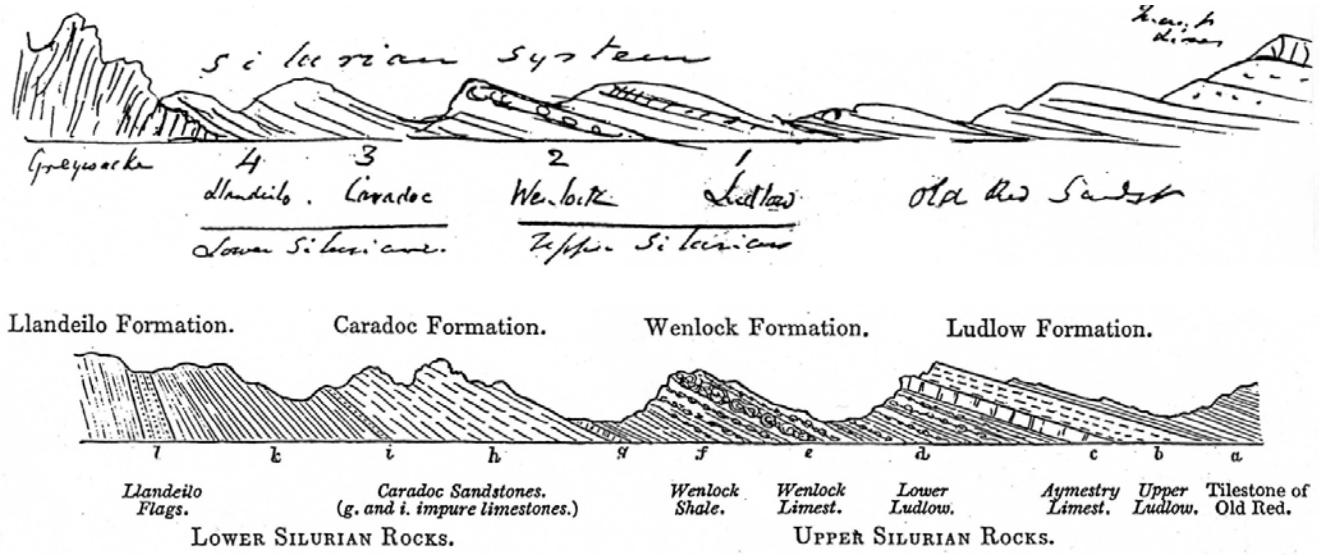

Figure 3. Murchison's standard Silurian cross-sections, 1835 (above) and 1839 (below, as it appeared in the *Silurian System* p.196). Murchison's sketch section of 1835 was in a letter addressed to William Buckland, June 17, 1835: "I scribble you a little woodcut intended for the annals of Philosophy which tells the whole history to the unlearned. I am, he wrote, "quite resolved to adopt the term "Silurian System" for all the fossiliferous strata which I have described & which are interpolated between the Old Red Sandstone & Greywacke properly so called." Unlike De la Beche, Murchison evidently considered that the Silurian System was an entity separate from the Greywacke.

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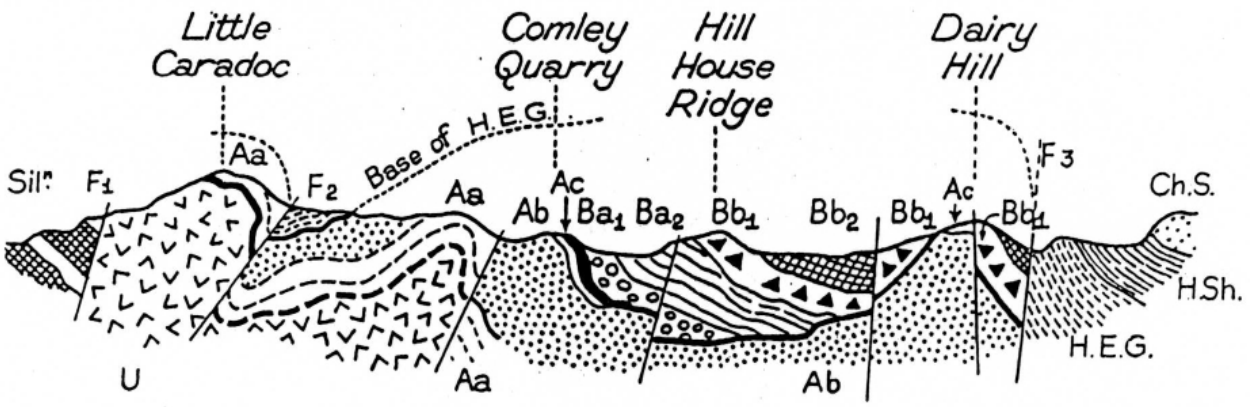

The Silurian on the west is part of the All Stretton area, showing the Wenlock and Aymestry limestones.

Caradocian: Ch.S. = Chatwall Flags and Sandstone; H.Sh. = Harnage Shale; H.E.G. = Hoar Edge Grit. Cambrian: Bb2 = *Paradoxides intermedius* Shale; Bb1 = *P. intermedius* Grit and Breccia (Comley Breccia Bed); Ba2 = *P. groomi* Shale; Ba1 = *P. groomi* Grit and Conglomerate; Ac = Lower Comley Limestones (*Lapworthella*, *Protolenus*, *Strenuella*, '*Eodiscus*' *bellimarginatus*, *Callavia*); Ab = Lower Comley Sandstone; Aa = Wrekin Quartzite; U = Uriconian.

Thickened sinuous lines indicate three unconformities: **1.** At the base of the Cambrian (over Little Caradoc); **2.** At the base of the Middle Cambrian (Comley Quarry to Dairy Hill); **3.** At the base of the Caradoc Series (from near F2 to F3).

F1, F2 and F3 are branches of the Church Stretton Fault Complex.

(After Cobbold 1927.)

Figure 4. The geological section (above) and explanatory text (below) prepared by Cobbold (1927).

Radical consequences were to flow from Lapworth's investigations:

(1) A true Lower Cambrian fauna was proved in Britain for the first time.

(2) Uriconian rocks were shown with practical certainty to be Precambrian.

(3) In consequence of a Precambrian age of the Uriconian, the quartzites overlying Uriconian in the Caradoc Hills could not be thermally altered Lower Silurian sandstone, as identified by Murchison and the Survey.

(4) A decisive case was established that Longmyndian rocks were not Cambrian.

Stop 8, Near Penkridge Hall, off Watling Street.

Park at Grid Ref. SO 484 983, 5.45 pm, by a field-gate opposite Day House, in expectation that Dr H.S. Torrens would join the excursion at this point. Aikin and Townson would be reviewed in an illustrated talk at the hotel by Torrens entitled "Thoughts on Shropshire Geology Before Murchison".

Thence to The Feathers, Ludlow, by 6.30 pm.

Dinner: 7.00 for 7.30. Two guests joined the party: Kate Andrew, Curator of Ludlow Museum, and Joan Nash, Chairman of the Friends of the Museum. The Group's AGM, a short affair, was held as previously announced.

MURCHISON'S TOUR, 1831
Saturday, May 9th, 1998, all day

The bus picked up the party at The Feathers, 9.15 am, and proceeded southwesterly via Richards Castle, Mortimer's Cross, Glasbury, Llyswen in upper Wye valley; Old Red all the way. Trericket Mill, arrived at about 10.30 to 11.00 am. Visited Cavenshane Ferry and the Boat Pool. Lunch stop at The Wheelwrights, Erwood. Then Builth, Carneddau Hills, Old Radnor, Kington, Mortimer's Cross, and Aymestrey.

Remarks on Murchison's Geological Intentions in 1831

The day's trip to the upper Wye valley visited sites associated with a sketch cross-section in one of Murchison's field notebooks, inscribed by him with the words: "This was the first true Silurian." An enlarged copy of this cross-section is attached (Figure 5a), together with an extract from his notebook (Figure 5b).

At face value, such an inscription might be quite unexceptionable, merely a recollection added

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to the sketch at some later time. Samuel Beckett would have understood it -- an aging man's reminiscence of an auspicious day in the past -- one that led on to a series of opportune meetings and singular feats that taken together became the stuff of imperial fame.

From another point of view, one might see such an added annotation to an old notebook as an attempt to manipulate history, an attempt to register the day and the place that would establish as fact an imaginary event. Was the road to Builth really the site of a prescient experience?

"As might be expected, a far more radical process of autobiographical myth-making informed Murchison's retrospective accounts" (Secord, 1986).

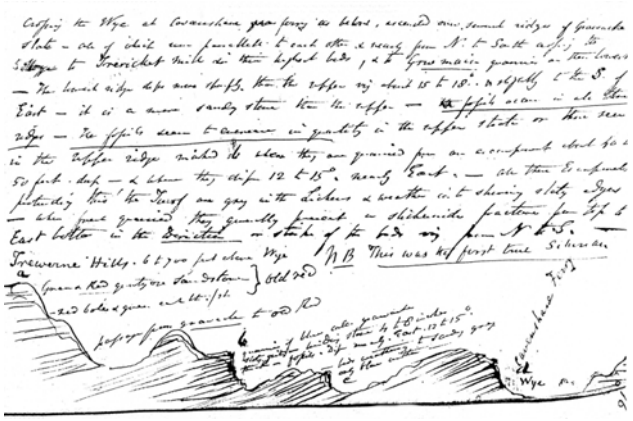

Figure 5a. The annotated geological section from Murchison's visit of 1831 to the upper Wye valley. It concerns the strata immediately below the Old Red Sandstone between Llanstephan and Trericket Mill, south of Builth. The section was later inscribed: "the first true Silurian" *[lower right of text block]*.

Line by line transcription, page 8:
"Crossing the Wye at Cavanshane ferry as below, ascended over several ridges of Grauwacke
Slate -- all of which run parallele to each other & nearly from N. to South crossing the
Wye to Trericket Mill in their highest beds, & to Grw main [Gromaen] quarries on their lowest
- The lowest ridge dips more steeply than the upper viz about 15 to 18°, & slightly to the S. of East -- it is a more sandy stone than the upper -- fossils occur in all these ridges -- The fossils seem to encrease in quantity in the upper strata or those seen in the Upper ridge marked b where they are quarried from an escarpment about 40 to 50 feet deep -- & where they dip 12 to 15°, nearly East. -- All these Escarpments protruding thro' the Turf are grey with Lichens & weather in to shewing slaty edges -- when fresh quarried they generally present a slickenside fracture from top to bottom in the Direction or strike of the beds rising from N. to S. - "

The section, northeast to southwest:

"East Trewerne Hills [SO 125 4311 6 to 700 feet above Wye
a Green & Red quartzose Sandstone
b quarries of blue calc. grauwacke [500 yds NW Llanstephan Ho.]
slaty grits -- building stone 4 to 8 inches
thick -- fossils. Dip mainly East 12 to 15°
c beds weathering to sandy grey, only blue within d Cavanshane Ferry Wye West"

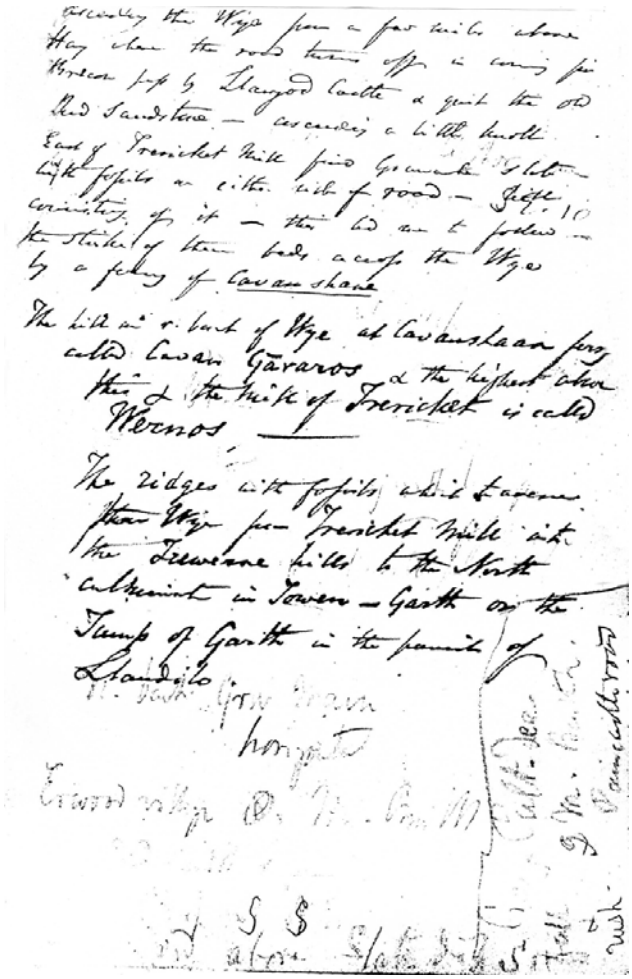

Figure 5b. An extract from the notebook written during Murchison's visit of 1831 to the upper Wye valley.

Murchison's journey in the summer of 1831, its purpose, and his actual route (Figure 6), were the subjects of an unpublished study by James Secord (1981). He adopted the view that in 1831 Murchison was travelling in the Welsh Borderland area as part of a general geological reconnaissance:

"Contrary to his own later testimony and the statements in dozens of histories and textbooks of geology, he had no particular plans for a major study either of the Transition rocks or of the geology of Wales when he first crossed the Welsh border in 1831" (Secord, 1986).

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Figure 6. The route followed by Murchison during his tour of 1831, reproduced from an unpublished manuscript by J.A. Secord, 1981, entitled “Roderick Murchison’s geological tour of England and Wales in 1831”.

"Murchison's plans included a general survey of British geology; with Greenough's map in hand he could clear up unsolved stratigraphical difficulties across the length and breadth of the island. By 1831 the boundaries of this map needed many important corrections, one of the most notoriously inaccurate lines being that between the Old Red Sandstone and the Grauwacke in Wales and the Welsh Borders. In the north of England, visits to old hunting companions could be combined with mapping of the Secondary strata on their estates. Other aspects of the tour demonstrate Murchison's special interest in the theoretical programme of Lyell, a close personal and scientific associate at this time. For example, in many areas (again especially in Wales and the Borders) Murchison could investigate the relation between uplift of strata and underlying processes of igneous action."

"According to his version of events, repeated by all subsequent commentators, Murchison intended from the start of his 1831 tour to look for passage beds below the Old Red. South of Builth, along the banks of the River Wye, he found in a series of gently dipping mudstones what retrospectively became the "first true Silurian" section, the site of a discovery that filled a gaping hole in the succession. As so often in the history of science, this romantic account telescopes a complex series of researches into a single moment of blinding illumination. But the reconstruction of his actions in light of later events went further still, affecting the very essence of the "discovery" itself. Because of his wish to investigate igneous uplift and make corrections to Greenough's map, he had happened on one of the few areas in Britain where such a conformable series could readily be seen."

Two Retrospective Inventions, 1839

"But to proceed to facts connected with our own country. No one was aware of the existence below the Old Red Sandstone, of a regular series of deposits, containing peculiar organic remains. For example, although it was supposed, that the limestone of Dudley was of greater antiquity than the Old Red Sandstone, no one had observed that those deposits were connected by an intermediate formation" (Murchison, 1839).

"In this condition of the subject, I first explored the borders of England and Wales in 1831. The order of succession seen in the ridges on the left bank of the Wye . . . where the Old Red Sandstone is distinctly underlaid by grey fossiliferous strata, first led me to suspect, that I had met with a district containing a good part of the evidence required to lead to a systematic study of our older formations; a surmise which was confirmed by following out these rocks upon their line of bearing to the neighbourhood of Ludlow and Wenlock, where I found them much expanded" (Murchison, 1839).

Preliminary Notes for a Campaign, 1831

Entries in Murchison's notebooks for the period between April 22 and June 17, 1831, before he reached the Wye, offer substantial hints about the ground he was planning to reconnoitre in the Welsh Borderland (Murchison, 1830–31).

> "Visit Bualt & follow Syenite & Trap. Presteign, Kington. - Amestree curious fossils in Slaty limestone - ."
>
> "Ludlow to Craven Arms & Church Stretton & thence by Trap & Coal to Shrewsbury." "fossils in Slate by roadside Grauwacke?"
>
> "From Shrewsbury see Wellington Trap & Wrekin."
>
> "Dudley -- see whether the limestone be unconformable to the Coal -- ? "

Besides trap, greywacke, and fossils, Murchison included the Amestree limestone among his objectives. Someone will surely soon allege that he added it to the list after 1831, to avoid giving credit to Thomas Lewis of Aymestrey. In fact, . . .

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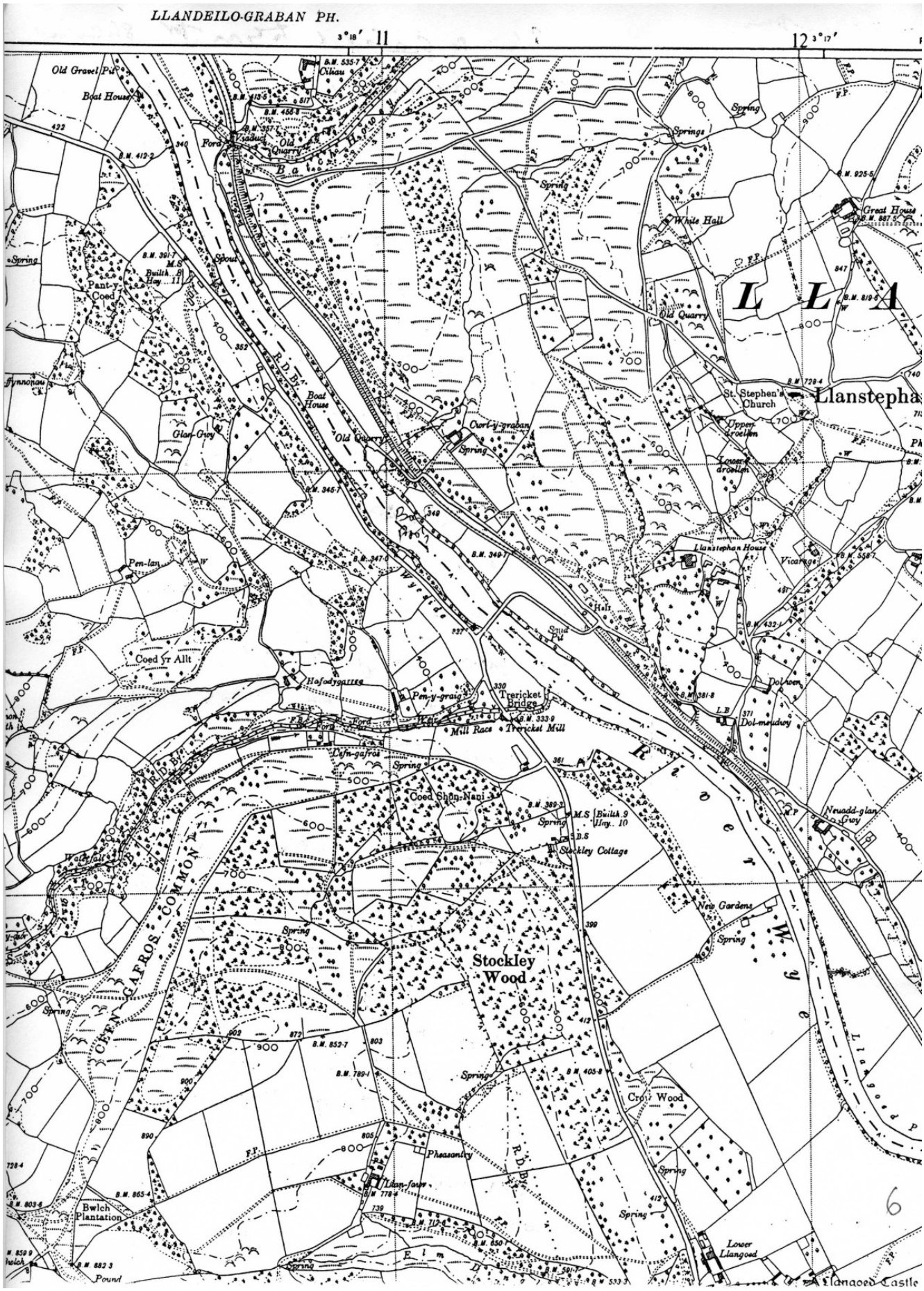

Figure 7. A map showing the area around Trericket Mill to the west side of A 470(T) about 2.5 miles north of Llyswen.

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. . . Murchison may well have heard of the curious fossils in slatey limestone from Conybeare or Buckland, both of whom he consulted during the early days of his tour. Phonetic mis-spellings both of Aymestrey and Builth reveal that the words were taken down from conversation.

Locality 9, Trericket Mill (Grid SO 113 414)
"The first true Silurian"

Trericket Mill stands in a lay-by on the west side of A 470(T) about 2.5 miles north of Llyswen, and about 1.4 miles south of Erwood. Figure 7 is a map of this area.

"Compared with the Shropshire succession, that of this area shows certain notable differences. There is no development, as such, of either the Downton Castle Sandstone or the Ludlow Bone Bed, nor is their rich fish fauna present. Correlation of the Downtonian strata of the two regions has been based, therefore, of necessity, upon the invertebrate faunas. The Silurian rocks have increased greatly in thickness; the Upper Ludlow is at least 600 feet thick in the Wye valley, and the middle Ludlow (= Aymestry Group) exceeds 1000 feet in thickness over most of its course. Though the Upper Ludlow beds are for the most part of the same calcareous flaggy character as in the Ludlow District, they are darker in colour, with more muddy matter; the Middle Ludlow on the other hand, except for occasional thin lenticular limestone bands, never more than a few inches thick, has completely lost its great calcareous member, the Aymestry Limestone, and consists only of sandstones, siltstones and sandy shales" (Straw, 1930).

The best current account of Murchison's explorations in this vicinity is by Duncan Hawley, who described the principal historical locations (Hawley, 1997).

"Immediately to the southeast of the Mill, the road descends from an upper river terrace (*ca.* 20-30 m above river level) to a lower, narrower terrace about 10 m above river level. The soil on the upper terrace is dark red, similar to that typically found covering the Old Red Sandstone, and no doubt Murchison observed this". By contrast, the soil in the bank which descends to the lower terrace is buff yellow with small exposures of grey Upper Silurian rock. It is here that Murchison decided he had "quit the Old Red Sandstone." Confirmation of the change in the underlying geology may well have been realised by his observation of grey beds forming a small waterfall in the Sgithwen Brook, which are easily seen from the bridge at Trericket Mill" (Hawley, 1997).

Locality 10, Viewpoint at Coed Sion-Nani.

About 100 yards south of Trericket Mill a small road climbs westward up to Cefn Gafros. Park the vehicle a short way up on open ground. A gate to the left gives access by a track to a knoll among half-felled forestry work. In 1832 Murchison made a sketch here of the Trewerne Hills, over the Wye.

Looking eastward, Murchison "noticed a series of rising ridges in the hillside on the opposite (Radnorshire) bank of the Wye, and having taken account of the dip of the beds, here about 12° to the east-southeast, he assumed that the ridges represented the strike of the Greywacke beds."

Murchison evidently wished to examine the Greywacke on the other side of Wye, and to sketch a cross-section. To do that he would have to cross the river. He accomplished that "by a ferry of Cavanshane."

No known maps show a ferry of that name, so considerable credit is due to Duncan Hawley for indicating that Murchison was writing a phonetic version of a Welsh name, namely Cavan Shaan or Cafan Sion, meaning John's Boat.

Locality 11, The Boat Pool and Cafan Sion Ferry.

Cross the Wye from Trericket Mill by an amazing one-lane bridge, turn left and park at a gate entrance about 700 yards along on the left. Cross the stile, down a few yards to a gate at the bottom, and turn back downstream along the river bank. The pool of quiet water here is known to anglers on the river as Boat Pool. On the bank, more or less opposite a cottage on the other side, "are the remains of a stone landing platform (1111 4185)."

Over the river, "in the bankside garden of the cottage is a buried anchor point bolted into the rock. Immediately upstream of Boat Pool the river crosses over a series of very prominent rocky ledges, known locally as Hiro Rocks. In the summer months these ledges generally provide

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excellent and extensive exposure of the Upper Silurian" (Hawley, 1997).

Locality 12, at Llanstephan Quarry.

After crossing to the Radnorshire bank, Murchison made his way up the valley side, which here rises in a series of minor scarp and dip slopes. These are the "low terrace-shaped ridges of grey rock dipping slightly to the S.E. on the opposite [left] bank." The largest, located to the northwest of Llanstephan House was being actively quarried in the early 1800s, and this afforded Murchison an opportunity to examine the Grauwacke and its fossils, marking the place "b" on his cross-section, and noting there "quarries of blue calc. grauwacke, slaty grits -- building stone 4 to 8 inches thick -- fossils. Dip mainly East 12 to 15°."

Murchison continued up the side of the valley "in the expectation of finding a conformable passage from the Grauwacke to the Old Red Sandstone. He noted . . . the strata of the 3rd ridge (b) . . . pass upwards (the fossils gradually disappearing) into micaceous greenish hard grit sandstone which plunges to the East under the Old Red Sandstone."

On the other hand, S.H. Straw said that at this place "The actual junction of the Upper Ludlow and the Old Red Sandstone is not exposed, but in the field above the quarry green marls form a small feature" (Straw, 1930).

Locality 13, Erwood, The Wheelwrights.

This is probably a lunch stop. In the dip of the main road passing through the village is a bridge over Cletwr Brook (SO 097 430). Look down from the parapet into the bed of the stream below and see, somewhat unexpectedly, greenish-coloured Old Red Sandstone. You are moreover standing here on the southwestern expression of the great Wrekin-Stretton-Radnor fault-line.

Murchison was puzzled by this reappearance of Old Red Sandstone: "At Erwood the Old Red mottled & green marl & hard green grit are brought in, dipping to the South at about 15°." And he added, "Greenoughs map has I think been put into error by this outlier of Old Red."

"Murchison made several further visits to the area. On August 3, 1832, with the Reverend T.T. Lewis of Aymestry, he visited Craig Pwll Du in the Bach Howey gorge (SO 121 435) about 1.5 km northeast of Llanstephan quarries . . . The following day he travelled (without Lewis) along the Hay to Builth road and stopped at Coed Sion-Nani to draw a field sketch . . . and then completed a traverse on the right bank from Trericket Mill to Cefn Gafros. His notes also show that he had begun to subdivide the rocks based on fossils. He proceeded to the Cletwr Brook at Erwood in order to undertake a more complete survey . . . " (Hawley, 1997).

"The great flexure or the Brecon Anticlinal as it became termed, with its "inlier" of Greywacke, continued to intrigue Murchison and he discovered its western extension a few days later while crossing over Mynydd Eppynt to Brecon . . . he revisited the western part again in July 1833 and made yet a further survey in July 1836 . . . " (Hawley, 1997).

Locality 14, Charlotte Murchison's Sketch of the Carneddau Hills.

The road alongside the Wye from Erwood to Builth passes through rugged hills exposing tracts of Upper Silurian greywacke on both sides of the river, famously known as Aberadw Rocks, and at one time thought to have been the site of the first Silurian.

At Builth in 1831, Murchison hoped to see evidence of structural uplift associated with igneous action, which was one of the themes of his tour.

"The Carneddau Hills," he wrote, are "truly amorphous and eruptive masses of igneous rock, which have broken through and highly altered the Llandeilo flags and associated sandstones."

He also noted that the black and hardened schists of contact on which films of anthracite had been found "led credulous farmers to search for coal" (Murchison, 1854).

What are now called Ordovician basic lavas and tuffs form the Carneddau Hills, and are heavily quarried at Llanelwedd. Yet an aesthetic and scenic quality of landscape, as Charlotte Murchison saw it, can still be found. Cross the Wye at Builth, turning east on A 483(T), and fork right after half a mile to A 481. Proceed for exactly one mile after the fork: ignore the B 4567 turn-off, but turn right into a poorly-marked access road to private residences at 0625 5200. There might be enough space for parking one car at the foot of this lane.

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Walk up the track, gaining elevation. On the left across the valley the two hills of Gaer-fawr and Graig-ddu come into view exactly as Charlotte Murchison sketched them for the illustration that now embellishes her husband's book (Figure 8).

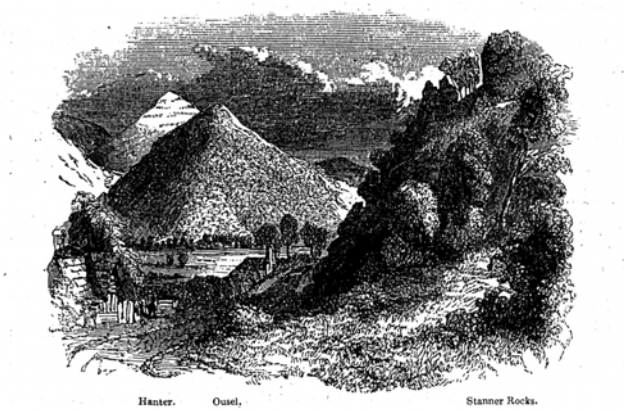
Figure 8. Sketch of the two Carneddau hills of Gaer-fawr and Graig-ddu by Charlotte Murchison (published as a plate in Murchison's *Silurian System*, 1839).

Locality 15, Old Radnor, Stanner Rocks, and the Stretton Fault Line.

At this locality, just before reaching Kington, Murchison recorded another example of the igneous uplift phenomenon that he had set out to find, but here, unknown to Murchison, there was also an appearance of Longmyndian and Uriconian rocks on the alignment of the Stretton-fault complex.

The Caradoc formation, Murchison wrote, "is seen to protrude along a line of fault as an isolated patch (discovered by my friend the Rev. T.T. Lewis) among the Wenlock shale of Brampton Bryan Park, and is again visible further to the S.W. at two points in Radnorshire, the one in a dome to the south of the town of Presteign, the other on the western slopes of the hill of Old Radnor . . . Along this line it is also obviously the uppermost bed of the formation as brought up in domes and arches by a line of igneous eruption, which in evolving the adjacent crystalline hypersthene and feldspathic rocks of Stanner, Hanter, and Ousel, has . . . altered the contiguous sandstones, schists, and grits (just as around the Wrekin, and the Caer Caradoc)" (Murchison, 1854). Figure 9 is Murchison's illustration of Stanner Rocks reproduced from the woodcut version in *Siluria*.

In more recent terms these rocks near Old Radnor consist of basic igneous rocks, with dykes of quartz-porphyry, felsite, and granophyre resembling Uriconian rocks at the Wrekin. They were for some time thought intrusive, but later opinion regards most boundaries as faulted, and presumes these rocks to be Precambrian, probably Uriconian (Earp & Hains, 1971).



VIEW FROM STANNER ROCKS (OUSAL WOOD, HANTER HILL, AND HERGEST RIDGE BEING SUCCESSIVELY SEEN IN THE DISTANCE).

Figure 9. Sketch of Stanner Rocks by Charlotte Murchison (published in both Murchison's *Silurian System*, 1839, p.311, and his *Siluria*, 1854).

Locality 16, Kington.

Murchison stopped here on July 15, 1831; and noted in his field-book:

> "Mr. Mitchell, Surgeon, of Kington first shewed me Pentameri & told me of Mr. Lewis of Aymestry."

This was one of the most important events in the history of the Silurian System, for it introduced Murchison to a collector of fossils among strata underlying the Old Red Sandstone, who had already worked out a sequence of formations and freely supplied Murchison with his knowledge of the ground and collections of fossils.

> "Lewis of Aymestry did more than ever Murchison did in Siluria" (Manuscript marginalia dated June 3, 1897, by R.H. Newill)

Locality 17, Aymestrey Church.

Memorial tablet to Thomas Taylor Lewis M.A. (1801-1858), for fifteen years Curate of Aymestrey; on the south wall of the chancel. Also to his first wife Eliza whom he married in 1827. Eliza died suddenly in the following year, a few days after the birth of their daughter Grace Katherine. Lewis remarried in 1838, Eliza Ferguson of Aymestrey, who erected the memorial.

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Figure 10. Yatton Court.

LEWIS OF AYMESTREY
Sunday morning, May 10th, 1998

Even before he was given the recommendation at Kington to consult the Reverend Thomas Lewis, Curate of Aymestrey, Murchison had been told about the "curious fossils in slatey limestone that could be found there. The best current work on Lewis and Murchison's Silurian System is by John Thackray (1977).

Today we try to recreate the stratigraphical insight that enabled Lewis to show Murchison the succession of strata that later were to be named Silurian. There are two key documents:

1. A cross-section in Murchison's notebook for 1831, on which he wrote "First Section with Lewis of Aymestry" (Figure 11a, top left); and

2. Remarks made by Lewis in an address on January 24, 1854, as retiring President of the Woolhope Field Club, that stated precisely how in July of 1831 he had led Murchison through a continuous geological section from the Lower Ludlow Rock to the Old Red Sandstone (Lewis, 1855).

Locality 1, Murchison's Section of Strata at Aymestrey

The line of section (Figure 11a) runs from NNW to SSE between Garden House quarry (SO 421 658) and the village of Lucton (SO 437 641). Murchison's notes reveal close attention to field observation (Figure 11b). At Garden House quarry he notes a face of "30 to 40 feet" (which still exists) and "Dip S & by E. 45°." Across the "Lug River" in the Aymestry great quarries he writes "capped by thin bedded grauwacke slate & calc. Shale (a);" at "b. Thick bedded blue limestone 4 to 7 feet thick, Pentameri abundant -- lines of fossils on bedding."

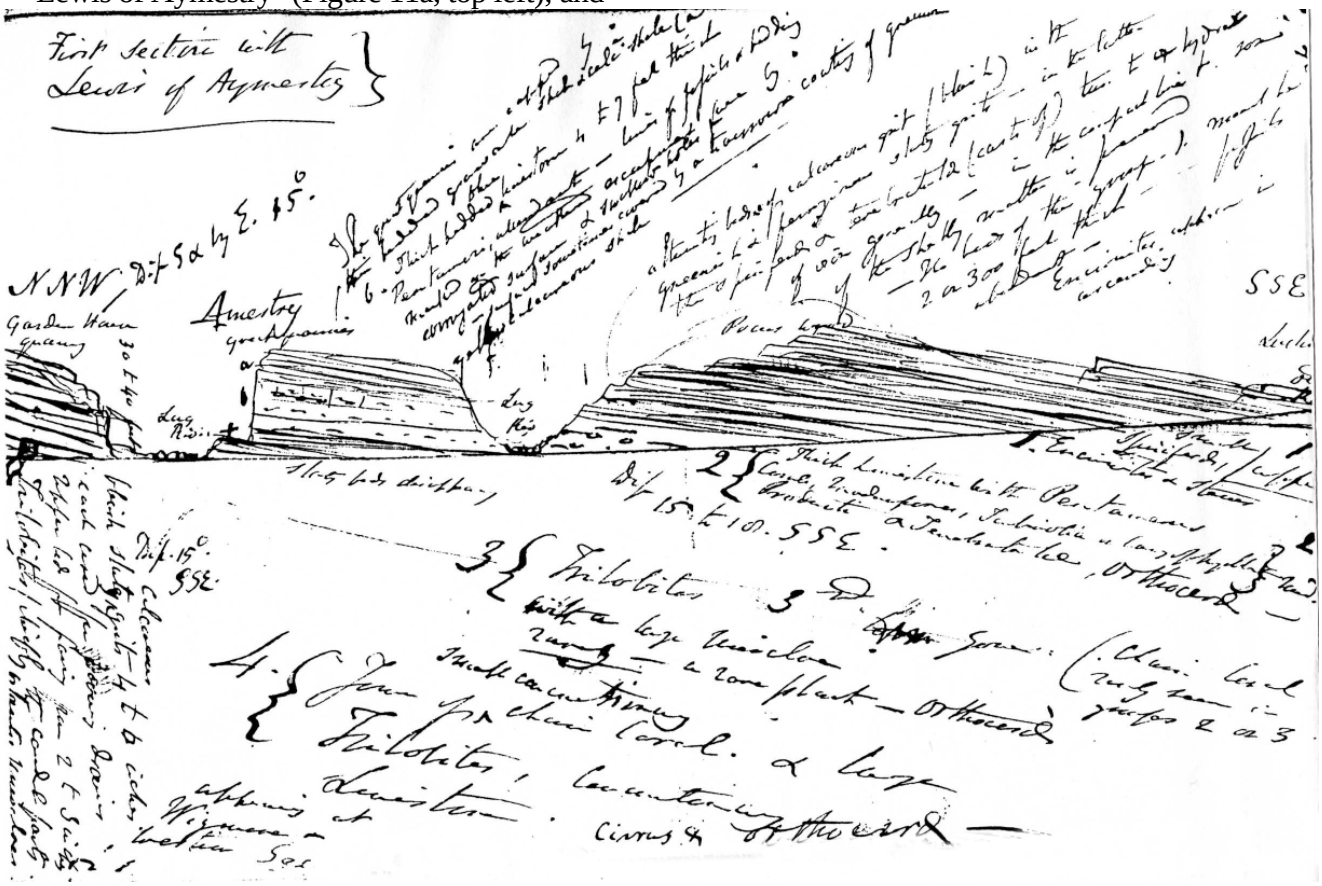

Figure 11a. An extract from the notebook written during Murchison's 1831 visit to Aymestrey showing a section through the quarries. It is inscribed "First Section with Lewis of Aymestry" and runs from Garden House quarry across Pokeshouse Wood to Lucton.

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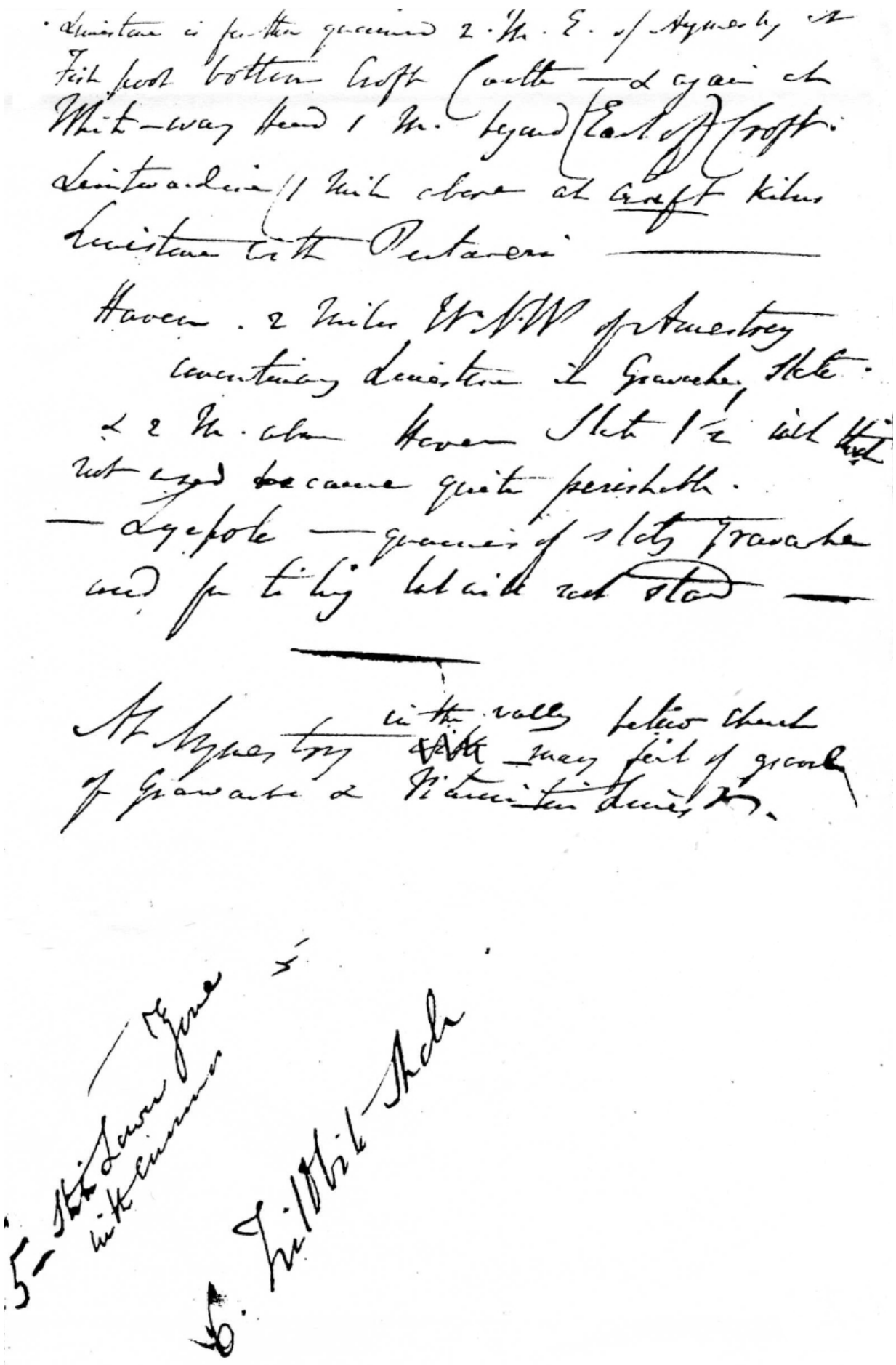

Figure 11b. An extract from the notebook written during Murchison's 1831 visit to Aymestrey. *[see main text for interpretation]*

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The section line recrosses the Lugg and passes through Pokeshouse Wood ("Pocus Wood") on the crest of the hill, and runs down the old road to Lucton, noted as "Old Red." The unit above the Pentameri limestone, Murchison marks as:

> "1 alternating beds of calcareous grit (bluish) with greenish ferruginous slaty grits -- the Spirifers & terebratulas (casts of) turn to ox hydrate of iron generally -- in the compact limest. some of the shelly matter is preserved -- The beds of this group, 1. must be 2 or 300 feet thick -fossils abundant -- "

Murchison then listed five units characterised mainly by their fossil content, beginning with 1, the shales between Pocus Wood and Lucton, named "Grauwacke" by Lewis. Below that: 2 was Thick Limestone with Pentamerus, Lewis's name.

Written under the section as it appears in the notebook, and spilling on to the next page we are among the first thoughts of a systematised stratigraphy of the rocks immediately below the Old Red Sandstone. A list of six groups or zones characterised both by rock type and fossil content is set out. Starting at the top (Figure 11a, extending into Figure 11b) we see:

> "1. Upper Shale Spiriferids, Encrinites & [?]
> 2. Thick limestone with Pentamerus
> Corals, Madrepores [?] Producti & Terebratulae; Orthocerae
> 3. Trilobites with a large Univalve [?]
> 3rd zone (Chain corals rarely seen in groups 2 or 3)
> 4. Zone of small concretionary chain corals & large Trilobites, Concretionary Limestone. Appearing at Wigmore & [?]
> 5. Shale Lower Zone with encrines [?]
> 6. Trilobite Shale"

No rearrangement or special insight is needed to understand this as an 1831 draft or precursor to a future Silurian stratigraphy. Yet one cannot avoid thinking that there is more than one day's fossil collecting here.

For example, the cross-section does not have any strata on it lower than Zone 3, though some of the fossils to be found in Zones 4, 5 and 6 are listed. The fossils for Zones 1, 2 and 3 are placed adjacent to, and on the same slope or dip as the strata to which they refer. But Zone 4 appears at Wigmore, about two miles north of Garden House quarry, along with other lower strata.

T.T. Lewis was a fossil collector long before he met Murchison. One feels that at the end of a day in the field, constructing the "First Section with Lewis of Aymestry", Murchison was shown by Lewis the contents of his cabinet in which the various specimens had been arranged according to the bed in which Lewis found them (Table 2). Murchison began by writing fossil names against the strata he had seen during the day, but continued the list downward as further Zones or groups were demonstrated.

Strata near Aymestrey Underlying the Old Red Sandstone, 1829-39

Lewis, 1829-30 (14)	Murchison, 1831 Field Notebook	Murchison, 1839 Silurian System
Grauwacke	Zone 1	Upper Ludlow
Pentamerus Limestone	Zone 2	Aymestry Limestone
Pendle	Zone 3	Lower Ludlow
Coral or Nodular Limestone	Zone 4	Wenlock Limestone
Lower Fossiliferous Strata	Zone 5	Wenlock Shale
Do.	Zone 6	Do.

Table 2. Murchison's recording of strata (1831; 1839) compared with Lewis (1829-30).

Locality 2, Lucton Lane, the Old Road

While one might surmise and conjecture about Murchison's rapid grasp of waiting opportunities for geological discovery in the mass of undivided Greywacke, documents to prove that he had significant early guidance are scarce. Also, there seems to be a nicely balanced consensus of opinion that Murchison was sparing of thanks to everyone.

Nevertheless, a printed item by T.T. Lewis himself virtually proves that he demonstrated in the field to Murchison the sequence of fossiliferous strata lying under the Old Red Sandstone. In his Presidential address to the Woolhope Naturalists' Field Club, at the end of the 1853-54 session, Lewis remarked on a recently-held field meeting in these words (Lewis, 1855):

"In our descent to Aymestry we took the path of an old road, up which I had the honour of conducting Mr. Murchison (now Sir Roderick), in his first visit to Herefordshire, July, 1831, presenting in itself a continuous section from the Lower Ludlow rock to the Old Red Sandstone. I had at this time very fairly developed the structure of the surrounding country. My own researches in this district commenced with my residence at

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Aymestry, in 1827. I had, unknowingly, discovered the key, and made some progress."

Lewis died in 1858, only three years after ending his Presidency of the Club.

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REFERENCES

Aikin, A. (1810) *Proposals for a mineralogical survey of Shropshire.* (unpublished)

Cobbold, E.S. (1927). Stratigraphy and geological structure of the Cambrian area of Comley, Shropshire. *Quarterly Journal of the Geological Society*, **83** (4), 551-573.

Earp, J.R. & Hains, B.A. (1971). *The Welsh Borderland*. British Regional Geology London, HMSO, xi, 118pp.

[Fitton, W.H.] 1841. The Silurian System. Edinburgh Review, **73**, 1-41.

Hawley, D. (1997). The first true Silurian. *Proceedings of the Geologists' Association*, **108**, 131-140.

Lapworth C. & Watts, W.W. (1894a). The geology of south Shropshire. *Proceedings of the Geologists' Association*, **13** (9), 297-355.

Lapworth, C. & Watts, W.W. (1894b). Excursion to the County of Shropshire, 30 Jul to 4 Aug 1894. *Proceedings of the Geologists' Association*, **13** (10), 381-387.

Lewis, T.T. (1855). Address of the President to the Woolhope Naturalists' Field Club. *Transactions of the Woolhope Naturalists' Field Club*, **1**, 94-104.

Murchison's Field Notebook No. l, 1830-1831, p.43. (M/N57 and M/N58 in the Geological Society of London archive) (unpublished).

Murchison, R.I. (1839). *The Silurian System founded on geological researches in the counties of Salop, Hereford, Radnor, Montgomery, Caermarthen, Brecon, Pembroke, Monmouth, Gloucester, Worcester, and Stafford : with descriptions of the coal-fields and overlying formations*. John Murray, Albermarle Street, London, 768pp.

Murchison, R.I. (1854) *Siluria: a history of the oldest fossiliferous rocks and their foundations, with a brief sketch of the distribution of gold over the Earth*. John Murray, Albermarle Street, London. xvi, 523pp.

Manuscript marginalia dated June 3, 1897, by R.H. Newill of Lydbury North, in the Ludlow Museum copy of: Geikie, Archibald, 1875. Life of Sir Roderick I. Murchison. (unpublished)

Secord, J.A. (1981). Roderick Murchison's geological tour of England and Wales in 1831. (unpublished).

Secord, J.A. (1986). Controversy in Victorian Geology. Princeton, xix, 364p.

Straw, S.H. (1930). The Siluro-Devonian boundary in south-central Wales. *Journal of the Manchester Geologists Association*, **1** (2), 79-102.

Thackray, J.C. (1977). T.T. Lewis and Murchison's Silurian System. *Transactions of the Woolhope Naturalists' Field Club*, **42**, 186-193.

Torrens, H.S. (1983). Arthur Aikin's mineralogical survey of Shropshire ... British Journal for the History of Science, **16**, 111-153.

Torrens, H.S. (2000). Robert Townson (1762-1827): Thoughts on a Polymathic Natural Historian and Traveller Extraordinary, pp. 19-26, *in:* Rózsa, P. (ed.) *Robert Townson's Travels in Hungary*. Kossuth Egyetemi Kiadó, Debrecen, Hungary. 220 pages.

Townson, R. (1799). *A Sketch of the Mineralogy of Shropshire. From: Tracts and Observations in Natural History and Physiology*. White (for the author), London, 158-203.

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